THE LOS ALAMOS NATIONAL LABORATORY SITE-WIDE ENVIRONMENTAL IMPACT STATEMENT PROCESS

The United States Department of Energy (DOE) has a policy (10 Code of Federal Regulations [CFR] 1021.330) of preparing a Site-Wide Environmental Impact Statement (SWEIS) for certain large, multiple-facility sites, such as the Los Alamos National Laboratory (LANL). The purpose of a SWEIS is to provide DOE and its stakeholders with an analysis of the environmental impacts resulting from ongoing and reasonably foreseeable new operations and facilities and reasonable alternatives at the DOE site. The SWEIS analyzes four alternatives for the continued operation of LANL to identify the potential effects that each alternative could have on the human environment.

The SWEIS Advance Notice of Intent, published in the *Federal Register* (FR) on August 10, 1994 (59 FR 40889), identified possible issues and alternatives to be analyzed. Based on public input received during prescoping, DOE published the Notice of Intent to prepare the SWEIS in the *Federal Register* on May 12, 1995 (60 FR 25697). DOE held a series of public meetings during prescoping and scoping to provide opportunities for stakeholders to identify the issues, environmental concerns, and alternatives that should be analyzed in the SWEIS. An Implementation Plan[1] was published in November 1995 to summarize the results of scoping, describe the scope of the SWEIS based on the scoping process, and present an outline for the draft SWEIS. The Implementation Plan also included a discussion of the issues reflected in public comments during scoping.

In addition to the required meetings and documents described above, the SWEIS process has included a number of other activities intended to enhance public participation in this effort. These activities have included:

- Workshops to develop the Greener Alternative described and analyzed in the SWEIS.
- Meetings with and briefings to representatives of federal, state, tribal, and local governments during prescoping, scoping, and preparation of the draft SWEIS.
- Preparation and submission to the Los Alamos Community Outreach Center of information requested by members of the public related to LANL operations and proposed projects.
- Numerous Open Forum public meetings in the communities around LANL to discuss LANL activities, the status of the SWEIS, and other issues raised by the public.

The draft SWEIS was distributed to interested stakeholders for comment. The comment period extended from May 15, 1998, to July 15, 1998. Public hearings on the draft SWEIS were announced in the *Federal Register*, as well as community newspapers and radio broadcasts. Public hearings were held in Los Alamos, Santa Fe, and Española, New Mexico, on June 9, 1998, June 10, 1998, and June 24, 1998, respectively.

Oral and written comments were accepted during the 60-day comment period for the draft SWEIS. All comments received, whether orally or in writing, were considered in preparation of the final SWEIS. The final SWEIS includes a new volume IV with responses to individual comments and a discussion of general major issues. DOE will prepare a Record of Decision no sooner than 30 days after the final SWEIS Notice of Availability is published in the *Federal Register*. The Record of Decision will describe the rationale used for DOE's selection of an alternative or portions of the alternatives. Following the issuance of the Record of Decision, a Mitigation Action Plan may also be issued to describe any mitigation measures that DOE commits to in concert with its decision.

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1. DOE *National Environmental Policy Act* regulations (10 CFR 1021) previously required that an implementation plan be prepared; a regulation change (61 FR 64604) deleted this requirement. An implementation plan was prepared for this SWEIS.

COVER SHEET

Responsible Agency: U.S. Department of Energy (DOE)

Cooperating Agency: Incorporated County of Los Alamos

Title: Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (DOE/EIS-0238)

Contact: For further information concerning this Site-Wide Environmental Impact Statement (SWEIS), contact:

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Abstract: DOE proposes to continue operating the Los Alamos National Laboratory (LANL) located in Los Alamos County, in north-central New Mexico. DOE has identified and assessed four alternatives for the operation of LANL: (1) No Action, (2) Expanded Operations, (3) Reduced Operations, and (4) Greener. Expanded Operations is DOE's Preferred Alternative, with the exception that DOE would only implement pit manufacturing at a level of 20 pits per year. In the No Action Alternative, DOE would continue the historical mission support activities LANL has conducted at planned operational levels. In the Expanded Operations Alternative, DOE would operate LANL at the highest levels of activity currently foreseeable, including full implementation of the mission assignments from recent programmatic documents. Under the Reduced Operations Alternative, DOE would operate LANL at the minimum levels of activity necessary to maintain the capabilities to support the DOE mission in the near term. Under the Greener Alternative, DOE would operate LANL to maximize operations in support of nonproliferation, basic science, materials science, and other nonweapons areas, while minimizing weapons activities. Under all of the alternatives, the affected environment is primarily within 50 miles (80 kilometers) of LANL. Analyses indicate little difference in the environmental impacts among alternatives. The primary discriminators are: collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, and electrical power demand.

Public Comment and DOE Decision: The draft SWEIS was released to the public for review and comment on May 15, 1998. The comment period extended until July 15, 1998, although late comments were accepted to the extent practicable. All comments received were considered in preparation of the final SWEIS[1]. DOE will utilize the analysis in this final SWEIS and prepare a Record of Decision on the level of continued operation of LANL. This decision will be no sooner than 30 days after the Notice of Availability of the final SWEIS is published in the *Federal Register*.

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1. Changes made to this SWEIS since publication of the draft SWEIS are marked with a vertical bar to the right or left of the text.

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ABBREVIATIONS AND ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ACIS	Automated Chemical Inventory System
ACL	administrative control level
ACM	asbestos-containing material
ADTT	accelerator-driven transmutation technology
AEA	*Atomic Energy Act*
AEC	U.S. Atomic Energy Commission
AIP	Agreement in Principle
AIRNET	ambient air monitoring program
ALARA	as low as reasonably achievable
ALOHA™	Areal Locations of Hazardous Atmospheres (computer model)
ANSI	American National Standards Institute
AO	Administrative Order
APT	accelerator production of tritium
BAT	best available technology
BIA	Bureau of Indian Affairs
BIO	Basis for Interim Operation
BLM	Bureau of Land Management
BMP	best management practice
BNM	Bandelier National Monument
BOD	biochemical/biological oxygen demand
BTC	Beryllium Technology Center
°C	degrees Celsius

CA	composite analysis
CAA	*Clean Air Act*
CAD	computer-aided design
CAM	continuous air monitor
CAMP	Capital Assets Management Process
CAP–88	Clean Air Act Assessment Package for 1988
CBD	chronic beryllium disease
CCNS	Concerned Citizens for Nuclear Safety
CDE	committed dose equivalent
CDP	Census Designated Place
CDR	Conceptual Design Report
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	Code of Federal Regulations
CH	contact-handled (waste)
CH TRU	contact-handled transuranic (waste)
Ci	curie
cm	centimeter
CMIP	Capability Maintenance and Improvement Project
CMR	Chemistry and Metallurgy Research
COD	chemical oxygen demand
CRMT	Cultural Resources Management Team
CT	Conveyance and Transfer (EIS)
CTBT	Comprehensive Test Ban Treaty

CVD	chemical vapor deposition
CVI	chemical vapor infiltration
CY	calendar year
D&D	decontamination and decommissioning
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
dB	decibel
dBA	decibels A-weighted frequency scale
DCG	derived concentration guide
DEGADIS	dense gas dispersion (computer model)
DNFSB	Defense Nuclear Facilities Safety Board
DEL	Dynamic Experiment Laboratory
DNA	deoxyribonucleic acid
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOP	detailed operating procedure
DOT	U.S. Department of Transportation
DU	depleted uranium
EA	environmental assessment
EDE	effective dose equivalent
EIS	environmental impact statement
EM	DOE Office of Environmental Management
EM&R	emergency management and response
EPA	U.S. Environmental Protection Agency
EPCRA	*Emergency Planning and Community-Right-to-Know Act*

ER	environmental restoration
ERPG	Emergency Response Planning Guideline
ES&H	Environmental, Safety and Health (division of LANL)
°F	degrees Fahrenheit
FAA	Federal Aviation Administration
FIFRA	*Federal Insecticide, Fungicide, and Rodenticide Act*
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FS MEI	facility-specific maximally exposed individual
ft	feet
FTE	full-time equivalent (employees)
FU	field unit
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
g	gram
GV	guideline value
GWPMPP	Groundwater Protection Management Program Plan
ha	hectares
HA	hazard analysis
HAP	hazardous air pollutant
HE	high explosives
HEFS	High Explosives Firing Site
HELWTF	High Explosives Liquid Wastewater Treatment Facility
HEPA	high-efficiency particulate air (filter)
HEPP	High Explosives Pulsed Power

HEU	highly enriched uranium
HEWTF	High Explosives Wastewater Treatment Facility
HI	hazard index
HLW	high-level waste
HRL	Health Research Laboratory
HSWA	*Hazardous and Solid Waste Amendments of 1984*
HT	tritium gas
HTO	tritiated water
HVAC	heating, ventilation, and air conditioning
HW	hazardous waste
IATA	International Air Traffic Association
ICF	inertial confinement fusion
ICRP	International Commission on Radiological Protection
IH	industrial hygiene
in.	inch
IPF	Isotope Production Facility
IR	infrared
IRIS	Integrated Risk Information System
ISC–3	Industrial Source Complex (Model) Version 3
ISCST3	Industrial Source Complex Short Term (Model)
JCI	Johnson Controls, Inc.
km	kilometer
LAC	Los Alamos County
LACEF	Los Alamos Critical Experiments Facility
LADF	Los Alamos Detonator Facility

LAMPF	Los Alamos Meson Physics Facility (former name for LANSCE)
LAMPRE	Los Alamos Molten Plutonium Reactor Experiment
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
lb	pound
LCF	latent cancer fatality
L/CHEM	low chemical hazard
LCO	limiting condition for operation
LDR	land disposal restrictions
LEDA	low-energy demonstration accelerator
L/ENS	low energetic source hazard
LIDAR	light detection and ranging
LIFT	Los Alamos International Facility for Transmutation
linac	linear accelerator
LLMW	low-level radioactive mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
LPSS	Long-Pulse Spallation Source
L/RAD	low radioactive hazard
LSA	low specific activity
m	meter
MAA	Material Access Area
MACCS	MELCOR Accident Consequences Code System
MAR	material-at-risk
M/CHEM	moderate chemical hazard

MCL	maximum contaminant level
MDA	Material Disposal Area
MEI	maximally exposed individual
MeV	million electron volts
MGD	million gallons per day
MGY	million gallons per year
mi	mile
MLY	million liters per year
MOU	memorandum of understanding
MOX	mixed oxide (fuel)
M/RAD	moderate radioactive hazard
MSL	Materials Science Laboratory
MW	megawatt
NA	not applicable (or not available)
NAAQS	National Ambient Air Quality Standards
NAGPRA	*Native American Graves Protection and Repatriation Act*
NCRP	National Council on Radiation Protection
NEPA	*National Environmental Policy Act of 1969*, as amended
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	U.S. National Institute for Occupational Safety and Health
NM	New Mexico (State Road)
NMAC	New Mexico Administrative Code
NMDGF	New Mexico Department of Game and Fish

NMDL	New Mexico Department of Labor
NMED	New Mexico Environment Department
NMEIB	New Mexico Environmental Improvement Board
NMSWA	*New Mexico Solid Waste Act*
NMSF	Nuclear Materials Storage Facility
NMWQCC	New Mexico Water Quality Control Commission
NOA	Notice of Availability
NOI	Notice of Intent
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NTTL	neutron tube target loading
OEL	occupational exposure limit
OLM	Ozone Limiting Method
ORNL	Oak Ridge National Laboratory
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
OU	operable unit
OWR	Omega West Reactor
PA	performance assessment
PAL	plant-wide applicability limit
PCB	polychlorinated biphenyl

PDD	Presidential Decision Directive
PEIS	programmatic environmental impact statement
PF	Plutonium Facility
pH	a measure of acidity and alkalinity
PHERMEX	Pulsed High-Energy Radiation Machine Emitting X-Rays (facility)
PL	public law
PM	particulate matter
PM_{10}	particulate matter equal to or less than 10 micrometers aerodynamic diameter
PNM	Public Service Company of New Mexico
PPE	personal protective equipment
ppb	parts per billion
ppm	parts per million
PRA	probabilistic risk assessment
PrHA	process hazard analysis
PRS	potential release site
PSD	prevention of significant deterioration
psi	pounds per square inch
PSR	proton storage ring
PSSC	project-specific siting and construction
PTLA	Protection Technology of Los Alamos
rad	radiation absorbed dose
RAMROD	Radioactive Materials Research, Operations, and Demonstration (facility)
RANT	Radioactive Assay and Nondestructive Test (facility)
RCRA	*Resource Conservation and Recovery Act*
rem	roentgen equivalent man

RF	radiofrequency (also, respirable fraction)
RfC	inhalation reference concentrations
RFETS	Rocky Flats Environmental Technology Site
RFI	RCRA Facility Investigation
RH	remote-handled (waste)
RH TRU	remote-handled transuranic (waste)
RLW	radioactive liquid waste
RLWTF	Radioactive Liquid Waste Treatment Facility
ROD	Record of Decision
ROI	region of influence
RSRL	regional statistical reference level
RTG	radioisotopic thermoelectric generator
SA	safety assessment
SAL	screening action level
SAR	safety analysis report
SARA	*Superfund Amendment and Reauthorization Act*
SCC	Strategic Computing Complex
SDWA	*Safe Drinking Water Act*
SEER	Surveillance, Epidemiology, and End Results
SEIS-II	second supplemental environmental impact statement
SFNF	Santa Fe National Forest
SHEBA	Solution High-Energy Burst Assembly
SHPO	State Historic Preservation Office(r)
SIP	State Implementation Plan
SLEV	screening level emission value

SMAC	shipment mobility/accountability collection
SNM	special nuclear material
SNS	spallation neutron source
SPD	surplus plutonium disposition
SPSS	short-pulse spallation source
SSM	Stockpile Stewardship and Management
SST	safe secure transport
START	Strategic Arms Reduction Talks (or Treaty)
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
SWDA	*Solid Waste Disposal Act*
SWEIS	site-wide environmental impact statement
SWMU	solid waste management unit
SWPP	Stormwater Pollution Prevention Plan
SWSC	sanitary wastewater systems consolidation
T&E	threatened and endangered (species)
TA	Technical Area
TCP	traditional cultural property
TEDE	total effective dose equivalent
TFF	Target Fabrication Facility
TI	transport index
TLD	thermoluminescent dosimeter
TLV	threshold limit value
TRU	transuranic (waste)
TSCA	*Toxic Substances Control Act*

TSD	treatment, storage, and disposal
TSFF	Tritium Science and Fabrication Facility
TSR	technical safety requirement
TSTA	Tritium System Test Assembly
TW	test well
TWA	time-weighted average
TWISP	Transuranic Waste Inspectable Storage Project
UC	University of California
UCL	upper confidence limit
UNM	University of New Mexico
U.S.	United States
U.S.C.	United States Code
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UST	underground storage tank
UV	ultraviolet
VOC	volatile organic compound
WAC	waste acceptance criteria
WCRR	Waste Characterization, Reduction, and Repackaging (facility)
WCTF	Weapon Component Testing Facility
WETF	Weapons Engineering Tritium Facility
WIPP	Waste Isolation Pilot Plant
WM	waste management
WNR	Weapons Neutron Research
WR	war reserve
WWTF	Waste Water Treatment Facility

VOLUME I
MEASUREMENTS AND CONVERSIONS

The following information is provided to assist the reader in understanding certain concepts in this SWEIS. Definitions of technical terms can be found in volume I, chapter 10, Glossary.

SCIENTIFIC NOTATION

Scientific notation is used in this report to express very large or very small numbers. For example, the number 1 billion could be written as 1,000,000,000 or, using scientific notation, as 1×10^9. Translating from scientific notation to a more traditional number requires moving the decimal point either right (for a positive power of 10) or left (for a negative power of 10). If the value given is 2.0×10^3, move the decimal point three places (insert zeros if no numbers are given) to the right of its current location. The result would be 2,000. If the value given is 2.0×10^{-5}, move the decimal point five places to the left of its present location. The result would be 0.00002. An alternative way of expressing numbers, used primarily in the appendixes of this SWEIS, is exponential notation, which is very similar in use to scientific notation. For example, using the scientific notation for 1×10^9, in exponential notation the 10^9 (10 to the power of 9) would be replaced by E+09. (For positive powers, sometimes the "+" sign is omitted, and so the example here could be expressed as E09.) If the value is given as 2.0×10^{-5} in scientific notation, then the equivalent exponential notation is 2.0E-05.

UNITS OF MEASUREMENT

The primary units of measurement used in this report are English units with metric equivalents enclosed in parentheses.

Many metric measurements presented include prefixes that denote a multiplication factor that is applied to the base standard (e.g., 1 kilometer = 1,000 meters). The following list presents these metric prefixes:

giga	1,000,000,000 (10^9; E+09; one billion)
mega	1,000,000 (10^6; E+06; one million)
kilo	1,000 (10^3; E+03; one thousand)
hecto	100 (10^2; E+02; one hundred)
deka	10 (10^1; E+01; ten)
unit	1 (10^0; E+00; one)
deci	0.1 (10^{-1}; E-01; one tenth)
centi	0.01 (10^{-2}; E-02; one hundredth)
milli	0.001 (10^{-3}; E-03; one thousandth)

micro	0.000001 (10^{-6}; E-06; one millionth)
nano	0.000000001 (10^{-9}; E-09; one billionth)
pico	0.000000000001 (10^{-12}; E-12; one trillionth)

DOE Order 5900.2A, *Use of the Metric System of Measurement*, prescribes the use of this system in DOE documents. Table MC–1 lists the mathematical values or formulas needed for conversion between English and metric units. Table MC–2 summarizes and defines the terms for units of measure and corresponding symbols found throughout this report.

RADIOACTIVITY UNIT

Part of this report deals with levels of radioactivity that might be found in various environmental media. Radioactivity is a property; the amount of a radioactive material is usually expressed as "activity" in curies (Ci) (Table MC–3). The curie is the basic unit used to describe the amount of substance present, and concentrations are generally expressed in terms of curies per unit of mass or volume. One curie is equivalent to 37 billion disintegrations per second or is a quantity of any radionuclide that decays at the rate of 37 billion disintegrations per second. Disintegrations generally include emissions of alpha or beta particles, gamma radiation, or combinations of these.

RADIATION DOSE UNITS

The amount of ionizing radiation energy received by a living organism is expressed in terms of radiation dose. Radiation dose in this report is usually expressed in terms of effective dose equivalent and reported numerically in units of rem (Table MC–4). Rem is a term that relates ionizing radiation and biological effect or risk. A dose of 1 millirem (0.001 rem) has a biological effect similar to the dose received from about a 1-day exposure to natural background radiation. A list of the radionuclides discussed in this document and their half-lives is included in Table MC–5.

CHEMICAL ELEMENTS

A list of selected chemical elements, chemical constituents, and their nomenclature is presented in Table MC–6.

TABLE MC–1.—*Conversion Table*

MULTIPLY	BY	TO OBTAIN	MULTIPLY	BY	TO OBTAIN
ac	0.405	ha	ha	2.47	ac
°F	(°F -32) x 5/9	°C	°C	(°C x 9/5) + 32	°F
ft	0.305	m	m	3.28	ft
ft^2	0.0929	m^2	m^2	10.76	ft^2
ft^3	0.0283	m^3	m^3	35.3	ft^3
gal.	3.785	l	l	0.264	gal.
in.	2.54	cm	cm	0.394	in.
lb	0.454	kg	kg	2.205	lb
mCi/km^2	1.0	nCi/m^2	nCi/m^2	1.0	mCi/km^2
mi	1.61	km	km	0.621	mi
mi^2	2.59	km^2	km^2	0.386	mi^2
mi/h	0.447	m/s	m/s	2.237	mi/h
nCi	0.001	pCi	pCi	1,000	nCi
oz	28.35	g	g	0.0353	oz
pCi/l	10^{-9}	µCi/ml	µCi/ml	10^{9}	pCi/l
pCi/m^3	10^{-12}	Ci/m^3	Ci/m^3	10^{12}	pCi/m^3
pCi/m^3	10^{-15}	mCi/cm^3	mCi/cm^3	10^{15}	pCi/m^3
ppb	0.001	ppm	ppm	1,000	ppb
ton	0.907	metric ton	metric ton	1.102	ton

TABLE MC–2.—*Names and Symbols for Units of Measure*

LENGTH	
SYMBOL	**NAME**
cm	centimeter (1×10^{-2} m)
ft	foot
in.	inch
km	kilometer (1×10^{3} m)
m	meter
mi	mile
mm	millimeter (1×10^{-3} m)
µm	micrometer (1×10^{-6} m)
VOLUME	
SYMBOL	**NAME**
cm^3	cubic centimeter
ft^3	cubic foot
gal.	gallon
$in.^3$	cubic inch
l	liter
m^3	cubic meter
ml	milliliter (1×10^{-3} l)
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard
RATE	
SYMBOL	**NAME**
Ci/yr	curies per year
cm^3/s	cubic meters per second
ft^3/s	cubic feet per second
ft^3/min	cubic feet per minute
gpm	gallons per minute
kg/yr	kilograms per year
km/h	kilometers per hour
mg/l	milligrams per liter
MGY	million gallons per year
MLY	million liters per year
m^3/yr	cubic meters per year
mi/h or mph	miles per hour
µCi/l	microcuries per liter
pCi/l	picocuries per liter

TABLE MC–2.—*Names and Symbols for Units of Measure*-Continued

NUMERICAL RELATIONSHIPS	
SYMBOL	**MEANING**
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to
2σ	two standard deviations
TIME	
SYMBOL	**NAME**
d	day
h	hour
min	minute
nsec	nanosecond
s	second
yr	year
AREA	
SYMBOL	**NAME**
ac	acre (640 per mi^2)
cm^2	square centimeter
ft^2	square foot
ha	hectare (1×10^{4} m^2)
$in.^2$	square inch
km^2	square kilometer
mi^2	square mile
MASS	
SYMBOL	**NAME**
g	gram
kg	kilogram (1×10^{3} g)
mg	milligram (1×10^{-3} g)
µg	microgram (1×10^{-6} g)
ng	nanogram (1×10^{-9} g)
lb	pound
ton	metric ton (1×10^{6} g)
oz	ounce

TABLE MC–2.—*Names and Symbols for Units of Measure*-Continued

TEMPERATURE	
SYMBOL	**NAME**
°C	degrees Celsius
°F	degrees Fahrenheit
°K	degrees Kelvin
SOUND/NOISE	
SYMBOL	**NAME**
dB	decibel
dBA	A-weighted decibel

TABLE MC–3.—*Names and Symbols for Units of Radioactivity*

RADIOACTIVITY	
SYMBOL	**NAME**
Ci	curie
cpm	counts per minute
mCi	millicurie (1 x 10^{-3} Ci)
µCi	microcurie (1 x 10^{-6} Ci)
nCi	nanocurie (1 x 10^{-9} Ci)
pCi	picocurie (1 x 10^{-12} Ci)

TABLE MC–4.—*Names and Symbols for Units of Radiation Dose*

RADIATION DOSE	
SYMBOL	**NAME**
mrad	millirad (1 x 10^{-3} rad)
mrem	millirem (1 x 10^{-3} rem)
R	roentgen
mR	milliroentgen (1 x 10^{-3} R)
µR	microroentgen (1 x 10^{-6} R)

TABLE MC–5.—*Radionuclide Nomenclature*

SYMBOL	RADIONUCLIDE	HALF-LIFE	SYMBOL	RADIONUCLIDE	HALF-LIFE
Am-241	americium-241	432 yr	Pu-241	plutonium-241	14.4 yr
H-3	tritium	12.26 yr	Pu-242	plutonium-242	3.8×10^5 yr
Mo-99	molybdenum-99	66 hr	Pu-244	plutonium-244	8.2×10^7 yr
Pa-234	protactinium-234	6.7 hr	Th-231	thorium-231	25.5 hr
Pa-234m	protactinium-234m	1.17 min	Th-234	thorium-234	24.1 d
Pu-236	plutonium-236	2.9yr	U-234	uranium-234	2.4×10^5 yr
Pu-238	plutonium-238	87.7 yr	U-235	uranium-234	7×10^8 yr
Pu-239	plutonium-239	2.4×10^4 yr	U-238	uranium-238	4.5×10^9 yr
Pu-240	plutonium-240	6.5×10^3 yr			

TABLE MC–6.—*Elemental and Chemical Constituent Nomenclature*

SYMBOL	CONSTITUENT	SYMBOL	CONSTITUENT
Ag	silver	Pa	protactinium
Al	aluminum	Pb	lead
Ar	argon	Pu	plutonium
B	boron	SF_6	sulfur hexafluoride
Be	beryllium	Si	silicon
CO	carbon monoxide	SO_2	sulfur dioxide
CO_2	carbon dioxide	Ta	tantalum
Cu	copper	Th	thorium
F	fluorine	Ti	titanium
Fe	iron	U	uranium
Kr	krypton	V	vanadium
N	nitrogen	W	tungsten
Ni	nickel	Xe	xenon
NO_2^-	nitrite ion	Zn	zinc
NO_3^-	nitrate ion		

ABOUT THE *NATIONAL ENVIRONMENTAL POLICY ACT*

The *National Environmental Policy Act* (NEPA) (42 United States Code [U.S.C.] §4321 *et seq.*) was enacted to ensure that federal decision makers consider the effects of proposed actions on the human environment and to lay their decisionmaking process open for public scrutiny. NEPA also created the President's Council on Environmental Quality (CEQ). The U.S. Department of Energy's (DOE's) NEPA regulations (10 Code of Federal Regulations [CFR] 1021) augment the CEQ regulations (40 CFR 1500 through 1508).

Under NEPA, an environmental impact statement (EIS) documents a federal agency's analysis of the environmental consequences that might be caused by major federal actions, defined as those proposed actions that may result in a significant impact to the environment. An EIS also:

- Explains the purpose and need for the agency to take action.
- Describes the proposed action and the reasonable alternative courses of action that the agency could take to meet the need.
- Describes what would happen if the proposed action were not implemented—the "No Action" (or status quo) Alternative.
- Describes what aspects of the human environment would be affected if the proposed action or any alternative were implemented.
- Analyzes the changes, or impacts, to the environment that would be expected to take place if the proposed action or an alternative were implemented, compared to the expected condition of the environment if no action were taken.

The DOE EIS process follows these steps:

- The Notice of Intent, published in the *Federal Register*, identifies potential EIS issues and alternatives and asks for public comment on the scope of the analysis.
- The public scoping period, with at least one public meeting, during which public comments on the scope of the document are collected and considered.
- The issuance of a draft EIS for public review and comment (for a minimum of 45 days), with at least one public hearing.
- The preparation and issuance of the final EIS, which incorporates the results of the public comment period on the draft EIS.
- Preparation and issuance of a Record of Decision, which states:
  - — The decision.
  - — The alternatives that were considered in the EIS and the environmentally preferable alternative.
  - — All decision factors, such as cost and technical considerations, that were considered by the agency along with environmental consequences.
  - — Mitigation measures designed to reduce adverse environmental impacts.
- Preparation of a Mitigation Action Plan, as appropriate, which explains how the mitigation measures will be implemented and monitored.

CHAPTER 1.0
INTRODUCTION AND PURPOSE AND NEED FOR AGENCY ACTION

This chapter provides an introduction to the Los Alamos National Laboratory's role in supporting the U.S. Department of Energy's missions, a statement of the purpose and need for DOE's action, and an overview of the alternatives analyzed in this Site-Wide Environmental Impact Statement. In addition, this chapter explains DOE decisions that this SWEIS is intended to support and the relationship of this document to other environmental documentation prepared by DOE. At the conclusion of the chapter is an introduction to the objectives of the SWEIS and the approaches used in its preparation, along with a brief summary of the remaining chapters of the document.

The Los Alamos National Laboratory (LANL) is one of several national laboratories that support the U.S. Department of Energy's (DOE's) responsibilities for national security, energy resources, environmental quality, and science. LANL occupies approximately 43 square miles (111 square kilometers) of land owned by the U.S. Government and under the administrative control of DOE; it is located in north-central New Mexico, 60 miles (97 kilometers) north-northeast of Albuquerque and 25 miles (40 kilometers) northwest of Santa Fe (see Figure 1–1). An in-depth description of LANL's facilities and capabilities is contained in chapter 2 of this document.

DOE has prepared this Site-Wide Environmental Impact Statement (SWEIS) in accordance with the *National Environmental Policy Act* (NEPA) (42 United States Code [U.S.C.] §4321) to examine the environmental impacts associated with four alternatives for the continued operation of LANL. (Section 1.3 and chapter 3 provide additional detail regarding the alternatives analyzed.) In this SWEIS, DOE describes consequences (both on the site and off the site) of ongoing LANL operations, and compares the potential consequences of alternative levels of future operations.

1.1 LANL SUPPORT FOR DOE MISSIONS

Based on responsibilities described in the *Atomic Energy Act of 1954* (42 U.S.C. §2011) and the *Energy Reorganization Act of 1974* (42 U.S.C. §5801), DOE's principal missions are:

- *National Security*—This DOE mission includes the safety and reliability of the nuclear weapons in the stockpile, maintenance of the nuclear weapons stockpile in accordance with executive directives, stemming the international spread of nuclear weapons materials and technologies, and production of nuclear propulsion plants for the U.S. Navy.
- *Energy Resources*—This DOE mission includes research and development for energy efficiency, renewable energy, fossil energy, and nuclear energy.
- *Environmental Quality*—This DOE mission includes treatment, storage, and disposal of DOE wastes; cleanup of nuclear weapons sites; pollution prevention; storage and disposal of civilian radioactive waste; and development of technologies to reduce risks and reduce cleanup costs for DOE activities.
- *Science*—This DOE mission includes fundamental research in physics, materials

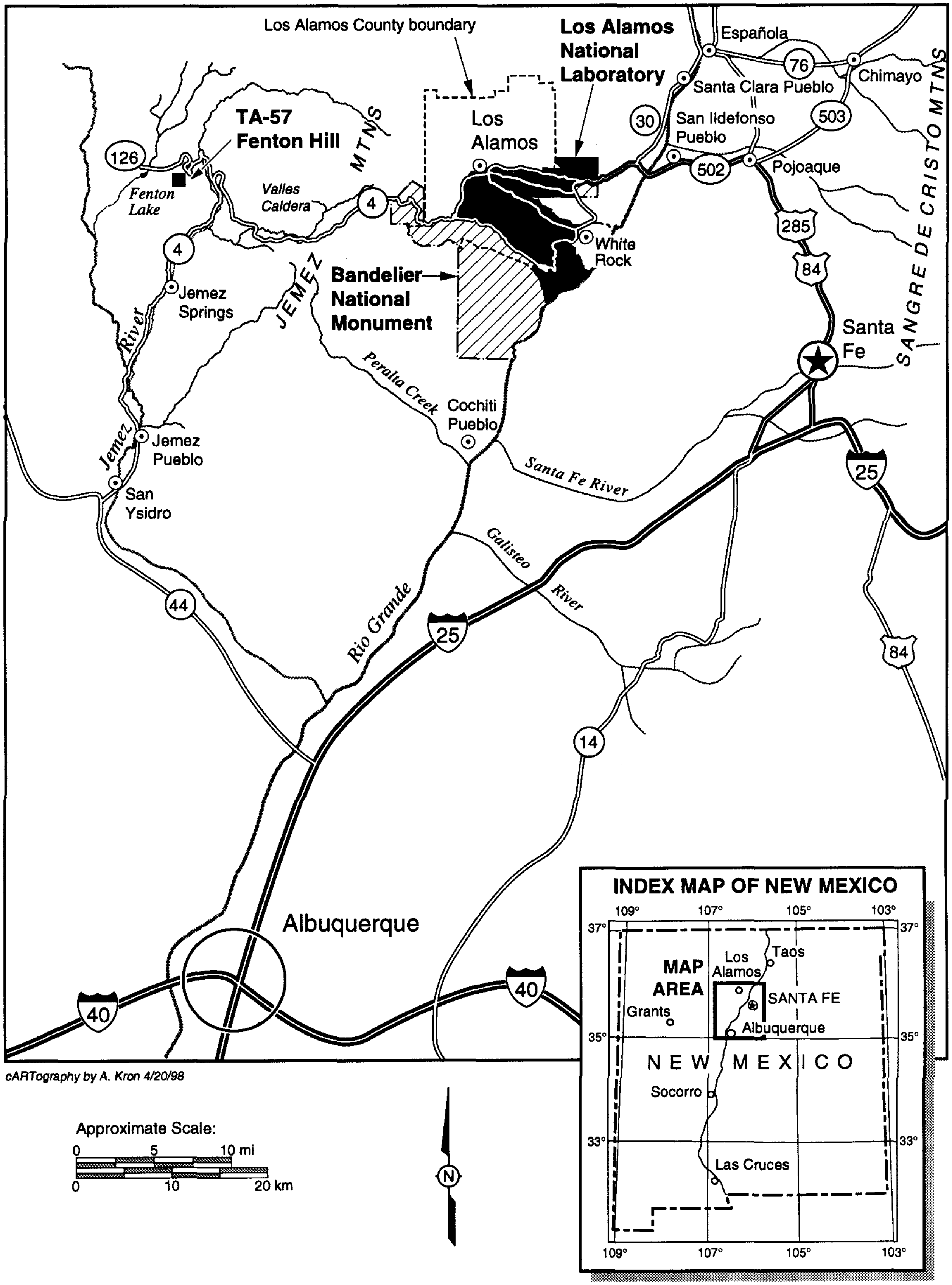

FIGURE 1–1.—*Location of the Los Alamos National Laboratory.*

science, chemistry, nuclear medicine, basic energy sciences, computational sciences, environmental sciences, and biological sciences. Work related to this mission often contributes to the other three DOE missions.

LANL provides support to each of these departmental missions, with a special focus on national security[1]. DOE assigns mission elements to LANL based on the facilities and expertise of the staff located there. Such assignments are made within the context of national security needs as expressed, for example, in Presidential Decision Directives; the *National Defense Authorization Act for Fiscal Year 1994* (Public Law [PL] 103-160) and other congressional actions; the U.S. Department of Defense (DoD) Nuclear Posture Review; treaties in force, such as the Nuclear Nonproliferation Treaty and the Strategic Arms Reduction Treaty (START) I, and treaties signed but not yet entered into force, such as the START II and the Comprehensive Test Ban Treaty (CTBT).

The existing facilities and areas of expertise at LANL have evolved since its inception in the early 1940's. In particular, LANL has developed facilities and expertise to perform:

- Theoretical research, including analysis, mathematical modeling, and high-performance computing
- Experimental science and engineering—ranging from bench-scale to multi-site, multi-technology facilities (including accelerators and radiographic facilities)
- Advanced and nuclear materials research, development, and applications, including weapons *components* testing, fabrication,

SWEIS Terminology

Mission. *In this SWEIS, "missions" refer to the major responsibilities assigned to DOE (described in this section). DOE accomplishes its major responsibilities by assigning groups or types of activities (referred to in this SWEIS as mission elements) to its system of national laboratories, production facilities, and other sites.*

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

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

Projects. *This is used to describe activities with a clear beginning and end that are undertaken to meet a specific goal or need. Projects can vary in scale from very small (such as a project to undertake one experiment or a series of small experiments) to major (e.g., a project to construct and start up a new nuclear facility). Projects are usually relatively short-term efforts, and they can cross multiple programs and missions, although they are usually "sponsored" by a primary Program Office. In this SWEIS, this term is usually used more narrowly to describe construction (including facility modification) activities (e.g., a project to build a new office building or a project to establish and demonstrate a new capability). Construction projects considered reasonably foreseeable at LANL over the next 10 years are discussed and analyzed in this SWEIS (section 1.6.3)*

1. While LANL supports each of these four missions, LANL does not undertake work in all elements of the missions described. For example, LANL supports DOE's national security mission but LANL does not undertake production of nuclear propulsion plants for the U.S. Navy.

stockpile assurance, replacement, surveillance, and maintenance (including theoretical and experimental activities)

These capabilities allow LANL to conduct research and development activities such as high explosives processing, chemical research, nuclear physics research, materials science research, systems analysis and engineering, human genome "mapping," biotechnology applications, and remote sensing technologies applied to resource exploration and environmental surveillance.

Below is a description of LANL's assignments to support DOE's missions (with a focus on recent developments in these mission areas) and a description of how LANL fits within the DOE national laboratory system. In addition, the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (SSM PEIS) (DOE 1996a) lists the major mission elements at LANL, including the primary DOE program offices that sponsor efforts under each of the mission elements listed (Table 3.2.6–1 of the SSM PEIS).

1.1.1 National Security Assignments to LANL

The following sections highlight LANL's principal assignments under the national security mission, including: stockpile stewardship and management[2], accelerator production of tritium, stabilization of commercial nuclear materials, nonproliferation, and other national security assignments.

1.1.1.1 *Stockpile Stewardship Assignments*

DOE's nuclear weapons research, development, and testing has evolved into a program referred to as "stockpile stewardship." Under this program, LANL is responsible (along with Lawrence Livermore National Laboratory and Sandia National Laboratories) for ensuring the safety and reliability of weapons systems in the stockpile for the foreseeable future, in the absence of underground testing. LANL has additional specific responsibilities for weapons of LANL design. Stockpile stewardship remains LANL's central responsibility, and this is the focus of much of the research and development throughout LANL.

DOE examined the environmental impacts of implementing this program at LANL and other DOE sites in the SSM PEIS (DOE 1996a). In the SSM PEIS, DOE identified a need for certain nuclear weapons experimental capabilities in addition to those that currently exist at DOE sites. In its Record of Decision (ROD) for the SSM PEIS (61 *Federal Register* [FR] 68014), DOE stated its intention to construct and operate *Atlas*, a research pulse-power facility at LANL, to assist in fulfilling this need. In addition, DOE decided that this facility will be installed in an existing building at LANL.

1.1.1.2 *Stockpile Management Assignments*

In addition to its responsibilities for stockpile stewardship, LANL also has been assigned responsibilities for stockpile management, which address DOE's production and maintenance of nuclear weapons, including component production and weapon disassembly, as well as stockpile surveillance and process development. Stockpile stewardship and stockpile management are parts of an integrated DOE program. LANL's nuclear weapons production capabilities were

[2] DOE has recently adopted the name "stockpile stewardship" to encompass all activities within the program recently referred to as "stockpile stewardship and management." However, stockpile stewardship and management is used in this SWEIS.

National Security Context for LANL Nuclear Weapons-Related Mission Assignments

LANL performs activities in support of DOE's national security mission, including assessment and certification of nuclear weapon safety and reliability, weapons-related research and development, some nonnuclear component production, pit fabrication, and surveillance of plutonium pits. DOE is obligated to conduct these activities in the context of presidential and congressional actions, and international treaties, including the following:

START I, 1988*—Ratified in 1988, the START I negotiations between the U.S. and Russia aimed at limiting and reducing nuclear arms. One of DOE's missions is national security; LANL has a role in several elements of that mission, including arms control and nonproliferation via treaty verification programs.*

Presidential Decision Directive (PDD), November 1993*—Presidential document that provided for the establishment of a program to maintain the U.S. nuclear stockpile (stockpile stewardship), preservation of a nuclear deterrent force without nuclear tests, and preservation of the technical and intellectual ability to design and maintain nuclear weapons. LANL and other weapons laboratories would preserve these abilities.*

National Defense Authorization Act of 1994 (PL 103-160), November 1993*—Passed by Congress, PL 103-160 directed DOE to "establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the U.S. in nuclear weapons, including weapons design, system integration, manufacturing, security, use control, reliability assessment, and certification." Subsequent congressional actions have provided similar guidance and direction.*

DoD Nuclear Posture Review, September 1994*—A report prepared by the DoD and approved by the President that addressed possible changes in U.S. nuclear policy. The report reaffirmed that nuclear weapons remain essential even though stockpiles will be reduced. It commits the U.S. to maintaining a safe and reliable nuclear deterrent and the core competencies of the U.S. in nuclear weapons without nuclear testing.*

Nonproliferation Treaty, May 1995*—On May 11, 1995, 178 nations agreed to permanently extend the expiring Nuclear Nonproliferation Treaty that controls the spread of nuclear weapons technologies, limits the number of nuclear weapons states, and commits to the long-term goal of disarmament. The five nuclear states also agreed to work toward a comprehensive test ban and rapid negotiation of a treaty to end production of nuclear bomb material.*

Presidential Announcement on the CTBT and Safeguards, August 1995*—The President announced the U.S. intent to seek a zero-yield CTBT, the requirement for a new annual certification procedure, and the establishment of safeguards for U.S. entry into a CTBT.*

PDD, September 1995*—After an administration review of the laboratory systems of DOE, the President determined that "the continued vitality of all three DOE nuclear weapons laboratories will be essential: for the purpose of ensuring confidence in the safety and reliability of the nuclear weapons stockpile in the absence of nuclear testing." (DOE 1995a)*

START II, January 1996*—The START II protocol, ratified by the U.S. Senate in January 1996, further reduces the limits of nuclear systems. Within DOE's national security mission, LANL has a substantial role in arms control and nonproliferation through intelligence analysis, technology research and development, treaty verification, fissile material control, and counterproliferation analysis.*

CTBT, September 1996*—The CTBT, approved in September 1996 but not yet ratified, would prohibit nuclear tests of all magnitudes. DOE, with the assistance of the weapons laboratories, must meet the challenge of maintaining the nation's nuclear stockpile without underground testing and develop the verification technologies that will ensure compliance with the treaty.*

Note: For additional information, see the SSM PEIS (DOE 1996a), chapter 2, Purpose and Need.

developed in the 1940's as part of the Manhattan Project when LANL produced the first weapons components for the early nuclear weapons stockpile. Over time, most of the production activities were reassigned to other DOE facilities, and LANL's national security focus became nuclear weapons research, development, and testing (which has evolved into the Stockpile Stewardship Program).

In the early 1990's, DOE recognized that its responsibilities for the reduced nuclear weapons stockpile did not require the extensive complex of production facilities that was being maintained. Thus, DOE undertook a study to reconfigure this complex to a smaller, less expensive form. As a first step, DOE prepared the *Nonnuclear Consolidation Environmental Assessment for the Nuclear Weapons Complex Reconfiguration Program* (DOE 1993), focusing on consolidation arrangements for the nonnuclear operations associated with nuclear weapons production. As a result of that assessment, LANL received several new assignments that were complementary to work already being performed at LANL:

- Detonator production and calorimetry work was transferred from the Mound Plant in Ohio.
- Neutron tube target loading work was transferred from the Pinellas Plant in Florida.
- Beryllium technology work and production of nonnuclear pit components (a pit is a component of a nuclear weapon, as discussed in the text box on this page) were transferred from the Rocky Flats Plant (now known as the Rocky Flats Environmental Technology Site [RFETS]) in Colorado.

The next step was to reconfigure nuclear facilities in the weapons complex. In 1994, DOE defined its ongoing Stockpile Stewardship and Management Program; the SSM PEIS analyzed the environmental impacts of implementing this integrated program (DOE 1996a). The SSM PEIS studied options for consolidating nuclear weapons work at a smaller number of facilities and downsizing the remaining complex, as well as reestablishing plutonium pit production. Under the ROD for the SSM PEIS (61 FR 68014), DOE assigned LANL new work within both the Stockpile Stewardship Program (section 1.1.1.1) and the Stockpile Management Program. Specific to stockpile management, DOE decided to reestablish its pit production capability at LANL at a capacity significantly reduced from that of the Rocky Flats Plant at the height of the Cold War. (The pit production capability at the Rocky Flats plant had previously been shut down.)

Operation of a Nuclear Weapon

Nuclear explosions are produced by initiating and sustaining nuclear chain reactions in highly compressed material that can undergo both fission and fusion reactions. Modern strategic, and most tactical, nuclear weapons use a nuclear package with two assemblies: the primary assembly, which is used as the initial source of energy, and the secondary assembly, which provides additional explosive energy release. The primary assembly contains a central core, called the "pit," which is surrounded by a layer of high explosive. The "pit" is typically composed of plutonium-239 and/or highly enriched uranium (HEU) and other materials. HEU contains large fractions of the isotope uranium-235.

1.1.1.3 *Accelerator Production of Tritium Assignment*

DOE's work to reconfigure the nation's nuclear weapons complex also addressed the supply and recycling of tritium. Tritium is one of the materials used in modern nuclear weapons. However, tritium has a half-life of 12.26 years; that is, about 5.5 percent is lost every year, and the tritium in a nuclear weapon must be replaced periodically if the weapon is to remain reliable. In the past, DOE produced tritium in some of its nuclear reactors; at present, however, none of the DOE reactors that had been capable of producing tritium is in operation. As the number of nuclear weapons in the U.S. stockpile is decreased, tritium from retired weapons can be purified and repackaged. However, at some time in the near future, there will be insufficient tritium to meet DOE's mission requirements.

In the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (Tritium PEIS) (DOE 1995b), DOE examined the environmental impacts of tritium production by means of both an accelerator and a commercial nuclear reactor. In the ROD for the Tritium PEIS (60 FR 63878), DOE decided on a dual-track approach that pursues production by both an accelerator and a commercial nuclear reactor for about 3 years. At the completion of this additional development work, DOE expects to make a final decision regarding which technology to pursue as the primary source of tritium.

Also in the Tritium PEIS ROD, DOE assigned to LANL the task of investigating the feasibility and consequences of designing, building, and testing the front-end, low-energy prototype for an accelerator that could produce tritium. DOE prepared the *Low-Energy Demonstration Accelerator (LEDA) Environmental Assessment* (DOE 1996b) to examine the site-specific environmental impacts of locating this research activity at LANL.

1.1.1.4 *Stabilization of Commercial Nuclear Materials Assignment*

Radioactive sealed sources are used in research and commerce for applications such as measuring the thickness of materials. These sources usually contain radionuclides such as plutonium or americium, packaged within multiple stainless steel jackets. Sealed radioactive sources for federal and commercial use were produced from materials supplied by the U.S. Atomic Energy Commission (AEC) and successor agencies (including DOE), beginning about 1950. Licensing was taken over by the U.S. Nuclear Regulatory Commission (NRC) when some AEC functions were reassigned to NRC in 1974.

These sealed sources have a finite life because the welds begin to fail after several years. Because the NRC has no facilities for managing unwanted and excess sources, owners of sealed sources who want to dispose of them have had no option for doing so. DOE addressed some of the health and safety concerns associated with unmanaged or abandoned sealed sources by reactivating a program to accept and manage plutonium-239 sources on an emergency basis. In the case of these sealed sources, management means chemically stabilizing, repackaging, or storing nuclear materials from the sources.

As more needs became apparent and after DOE prepared the *Radioactive Source Recovery Program Environmental Assessment* (DOE 1995c), DOE assigned the Radioactive Source Recovery Program to LANL building on the existing ability to manage these materials. In order to reduce the risk of personal injury resulting from unmanaged or abandoned sealed sources, the program now includes the proactive search for such sealed sources so that they can be brought to LANL and managed safely.

1.1.1.5 *Nonproliferation and Counter-Proliferation Assignments*

DOE has responsibility for national programs to reduce and counter threats from weapons of mass destruction (nuclear, biological, and chemical weapons). Activities conducted in this area include assisting with control of nuclear materials in states of the former Soviet Union, developing technologies for verification of the

CTBT, countering nuclear smuggling, safeguarding nuclear materials and weapons, and countering threats involving chemical and biological agents. These programs also include supporting continuation of the START process to further reduce nuclear weapons stockpiles.

LANL has been assigned research and development activities in support of these DOE responsibilities, including development of detection systems and technologies, assessment of foreign nuclear weapons capabilities, and responding to nuclear-related emergencies. In support of this assignment, LANL has:

- Provided much of the technology and expertise needed to verify treaties and implement various safeguards to ensure compliance with terms and conditions of treaties and agreements
- Undertaken satellite and remote sensing research to provide the technology to detect clandestine nuclear tests and other indicators of nuclear proliferation
- Undertaken research in personnel and vehicle monitoring and other nuclear safeguards technologies, which has helped to improve the security of many tons of plutonium and highly enriched uranium located in more than 50 facilities in the former Soviet Union
- Begun research aimed at countering nuclear smuggling and proliferation of chemical and biological weapons
- Assisted in the establishment, training, and technology development for DOE's Nuclear Emergency Search Team and Accident Response Group, which provide vital emergency response capabilities

1.1.1.6 *Other National Security Assignments*

LANL also measures and controls nuclear materials on the site and conducts research and development for such activities throughout DOE, including analytical chemistry and other destructive and nondestructive measurement techniques. LANL also performs research and demonstration activities regarding the disposition of surplus plutonium under DOE's Fissile Materials Disposition Program. While many of these activities support multiple mission elements, they are funded and managed under the national security mission.

1.1.2 Energy Resources Assignments

LANL's activities in this arena generally include: research to improve the safety and effectiveness of reactor operations; production of components for the radioisotopic power systems used in space exploration; geophysics and geothermal energy research; modeling and other support for the efficient use of fossil fuels; research and development related to the use of radioisotopes in industry, research, and healthcare; and research and development in the areas of global change, energy efficiency, and nuclear power.

After issuance of the *Medical Isotope Production Project: Molybdenum-99 and Related Isotopes, Environmental Impact Statement* (DOE 1996c), the related ROD assigned to LANL the fabrication of targets[3] for use in the production of molybdenum-99 for medical use (60 FR 48921). The fabricated targets are sent from LANL to Sandia National Laboratories in Albuquerque, New Mexico, where this medical isotope is actually produced.

1.1.3 Environmental Quality Assignments

LANL's support for this DOE mission includes:

3. A target, in this context, is material placed in a nuclear reactor to be bombarded with neutrons in order to produce radioactive materials.

- Development of environmental technologies to destroy explosives and propellants associated with DOE and DoD activities
- Research regarding appropriate treatment and handling of radioactive waste at the DOE sites at RFETS and Hanford
- Research on the coexistence of technology and the environment under the National Environmental Research Park Program
- Analytical and measurement support to characterize sites and materials in support of safe and effective waste disposal (e.g., the Waste Isolation Pilot Plant [WIPP])
- Operations to ensure the safe and effective treatment, handling, and disposal of waste generated at LANL

1.1.4 Science Assignments

LANL's facilities and expertise are utilized for research and development in the areas of theory, modeling and computation, engineering and experimentation, and advanced and nuclear materials. Recent examples of such research and development activities at LANL include:

- Application of high-energy protons to make high-resolution radiographs of rapid events in high-density material
- Application of experimentation and theory to predict how changes in polymer chemical structure, physical structure, and state of stress affect the mechanical properties of the materials
- Development of the high-performance parallel interface, which supports fast data-transfer network technology
- Development of a rapid, one-step method for making complex metal parts by fusing metal powder in the focal zone of a laser beam without the use of a mold, pattern, or forming die
- Measurements to study fundamental properties of neutrinos (a type of elementary particle)
- Studies of the human genome sequence and the structure of other biomolecules
- Development and fielding of sensors in support of nonproliferation, including detectors on Earth-orbiting satellites
- Research on the properties of actinide material that can affect their behavior where they are present in the environment
- Development of techniques to remotely detect atmospheric pollutants

In addition, LANL conducts nuclear criticality studies, performs reimbursable work for other federal agencies and for other sponsors (including the private sector), and allows university researchers to utilize its facilities. Each of these aspects of LANL's support for DOE's science mission are described below.

1.1.4.1 *Nuclear Criticality Studies*

DOE's science mission includes research intended to result in the avoidance of nuclear criticality accidents through understanding the processes of criticality and criticality control, continuing the research on criticality, and continuing to train individuals who will implement policies regarding criticality safety. At present, the only U.S. general criticality research program is at the Los Alamos Critical Experiments Facility (LACEF). In 1993, the Defense Nuclear Facilities Safety Board, an oversight organization, recommended to DOE that it continue the capability to carry on research in criticality. DOE has consolidated certain nuclear materials and machines used for criticality experiments at LANL to be maintained for the purposes of criticality experimentation and training (DOE 1996e).

1.1.4.2 *Reimbursable Work*

This work, sometimes termed "work for others," must be compatible with the DOE mission work conducted at LANL, and must be work that cannot reasonably be performed by the private sector. The nature of the Work for Others Program ranges from long-term work for other agencies to short-term work for industrial clients. Examples of such work for other agencies include:

- DoD development of conventional weapons technology, command and control detection systems, systems analysis and risk assessment, and environmental remediation of hazardous materials
- NRC analysis of reactor safety systems
- National Institutes of Health investigations into biological processes and genetic material

A small but growing amount of work performed by LANL is for industrial sponsors. These partnerships are often shorter-term projects such as modeling work on computer systems, applications of previous research, and new industrial product lines.

1.1.4.3 *University Research and Development*

LANL facilities may be used by universities and others to conduct research that could not otherwise be supported. For example, the Los Alamos Neutron Science Center (LANSCE) allows for university research into condensed matter science and subatomic physics, the results of which may be applicable to DOE missions or to commercial enterprise.

DOE also provides opportunities for university faculty and student training and research visits to LANL. Such programs allow DOE to combine scientific research with practical applications.

1.1.5 DOE National Laboratory System

LANL is part of the DOE national laboratory system that supports DOE's responsibilities and those of other federal agencies, government groups, utilities, and industry. DOE assigns mission elements or tasks to each of its national laboratories based on a variety of factors, including their existing areas of research and experimental capabilities. Table 1.1.5–1 shows the primary laboratory performers for each of the primary DOE missions.

1.2 Purpose and Need for Agency Action

The purpose of continued operation of LANL is to provide support for DOE's core missions as directed by Congress and the President. DOE's core missions and LANL's support of each of these missions are described in section 1.1.

DOE's need to continue to operate LANL is focused on its obligation to ensure a safe and reliable nuclear stockpile. The key capabilities of LANL that respond directly to this need include:

- Science-based performance safety and reliability evaluations and computer-based modeling of nuclear weapons components, particularly primaries and secondaries
- High-performance computing and computational science
- Weapons-related engineering
- Nuclear materials technology involving transuranic (TRU) materials
- Materials science, including behavior of materials under high temperature and pressure
- Engineering and high-energy physics, supporting activities such as accelerator production of tritium
- High explosives research and development and testing, including detonator development and production
- Tritium gas process development and applications, including neutron target tube loading
- Criticality studies

TABLE 1.1.5–1.—*Primary Laboratory Performers for DOE Missions*[a]

MISSION	PRIMARY LABORATORY PERFORMERS
National Security	Bettis Atomic Power Laboratory, Knolls Atomic Power Laboratory, Lawrence Livermore National Laboratory, **Los Alamos National Laboratory**, Sandia National Laboratories
Energy Resources	Argonne National Laboratory, Federal Energy Technology Center[b], National Renewable Energy Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory
Environmental Quality	Federal Energy Technology Center[b], Idaho National Engineering and Environmental Laboratory, Lawrence Livermore National Laboratory, **Los Alamos National Laboratory**, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratories, Savannah River Technology Center
Science	Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, **Los Alamos National Laboratory,** Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Princeton Plasma Physics Laboratory, Stanford Linear Accelerator Center, Thomas Jefferson National Accelerator Facility

[a] Based on Table 2 of the *Strategic Laboratory Missions Plan—Phase 1*, Volume 1, July 1996, which was prepared by the DOE Laboratory Operations Board (DOE 1996f).
[b] Formerly referred to as the Morgantown Energy Technology Center/Pittsburgh Energy Technology Center.

- Specialty isotope production
- Neutron scattering experimentation for materials science and other purposes, including enhancing surveillance technologies
- Science and technology associated with nonproliferation and threat reduction
- Measurements to study fundamental nuclear and subatomic physics
- Studies of the structure of biomolecules
- Research on properties of actinide materials, including properties that can affect their behavior when they are present in the environment
- Development of techniques to remotely detect atmospheric pollutants

The continuing need for LANL to support the DOE's national security mission elements was recently confirmed by President Clinton, who stated, "to meet the challenge of ensuring confidence in the safety and reliability of our stockpile, I have concluded that the continued vitality of all three DOE nuclear weapons laboratories will be essential" (DOE 1995a). (LANL, Lawrence Livermore National Laboratory and Sandia National Laboratories are often referred to as the three "DOE nuclear weapons laboratories.")

For the foreseeable future, DOE, on behalf of the U.S. Government, will need to continue its nuclear weapons research and development, surveillance, computational analyses, components manufacturing, and nonnuclear aboveground experimentation. Currently, many of these activities are conducted solely at LANL. For example, LANL designed the nuclear components for the majority of the nuclear weapons that are expected to comprise the U.S. stockpile under current arms control agreements and treaties, and will continue to be responsible for assessing the safety and reliability of these weapons (Lawrence Livermore National Laboratory designed the others). Ceasing these activities would run counter to national security policy as established by Congress and the President.

DOE has evaluated and continues to evaluate its mission element assignments, including those at LANL, in other programmatic NEPA documents. LANL's mission element assignments are not under evaluation in the SWEIS.

1.3 OVERVIEW OF THE ALTERNATIVES CONSIDERED

Four alternatives were identified that would meet DOE's purpose and need. The alternatives analyzed in the SWEIS are:

- *No Action Alternative*. Under this alternative, LANL operations would continue at their currently planned levels.
- *Expanded Operations Alternative*. Under this alternative, LANL's level of operations would allow full implementation of earlier DOE decisions and current programs. This alternative represents the highest foreseeable level of future activities that could be supported by the LANL infrastructure.
- *Reduced Operations Alternative*. Under this alternative, LANL's operations would be reduced to the minimum levels that would maintain (for the near term) the capabilities necessary to support the mission elements currently assigned to LANL.
- *Greener Alternative*. Under this alternative, LANL's support for DOE nonproliferation, materials recovery stabilization, and basic science would be maximized. This alternative would also emphasize the use of LANL capabilities for energy and other nonweapons research, including waste treatment technology research and development. LANL's current support to DOE defense and nuclear weapons programs would be minimized.

The first three alternatives present differing operational levels of the same types of activities. The fourth, the "Greener" Alternative, was suggested and titled by stakeholders. This alternative would emphasize the use of LANL capabilities in nonweapons mission elements, as discussed above. In some cases, levels of operations in the Greener Alternative would be higher than in the No Action Alternative (but no higher than the levels reflected in the Expanded Operations Alternative). In other cases, operations under the Greener Alternative would be the same or less than those under the No Action Alternative (but not less than those reflected in the Reduced Operations Alternative).

In the draft SWEIS, the DOE's Preferred Alternative was the Expanded Operations Alternative. In this final SWEIS, the Expanded Operations Alternative remains the Preferred Alternative with one modification, as noted below. The modification to the Preferred Alternative involves the level at which pit manufacturing will be implemented at LANL. Under the Expanded Operations Alternative, DOE would implement pit manufacturing up to the capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts). However, as a result of delays in the implementation of the Capability Maintenance and Improvement Project (CMIP) and recent additional controls and operational constraints in the Chemistry and Metallurgy Research (CMR) Building (instituted to ensure that the risks associated with the CMR Building operations are maintained at an acceptable level), the DOE has determined that additional study of methods for implementing the 50 pits per year production capacity is warranted. In effect, because DOE has postponed any decision to expand pit manufacturing beyond a level of 20 pits per year in the near future, the revised Preferred Alternative would only implement pit manufacturing at this level. This postponement does not modify the long-term goal announced in the ROD for the SSM PEIS (up to 80 pits per year using multiple shifts).

1.4 DECISIONS TO BE SUPPORTED BY THE SWEIS

The decisions that DOE expects to make as a result of the alternatives analyzed in this SWEIS would satisfy the purpose and need discussed in section 1.2. The decisions to be reached include the level of operation for LANL and specific decisions regarding facility construction or modification projects discussed across the alternatives, including: (1) the site-specific implementation of the plutonium pit production capacity assigned in the SSM PEIS ROD (61 FR 68014) and (2) the disposition of low-level radioactive waste, given the waste volumes associated with the decisions made regarding the level of operation of LANL. In addition, DOE will select mitigating actions presented in the SWEIS for implementation at LANL. These decisions will be announced in a ROD no sooner than 30 days after the issuance of the final SWEIS Notice of Availability (NOA) by the U.S. Environmental Protection Agency (EPA).

1.4.1 Public Comment Process on the Draft SWEIS

The draft SWEIS was developed after a series of public pre-scoping and scoping hearings to provide opportunities for stakeholders to identify the issues, environmental concerns, and alternatives that should be analyzed in the SWEIS. The scoping process and issues raised during the scoping phase are described in the SWEIS Implementation Plan (November 1995). DOE released the draft SWEIS on May 15, 1998, for review and comment by the State of New Mexico, Indian tribes, local governments, other federal agencies, and the general public. The formal public comment period lasted 60 days, ending on July 15, 1998. Comments received after close of the comment period were considered in the preparation of the final SWEIS to the extent practical.

DOE considered all comments to evaluate the accuracy and adequacy of the draft SWEIS and to determine when the SWEIS text needed to be corrected, clarified, or otherwise revised. DOE gave equal weight to spoken and written comments, comments received at the public hearings, and comments received in other ways. Comments were reviewed for content and relevance to the environmental analysis contained in the SWEIS. Each comment is addressed individually in volume IV, chapter 3 of the SWEIS.

Commentors raised several common topics during the SWEIS public comment process that the DOE has attempted to address in the Major Issues section located in chapter 2 of volume IV. In some cases, commentors raised issues that were not within the scope of this SWEIS, such as comments regarding opposition to nuclear weapons. To the extent practical, DOE addressed these comments in the Major Issues section and in the individual responses.

1.5 RELATIONSHIP TO OTHER DOE NEPA DOCUMENTS

In this SWEIS, DOE examines the environmental consequences of alternative levels of operation to meet the ongoing mission elements assigned to LANL. However, other DOE NEPA reviews recently completed or currently being conducted could affect LANL operations. Below, these DOE NEPA documents are summarized and their relationships to the SWEIS alternatives are identified.

DOE Waste Types

DOE is responsible for managing inventories of several types of wastes. These wastes are defined as follows:

Low-level radioactive waste *(LLW) includes all radioactive waste that is not classified as high-level waste (HLW), spent nuclear fuel (fuel discharged from nuclear reactors), TRU, uranium and thorium mill tailings, or waste from processed ore. LLW does not contain hazardous constituents that are regulated under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §6901)*

Low-level radioactive mixed waste *(LLMW) contains both hazardous and low-level radioactive components. The hazardous component in LLMW is subject to regulation under RCRA.*

Transuranic waste *contains more than 100 nanocuries of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years, and an atomic number greater than that of uranium (92). TRU waste has radioactive components such as plutonium.*

TRU mixed waste *is TRU waste that also has hazardous components, and thus, is mixed waste regulated under RCRA.*

High-level waste *is the highly radioactive waste that results from reprocessing spent nuclear fuel and irradiated targets from reactors. LANL has no HLW in its inventory.*

Hazardous waste *(HW) is defined as a solid waste that, because of its characteristics, may significantly contribute to an increase in mortality, or may pose a potential hazard to human health or the environment when improperly treated, stored, or disposed. RCRA defines a "solid" waste to include solid, liquid, semisolid, or contained gaseous material (42 U.S.C. §6901 et seq.). By definition, HW has no radioactive components.*

1.5.1 Waste Management Programmatic Environmental Impact Statement (DOE/EIS–0200)

NEPA Analysis

The *Waste Management Final Programmatic Environmental Impact Statement* (DOE 1997a) (WM PEIS) is a nationwide study examining the potential environmental impacts of managing five types of radioactive and hazardous wastes that result primarily from nuclear defense activities. The ROD for treatment and storage of TRU waste was issued on January 20, 1998 (63 FR 3629), and the ROD for nonwastewater hazardous waste was issued on August 5, 1998 (63 FR 41810). DOE plans to issue other RODs for other waste types at a later time. DOE will use the WM PEIS in deciding how to configure needed treatment, storage, and disposal capacity, depending on waste type. However, the specific location of a facility at a selected site may not be decided until completion of a subsequent site-wide or project-specific NEPA review.

Relationship to LANL

LANL currently generates and manages four types of waste analyzed in the WM PEIS: LLW, LLMW, TRU waste, and HW. The WM PEIS includes preferred alternatives for locations of treatment, storage, and/or disposal of each of the waste types analyzed. The following list briefly describes how LANL could be affected by the respective WM PEIS preferred alternatives.

- *LLW and LLMW Treatment.* Under the WM PEIS Preferred Alternative, LANL would treat its own LLW and LLMW on the site and would not receive LLW or LLMW from off-site locations for treatment.
- *LLW and LLMW Disposal.* Under the WM PEIS Preferred Alternative, LANL is one of six sites from which DOE would select two

or three preferred regional disposal sites, after further consultations with regulatory agencies, state and tribal governments, and other interested stakeholders; that is, LANL would either be a regional disposal site for LLW and LLMW or would ship these wastes off the site for disposal.

- *TRU Waste Treatment and Storage.* Under the TRU waste ROD (63 FR 3629), LANL will treat its own TRU waste on site and receive small amounts of TRU waste from Sandia National Laboratories in Albuquerque, New Mexico, for treatment and storage, pending its disposal.
- *HW Treatment.* Under the nonwastewater HW ROD, LANL will continue to use commercial facilities to treat most of its nonwastewater HW.

SWEIS Inclusion

The SWEIS analyzes on-site treatment of all of LANL's radioactive waste and the use of commercial facilities to treat most of its nonwastewater HW. The TRU waste inventory analyzed in the SWEIS includes the small amounts of such waste that would come to LANL from Sandia National Laboratories (in Albuquerque, New Mexico) under the WM PEIS ROD for TRU waste. The SWEIS also addresses the range of decisions (i.e., regional disposal at LANL or shipment off the site) that could be made concerning disposal of LLW and LLMW. If LANL is chosen as a regional disposal site for LLW and LLMW, the site-specific impacts of that decision would be addressed in further NEPA review tiered from the WM PEIS and this SWEIS.

1.5.2 Stockpile Stewardship and Management Programmatic Environmental Impact Statement (DOE/EIS–0236)

NEPA Analysis

The SSM PEIS addressed the facilities and missions to support the stewardship and management of the U.S. nuclear stockpile (DOE 1996a). The ROD was issued December 19, 1996 (61 FR 68014). The purpose of stockpile stewardship is to ensure the continued reliability and safety of U.S. nuclear weapons and the preservation of the U.S. core intellectual and technical competencies in nuclear weapons in the absence of underground nuclear testing. In order to accomplish this goal, it is necessary to provide the facilities and expert judgment to predict, identify, and provide solutions to problems that might affect the safety and reliability of nuclear weapons.

A primary goal of stockpile management is to provide an effective and efficient production capability for a smaller stockpile by downsizing and/or consolidating functions where appropriate. Stockpile management activities include dismantlement, surveillance, maintenance, evaluation, production, and repair or replacement of nuclear weapons and weapons components.

Relationship to LANL

LANL was one of the sites analyzed for several potential assignments in the SSM PEIS. Based on the SSM PEIS, DOE decided to reestablish DOE's plutonium pit production capability, as well as to construct and operate Atlas at LANL. Atlas is a pulse-powered experimental facility that will aid in studying the physics of secondaries of nuclear weapons. (It should be noted that the data for the SSM PEIS were provided at a level that supported mission element assignment decisions, except in the case of Atlas at LANL and two projects at other sites that were the subject of a complete project-level NEPA analysis. More extensive data were developed to analyze implementation of potential mission element assignments as part of the SWEIS process.)

The SSM PEIS also examined alternatives for assigning the production of high explosives components and the production of secondary assemblies to LANL. Thus, the SWEIS Notice of Intent (NOI) (60 FR 25697) included consideration of these mission element assignments in the Expanded Operations Alternative. Since that time, the SSM PEIS ROD assigned the high explosives component production to the Pantex Plant in Amarillo, Texas, and secondary assembly production to the Y-12 Plant in Oak Ridge, Tennessee. Because LANL was not assigned these mission elements, the SWEIS Expanded Operations Alternative no longer includes them[4].

SWEIS Inclusion

Because DOE has decided to proceed with Atlas, this project is included in all alternatives in the SWEIS. In addition, different levels of plutonium pit manufacturing operations are addressed in the different alternatives in the SWEIS.

4. The scope of the SWEIS was developed prior to the issuance of the SSM PEIS ROD. Thus, the Expanded Operations Alternative was originally defined to include the high explosives component production and the secondary assembly production mission elements. Accordingly, the environmental consequences of the Expanded Operations Alternative (described in chapter 5) include the impacts associated with these mission elements. However, because these activities do not contribute substantially to air quality, water resources, land use, socioeconomic, or other impact projections regarding LANL operations, the environmental consequences of the Expanded Operations Alternative, with or without these mission elements, are substantially the same. Therefore, DOE determined that it was not cost effective to restructure and reanalyze the alternative. To the extent that this affects the impact analyses, the environmental consequences of the Expanded Operations Alternative can be expected to be somewhat less than those identified in chapter 5.

Even though the SSM PEIS has assigned the pit production mission element to LANL at a higher rate of production (up to 80 pits per year using multiple shifts), than can be supported with the existing fabrication capacity, production at this level would not begin until an implementation decision is reached based on the SWEIS and until completion of a construction project to establish the higher level of production. At this time, DOE is evaluating its options for achieving this pit fabrication rate (tiered from the SSM PEIS). The Expanded Operations Alternative reflects the proposed construction of a project to enhance the existing manufacturing capability and operations to the level of 80 pits per year with multiple shift operations. However, it is possible that, over the next 10 years (the period of evaluation in the SWEIS), DOE could operate at the No Action Alternative level of pit fabrication operations (up to 14 pits per year), or slightly above that level (up to 20 pits per year, the DOE's Preferred Alternative) for some period of time, and later provide the full capacity. It is also reasonable that DOE could operate at Reduced Operations or Greener Alternatives levels of pit manufacturing (6 to 12 pits per year) for a period of time, while still maintaining a pit fabrication capability and the ability to return later to a higher capacity. Thus, the SWEIS analyzes all levels of operations that could reasonably occur over the next 10 years regarding the manufacturing of pits, given the recent assignment of pit production to LANL.

This approach is discussed further in volume II, section II.2, in the discussion on enhancement of pit manufacturing.

In May 1997, 39 organizations challenged the adequacy of the SSM PEIS by filing a complaint in the U.S. District Court for the District of Columbia, citing a total of 13 claims to support this allegation. In January 1998, these organizations amended their complaint, replacing the original 13 claims with two new claims that alleged that DOE is required to prepare a Supplemental PEIS because of new information made available since the SSM PEIS was issued. One of the two new claims involved information concerning pit manufacturing at LANL. Pursuant to its regulations implementing NEPA, DOE prepared a supplement analysis of the pit manufacturing information contained in the amended complaint. Based on this supplement analysis DOE determined that a Supplemental PEIS was not required. The supplement analysis and the memorandum documenting DOE determination are included in this SWEIS as appendix H.

In an opinion and order issued on August 19, 1998, the court agreed that a supplemental PEIS is not required at this time and dismissed that part of the lawsuit involving the SSM PEIS. As part of the settlement, DOE agreed to prepare an additional Supplement Analysis of pit production based on (1) the results of several pending peer-reviewed seismic reports due to be issued by March 1999, and (2) technical analysis of the plausibility of a building-wide fire at Technical Area (TA)–55 under glove-box propagation or seismic or sabotage initiation. The Supplement Analysis is under preparation. A summary of the methodology used in the preparation of the Supplement Analysis is included in chapter 5, section 5.1.11.12. Information from the seismic reports published by the end of December 1998 have been incorporated into the SWEIS accident analyses.

1.5.3 Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement (DOE/EIS–0026–S2)

NEPA Analysis

WIPP is the proposed repository for retrievably stored defense TRU waste. In October 1980, DOE issued an EIS on proposed development of WIPP (DOE 1980). The January 1981 ROD (46 FR 9162) called for phased development of WIPP, beginning with construction of the WIPP facility. In 1990, DOE issued a supplemental EIS that considered previously unavailable information (DOE 1990). Based on this supplemental EIS, DOE decided to continue phased development.

DOE has issued a second supplemental EIS (SEIS-II) to analyze the impacts of TRU waste disposal at WIPP or continued storage at the generating sites (DOE 1997b). The SEIS-II updates the information contained in the previous EIS and supplemental EIS, analyzes various treatment alternatives for TRU waste, and examines any changes in environmental impacts due to new information or changed circumstances. Based on this analysis, DOE has decided (63 FR 3623, January 23, 1998) to dispose of defense-related TRU waste at WIPP up to legal limits, once the waste is treated to the WIPP waste acceptance criteria (WAC). DOE will transport TRU waste to WIPP by truck.

Relationship to LANL

The WIPP SEIS-II analyzes the impacts of LANL TRU waste treatment and subsequent transportation to WIPP, in accordance with current DOE planning schedules.

SWEIS Inclusion

The treatment of TRU waste to the WIPP WAC and transportation to WIPP is included in all SWEIS alternatives. The SWEIS transportation analyses address the use of the proposed route that would bypass the City of Santa Fe.

1.5.4 Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement (DOE/EIS–0249)

NEPA Analysis

In the Molybdenum-99 EIS, DOE analyzed alternatives to establish, as soon as practical, a domestic capacity to produce molybdenum-99 and related medical isotopes for use by the U.S. healthcare community using the U.S. Food and Drug Administration-approved Molybdenum-99 production process (DOE 1996c).

Relationship to LANL

The ROD associated with the Molybdenum–99 and Related Isotopes EIS (60 FR 48921) states that DOE will use the facilities of Sandia National Laboratories, New Mexico, and LANL. Under this approach, DOE uses the CMR Building at LANL to fabricate the targets containing HEU. Molybdenum-99 is produced at Sandia National Laboratories. LLW from target fabrication at LANL is disposed of on the site, pending decisions based on the WM PEIS and this SWEIS.

SWEIS Inclusion

The modifications required to fabricate targets at LANL's CMR Building are relatively minor. Some interior walls will be removed, doors will be relocated, and gloveboxes with filtered exhaust systems will be installed. These activities and the target fabrication operations are included in all alternatives in the SWEIS.

1.5.5 Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement (DOE/EIS–0229)

NEPA Analysis

After completion of the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (DOE 1996d), DOE decided in the related ROD how to implement its program to provide for safe and secure storage of weapons-usable fissile materials (plutonium and HEU) and a strategy for the disposition of surplus weapons-usable plutonium (62 FR 3014). The fundamental purposes of the program are to maintain a high standard of security and accounting for these materials while in storage and to ensure that plutonium produced for nuclear weapons and declared excess to national security needs is never again used for nuclear weapons.

Relationship to LANL

LANL participates in the research and development program to develop and demonstrate the technologies necessary for disposition and storage of plutonium. In particular, research and development regarding the conversion of surplus plutonium in weapons components to mixed oxide (MOX) reactor fuel is conducted at LANL.

SWEIS Inclusion

The research and development efforts supporting plutonium pit disassembly and MOX fuels development and demonstration are within the levels of operation addressed in the SWEIS. Specifically, the No Action, Reduced Operations, and Greener Alternatives include the current level of operation, and the Expanded Operations Alternative includes a higher level of these activities.

1.5.6 EIS on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site (DOE/EIS–0277)

NEPA Analysis

DOE has issued an EIS (DOE 1998d) to evaluate the potential environmental impacts associated with management of certain plutonium residues and scrub alloy currently being stored at RFETS in Golden, Colorado. The residues and scrub alloy are materials that were generated during the separation and purification of plutonium or during the manufacture of plutonium-bearing components for nuclear weapons. Alternatives analyzed in the Residues EIS include No Action, process for disposal without plutonium separation, and process for disposal or other disposition with plutonium separation. In its ROD (63 FR 66136) DOE selected processing technologies for these residues, including some that would involve separation of plutonium. In a second ROD, DOE will make a decision about technologies for pyrochemical salt residues. The preferred alternative is to preprocess at RFETS, with plutonium separation to take place at LANL. The impacts of off-site transportation and processing are analyzed in detail for the Savannah River Site and LANL.

Relationship to LANL

LANL participates in the research and development program to develop and demonstrate the technologies necessary for management (including the processing, measuring and storing) of plutonium residues. At times, LANL has processed and is expected to continue to process small quantities of unique or difficult-to-process residues from off-site locations. In addition, as noted above, the Residues EIS analyzed LANL as a possible site for processing some of RFETS' chloride salt residues.

SWEIS Inclusion

The development and demonstration activities for the processing, measuring, and storing of plutonium residues are within the levels of operation addressed under each of the SWEIS alternatives. The No Action Alternative includes the current level of such operations, and the Reduced Operations Alternative includes a level of operations lower than that in the No Action Alternative. The Expanded Operations and Greener Alternatives include a larger throughput of residue processing than the No Action Alternative, and in addition, include increases in the amount of off-site material that would be processed and transported from RFETS.

1.5.7 Pit Disassembly and Conversion Demonstration Environmental Assessment (DOE/EA–1207)

NEPA Analysis

DOE prepared an environmental assessment (EA) (DOE 1998a) to examine the environmental impacts of the proposed development and demonstration of an integrated pit disassembly and conversion process for fissile material disposition. The demonstration would involve the disassembly of up to 250 weapons components (pits) over 4 years and conversion of the recovered plutonium to plutonium oxide. DOE determined that this proposed action would not significantly affect the quality of the human environment and issued a Finding of No Significant Impact in August, 1998 (63 FR 44851). Because this EA was under preparation, the proposed action of 250 components was part of the Expanded Operations Alternative in the draft SWEIS.

Relationship to LANL

The proposed work would be conducted at LANL's Plutonium Facility at TA–55. No new facilities would need to be constructed to support the demonstration, although internal modifications to the facility would be required. All work would be performed in a series of interconnected gloveboxes using remote handling and computerized control systems.

SWEIS Inclusion

The modifications and conduct of the plutonium pit disassembly and conversion demonstration using up to 40 pits are within the level of operations addressed in the SWEIS No Action, Reduced Operations, and Greener Alternatives. Demonstration activities using up to 250 pits over 4 years is within the level of operations included in the SWEIS Expanded Operations Alternative. The Expanded Operations Alternative also includes continued use of the process equipment for pit disassembly by other programs after this demonstration project has been completed.

1.5.8 Surplus Plutonium Disposition Environmental Impact Statement (DOE/EIS–0283)

NEPA Analysis

DOE is preparing an EIS (DOE 1998b) to evaluate the potential environmental impacts for the proposed siting, construction, and operation of facilities for plutonium disposition. These would include a facility to disassemble and convert plutonium pits into plutonium oxide suitable for disposition, a facility to immobilize surplus plutonium in glass or ceramic form, and a facility to fabricate plutonium oxide into MOX fuel. The EIS also examines the potential impacts of the siting, modification, and operation of existing facilities for the fabrication of lead test assemblies that would be used in MOX fuel qualification demonstrations. The Draft Surplus Plutonium Disposition EIS was issued in July 1998.

Relationship to LANL

DOE is analyzing LANL as one of five potential sites for the location of the fabrication of MOX fuel lead test assemblies demonstration as part of the surplus plutonium disposition program.

SWEIS Inclusion

The development and fabrication activities for the production of MOX fuel pellets would be a demonstration activity. The SWEIS includes continued development and demonstration activities for ceramic fuels. The impacts of implementing the Lead Test Assembly demonstration activities at LANL are presented in chapter 5, section 5.6. Facility information also is provided in chapter 2 (sections 2.2.2.1 and 2.2.2.15) regarding both operations.

1.5.9 EIS for Siting, Construction, and Operation of the Spallation Neutron Source (DOE/EIS–0247)

NEPA Analysis

DOE is evaluating the siting, construction, and operation of a proposed spallation neutron source (SNS) (DOE 1998c). This facility would consist of a proton accelerator system; a spallation target; and appropriate experimental areas, laboratories, offices, and support facilities to allow ongoing and expanded programs of neutron research. The proposed site for the SNS is the DOE-owned Oak Ridge National Laboratory in Oak Ridge, Tennessee. The alternative sites under consideration are three other DOE-owned laboratories: Argonne National Laboratory, Argonne, Illinois; LANL; and Brookhaven National Laboratory, Upton, New York. The public scoping period for this

EIS was completed in September 1997. A draft EIS was completed in December 1998.

This facility is considered complementary to existing accelerator-based spallation sources at LANL, and would not be intended to replace the existing facility.

Relationship to LANL

LANL is one of four alternatives for the SNS; though not the preferred site. If LANL is selected, the facility would be built on a currently undeveloped site. This project is independent of all current or planned future operations at LANL.

SWEIS Inclusion

The SNS EIS is being coordinated with this SWEIS so that it can make use of the information developed for the SWEIS and to ensure that the SNS EIS considers the LANL alternative in light of the information regarding LANL operations and the corresponding impacts, as described in this SWEIS. Impacts associated with the SNS project, including site development, utilities, and waste management are to be analyzed in the EIS specific to that project and are not included in the SWEIS.

1.5.10 EIS for the Proposed Conveyance and Transfer of Certain Land Tracts Located Within Los Alamos and Santa Fe Counties and Los Alamos National Laboratory

NEPA Analysis

DOE is preparing an EIS to assess the potential environmental impacts of conveying or transferring certain land tracts under the administrative control of DOE located within the Counties of Los Alamos and Santa Fe (the CT EIS). The EIS is evaluating the congressionally mandated action required under PL 105-119 of conveying certain land tracts to the County of Los Alamos and to the Secretary of the Interior in trust for the Pueblo of San Ildefonso.

Relationship to LANL

LANL is the only DOE site involved in the proposed action. The NEPA review is proceeding separately from the SWEIS.

SWEIS Inclusion

The SWEIS analysis does not include a consideration for changing the size or configuration of the LANL reserve through land conveyance or transfer, such as those to be included in this CT EIS. A draft CT EIS is expected to be released for public review and comment in early 1999. The impacts of implementing the proposed action are summarized in chapter 5, section 5.6 of the SWEIS. The SWEIS does take into account two proposals for land transfer or leasing that have already been analyzed by EAs with Findings of No Significant Impacts (FONSI) (discussed in section 1.6.2), although DOE has not reached a final decision to implement either of these proposals to date.

1.5.11 Environmental Assessment for the Proposed Strategic Computing Complex (DOE/EA-1250)

NEPA Analysis

DOE prepared an environmental assessment to evaluate the environmental impacts of construction and operation of a Strategic Computing Complex (SCC) within LANL's TA–3. The SCC will be a facility designed to house and operate an integrated system of computer processors capable of performing approximately 50 trillion floating point operations per second, as part of the Accelerated Strategic Computing Initiative in support of the Stockpile Stewardship and Management Program.

Relationship to LANL

LANL is the only site under consideration for the SCC. The SCC proposal was an allowable interim action, and the NEPA review proceeded separately from the SWEIS. Based on the EA, DOE determined that the proposed action would not significantly affect the quality of the human environment and issued a Finding of No Significant Impact in December 1998.

SWEIS Inclusion

The major impacts of the operation of the SCC will be on water consumption and use of electric power. The impacts of the construction and operation of the SCC are included in the levels of operation for all of the alternatives in the SWEIS.

1.6 OVERVIEW OF THE LANL SWEIS

General information regarding the NEPA process and the process DOE used in preparation of this SWEIS (including public involvement) are included on the inside covers of volume I of the SWEIS. Additional information specific to the SWEIS is described in this section, including the objectives of the SWEIS, DOE's approaches in preparing the document, the consideration of future projects in the SWEIS alternatives and analyses, the role of the Cooperating Agency, and a preview of the remaining sections of the document.

1.6.1 Objectives of the SWEIS

The environmental impacts of LANL operations have been addressed in the *Final Environmental Impact Statement: Los Alamos Scientific Laboratory Site* (DOE 1979) and in subsequent EISs, EAs, categorical exclusion determinations, and other types of environmental reviews for specific projects and activities. Changes in the world political situation have the potential to alter the role of LANL and its operations now and during the next 10 years, and this SWEIS is intended to support decision-making regarding LANL's operations. In this SWEIS, DOE is examining the environmental impacts of four alternatives for the continued operation of the laboratory (section 1.3 and chapter 3 provide descriptions of the alternatives analyzed).

Given the decisions DOE intends to make based on this SWEIS (section 1.4), the objectives of the SWEIS are to:

- Describe the current environment, current operations, and the impacts associated with the continued operation of LANL.
- Compare the environmental consequences, including cumulative impacts, of reasonable alternatives for the continued operation of LANL.
- Provide a sufficient level of information to facilitate routine decisions about, and verification of, operational status with respect to the SWEIS analyses.
- Provide the project-specific NEPA analyses for proposed projects (including the expansion of LLW disposal capacity at Area G and the enhancement of plutonium pit manufacturing at LANL) and include them in the overall SWEIS impact assessment.
- Serve as a site-wide document for tiering and reference information for future NEPA analyses at LANL.

1.6.2 SWEIS Approaches

To meet these objectives, DOE used the following approaches:

- The sources of potential impacts analyzed in the SWEIS are those associated with LANL operations within the 43-square-mile (111-square-kilometer) LANL main site and the 0.3-square-mile (0.77-square-kilometer) Fenton Hill site, located about 20 miles (32 kilometers) west of LANL.

- The SWEIS analyzes current and proposed activities that could occur over the next 10 years. DOE chose the 10-year period as one in which future activities could be reasonably anticipated and described. Predicting activities beyond 10 years would have been excessively speculative.
- Those operations that have the most potential for significant environmental and human health impacts, including areas of concern identified by the public during the scoping process, are described in detail by facility. Operations of lesser potential impact are described and analyzed at the site-wide level only.
- Descriptions of the affected environment are based on the geographical area of the potential impact. If the impact would be limited to a canyon or mesa top, the discussion is largely focused at that level. Parameters such as radiological air emissions and the potential consequences to air quality and human health are discussed at the regional level.
- The SWEIS also includes the impacts of a proposed land transfer and a proposed lease action that are currently being finalized. These proposals (Transfer of the DP Road Tract to the County of Los Alamos and Lease of Land for the Development of a Research Park) were analyzed in EAs (DOE 1997c and DOE 1997d). The Secretary of Energy is directed to make additional land transfers in the *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act of 1998* (PL 105-119, Section 632), but the actual parcels to be transferred are not sufficiently defined to allow for meaningful analysis in this SWEIS. On May 6, 1998, DOE published an NOI to prepare an EIS for the Proposed Conveyance and Transfer of Certain Land Tracts in the FR (63 FR 25022). (See Section 1.5.10.)
- The SWEIS generally describes the environmental restoration actions planned during the next 10 years to meet the requirements of LANL's Hazardous Waste Operating Permit and the various strategies for managing the resulting wastes. The types of impacts experienced and expected from such activities are described in general and are included with the site-wide impacts of each of the four alternatives analyzed in the SWEIS. These impacts are also analyzed in NEPA reviews and in RCRA documentation prepared using processes that include opportunities for public comment, within the framework agreed upon among DOE, the LANL management and operating contractor (University of California [UC]), and the New Mexico Environment Department (NMED).
- For the cumulative impact analysis, other proposals and plans by both private and government entities in the northern New Mexico area were reviewed, and their effects were considered together with those from LANL operations.

In this SWEIS, DOE also examines mitigation measures for impacts of LANL operations, planning strategies to protect and conserve natural and cultural resources, and waste management (treatment, storage, and disposal) strategies for LANL, including pollution prevention.

1.6.3 Consideration of Future Projects

DOE and researchers at LANL frequently develop new ideas and proposals for which funding and programmatic support are requested. Such proposals vary in terms of size, complexity, and potential environmental impact. Many of these proposals are characterized as projects. These are typically activities or groups of activities within the broad research, development, and applications activities across LANL. Some of these activities also require construction or modification of facilities or equipment. The discussion in this section focuses on these construction and modification projects.

Construction and facility modification projects being considered by and for LANL are of many sizes and levels of complexity and were identified using a variety of sources. These sources included Capital Assets Management Process (CAMP) Reports (e.g., LANL 1995), LANL Institutional Plans (e.g., LANL 1996), and other DOE NEPA documents and reports. The potential projects identified were reviewed to determine the appropriate level of analysis in the SWEIS. As a result of this process, potential LANL projects were placed into one of these three categories.

- *Projects for which NEPA review has been completed and for which a decision has been made prior to the completion of the SWEIS.* These projects support the DOE mission and DOE's ongoing program requirements and are included in all of the SWEIS alternatives. Any of these projects that are considered major federal actions meet the test for interim actions found in the Council on Environmental Quality's (CEQ's) regulations for implementing NEPA at 40 Code of Federal Regulations (CFR) 1506.1.
- *Site-specific proposed projects that are ripe for decision and are on the same schedule as the SWEIS and its ROD.* Several facility or equipment modification activities are described in the SWEIS (chapters 2 and 3). It is expected that the SWEIS will constitute the NEPA review for these projects. However, if the scope or design for these projects changes substantially in the future, additional NEPA review may be necessary. The construction projects analyzed include the expansion of LLW disposal capacity in Area G and the enhancement of plutonium pit manufacturing operations (to reestablish DOE's production capability for these weapons components). For these two project-level analyses, a description of the different locations within LANL considered and the environmental impacts of constructing those facilities at the different locations is included in volume II of the SWEIS, Project-Specific Siting and Construction (PSSC) Analyses. These construction activities and subsequent facility operations are included in the Expanded Operations Alternative (chapter 3, section 3.2), and the impacts of these activities are included in the impacts of the Expanded Operations Alternative (chapter 5, section 5.3) in volume I of the SWEIS.
- *Projects that are not reasonably foreseeable within the next 10 years.* Such projects are considered speculative; thus, they are not analyzed in the SWEIS. If such projects were eventually proposed, it is anticipated that they would require NEPA review prior to being undertaken. Such analyses would be tiered from the SWEIS that is in effect at the time.

1.6.3.1 *Emerging Actions at LANL*

Because LANL is a site of ongoing and evolving research and development, there may be potential actions or projects for which concepts are emerging or may emerge during the preparation of this SWEIS. Typically, such projects are still somewhat speculative or not at a sufficient stage of definition to allow for detailed NEPA analysis. These projects are not yet proposed (in the NEPA sense) and are not ripe for analysis in the SWEIS. If and when these projects are sufficiently defined, they would be subject to appropriate NEPA review at that time. For the purposes of public disclosure and to ensure the fullest possible description of site-wide activities, however, the following information is provided on some emerging projects.

- DOE currently is studying a variety of options for the renovation of infrastructure at TA–3 that would include replacing a number of aging structures either individually or as part of a multi-building effort. It is anticipated that one or more building replacements will be needed at TA–3. The construction would be of office and light laboratory buildings to continue housing the existing types of activities currently pursued at this TA. Planning for renovations and/or replacements is still being discussed, and impacts cannot yet be analyzed.
- An additional facility, the Los Alamos Nonproliferation and International Security Center, is also being studied. This building would consolidate about 80 percent of office and light laboratory activities undertaken at LANL for verification and intelligence purposes. The activities are currently undertaken in about 50 separate structures consisting of a variety of transportable facilities and various buildings spread out over five TAs. TA–3 is being considered as a potential site.
- As discussed further in chapter 4 (section 4.9.2.1) and chapter 6 (section 6.1.1) of this SWEIS, DOE and other users of electric power in the area have been working with suppliers to resolve foreseeable power supply and reliability issues. Some specific solutions to these issues are currently being examined for feasibility. In particular, DOE is examining the potential for constructing a power line that would extend from the existing Public Service Company of New Mexico (PNM) Norton substation southeast of LANL to existing LANL substations, and potentially to a new LANL substation (which would be constructed if this is determined to be a feasible solution).

As noted above, these projects would be subject to appropriate NEPA review when they are sufficiently defined for analysis.

1.6.4 Cooperating Agency

In November, 1995, DOE agreed to the request of the Incorporated County of Los Alamos, New Mexico, to be a Cooperating Agency in the preparation of the SWEIS. DOE and the County of Los Alamos believed this status to be appropriate given the interdependence of the county's planning and DOE's planning for LANL. DOE and the County of Los Alamos signed a Memorandum of Agreement that governs interactions with respect to the SWEIS. The county's participation in the SWEIS has included participation in planning meetings, development of analytical methodologies, data projections, and review of analyses for, and predecisional drafts of, the draft SWEIS. The county's participation has been greatest with respect to socioeconomic analyses, including utilities and infrastructure demands associated with LANL activities.

1.6.5 Organization of the SWEIS

The SWEIS is organized into four volumes and a classified appendix. The first volume contains the following parts:

- *Chapter 1* presents a description of LANL's role in supporting DOE's missions, the purpose and need for agency action, and an overview of the SWEIS.
- *Chapter 2* presents a detailed description of LANL's facilities and activities.
- *Chapter 3* describes the alternatives analyzed in the SWEIS and the alternatives not considered in detail, and provides comparison of the potential consequences of the alternatives for continued operations.
- *Chapter 4* presents a description of the affected environment as it exists under current conditions and provides the basis against which impacts resulting from actions under each alternative can be compared.

- *Chapter 5* describes the potential consequences that could result from implementing each of the alternatives.
- *Chapter 6* describes the mitigation measures that could be applied to minimize or reduce potential environmental consequences of the alternatives.
- *Chapter 7* presents a summary of the regulatory requirements and provides information on federal permits and licenses that apply to LANL operations, as well as agencies consulted in the preparation of this SWEIS.
- *Chapter 8* is a list of preparers of the SWEIS.
- *Chapter 9* is a list of individuals and organizations receiving a copy of the SWEIS.
- *Chapter 10* is a glossary of terms used in the SWEIS.
- *Chapter 11* contains copies of statements by contractors who worked on the SWEIS regarding potential conflicts of interest.
- *Chapter 12* is an index of key words or expressions used in this volume of the SWEIS.

The second volume of the SWEIS contains two parts and addresses the siting and construction impacts associated with the Expansion of TA–54/Area G Low-Level Waste Area (part I) and the Enhance of Plutonium Pit Manufacturing (part II).

The third volume of the SWEIS contains nine appendixes that present detailed information to support the analyses presented in chapter 5 of the SWEIS.

- Appendix A, Water Resources
- Appendix B, Air Quality
- Appendix C, Contaminant Data Sets Supporting Ecological and Human Health Consequence Analysis
- Appendix D, Human Health
- Appendix E, Cultural Resources
- Appendix F, Transportation Risk Analysis
- Appendix G, Accident Analysis
- Appendix H, Supplement Analysis for the Enhancement of Pit Manufacturing at Los Alamos National Laboratory, Stockpile Stewardship and Management Programmatic Environmental Impact Statement
- Appendix I, Report on the Status and Implications of Seismic Hazard Studies at LANL

The fourth volume of the SWEIS contains the public comments received on the draft SWEIS and DOE's responses. The volume contains three chapters.

- *Chapter 1* describes the public comment process for the draft SWEIS.
- *Chapter 2* discusses several topics associated with the comments received on the draft SWEIS that were of broad interest or concern. These topics were categorized as "Major Issues." This chapter reflects how these broad issues were considered.
- *Chapter 3* presents the comments received on the draft SWEIS and DOE's response to each individual comment.

The discussions in this SWEIS are augmented by a classified supplement to the SWEIS. This supplement contains certain classified information and data related to the activities at LANL that, though important to support understanding of certain details underlying the SWEIS and its analyses, must be protected in accordance with the *Atomic Energy Act of 1954* (42 U.S.C. §2011). This information includes details associated with some operations, experiments, processes, or source terms. DOE presents as much information as possible in this unclassified document. Furthermore, the environmental impacts are fully contained in the results presented to the public in this unclassified document.

DOE invited the EPA, the DoD, the Accord Pueblos, and the State of New Mexico to review the classified supplement. Only those individuals with appropriate clearances and a need to know were given access to the classified information.

References used for the preparation of this SWEIS are, to the extent practical, publicly available. To request assistance in obtaining or accessing any of these references, please contact Mr. Corey Cruz of DOE by the mechanisms described on the cover sheet for this volume.

1.7 CHANGES TO THE DRAFT SWEIS

DOE revised the draft SWEIS in response to comments received from other federal agencies; tribal, state, and local governments; nongovernmental organizations; the general public; and DOE reviews. The text was changed to provide additional environmental baseline information, to correct inaccuracies and make editorial corrections, and provide additional discussion of technical considerations to respond to comments and clarify text. In addition, DOE updated information due to events or decisions made in other documents since the draft SWEIS was provided for public comment in May 1998.

1.7.1 Summary of Significant Changes

1.7.1.1 *Revised Preferred Alternative*

In the draft SWEIS, the DOE's Preferred Alternative was the Expanded Operations Alternative. In this final SWEIS, the Expanded Operations Alternative remains the Preferred Alternative with one modification, as noted below. The modification to the Preferred Alternative involves the level at which pit manufacturing will be implemented at LANL. Under the Expanded Operations Alternative, DOE would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels, including the full implementation of pit manufacturing up to the capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts). However, as a result of delays in the implementation of the CMIP and recent additional controls and operational constraints in the CMR Building (instituted to ensure that the risks associated with the CMR Building operations are maintained at an acceptable level), the DOE has determined that additional study of methods for implementing the 50 pits per year production capacity is warranted. In effect, because DOE has postponed any decision to expand pit manufacturing beyond a level of 20 pits per year in the near future, the revised Preferred Alternative would only implement pit manufacturing at this level. This postponement does not modify the long-term goal announced in the ROD for the SSM PEIS (up to 80 pits per year using multiple shifts).

1.7.1.2 *Enhanced Pit Manufacturing*

As described above, as a result of delays in the implementation of the CMIP and recent additional controls and operational constraints in the CMR Building (section 2.2.2.3), DOE has postponed any decision to implement the pit manufacturing capability beyond a level of 20 pits per year (14 pits is the No Action level). DOE believes it can expand the pit manufacturing capability to 20 pits at TA–55 without significant infrastructure upgrades and still meet its near-term mission requirements. When the additional studies are completed, DOE will provide the appropriate NEPA review, tiered from this SWEIS, to implement the pit manufacturing capability beyond the 20 pits per year capacity. The PSSC analysis for the Enhancement of Plutonium Pit Manufacturing (in volume II of this SWEIS) no longer states a "Preferred PSSC Alternative." The Preferred Alternative would only implement pit production at a level of 20 pits per year. However, for completeness and to bound the impacts of implementing pit production at LANL, the "Utilize Existing Unused Space in the CMR Building" Alternative (the Preferred PSSC Alternative in the draft SWEIS) is still included in the Expanded Operations Alternative as the "CMR Building Use" Alternative. The ROD for the SWEIS will only include a decision regarding the operations to implement the pit production mission at LANL for up to 20 pits per year. This change is reflected in volume II, part II of the SWEIS.

1.7.1.3 *Wildfire*

The scenario that a wildfire could encroach on LANL was analyzed and included in the accident set presented for all the alternatives. The detailed wildfire analysis, referred to as the SITE–04 accident, is presented in appendix G, section G.5.4.4 of volume III of this SWEIS. A summary of the impacts is presented in chapter 5.

1.7.1.4 *Comparison Between the Rocky Flats Plant and LANL*

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and LANL are included in appendix G, section G.4.1.2. A summary is included in chapter 5.

1.7.1.5 *CMR Building Seismic Upgrades*

DOE has decided not to implement the seismic upgrades as part of the CMR Building Upgrades Project, Phase II, as a result of: (1) new seismic studies (chapter 4, section 4.2.2.2, and appendix I) released after the draft SWEIS was issued indicating the additional hazard of a seismic rupture at the CMR Building and (2) DOE's postponement of any decisions to implement the pit manufacturing capability beyond 20 pits per year in the near future. Although the seismic rupture risk does not have a substantial effect on the overall seismic risk (chapter 2, section 2.2.2.3), it is an aspect of risk that cannot be cost-effectively mitigated through engineered structural upgrades. Given that assessment, the DOE is considering more substantial actions that are not yet ripe for analysis in the SWEIS (e.g., replacement of aging structures). The overall goal of DOE's evaluation is ultimately to reduce the risk associated with a seismic event, should one occur. In the meantime, DOE is taking actions to mitigate seismic risks through means other than seismic upgrades (e.g., minimizing material-at-risk and putting temporarily inactive material in process into containers). In any event, DOE is presenting the larger and more conservative impacts (no seismic upgrades) for the SITE–01, SITE–02, and SITE–03 accidents. Therefore, SITE–01, SITE–02, and SITE–03 accidents were revised to include new seismic data published after the draft SWEIS was released and to exclude the mitigation of the impacts of implementing the seismic upgrades. The detailed revised analysis is presented in appendix G. A summary of the impacts is presented in chapters 3 and 5.

1.7.1.6 *Strategic Computing Complex*

The impacts of constructing and operating the proposed SCC project, primarily electric power demand and water usage, were incorporated into all the alternatives analyzed. Water usage was not increased in these analyses because DOE and LANL committed to no net increase of water as a result of conservation measures and recycling of treated wastewater from the Sanitary Wastewater Systems Consolidation Plant, TA–46, as cooling water for the SCC project.

1.7.1.7 *Conveyance and Transfer of DOE Land*

DOE has begun the preparation of an EIS for the Conveyance and Transfer of Certain Land Tracts at LANL. The CT EIS, scheduled to be released in draft form for public review and comment in early 1999, will analyze the impacts of conveying and transferring certain tracts of land to the County of Los Alamos and the U.S. Department of the Interior in trust for the Pueblo of San Ildefonso. The CT EIS also will present the cumulative impacts of the land being developed by either the County of Los Alamos or the Pueblo, as well as the impacts of continuing to operate LANL.

1.7.2 Next Steps

The ROD, to be published no sooner than 30 days after NOA for the final SWEIS has been issued, will explain all factors, including environmental impacts, that the DOE considered in reaching its decision. The ROD also will identify the environmentally preferred alternative or alternatives. If mitigation measures, monitoring, or other conditions are adopted as part of DOE's decision, these will summarized in the ROD, as applicable, and will be included in the Mitigation Action Plan that would be prepared following the issuance of the ROD. The Mitigation Action Plan would explain how and when mitigation measures would be implemented and how the DOE would monitor the mitigation measures over time to judge their effectiveness.

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CHAPTER 2.0
BACKGROUND ON LOS ALAMOS NATIONAL LABORATORY FACILITIES AND ACTIVITIES

This chapter provides a description of the activities and facilities at LANL. The chapter includes a description of the 49 technical areas and focuses on the activities at 15 key facilities. The role of the University of California in LANL's operation and recent funding levels are also presented.

LANL's current activities stem from its original mission to build the world's first nuclear weapon. In March 1943, a small group of scientists led by J. Robert Oppenheimer, came to the small community of Los Alamos to carry out Project Y of the Manhattan Project (1943 through 1945).

Although the original mission was assigned to a few hundred scientists and technicians, by the time the first nuclear bomb was tested at Trinity Site, the Los Alamos Laboratory consisted of more than 3,000 civilian and military personnel. In 1947, Los Alamos Laboratory was renamed the Los Alamos Scientific Laboratory, and in 1981 it was designated as a national laboratory and became LANL. Following World War II, LANL activities continued to focus on nuclear defense and related research and development, but gradually expanded to include nuclear energy and other high-technology civilian research and development, and over time grew to serve other government and civilian programs.

This chapter provides an overview of LANL's activities, both direct-funded (section 2.1.1) and support activities (section 2.1.2). It includes a discussion of responsibilities associated with operational safety at LANL (section 2.1.3). It also provides a description of LANL's technical areas (TAs) (section 2.2.1), the 15 facilities that were identified as key facilities for purposes of the SWEIS (section 2.2.2), and identification of nuclear and moderate hazard non-key facilities (section 2.2.3). Sections 2.3 and 2.4 discuss the role of the University of California (UC) at LANL and recent LANL funding levels, respectively.

2.1 OVERVIEW OF LANL ACTIVITIES

The mission assignments and programs at LANL are discussed in chapter 1. However, the essence of operations at LANL lies in its various research and development and some fabrication activities, as well as the support activities. These serve as the foundation upon which new assignments and tasks build and rely. These activities are described in this section.

LANL is funded primarily to use its capabilities in undertaking a broad range of theoretical and experimental research and development, as well as several production activities, for DOE and other federal agencies (these are referred to as direct-funded activities). Various support activities throughout LANL are essential to these undertakings.

Research and development activities are dynamic by their very nature, with the norm being continual change within the limits of facility capabilities, authorizations, and operating procedures. This section describes the direct-funded activities at LANL in three (overlapping) major areas:

- Theory, modeling, analysis, and computation (section 2.1.1.1)

- Experimental science and engineering (section 2.1.1.2)
- Advanced and nuclear materials research, development, and applications (section 2.1.1.3)

In addition, this section describes the support services needed to operate the site, such as site-wide management activities and ecological and natural resource management.

2.1.1 Categories of Direct-Funded Activities

The operations of LANL are diverse and dispersed throughout the large government reservation. A general description of the types of direct-funded activities undertaken at LANL can be summarized as follows.

2.1.1.1 *Theory, Modeling, and High Performance Computing*

This class of research and development includes theoretical activities that are primarily directed toward model development, analysis, and assessment. Individual research activities integrate basic theory and experimental data across multiple disciplines into realistic analytical and simulation models; analyze and validate the models through comparison with experiments (including dynamic and hydrodynamic tests) and other expert information; or integrate the models into computer programs for the assessment of complex systems. Examples of such complex systems include weapons performance and surety, energy systems, military systems, transportation, atmosphere and ocean environments, manufacturing and materials processes, nuclear facility performance and safety, and health system analysis. Another aspect of LANL activities of this type is fundamental theory in areas such as nuclear and particle physics, astrophysics, biology, plasma and beam physics, and materials.

Theory, modeling, and high-performance computing combines fundamental theory and numerical solution methods with high-performance computing to model a broad range of physical, chemical, and biological processes.

The operations supporting theory, modeling, and high-performance computing present risks similar to those of commercial or university administrative and research facilities; these are typically risks of industrial accidents/incidents.

2.1.1.2 *Experimental Science and Engineering*

Experimental science and engineering undertaken at LANL ranges from small-scale laboratory experimental activities and testing to the operation of one-of-a-kind facilities for measurements with radioactive, explosive, and hazardous materials and processes.

Experiments are conducted in nuclear and particle physics, astrophysics, chemistry, atomic and plasma physics, accelerator technology, hydrodynamics, laser science, and beam physics, as well as a wide range of technology applications of neutron scattering, transmutation technologies, plasma processing, radiography, microlithography, inertial fusion, and Earth and environmental sciences. The capability includes integrating theory and modeling with measurements from experiments that are made using a wide variety of instruments and techniques over a range of physical conditions.

These activities often utilize energy sources such as accelerators, high-powered lasers, high explosives, and pulsed-power systems. For example, Atlas and Pegasus-II provide pulse power for initiating hydrodynamic and other experiments and are located at TA–35, as is the Trident laser. (Atlas was analyzed in a project-specific appendix to the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (SSM PEIS)

[DOE 1996a, Appendix K]). Many smaller lasers and pulsed-power devices are used throughout LANL. Analysis related to these types of experiments is conducted at several locations throughout LANL and supports further theoretical development.

The hazards associated with experimental science and engineering work are primarily due to the presence of energy sources, such as lasers, explosives, accelerator beams, and electricity. These energy sources pose the risk of injury or death to workers; however, they pose minimal risk to the public because the public does not have access to the energy sources. Other risks associated with this type of work are similar to industrial, administrative, and research work and could result in accidents/incidents. Specific experiments that use radioactive or other hazardous materials also involve risk to workers and to the public associated with exposure to such materials. (Public risk is associated with the radioactive and hazardous contents of effluents and emissions.)

A similar energy source at LANL is a very high powered radiofrequency source called the "Antenna Test and Calibration Range," which is an outdoor test range at TA–49. As with lasers and other energy sources, the primary hazards associated with this type of work are due to the energy sources (which pose a risk to workers) and other hazards typical of industrial, administrative, and research work that could result in accidents/incidents. Specific experiments that use radioactive or other hazardous materials also involve risk to workers and to the public associated with exposure to such materials.

2.1.1.3 *Advanced and Nuclear Materials Research, Development, and Applications*

These activities include those which are theoretical and experimental in nature, but because they are often focused on hazardous and nuclear materials, may require unique facilities and equipment.

Advanced materials include energetic materials (such as high explosives and detonators), hazardous materials (such as beryllium and toxic organics), and structural materials (such as high load-bearing metals and metal alloys, intermetallic compounds, ceramics, and certain organics such as plastics and polymers). Nuclear materials include highly enriched uranium, tritium, and transuranics (including plutonium). These materials are used both in weapons and nonweapons research, development, and applications.

Activities under this category include research regarding the nature of materials, for example:

- Physical and chemical behavior in a variety of environments
- Development of technologies for handling and processing hazardous and nuclear materials
- Development of fabrication technologies
- Development of measurement and evaluation technologies

In addition, the activities in this area include casting, forging, extruding, drawing, forming, and machining materials, including metals, ceramics, polymers, and electronic materials of many types in both bulk and thin film forms into complex shapes over a range of sizes. Applications include: complex electronic materials development and characterization; development and use of thin films, coatings, and membranes; and fabrication of components for nuclear weapons (e.g., for primaries, gas reservoirs, and secondaries) or mock-ups of such components and parts for research on the behavior of materials.

The hazards associated with this type of work are those associated with energy sources (as discussed in section 2.1.1.2 above), industrial accidents/incidents, exposure to hazardous materials, and exposure to radioactive materials. While all of these hazards could affect workers, hazardous and radioactive constituents in emissions and effluents, and radiation exposures associated with the handling of nuclear materials also have the potential to affect the public and the environment.

2.1.2 Supporting Activities

As with the research and development activities across LANL, many of the support activities and infrastructure of LANL have varied within a range of activities. Such activities are expected to continue with similar variance under all of the SWEIS alternatives. In addition, renovations and some increased power, water, and natural gas supplies will be required regardless of which alternative is chosen.

These supporting activities, which are not expected to change among the alternatives, are:

- Most aspects of site-wide waste management
- Infrastructure and central services
- Facility maintenance and refurbishment
- Environmental, ecological, cultural, and natural resource management; and environmental restoration, including decontamination and decommissioning

These activities are crucial to LANL's capabilities in supporting its assigned missions. However, these activities present minimal risk to the public and the environment, and the risks posed to workers are similar to those in any research laboratory (the site-wide consequence analyses do include the contribution of these operations). These activities are described below.

2.1.2.1 *Waste Management*

Waste treatment, storage, and disposal, although not the primary business at LANL, are central to all facilities and TAs within LANL. Sewage wastes and industrial solid (nonhazardous under the *Resource Conservation and Recovery Act* [RCRA]) wastes at LANL are managed similarly to commercial and municipal practices for these wastes throughout northern New Mexico (including use of sewage treatment plants and landfills). These are discussed in section 4.9.3 and are not elaborated upon further here. Radioactive and chemical wastes that result from LANL operations receive treatment in accordance with regulatory requirements and are stored for off-site disposal or are disposed of in designated sites at LANL.

DOE directed the preparation of waste management strategies for treatment, storage, and disposal of LANL-generated radioactive and hazardous chemical waste (*Waste Management Strategies for LANL*, LANL 1998b). The current strategy at LANL is characterized by utilization of existing on-site capabilities and cost-effective treatment and disposal. In addition, DOE also considered two other strategies: minimizing the on-site treatment and disposal and maximizing the on-site treatment and disposal. In *Waste Management Strategies for LANL*, these three strategies are applied (to the extent practicable) to each radioactive and chemical waste type generated at LANL for the volumes of waste projected under each SWEIS alternative. Additionally, each waste type is subdivided into treatability groups (groupings of waste types that would undergo similar treatment and disposal activities). Specific plans for treatment and disposal of LANL-generated waste are presented in *Waste Management Strategies for LANL* for each waste type by treatability group (LANL 1998b).

Only the current strategy is carried through the SWEIS alternative descriptions and analyses, for all waste types across the alternatives. An examination of the changes caused by employing these different strategies did not reveal any deciding factors that would cause a change in the current strategy for most waste streams. Low-level radioactive mixed waste (LLMW) (which is a mixture of hazardous and low-level radioactive waste [LLW]) is primarily shipped off the site for treatment and disposal, with minimal on-site treatment. LANL is a minor user of these off-site facilities, and no capacity constraints have been noted. A change in this strategy would require the development of on-site treatment and disposal capability, which is not currently envisioned. Should conditions change such that a specific proposal might become viable in the future (such as a substantial change in waste volume [e.g., if LANL were chosen as a regional disposal site for LLMW disposal, as discussed in chapter 1, section 1.5.1] or type), an analysis would be done at that time. Transuranic (TRU) waste is treated on site and stored pending shipment to the Waste Isolation Pilot Plant (WIPP), consistent with recent DOE decisions (discussed in SWEIS sections 1.5.1 and 1.5.3). LLW is the only waste type where more than one viable strategy exists, and those options are evaluated in this document. The limited disposal space remaining in Area G, and the potential effects of the Waste Management Programmatic Environmental Impact Statement (WM PEIS) Record of Decision (ROD), causes DOE to evaluate the effects of expanding Area G or pursuing a strategy of shipping LLW off the site. The differences in these strategies are reflected in the differences between the alternatives (Expanded Operations is the only alternative that includes expansion of Area G). The project-specific siting and construction (PSSC) analysis for the expansion of Area G in volume II of this document reflects siting and construction alternatives for on-site disposal of LLW.

The principal radioactive and hazardous chemical waste management facilities at LANL are located at TA–50 and TA–54. A wide variety of waste types are managed at these facilities, and these wastes are generated in gaseous, liquid, and solid forms throughout LANL. These include administratively controlled industrial solid wastes, toxic wastes, hazardous wastes, LLW, TRU wastes, and mixtures of the above (e.g., radioactively contaminated asbestos, which is a toxic radioactive waste). The management of these wastes requires many different activities, including waste minimization, waste characterization, volume reduction, and waste treatment, storage, and disposal operations. Detailed analyses of the waste management operations across the SWEIS alternatives are focused on those activities conducted at TA–50 and TA–54. All other waste management activities (outside of those performed in these two facilities) are not expected to change among alternatives.

Pollution prevention programs are common to all alternatives as well. These programs have been successful in reducing overall LANL wastes requiring disposal by 30 percent over the last 5 years. These programs are site wide but have facility-specific components, especially for the larger generators of radioactive and hazardous chemical wastes. Waste projections developed by alternative reflect only demonstrated waste minimization and pollution prevention improvements. Past reductions, however, indicate that this is a conservative assumption and that actual waste generated in the future should be less than that projected. The *Site Pollution Prevention Plan for Los Alamos National Laboratory* (LANL 1997a) describes the LANL Pollution Prevention and Waste Minimization Programs, as well as general program descriptions, recently implemented actions, specific volume reductions due to recent actions, and current development/demonstration efforts that have not yet been implemented.

The DOE Stockpile Management Process Development Program also plays an important role in pollution prevention. This program assures the improvement of current production processes for regulatory compliance and efficiency and the development of processes expected to be used for future production.

Numerous initiatives have been and are currently being funded through this program, which will minimize the waste being generated from production activities. Additional initiatives are anticipated in the upcoming years, which will result in avoidance of TRU and mixed TRU waste at the point of generation. Process Development Program tasks associated with waste minimization include electrorefining and molten salt extraction processing, glovebox decontamination, supercritical carbon dioxide cleaning development, chloride solvent extraction, enhanced waste immobilization, nitric acid recycle and nitrate destruction, density measurement technology, in-line TRU waste assay and packaging, plutonium machining development, reusable coated metal molds for casting, and plutonium die casting.

As with the pollution prevention program, the SWEIS waste projections only take credit for demonstrated technologies; actual waste generation should continue to be reduced due to this program. A description of the major stockpile management waste reduction initiatives is included in the *Waste Minimization Activities for Pit Production at LANL* (LANL 1996a).

2.1.2.2 *Infrastructure and Central Services*

LANL has 2,043 structures containing 7.9 million square feet (734,700 square meters), of which 1,835 are buildings, totaling 7.3 million square feet (678,900 square meters). The other structures consist of such items as meteorological towers, pumphouses, water towers, manhole covers, and small storage sheds. According to LANL's Fiscal Year (FY) 1997–2002 Institutional Plan (LANL 1996b), administration occupies 25 percent of LANL space, and storage and services (including power facilities) occupy approximately 20 percent (Figure 2.1.2.2–1). In other words, central services and infrastructure use almost half of LANL's facilities and space. These activities include:

- *Administrative/Technical Services*—Facilities used for support functions that include the Director's Office; Business; Human Resources; Facilities, Security and Safeguards; Environment, Safety, and Health; and communications.
- *Public/Corporate Interface*—Facilities, both restricted and unrestricted, that allow public and corporate access and use, including such facilities as the Oppenheimer Study Center, Bradbury Museum, and special research centers.
- *Physical Support and Infrastructure*—Facilities used for physical support of other laboratory facilities. These include warehouses, general storage, utilities, and wastewater treatment.

The natural gas and electric power needs at LANL are interdependent and are presented in this SWEIS by alternative. Options to meet the increased capacity, as well as reliability needs, are being studied and involve multiple organizations and communities in the area. Beyond simple maintenance and replacement as needed for components of these systems, a project-specific NEPA review will be conducted when sufficient definition for the specific options to meet projected needs has been developed.

While demand for water and electricity differs among alternatives, there are no changes proposed in this SWEIS with respect to DOE operations to provide and distribute these resources at LANL. Thus, these operations do not change across the alternatives analyzed and are included in all alternatives.

2.1.2.3 *Maintenance and Refurbishment*

LANL facilities have an estimated replacement cost of $4.2 billion, which includes buildings,

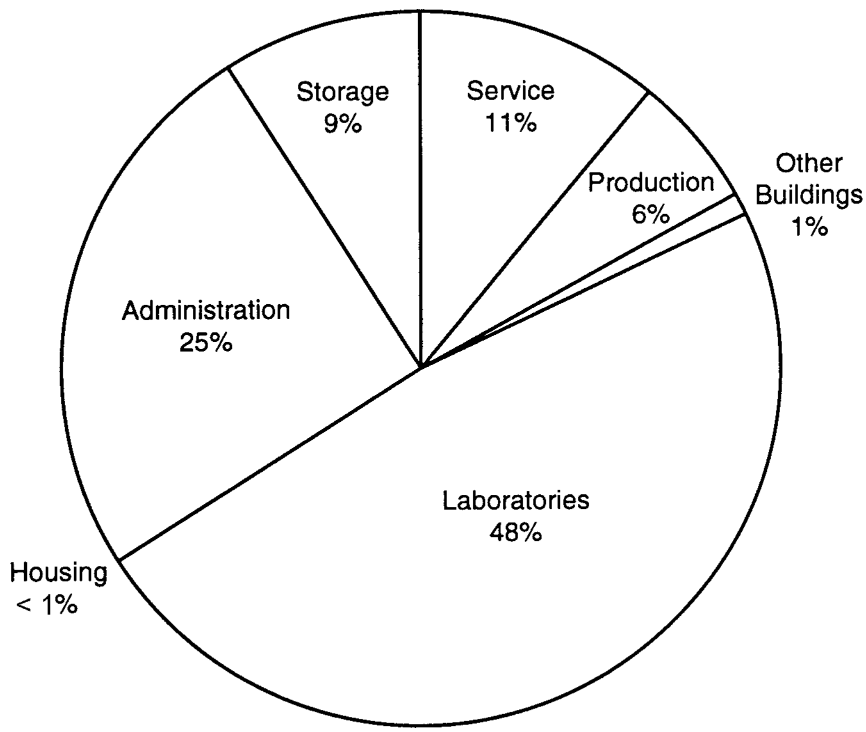


FIGURE 2.1.2.2–1.—*Gross Space Utilization by Function.*

infrastructure, and capital equipment. Many of the facilities at LANL are essential for DOE to meet mission requirements.

Many of the existing LANL facilities and equipment are approaching, or have already exceeded, their design life. Thus, the activities and cost to maintain these facilities and upgrade them to current standards are increasing. Currently, approximately 30 percent of laboratory facilities are more than 40 years old, with close to 80 percent of LANL facilities more than 20 years old. The 20-year design life of a facility is considered the standard age at which facility maintenance and operating costs significantly increase.

Many of these facilities are or soon will be one-of-a-kind in the consolidated DOE complex. Thus, their continued availability is essential for DOE to meet its mission requirements. Examples of the routine maintenance and refurbishment activities necessary to accomplish this and that are now underway or planned for each of the alternatives include:

- Maintaining and extending on-site roads and parking areas
- Replacing apparatus and components such as pumps and filters to retain and improve the performance and extend the usefulness of buildings and equipment
- Cleaning, painting, repairing, and servicing buildings, utility lines, and equipment
- Routine decontamination of equipment and facilities
- Erecting, operating, and demolishing support structures
- Relocating and consolidating equipment and operations from one building or area to another where similar activities are being performed
- Placing facilities in a safe shut-down condition when they will not be used for some time, if ever

DOE and LANL have the responsibility to upgrade buildings and equipment in order to protect the health, safety, and comfort of the operating personnel, the general public, and the environment (as discussed in section 2.1.3). Although these upgrades are often made in response to changed regulations, they are also made as proactive changes to prevent deterioration. These activities generally do not individually or collectively have significant impacts to the environment. These are accomplished within the organized framework of the laboratory support organization, including the waste management system. Typically, these upgrades are made in and around existing buildings, in developed areas, and along existing roadways. Examples of upgrades to enhance health, safety, and environmental protection include:

- Installing and maintaining high efficiency particulate air (HEPA) filters in work enclosures and building air exhaust systems
- Installing detection and emergency equipment such as radiation monitors, wash stations, and alarms
- Removing hazardous, toxic, and radioactive materials from buildings and areas to protect worker health and the environment
- Regrading, contouring, and revegetating disturbed areas
- Cutting and clearing fire protection buffers around facilities

Some of the typical maintenance and refurbishment projects at LANL are specific to the protection of the facilities, equipment, information, and materials located at LANL. There are specific upgrades being undertaken at LANL facilities to ensure compliance with safeguards and security requirements of DOE. Typically, these include replacement of equipment with similar items, upgrades to remove obsolete equipment, and upgrades to incorporate state-of-the-art technology. Those upgrades that are common to all SWEIS alternatives are those that need to be implemented in order to maintain the viability of existing facilities and ensure the availability of existing capabilities. Upgrades required for all alternatives for continued operations include:

- New security host systems (computer and software) including replacing some communications systems
- Replacement of sensors in Perimeter Intrusion Detection and Alarm Systems
- Installation of required alarms and access control panels

2.1.2.4 *Environmental, Ecological, and Natural Resources Management Activities*

DOE is responsible for the natural resources at LANL as a Natural Resources Trustee (DOE 1996d). In order to fulfill this responsibility, DOE and UC, as the DOE management and operating contractor for LANL, are implementing a Natural Resources Management Program integrating the ongoing natural resources management activities at LANL, which include:

- *Biological Management*—Includes research and characterization of biological resources (e.g., nongame and game species, wetlands and vegetation), habitat stabilization and renovation as necessary, and wildlife management.
- *Forest Management*—Addresses wildfire prevention, forest condition assessment, forest maintenance (including thinning and controlled burns), and firewood sales.
- *Threatened and Endangered Species Habitat Management*—Implements DOE responsibilities under the requirements of the *Endangered Species Act*, including species surveys and monitoring, habitat characterization and delineation, and implementation of project-specific mitigation and management measures, as needed.

- *Groundwater Protection*—Activities emphasize monitoring and characterization of groundwater resources, including the installation and maintenance of wells throughout LANL, sampling, analysis and characterization of quantities and qualities of groundwaters.
- *Watershed Management*—Activities include installation and maintenance of surface water monitoring stations, routine sampling and characterization, and surface water drainage stabilization and maintenance.
- *Air Quality Management*—Activities include installation of equipment and monitoring of stack emissions, ambient air quality monitoring stations, and air quality sample collection and analysis.

Results of these ongoing programs are reported in the LANL annual surveillance reports and other LANL documents. In addition, there are numerous small-scale research and development activities seeking to quantify the transport, fate, and effects of contaminants from historical LANL operations on environmental media and biological receptors. Some of these research and development activities are associated with the LANL Environmental Restoration Project.

Natural resources management activities are included in the site-wide analysis contained in all alternatives. These efforts are generally nonintrusive monitoring and surveillance activities that result in little disturbance to the environment. Construction activities for new wells or sampling stations undergo NEPA review as they are identified and proposed for development.

2.1.2.5 *Environmental Restoration*

Areas of known or suspected contamination resulting from past operations (i.e., legacy contamination) are being addressed by the Environmental Restoration (ER) Project. The ER Project at LANL was established by DOE in 1989 to assess and remediate potentially contaminated sites that either were or still are under LANL control. In 1996, the DOE Office of Environmental Management (EM) initiated a complex-wide strategy to accelerate site cleanup and enhance performance of the cleanup program. The national strategy focuses in particular on completing as much work as possible by the end of fiscal year 2006. Known as *Accelerating Cleanup: Paths to Closure* Report (DOE 1998b) (previously known as "2006 Plan"), it includes input from all major field sites, including LANL, to support EM's program planning process.

The ER Project is ongoing and its implementation is unaffected by the changes examined in the four alternatives in the SWEIS. The ER Project is included in all alternatives.

The primary objectives of LANL's ER Project are: (1) to protect human health and the environment from exposure to releases of wastes; (2) to meet the environmental cleanup requirements of the Hazardous and Solid Waste Amendments Module VIII of LANL's permit to operate under RCRA; (3) to conduct closure of historical treatment, storage, and disposal facilities; and (4) to decommission contaminated facilities considered to be surplus.

The ER Project provides formal and informal mechanisms through which stakeholders can participate in this corrective action process. NEPA review of corrective actions is performed as soon as enough information is available to make a meaningful determination on the appropriate level of review or analysis. These analyses, in combination with the remediation plans, are available to the public for review.

About 2,120 potential release sites (PRSs) have been identified at LANL by the ER Project. These sites are a combination of potential solid waste management units identified in the RCRA permit for LANL and potentially contaminated sites called "areas of concern," which may contain hazardous substances, such as radionuclides, that are not regulated under RCRA. As of September 1997, 1,370 of these sites had been identified as requiring no further action based on human health concerns; these sites will be reviewed in the future for ecological concerns. Included in these ecological concerns are threatened and endangered species.

The *Accelerating Cleanup: Paths to Closure* document (DOE 1998b) includes a schedule for the cleanup of the remaining approximately 700 to 750 sites. This schedule encompasses a period of 10 years, beginning with fiscal year 1998 and ending in fiscal year 2008. The number of cleanups per year varies from approximately 18 in fiscal year 2008 to 100 in fiscal year 2002. An important and integral part of the cleanup methodology and the need for any interim protection measures is ecological risk, which, again, includes threatened and endangered species. The location of threatened and endangered species, their habitat, or potential habitat in relation to these sites is an integral part of the site cleanup prioritization process.

Prior to 1994, the PRSs were organized into 24 operable units (OUs), for which RCRA Facility Investigation (RFI) work plans were written. In an effort to streamline the characterization and remediation process at LANL, the OUs were grouped into five field units (FUs). A sixth FU includes all of the Decommissioning Project areas. Geographic locations of the OUs are shown on Figure 2.1.2.5–1. While OUs are no longer used, they have been used in the recent past and in some of the documents used as references in the SWEIS. Table 2.1.2.5–1 presents the relationships between FUs, OUs, and TAs and the waste types that could be generated during characterization and remediation activities (note that Figure 2.2.1–1 reflects the locations of the TAs at LANL). Projection of waste types and quantities anticipated from remediation activities at the LANL PRSs over the lifetime of the ER Project (approximately the next 10 years) are included in the total waste projections for each of the SWEIS alternatives.

The LANL PRSs are diverse and include past material disposal areas (landfills), canyons, drain lines, firing sites, outfalls, and other random sites such as spill locations. The primary mechanisms for contaminant release from the ER sites are surface-water runoff carrying potentially contaminated sediments and soil erosion exposing buried contaminants. The main pathways by which released contaminants can reach off-site residents are through infiltration into alluvial aquifers, airborne dispersion of particulate matter, and sediment migration from surface-water runoff. The contaminants involved include volatile and semivolatile organics, polychlorinated biphenyls (PCBs), asbestos, pesticides, herbicides, heavy metals, beryllium, radionuclides, petroleum products, and high explosives.

Since 1990, LANL's ER Project has conducted over 100 cleanups. The ER Project has also decommissioned over 30 structures and conducted three RCRA closure actions during this period. Some major decommissioning activities are listed in Table 2.1.2.5–2. During these actions, no significant worker health and safety occurrences or environmental reportable incidents (contaminant releases) were reported.

DOE provides for surveillance, maintenance, decontamination, and decommissioning services for LANL's contaminated surplus or abandoned facilities following DOE guidelines and applicable regulations. The project's goal is to ensure that future programmatic uses of remaining facilities or surrounding areas are permitted without restriction. Major decontamination and decommissioning activities scheduled for completion in the next 10 years are shown in Table 2.1.2.5–3.

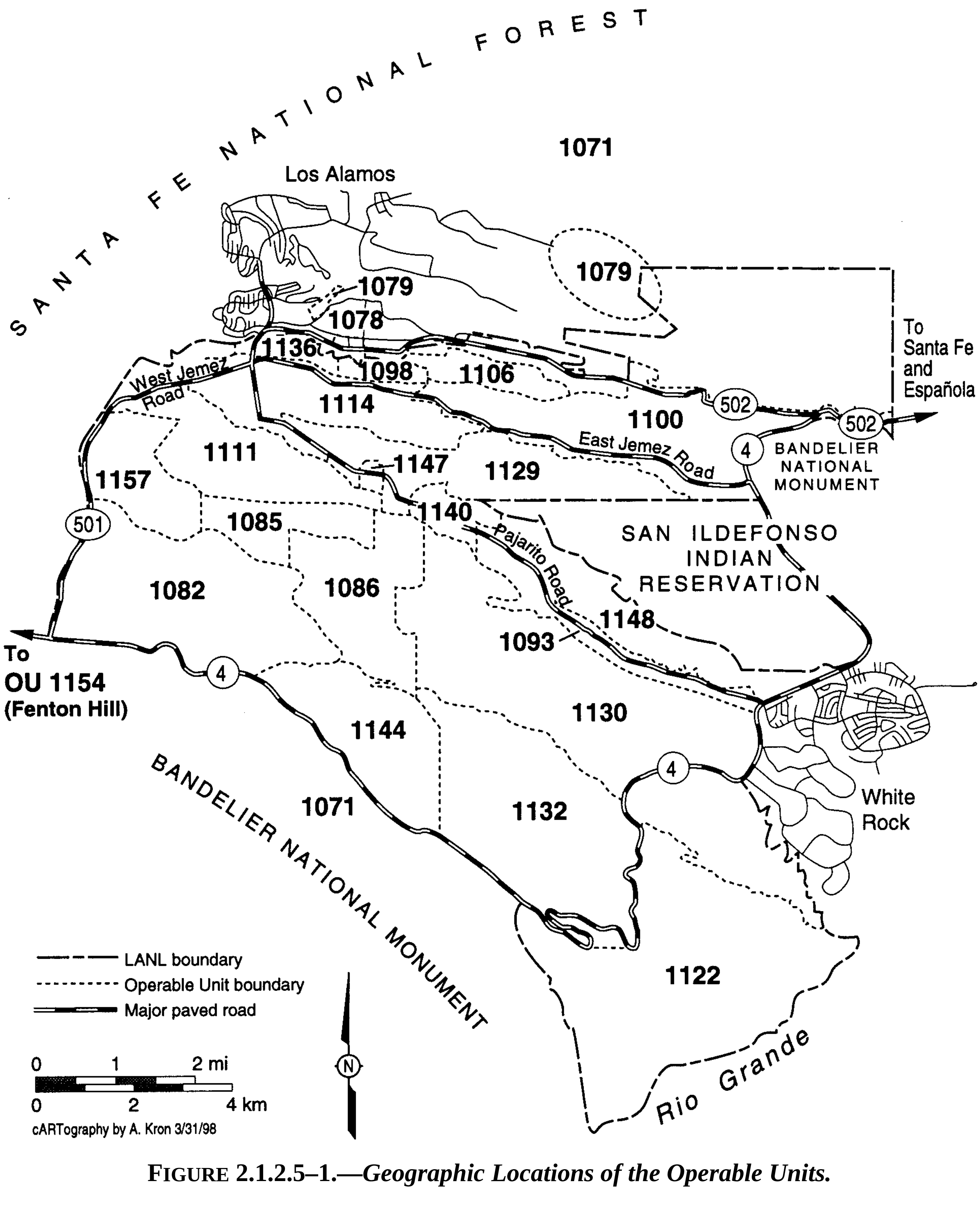


FIGURE 2.1.2.5–1.—*Geographic Locations of the Operable Units.*

TABLE 2.1.2.5–1.—*Summary of Environmental Restoration Project Field Units, Technical Areas, Operable Units, Potential Contaminants, and Waste Types Generated During Characterization/Remediation*

ER FIELD UNIT	LOCATION (TECHNICAL AREAS AND OPERABLE UNITS)	ENVIRONMENTAL RESTORATION SITES	CONTAMINANTS OF CONCERN	WASTE TYPES TO BE GENERATED DURING CHARACTERIZATION REMEDIATION
1	*TAs* 0, 1, 3, 10, 19, 21, 26, 30, 31, 32, 43, 45, 59, 60, 61, 64, 73, and 74 *OUs* 1071, 1078, 1079, 1106, 1114, and 1136	Consist of 664 potential release sites at Los Alamos townsite, old plutonium processing facility, municipal sanitary landfill, and historic land areas	High explosives, volatile and semivolatile organics, PCBs, asbestos, pesticides, heavy metals, radionuclides, and petroleum products	RCRA organics, RCRA metals, LLW, PCBs, industrial, sanitary, LLMW
2	*TAs* 12, 14, 15, 18, 20, 27, 36, 39, 53, 65, 67, 68, 71, and 72 *OUs* 1085, 1086, 1093, 1100, 1130, and 1132	Consist of 301 potential release sites all within DOE-controlled land at active/inactive firing sites, nuclear criticality research facility, and 0.5-mile (0.8-kilometer) long linear proton accelerator	Radionuclides, high explosives, organics, and heavy metals	RCRA organics, RCRA metals, LLW, LLMW
3	*TAs* 11, 13, 16, 24, 25, 28, 33, 37, 46, and 70 *OUs* 1082, 1122, and 1140	Consist of 555 potential release sites all within DOE-controlled land used for development and processing of high explosives and reactor components	High explosives, volatile and semivolatile organics, PCBs, asbestos, pesticides, herbicides, and radionuclides	RCRA organics, RCRA metals, LLW, PCBs, industrial, LLMW
4	*TAs* 2, 4, 5, 35, 41, 42, 48, 52, 55, 63, 66, and Canyons *OUs* 1049, 1098, and 1129	Consist of 260 potential release sites including 110 miles (177 kilometers) of canyon systems, reactor site, and other sites within DOE-controlled land	Radionuclides, high explosives, volatile and semivolatile organic compounds, and inorganics including heavy metals	RCRA organics, RCRA metals, LLW, LLMW
5	*TAs* 6, 7, 8, 9, 22, 23, 40, 49, 50, 51, 54, 57, 58, 62, and 69 *OUs* 1111, 1144, 1147, 1148, 1154, and 1157	Consist of 313 potential release sites including explosives development areas, major waste management areas, and the Fenton Hill geothermal site in the Jemez Mountains	Radionuclides, high explosives, volatile organic compounds, and metals	RCRA organics, RCRA metals, LLW, industrial, sanitary, asbestos, LLMW, TRU, mixed TRU
6	All TAs where surplus facilities are located	Facilities considered excess or surplus including the TA–35 Phase Separator Pit, TA–21 DP West Site, TA–33 Tritium Facility, TA–16 High Explosives Areas	Tritium, low-level radionuclides, asbestos, heavy metals, acids, volatile and semivolatile organics, high explosives	RCRA organics, RCRA metals, LLW, asbestos, LLMW, TRU, high explosives, mixed TRU

TABLE 2.1.2.5–2.—*Major Decommissioning Activities Completed to Date at LANL*

LOCATION	DECOMMISSIONING ACTIVITY	YEAR
TA–33–21	Disposition of a plutonium-contaminated experimental facility	1975
TA–21–12	Demolition of a plutonium filter facility	1975
TA–21–153	Decommissioning of an actinium-contaminated filter building	1981
TA–35	Decommissioning of the Los Alamos Molten Plutonium Reactor Experiment (LAMPRE I)	1981
TA–35	Decommissioning of a titanium-contaminated laboratory	1981
TA–35–7	Removal of contaminated air scrubbers	1981
TA–42	Decommissioning of a plutonium-contaminated incinerator facility	1981
TA–21	Decontamination of plutonium facility at DP West	1982
TA–3 to TA–50	Removal of radioactive liquid waste lines parallel Diamond Drive and Pajarito Road	1986
TA–2	Decommissioning of the water boiler reactor	1991
TA–52	Decommissioning of a reactor facility	1991
TA–35	Decommissioning of the Los Alamos Power Reactor Experiment (LAPRE II)	1991
TA– 35	Phase separator pit	1997

TABLE 2.1.2.5–3.—*Future Decommissioning Activities at LANL*

LOCATION	DECOMMISSIONING ACTIVITY	COMPLETION YEAR
TA–16	Certain high explosives areas at S-Site	2007
TA–21	Decommissioning of TA–21, DP West Site	2004
TA–33	Building 86, Tritium Facility	1999

2.1.3 Responsibilities for Safe Operations at LANL

This section describes the responsibilities for the safe operation of LANL, with a focus on nuclear facilities, as well as the policies and procedures in place to establish an understanding of the hazards and risks associated with these operations; to control operations such that workers, the public, and the environment are protected; and to improve safety performance and reduce the risks associated with the operation of LANL. This section provides an overview of these topics; other documents are cited that provide more comprehensive discussions.

DOE performs much of its work through its contractors. Therefore, the day-to-day responsibility for safe operation of nuclear facilities has also been delegated to contractors (e.g., UC at LANL). Through this delegation, the responsibility becomes shared but not relinquished by DOE. DOE line managers are responsible for assuring the safety of operations assigned to them, and this responsibility is delegated in part to contractors through formally established policies, programs, and processes.

There are numerous processes and levels of oversight for operations in existing nuclear facilities, for upgrades or changes to operations in existing nuclear facilities, and for start/restart of operations in existing or new nuclear facilities. All operations in DOE nuclear facilities are conducted only with authorization by DOE to operate. The form of DOE authorization is determined based on the hazard of the operations in the facility (including types and amounts of nuclear materials) and the evaluated risk of operating the facility. These evaluations may be in the form of a safety analysis report, a safety evaluation report, a Basis for Interim Operation, or other analysis or assessment document. (These are established in DOE Order 5480.22, *Technical Safety Requirements*, and DOE Order 5480.23, *Nuclear Safety Analysis Reports*.)

Contractor line management must operate nuclear facilities in accordance with the authorized DOE safety basis. LANL also operates within a standards-based Integrated Safety Management System (currently being implemented at DOE sites, including LANL) approved by DOE and contractually binding on UC for LANL operations. This system integrates the concept of “doing work safely” by institutionalizing the planning and execution of activities with the controls necessary to ensure that environment, safety, and health objectives are achieved. The contractor has a continuing obligation under the Integrated Safety Management System, and delegated line management safety responsibility, to self-assess and self-identify safety aspects of the work process and to address potential safety concerns with existing operations. Contractor line management must continually be confident that all operations being conducted are within acceptable safety risk (as agreed to by DOE), and may take independent action to partially or completely stop operations. At any time, the contractor, either at the management level or at the worker level, may cease operations for safety (or for any other relevant concern), and review internal processes and procedures, revise them as necessary, and restart operations when corrective actions are satisfactorily completed. At times, LANL has implemented this proactive approach by temporarily suspending operations to update training, or emphasize aspects of the safety basis for operations. This has been done recently in TA–55 (in 1994) and in the Chemistry and Metallurgy Research (CMR) Building at TA–3 (1997). DOE and LANL have also temporarily suspended operations to upgrade equipment or systems to meet current standards or to improve safety performance with state-of-the-art equipment (e.g., upgrades to fire suppression systems or replacement of outdated electrical systems); these types of upgrades happen frequently and are within the realm of maintenance and refurbishment, as described in section 2.1.2.3.

At times, it is possible that the DOE understanding of the risks associated with facility operations can change substantially. This could result, for example, from a different understanding of the hazards or from new information on health effects (e.g., a new determination that a material could threaten human health in ways not previously understood, identification of seismic risks that were not previously known, or identification of potential "common cause" failures for safety systems and their backups that were not previously known). In such cases, DOE and the contractor examine the implications of this new understanding with respect to the authorization basis to determine whether operational changes, facility or equipment upgrades, or other actions are appropriate.

Changes or upgrades to operations in a nuclear facility, or identification by either DOE or the contractor of potential concerns or needed changes in the authorized safety basis, must also be reviewed under formal DOE processes. Some of these changes or issues can be addressed by the contractor, and some of these require DOE resolutions, in accordance with processes established in DOE Order 5480.21, *Unreviewed Safety Questions*. Changes or upgrades to a facility are also subject to NEPA review under 10 Code of Federal Regulations (CFR) 1021 and DOE Order 451.1A.

Formal start/restart processes are also established in DOE Order 425.1, *Start-up and Restart of Nuclear Facilities*. Criteria are established in this order for invoking the formal DOE process of starting or restarting a nuclear operation, including a formal and independent DOE readiness review process for demonstrating that a facility is safe to operate, and authorizing the start/restart.

2.1.3.1 *Defense Nuclear Facilities Safety Board*

In addition to the responsibilities of DOE and UC, the Defense Nuclear Facilities Safety Board (DNFSB) also has broad oversight responsibilities. Under its enabling statute amending the *Atomic Energy Act*, (Public Law [PL] 100-456) the DNFSB is directed to:

- Review and evaluate the content and implementation of the standards relating to the design, construction, operation, and decommissioning of defense nuclear facilities of the DOE and recommend to the Secretary of Energy those specific measures that should be adopted to ensure that public health and safety are adequately protected.
- Investigate any event or practice at a DOE defense nuclear facility which the DNFSB determines has adversely affected or may adversely affect public health and safety.
- Review the design and construction of new DOE defense nuclear facilities.
- Analyze facility design and operational data.
- Provide a meaningful opportunity for public participation in the recommendation process.

The DNFSB stays closely attuned to the planning and execution of DOE's defense nuclear programs, gathering its information from a broad range of sources, including but not limited to on-site technical evaluations by the DNFSB and its staff, critical review of DOE safety analyses by technical experts, and public meetings at headquarters and in the field.

The DNFSB has issued a number of recommendations for action as a result of its reviews and evaluations of DOE's defense nuclear activities at LANL. DOE has in the past and continues to work closely with the DNFSB and its staff to respond to these recommendations as one means of ensuring the public health and safety.

2.2 DESCRIPTION OF LANL FACILITIES

LANL is located in north-central New Mexico, 60 miles (97 kilometers) north-northeast of Albuquerque and 25 miles (40 kilometers) northwest of Santa Fe (see Figure 1.1–1 in chapter 1). LANL occupies approximately 43 square miles (111 square kilometers) of land owned by the U.S. Government and under the administrative control of DOE. Most of LANL is undeveloped to provide a buffer for security, safety, and expansion possibilities for future use.

Approximately half of LANL's square footage is considered laboratory or production space; the remaining square footage is considered administrative, storage, service, and other space (LANL 1998c). The use of LANL space by function is shown in Figure 2.1.2.2–1.

All facilities at LANL (including those proposed, under construction, pre-operational, operational, or idle; DOE owned or leased; temporary or permanent; occupied or unoccupied) have been categorized according to hazards inherent to their actual operations or planned use. LANL operations not directly associated with a facility have also been similarly categorized.

DOE has identified two major hazard categories determined by the type and quantity of radionuclide: those with a potential nuclear (radiation) hazard (called nuclear facilities) and those with nonnuclear hazard potential (called nonnuclear facilities). As part of its safety analysis process for nuclear facilities or operations, DOE performs a hazard analysis of its nuclear activities and categorizes the facilities or operations based on the inventory of radioactive materials and the potential for unmitigated or uncontrolled release of these materials.

Nuclear Facilities Hazards Classification (DOE Order 5480.23)

Category 1 Hazard*: Hazard analysis shows the potential for significant off-site consequences.*

Category 2 Hazard*: Hazard analysis shows the potential for significant on-site consequences.*

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

For nuclear facilities, a Category 1 hazard categorization is usually applied to nuclear reactors. A Category 2 hazard categorization has been applied to facilities with potential for nuclear criticality events or that contain significant quantities of special nuclear materials (SNMs) and energy sources that could pose a risk to workers, the public and the environment on the site. Category 3, indicating potential for only localized consequences, has been applied to facilities with small quantities of SNMs. There are no Category 1 hazards or operations at LANL.

Facilities that do not meet the criteria for nuclear facilities (as defined in DOE Order 5480.23), but that still contain some amount of radioactive

Special Nuclear Material

SNM is defined in the Atomic Energy Act to mean (a) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that is designated as special nuclear material, or (b) any material artificially enriched by any of the foregoing.

> ***Nonnuclear Facility Hazard Classification (DOE Order 5481.1B)***
>
> ***High hazard**: Have potential for on-site or off-site impacts to large numbers of people or for major impacts to the environment.*
>
> ***Moderate hazard**: Present considerable potential for on-site impacts to people or the environment, but at most only minor off-site impacts.*
>
> ***Low hazard**: Present minor on-site and negligible off-site impacts to people or the environment.*

material are called radiological facilities. Radiological facilities may be categorized under the nonnuclear facility categories as low radioactive hazard (L/RAD) or moderate radioactive hazard (M/RAD).

The number of nuclear and radiological facilities by TA is provided in Table 2.2–1. The number of nonnuclear facilities that have moderate or low chemical hazard categorization (M/CHEM or L/CHEM), and those with energetic source hazard (L/ENS) are also listed. LANL has no high-hazard nonnuclear facilities.

2.2.1 Technical Areas

LANL is divided into 49 separate TAs (Figure 2.2.1–1) (the TAs are not numbered sequentially). These TAs compose the basic geographic configuration of LANL. TA–3 is located on South Mesa and is the main, or core, TA where approximately half of the personnel are located. TA–3 serves as the central technical, administrative, and physical support facility for LANL. One TA is remote from the main area; the Fenton Hill site, TA–57, is located approximately 20 miles (32 kilometers) west of LANL.

A brief description of each TA operated by LANL is presented in Table 2.2.1–1. Additional information is provided in the *Description of Technical Areas and Facilities at LANL* (LANL 1998c).

2.2.2 SWEIS Key Facilities

To facilitate a logical and comprehensive evaluation of the potential environmental impacts of the four alternatives for future operations of LANL, the SWEIS focuses on those facilities or operations that meet the following screening criteria. The facilities identified as key for the purposes of the SWEIS are those that house activities that are critical to meeting assignments given to LANL, and:

- House operations that have potential to cause significant environmental impacts, or
- Are of most interest or concern to the public based on scoping comments received, or
- Would be the most subject to change due to recent programmatic decisions

To identify the SWEIS key facilities, all LANL structures were evaluated. Of the over 2,000 numerically identified structures within the 43-square-mile (111-square-kilometer) area of LANL, most are used for offices, storage, or support functions. Buildings or facilities considered to have minimal environmental impact, such as office buildings, transportables, trailers, guard houses, and passageways were eliminated from detailed consideration as key facilities. DOE thus eliminated over 1,900 structures from identification as key facilities for the SWEIS. The remaining facilities or operations were evaluated based on operational emphasis, facility operations and capabilities, and physical location. Individual facilities or groups of facilities that are closely related were then evaluated against the criteria listed above.

Table 2.2.2–1 identifies the 15 key facilities. The locations of the key facilities are shown in Figure 2.2.2–1. Taken together, the key

TABLE 2.2–1.—*Number of Nuclear and Moderate/Low Hazard Facilities at LANL by Technical Area*[a]

TECHNICAL AREA	NUCLEAR FACILITIES		NONNUCLEAR FACILITIES				
	CATEGORY 2	CATEGORY 3	M/RAD	M/CHEM	L/RAD	L/ENS	L/CHEM
TA–0				4			
TA–2					4		
TA–3	2	4		1	4	1	8
TA–8	4					5	
TA–9						32	2
TA–11						4	
TA–14						7	
TA–15					4[b]	11	
TA–16	3			1		61	3
TA–18	4				5		
TA–21	2	1		2	4		2
TA–22						25	1
TA–28						5	
TA–33		1				3	
TA–35[c]		2		1	2	8	
TA–36					1	11	
TA–37						24	
TA–39					2	14	
TA–40						22	
TA–41			4		1		7
TA–43						1	2
TA–46				1	2	9	1
TA–48		1					
TA–49						3	
TA–50	2				1		
TA–53		1			21	5	
TA–54	19			1	1		17
TA–55	2[d]				1	7	2
TA–72				1		2	
TA–73				1			

M/ = moderate hazard, L/ = low hazard, RAD = radiological, ENS = energetic source, and CHEM = chemical.
[a] TAs without nuclear or moderate/low hazard facilities are not shown. LANL does not have any Category 1 nuclear facilities.
[b] Includes a facility not yet operational.
[c] In addition, TA–35 has one facility that is a low hazard environmental source facility, TA–35–85 (LANL 1998c), due to its mercury inventory.
[d] The Nuclear Materials Storage Facility is included, although it is not yet operational (discussed in section 2.2.2.1).

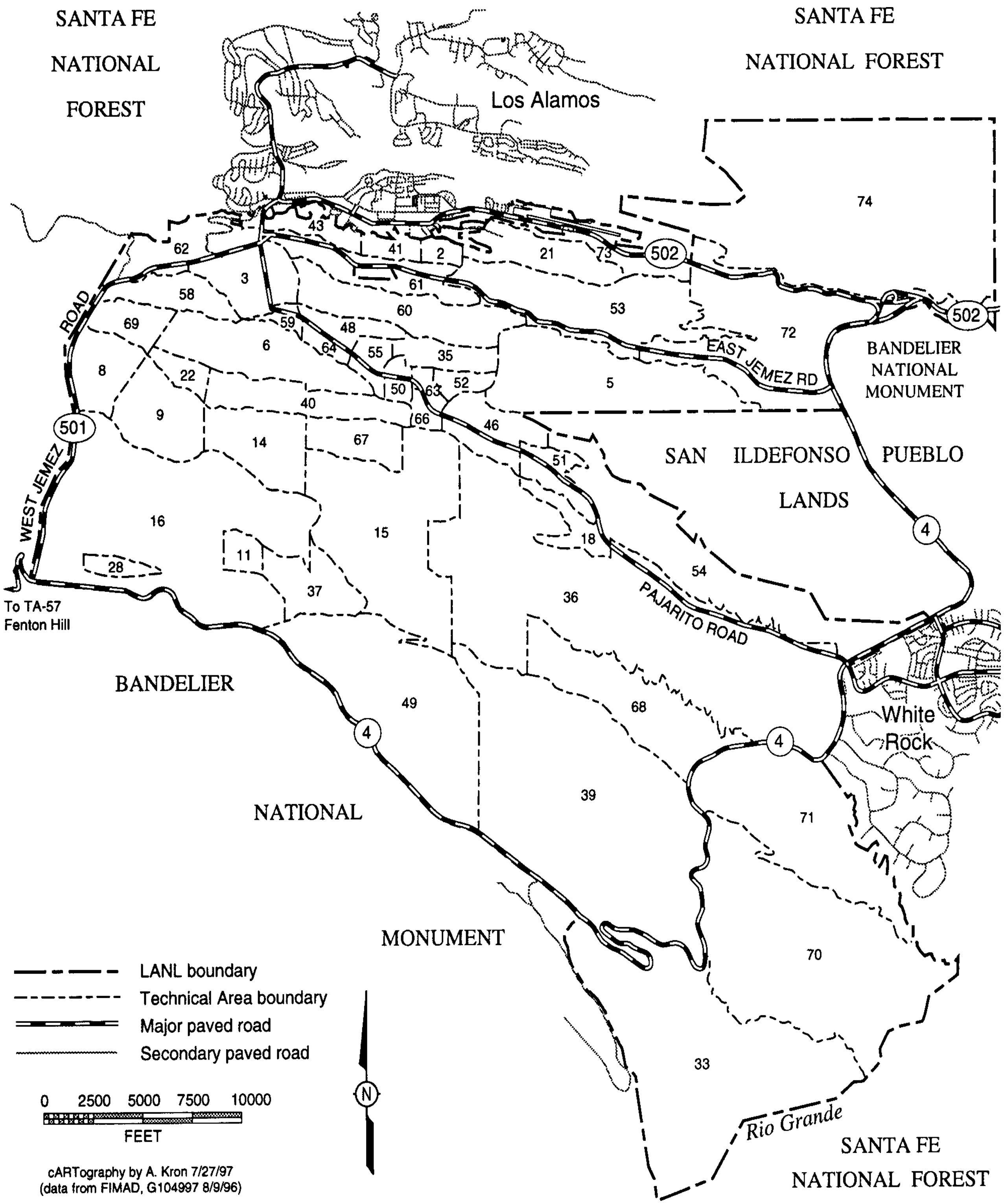


FIGURE 2.2.1–1.—*Technical Areas of Los Alamos National Laboratory.*

TABLE 2.2.1–1.—*Overview of Technical Areas and Their Associated Activities*

TECHNICAL AREA[a]	ACTIVITIES
TA–0	LANL has about 180,000 square feet (16,722 square meters) of leased space for training, support, architectural engineering design, and unclassified research and development in the Los Alamos townsite and White Rock. The Community Reading Room and the Bradbury Science Museum are also located in the Los Alamos townsite.
TA–2 (Omega Site)	Omega West Reactor, an 8-MW nuclear research reactor, is located here. It was placed in a safe shutdown condition in 1993. It is currently being removed from the nuclear facilities list and will be transferred into the decontamination and decommissioning (D&D) program possibly during 1998. All fuel has been removed from this reactor.
TA–3 (Core Area)	The Administration Complex contains the Director's office, administrative offices, and support facilities. Laboratories for several divisions are in the main TA. TA–3 contains major facilities such as the CMR Building, the Sigma Complex, the Main Shops, and the Materials Science Laboratory (MSL). Other buildings house central computing facilities, chemistry and materials science laboratories, Earth and space science laboratories, physics laboratories, technical shops, cryogenics laboratories, the main cafeteria, and the Study Center. TA–3 contains about 50 percent of LANL's employees and floor space.
TA–5 (Beta Site)	This site contains some physical support facilities such as an electrical substation, test wells, and environmental monitoring and buffer areas.
TA–6 (Two-Mile Mesa Site)	This site is mostly undeveloped and contains gas cylinder staging and vacant buildings pending decommissioning.
TA–8 (GT-Site [or Anchor Site West])	This is a dynamic testing site operated as a service facility for LANL. It maintains capability in all modern nondestructive testing techniques for ensuring quality of material, ranging from test weapons components to high-pressure dies and molds. Principal tools include radiographic techniques (x-ray machines with potentials up to 1 MeV and a 24-MeV betatron), radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.
TA–9 (Anchor Site East)	At this site, fabrication feasibility and physical properties of explosives are explored. New organic compounds are investigated for possible use as explosives. Storage and stability problems are also studied.
TA–11 (K-Site)	These facilities are used for testing explosives components and systems, including vibration testing and drop testing, under a variety of extreme physical environments. The facilities are arranged so that testing may be controlled and observed remotely and so that devices containing explosives or radioactive materials, as well as those containing nonhazardous materials, may be tested.
TA–14 (Q-Site)	This dynamic testing site is used for running various tests on relatively small explosive charges for fragment impact tests, explosives sensitivities, and thermal responses.
TA–15 (R-Site)	This site houses the Pulsed High-Energy Radiation Machine Emitting X-Rays (PHERMEX) Facility, a multiple-cavity electron accelerator capable of producing a very large flux of x-rays for dynamic experiments and hydrodynamic testing. It also is the site for the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility (now under construction), whose major feature will be its intense high-resolution, dual-machine radiographic capability. This site is also used for the investigation of weapons functioning and systems behavior in nonnuclear tests, principally through electronic recordings.
TA–16 (S-Site)	Investigations at this site include development, engineering design, prototype manufacture, and environmental testing of nuclear weapons components and subsystems. It is the site of the Weapons Engineering Tritium Facility (WETF) that focuses on research and applications using tritium. Development and testing of high explosives, plastics, and adhesives, and research on process development for manufacture of items using these and other materials are accomplished in extensive facilities.

TABLE 2.2.1–1.—*Overview of Technical Areas and Their Associated Activities*-Continued

TECHNICAL AREA[a]	ACTIVITIES
TA–18 (Pajarito Laboratory Site)	This is a nuclear facility that studies both static and dynamic behavior of multiplying assemblies of nuclear materials. SNMs are used to support a wide variety of activities for stockpile management, stockpile stewardship, emergency response, nonproliferation, safeguards, etc. In addition, this facility provides the capability to perform hands-on training and experiments with SNM in various configurations below critical.
TA–21 (DP-Site)	This site has two primary research areas: DP West and DP East. DP West has been in the D&D Program since 1992, and about half of the facility has been demolished. DP West continues to provide office space for ongoing functions. Some activities conducted at DP West, primarily in inorganic and biochemistry, are being relocated during 1997 and 1998, and the remainder of the site scheduled for D&D in future years. DP East is a tritium research site and includes the Tritium Science and Fabrication Facility (TSFF) and Tritium Systems Test Assembly (TSTA).
TA–22 (TD-Site)	This site is used in the development of special detonators to initiate high-explosives systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with initiating high explosives and research in rapid shock-induced reactions.
TA–28 (Magazine Area A)	This is an explosives storage area.
TA–33 (HP-Site)	The old, High-Pressure Tritium Laboratory Facility is being decommissioned. Tritium operations at this site were suspended in 1990, and the tritium inventory and operations were moved to WETF at TA–16. The National Radio Astronomy Observatory's Very Large Baseline Array Telescope is also located at this site.
TA–35 (Ten Site)	Activities include nuclear safeguards research and development that are concerned with techniques for nondestructive detection, and identification and analysis of fissionable isotopes. Research is also done on reactor safety, laser fusion, optical sciences, pulsed-power systems, high-energy density physics, metallurgy, ceramic technology, and chemical plating.
TA–36 (Kappa-Site)	This TA has four active firing sites that support explosives testing. Nonnuclear ordnance tests are conducted here, including tests of armor and armor-defeating mechanisms, as well as tests of shockwave effects on explosives and propellants. Phenomena of explosives, such as detonation velocity, are investigated at this dynamic testing site.
TA–37 (Magazine Area C)	This is an explosives storage area.
TA–39 (Ancho Canyon Site)	The behavior of nonnuclear weapons is studied here, primarily by photographic techniques. Investigations are also made into various phenomenological aspects of explosives, interactions of explosives, explosions involving other materials, shock wave physics, equation-of-state measurements, and pulsed-power systems design.
TA–40 (DF-Site)	This site is used in the development of special detonators to initiate high-explosives systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with the physics of explosives.
TA–41 (W-Site)	Personnel at this site engage primarily in engineering design and development of nuclear components, including fabrication and evaluation of test materials for weapons.
TA–43 (Health Research Laboratory)	This site is adjacent to the Los Alamos Medical Center. Research performed at this site includes structural, molecular, and cellular radiobiology; biophysics; mammalian radiobiology; mammalian metabolism; biochemistry; and genetics. The DOE Los Alamos Area Office is also located within TA–43.
TA–46 (WA-Site)	Activities include applied photochemistry research such as the development of technology for laser isotope separation and laser enhancement of chemical processes. A new facility completed during 1996 houses research in inorganic and materials chemistry. The Sanitary Wastewater Systems Consolidation Project is located at the east end of this site.
TA–48 (Radiochemistry Site)	Research and development activities at this site include a wide range of chemical processes such as nuclear and radiochemistry, geochemistry, biochemistry, actinide chemistry, and separations chemistry. Hot cells are used to produce medical radioisotopes.

TABLE 2.2.1–1.—*Overview of Technical Areas and Their Associated Activities*-Continued

TECHNICAL AREA[a]	ACTIVITIES
TA–49 (Frijoles Mesa Site)	This site is currently restricted to carefully selected functions because of its location near Bandelier National Monument and past use in high-explosives and radioactive materials experiments. The Hazardous Devices Team Training Facility and the Antenna Test Range are located here. A helicopter pad used for wildfire response and storage for interagency wildfire response supplies are also located here.
TA–50 (Waste Management Site)	Activities include management of the industrial liquid and radioactive liquid waste received from various TAs. Activities also include development of improved methods for solid waste treatment and containment of radionuclides removed by treatment.
TA–51 (Environmental Research Site)	Research and experimental studies on the long-term impact of radioactive waste on the environment and types of waste storage and coverings are studied at this site.
TA–52 (Reactor Development Site)	A wide variety of theoretical and computational activities related to nuclear reactor performance and safety are done at this site.
TA–53 (Los Alamos Neutron Science Center)	This site includes the Los Alamos Neutron Science Center (LANSCE), the LANSCE linear proton accelerator, the Manuel Lujan Jr. Neutron Scattering Center, and a medical isotope production facility. Also located at TA–53 are the Accelerator Production of Tritium Project Office, including the Low-Energy Demonstration Accelerator (LEDA), and research and development activities in accelerator technology and high-power microwaves.
TA–54 (Waste Disposal Site)	Activities consist of radioactive and hazardous solid waste management including storage, treatment, and disposal operations.
TA–55 (Plutonium Facility Site)	This facility provides research and applications in chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides into many compounds and forms, as well as research into material properties and fabrication of parts for research and stockpile applications. Additional activities include the means to safely and securely ship, receive, handle, and store nuclear materials, as well as manage the wastes and residues produced by TA–55 operations. The Nuclear Materials Storage Facility (NMSF) is located at this TA.
TA–57 (Fenton Hill Site)	This site is located about 20 miles (32 kilometers) west of Los Alamos on the southern edge of the Valles Caldera in the Jemez Mountains, and was the location of LANL's now decommissioned Hot Dry Rock geothermal project. The site is used for the testing and development of downhole well-logging instruments and other technologies of interest to the energy industry. Because of the high elevation and remoteness of Fenton Hill, a gamma ray observatory is located at the site, and other astrophysics experiments are planned.
TA–58 (Two-Mile North Site)	This site is reserved for multi-use experimental sciences requiring close functional ties to activities currently located at TA–3.
TA–59 (Occupational Health Site)	Occupational health and safety and environmental activities are conducted at this site. Environmental, safety and health offices, and emergency management facilities are also located here.
TA–60 (Sigma Mesa)	This area contains physical support and infrastructure facilities, including the Test Fabrication Facility and Rack Assembly and the Alignment Complex.
TA–61 (East Jemez Road)	This site is used for physical support and infrastructure facilities, including the Los Alamos County sanitary landfill.
TA–62 (Northwest Site)	This site is reserved for multi-use experimental science, public and corporate interface, and environmental research and buffer zones.
TA–63 (Pajarito Service Area)	This site is a major growth area with environmental and waste management functions and facilities. This area contains physical support facilities operated by Johnson Controls, Inc.
TA–64 (Central Guard Site)	This is the site of the Central Guard Facility and headquarters for the Hazardous Materials Response Team.
TA–66 (Central Technical Support Site)	This site is used for industrial partnership activities.
TA–67 (Pajarito Mesa Site)	This area is a buffer zone, designated as a TA in 1989. No operations or facilities are currently located here.

TABLE 2.2.1–1.—*Overview of Technical Areas and Their Associated Activities*-Continued

TECHNICAL AREA[a]	ACTIVITIES
TA–68 (Water Canyon Site)	This is a dynamic testing area.
TA–69 (Anchor North Site)	This undeveloped TA serves as an environmental buffer for the dynamic testing area.
TA–70 (Rio Grande Site)	This undeveloped TA serves as an environmental buffer for the high-explosives test area.
TA–71 (Southeast Site)	This undeveloped TA serves as an environmental buffer for the high-explosives test area.
TA–72 (East Entry Site)	This is the site of the Protective Forces Training Facility (Live Firing Range).
TA–73 (Airport Site)	This area is the Los Alamos Airport. DOE owns the airport, and the County of Los Alamos manages, operates, and maintains it under a leasing arrangement with DOE. Use of the airport by private individuals is permitted with special restrictions.
TA–74 (Otowi Tract)	This large area, bordering the Pueblo of San Ildefonso on the east, is isolated from most of LANL. This site contains LANL water wells and future well fields.

[a] The concept of technical areas (TAs) was implemented during the first 5 years of LANL's existence; however, the early TA designations did not cover all land within the LANL boundary and, in the early 1980's, LANL's TA numbering system was revamped to provide complete coverage. Because all TAs received new numbers, a correlation between the historic system and the current system does not exist. In addition, in the current system, some numbers were reserved for future TAs. Sites that have been closed or abandoned were incorporated into adjacent TAs.

MW = Megawatt, MeV = million electron volts

TABLE 2.2.2–1.—*Identification of Key Facilities for Analysis of LANL Operations*

KEY FACILITY IDENTIFICATION	TECHNICAL AREA
Plutonium Facility Complex	TA–55
Tritium Facilities	TA–16 & TA–21
CMR Building	TA–3
Pajarito Site (including the Los Alamos Critical Experiments Facility [LACEF])	TA–18
Sigma Complex	TA–3
MSL	TA–3
Target Fabrication Facility	TA–35
Machine Shops	TA–3
High Explosive Processing Facilities	TA–8, TA–9, TA–11, TA–16, TA–28 & TA–37
High Explosive Testing Facilities	TA–14, TA–15, TA–36, TA–39, & TA–40
LANSCE	TA–53
Health Research Laboratory (HRL)	TA–43
Radiochemistry Laboratory	TA–48
Waste Management Operations: Radioactive Liquid Waste Treatment Facility	TA–50 & 21
Waste Management Operations: Solid Radioactive and Chemical Waste Facilities	TA–50 & TA–54

facilities represent the great majority of exposure risks associated with continuing operations at LANL because these facilities represent:

- Over 99 percent of all radiation doses to LANL personnel
- Over 99 percent of all radiation doses to the public
- Over 90 percent of all radioactive liquid waste generated
- Over 90 percent of the radioactive solid waste generated
- Approximately 30 percent of chemical waste (both RCRA regulated and industrial) generated; the remaining 70 percent of chemical wastes are generated in very small volumes throughout the balance of the laboratory in individual bench-scale and laboratory experiments and in analytical chemistry support activities

Practically all of the facilities that are nuclear facilities or moderate hazard nonnuclear facilities are included as key facilities in the SWEIS. The only moderate hazard nonnuclear facilities not included are water treatment stations using chlorine (these nonnuclear facilities are considered in the accident analysis as discussed in section 5.1.11) and two nonoperating nuclear facilities, Omega West Reactor (fuel has been removed) and a tritium facility at TA–33, which have been stabilized, contain only minimal inventories and are awaiting decontamination and decommissioning (section 2.2.3).

LANL actions anticipated over the next 10 years within the key facilities are identified for each alternative, as described in chapter 3 and analyzed in chapter 5.

2.2.2.1 *Plutonium Facility Complex (TA–55)*

The facilities at TA–55 are located on a 40-acre (16-hectare) site about 1 mile (1.6 kilometers) southeast of TA–3 (Figure 2.2.2.1–1). TA–55 is one of the larger TAs at LANL. The main complex has five connected buildings: Administration Building (55–1), Support Office Building (55–2), Support Building (55–3), Plutonium Facility (55–4), and Warehouse (55–5) (listed in Table 2.2.2.1–1). The Nuclear Materials Storage Facility (NMSF, 55–41) is separate from the main complex but shares an underground transfer tunnel with 55–4. (Note that these buildings are sometimes referred to as Plutonium Facility [PF]–1, PF–2, PF–3, PF–4,

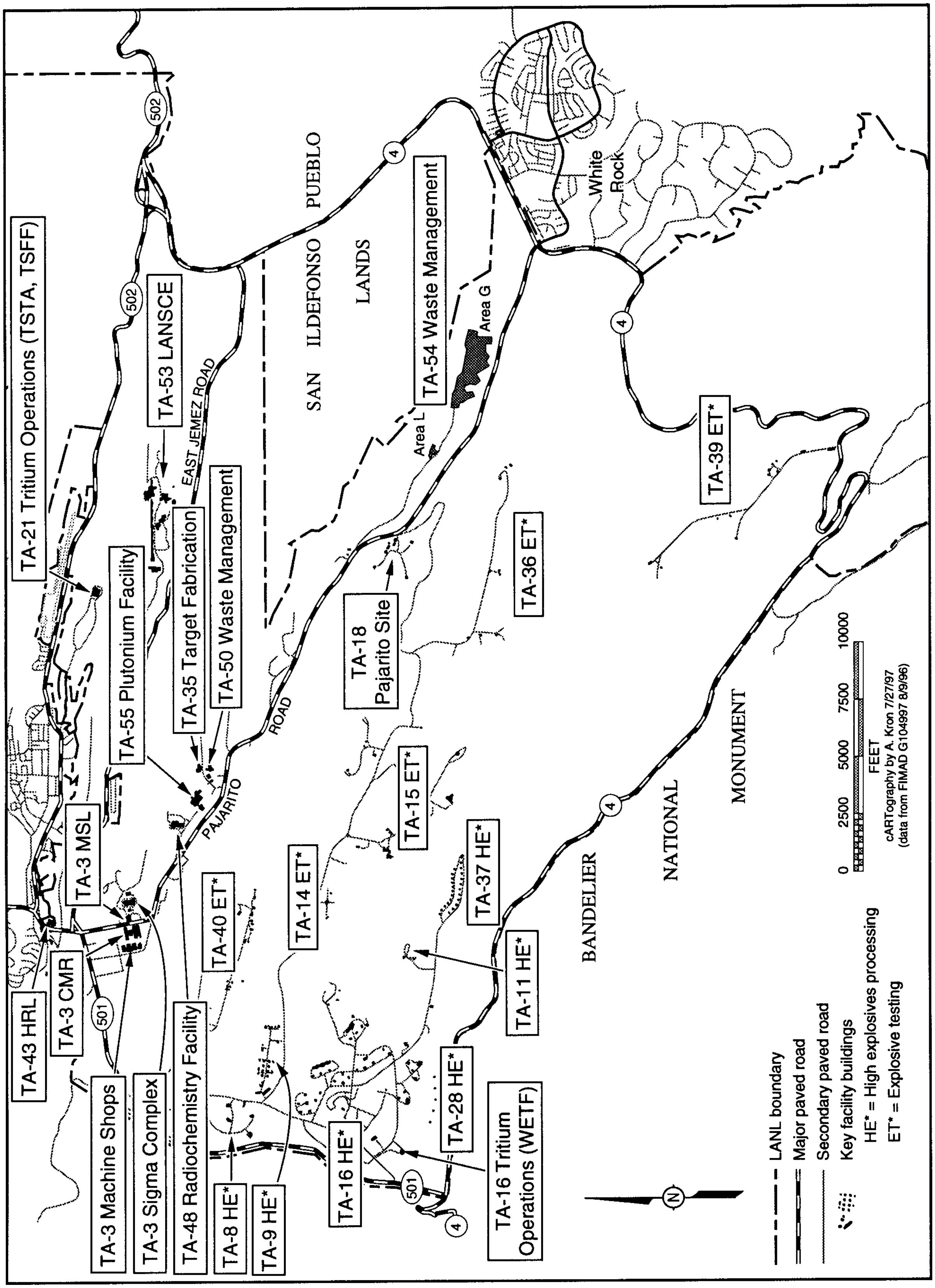


FIGURE 2.2.2–1.—*Key Facility Locations Within LANL.*

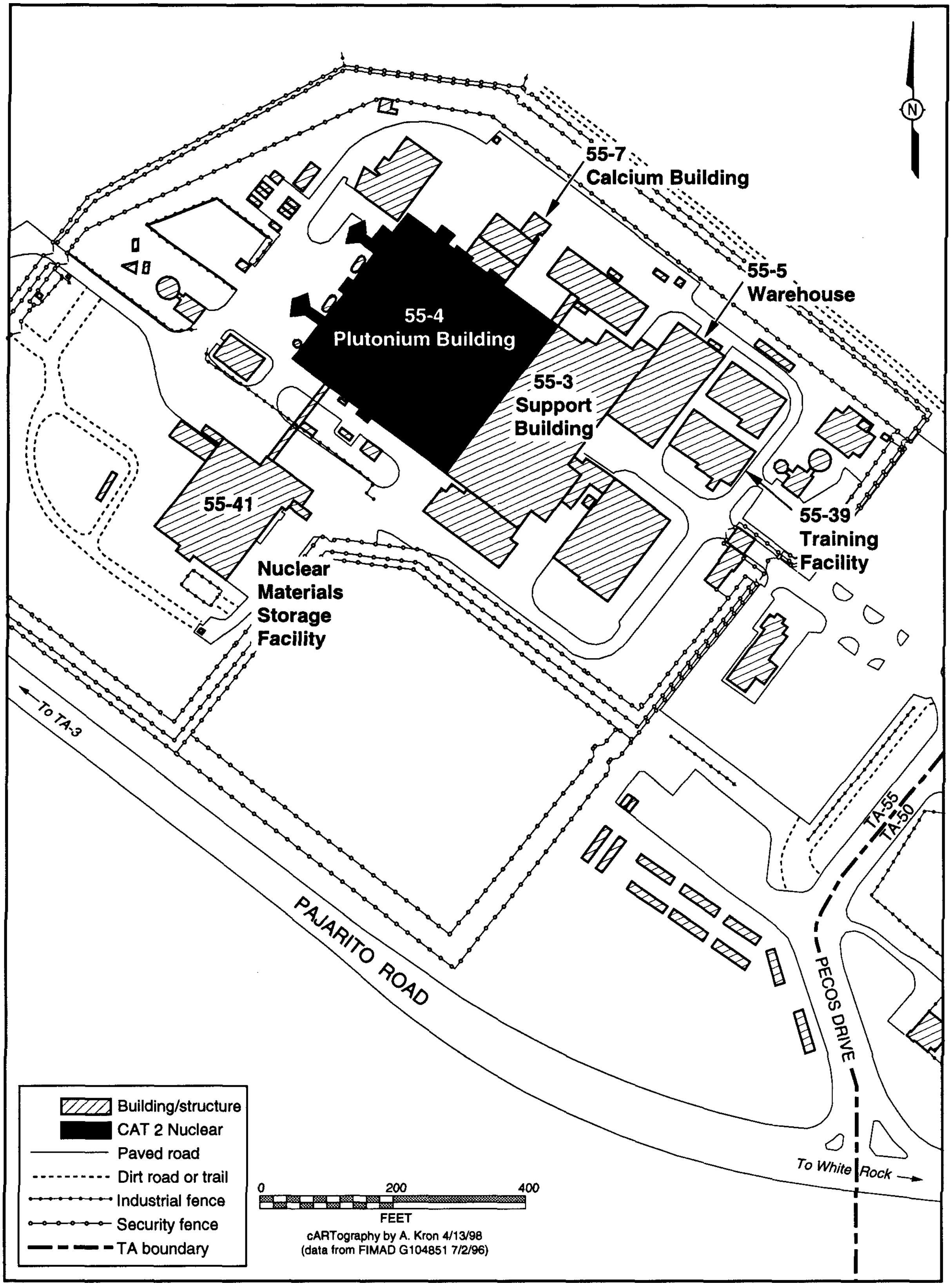


FIGURE 2.2.2.1–1.—*TA–55 Plutonium Facility Complex.*

TABLE 2.2.2.1–1.—*Principal Buildings and Structures of the Plutonium Facility Complex (TA–55)*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–55	Offices, Laboratories: 55–1, 2, 3, 20, 39, 107, 110, 114, 124, 135, 136, 137, 138, 139, 144, 145, 177, 264
	Plutonium Building: 55–4
	Warehouse: 55–5
	Calcium Building: 55–7
	Materials Control and Accountability Support Building: 55–28
	Training Center: 55–39
	Nuclear Materials Storage Facility: 55–41
	Process Support Building: 55–42
	Assessment Buildings: 55–43, 142
	Generator Building: 55–47
	TRU Drum Storage Building: 55–185

PF–5, and PF–41.) After renovations are completed, the NMSF will provide intermediate-term storage for up to 7.3 tons (6.6 metric tons) of LANL's SNM inventory, mainly plutonium. Various support, storage, security, and training structures are located throughout the main complex. The cornerstone research and development facility at TA–55 is the Plutonium Facility (55–4). Plutonium is processed at this facility, which is a two-story laboratory of approximately 151,000 square feet (14,028 square meters). The Plutonium Facility complex has the capability to process and perform research with the range of actinide materials (actinides are a series of chemically similar, mostly synthetic, radioactive elements with atomic numbering ranging from 89 [actinium] through 103 [lawrencium] and including thorium [90], uranium [92], plutonium [94], and americium [95]). The discussion focuses on plutonium because most of the work in this facility is done with plutonium; work done with other actinides is similar in nature.

Description of Facilities

Building TA–55–4 is categorized as a Hazard Category 2 nuclear facility (see the text box on Nuclear Facilities Hazards Classification in section 2.2), and was built to comply with seismic standards for Hazard Category 1 buildings. The ventilation system in the facility has four zones. The overall design concept for the Plutonium Facility separates the building into two halves, separated by a fire wall and other fire safety features. TA–55–4 was designed to correct the deficiencies that led to the 1969 Rocky Flats fire. An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 are presented in appendix G, section G.4.1.2. Two facilities (TA–55–3 and TA–55–5) are designated as low hazard chemical facilities, and one facility (TA–55–7) has a low hazard energetic source classification. The other facilities at TA–55 are designated as no hazard facilities. (These are administrative, technical, and general storage buildings, passageways, and pump stations.)

The NMSF (TA–55–41) is located to the west of the main Plutonium Facility complex (shown in Figure 2.2.2.1–1) but shares an underground transfer tunnel with that facility. The building's main vault area is a two-level design, 36 feet (11 meters) tall by 55 feet (17 meters) wide by 150 feet (46 meters) long, of reinforced concrete. The lower level is below grade (i.e., it is below the surface of the ground). The office, mechanical, and receiving area is a single-story concrete structure 85 feet (26 meters) wide by 150 feet (46 meters) long. The ventilation stack rises 17 feet (5 meters) above the roof line. The NMSF was designed to be an intermediate-duration (up to 50 years) storage facility for the LANL inventory of plutonium, uranium, and other actinides and to be the central shipping and receiving point for nuclear materials at TA–55. The design capacity is 7.3 tons (6.6 metric tons) of SNM in metal and oxide forms, which will make the facility Hazard

Category 2, once it is authorized to operate. Although construction was completed in 1987, the facility has never been operated because of major design and construction deficiencies.

Design for renovation of this facility is currently underway. The actual renovations are scheduled to begin in 2000, but are not yet funded. Renovations are scheduled for completion in 2005, and the facility is expected to be operational in 2005. The NMSF renovation project includes:

- Installing a drywell storage array system
- Reworking the air flow system to allow the storage array to be passively cooled by convection of ambient air
- Constructing a new mechanical penthouse for heating, ventilation, and air conditioning equipment
- Reconfiguring the administrative support area, security system, decontamination stations, and mechanical room
- Adding reinforcement to the structure
- Reconstructing the Material Access Area (MAA)

The facility is planned to operate as a passive air-cooled storage structure with air intake at the lower level and exhaust through the stack. A taller stack (as compared to the existing one) might be required for the passive convective cooling system to operate effectively. Alternatively, an active cooling system may be considered appropriate.

A material accountability and assay area may be established in the NMSF as support for the storage, shipping, and receiving functions. Nondestructive assays may be performed at the NMSF on sealed containers as they are received and before they are shipped, to verify identity and quantity of package contents. The primary containers of nuclear materials will not be opened within NMSF.

Because materials in the vault area are stored in sealed containers, the vault area will not be high HEPA filtered; the air in the receiving area, material assay area, and change rooms will exhaust through HEPA filters.

Description of Capabilities

The capabilities at TA–55 include many operations by which actinides (primarily plutonium):

- Are used in research on and characterization of physical and chemical properties and metallurgy of these materials and alloys.
- In weapons component form are taken apart or disassembled into metal scrap to be recovered.
- In metal scrap form are recovered (or reprocessed) into oxide and metal forms (stabilized) that may be stored or redirected into fabrication, research and development processes, or may be dispositioned.
- In residue form are dissolved and chemically processed to recover the plutonium as metal, oxalate or oxide, for further processing.
- In metallic form are manufactured into components or parts useful in research or weapons applications.
- In metal or oxide form are processed (or fabricated) into materials useful as sources of heat and nuclear power (fuel pellets and rods).
- Can be converted from metal to oxide and visa versa.
- In any of the above forms serve as feedstock for various research and development activities.
- Measurement technologies are developed for material control, nonproliferation, international inspection applications.

> ***Terminology Related to Pit Production***
>
> ***Fabrication/Manufacturing****—For purposes of the SWEIS, these terms are synonymous. LANL has an existing capability to fabricate or manufacture plutonium parts. That is, the equipment, knowledge, supporting infrastructure, and administrative procedures and controls exist at LANL to create plutonium metallic shapes to precise specifications. This capability is currently used in support of existing missions for research and development and will be used to rebuild some of the pits destroyed in stockpile surveillance activities.*
>
> ***Production****—For the purposes of the SWEIS, this term is used to describe the fabrication/manufacturing of a relatively large quantity of parts (as compared to the research and development and prototype capability). In the ROD for the SSM PEIS, DOE decided to meet its need for a pit production capability by enhancing its existing fabrication/manufacturing capability at LANL. This enhancement consists of changes to optimize material flows, remove "choke points" that limit the quantity that can be made, improve efficiency, and replace or upgrade equipment to improve process yield and reliability.*

The processing capabilities can be divided into manufacturing steps and reprocessing or recovery steps. Processes can also be considered as "wet" or "dry" in terms of the relative volumes of radioactive liquid wastes produced. Chemical reprocessing operations are generally considered wet because they generate radioactive liquid wastes from precipitation, wash, and ion exchange elution steps. The nitrate and chloride aqueous processes produce acid and caustic streams containing most of the radioactive content in the aqueous waste from TA–55.

Manufacturing processes are considered to be dry because they involve metal forming and oxide pressing operations that do not produce aqueous wastes containing dissolved actinides. Similarly, pyrochemical processing and other recovery processes that utilize heat to effect separations (e.g., tritium separations) are considered dry processes.

Division into wet and dry processes is complicated because 95 percent by volume of the radioactive liquid waste effluent from TA–55 is industrial wastewater, water used in various cooling processes within the facility. All the manufacturing and pyrochemical operations and many of the reprocessing operations require water for cooling. This includes water used in cooling processing equipment (cooling jackets on ion exchange columns and metal melting furnaces) and the discharge from the heating, ventilation, and air conditioning system that serves the radioactive processing areas in TA–55–4.

The principal activities conducted at the Plutonium Facility are described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

Plutonium Stabilization. Stabilization encompasses a variety of plutonium (and other actinide) recovery operations. The goal of this activity is to improve the storage condition of legacy plutonium in the LANL inventory. Some of the existing containers show signs of corrosion. Further, the stability of some of the materials can be improved through reprocessing, cleaning, high-firing (oxidizing at relatively high temperatures) oxides, and storage in improved containers. As of early 1996, the inventory included 1.2 tons (1.1 metric tons) of metallic plutonium, 0.83 tons (0.75 metric tons) of plutonium in residue forms, and 0.83 tons (0.75 metric tons) of plutonium in oxide forms. Under all of the alternatives, the plan is to reprocess 10 percent of the metal form, all of the residues, and 15 percent of the oxides to a stable oxide form. The remainder of the metal will be cleaned and remaining oxides will be high-fired. After these stabilization steps, the materials will be repackaged under inert atmosphere (an atmosphere free of materials that may initiate chemical reactions) in pressure-closure cans that are then placed in outer cans that are welded closed. These will be stored until needed to support program requirements. The processes that will be used to clean metallic plutonium, to convert metal to oxide, to reprocess the scrap material, and to high-fire oxides are parts of the regular chemical processing capability in operation at TA–55. The length of time that would be taken to complete these activities varies among the alternatives.

Manufacturing Plutonium Components. The goal of this activity is to take purified plutonium metal and use it to manufacture pits or other items for research and development or to manufacture components for the nuclear weapons stockpile. This capability includes the fabrication of samples and parts for research applications, including dynamic experiments, subcritical experiments (at the Nevada Test Site), fundamental research on plutonium at the Los Alamos Neutron Science Center (LANSCE), and has been used in the past to fabricate pits for nuclear tests. Some equipment, tools, designs, and documentation specific to pit manufacturing have been moved from the Rocky Flats Plant to LANL. Changes will be made in the manufacturing process to reduce waste production and worker exposure. In general, the processes and procedures used for this capability differ in capacity, in technology, and in safety and environmental measures as compared to those previously used at the Rocky Flats Plant. Some aspects of the manufacturing process such as welding and coating technologies are still being developed. Pure metal will be cast to a very close approximation of the final dimensions (near net shape). This will reduce the need for extensive machining and reduce the production of waste and scrap (as compared to techniques used in the past). Some final machining and polishing will be required. The plutonium items produced may be encapsulated or coated with stainless steel, beryllium, or other materials. At every step, the pieces are inspected and samples are taken for analysis. Those finished components that meet the specifications may be stored in the Plutonium Facility vault or NMSF pending shipment or research use. Those that do not meet specifications are reprocessed into plutonium metal.

Surveillance and Disassembly of Weapons Components. The goal of this activity is to conduct a series of nondestructive and destructive evaluation on pits removed from the stockpile and/or from storage, as well as for materials being considered in process development activities. These evaluations determine the effects of aging and other stresses on pits, as well as the compatibility of materials used or being considered for use in weapons. They are a part of the stockpile reliability and safety analysis and documentation programs that DOE has conducted for the nuclear weapons stockpile since pit production was initiated. The evaluation program was transferred from the Rocky Flats Plant to LANL in the early 1990's. Beginning with the intact pit, a series of tests are made to determine the changes in the materials from which the pit was constructed. Tests include leak testing, weighing, dimensional inspection and measurements, dye penetration tests, and radiography. Some of the pits evaluated at LANL are returned to storage after these nondestructive analyses (to be analyzed again at a later date). Other pits are taken apart (disassembled) for further tests, which include metallography, micro-tensile testing, and chemical analysis. The scrap remaining after these destructive tests is reprocessed. Any pit fabricated at LANL or sent to LANL could be evaluated or disassembled through these processes.

Actinide Materials Science and Processing Research and Development. Several aspects of materials research on plutonium (and other actinides) are conducted at TA–55. In general, these include metallurgical and other characterization of materials, and measurements of physical materials properties. These measurements provide data that support assessments of the safety and reliability performance of nuclear weapons, including the behavior of aging weapons components and replacement components and their suitability for certification. They also support other activities at LANL, such as characterizing samples for components, including those produced at TA–55, for experiments conducted at LANL or elsewhere, as well as measurements surveillance of stockpile components. Activities to develop new measurements for enhanced surveillance also are conducted at the facility. In addition, measurements at TA–55 study the properties of plutonium materials and samples at high strain rates using a 40-millimeter projectile launcher Impact Test Facility, apparatus such as Kolsky (split Hopkinson) Bars, and other bench-scale capabilities to measure mechanical and physical properties. These operations are usually conducted in gloveboxes and involve relatively small amounts of plutonium, as compared with other activities at TA–55.

In addition, research at TA–55 supports development and assessment of technologies for manufacturing and fabrication of components, a capability discussed previously in this section. These activities include research on welding and bonding processes and research associated with casting, machining, and other forming technology. In addition, measurements associated with fire-resistance of weapons components are conducted at TA–55.

Actinide processing (also called recovery and reprocessing) includes methods by which plutonium and other actinides can be extracted, concentrated, and converted into forms easier to store and to use in other activities. The discussion below focuses on plutonium because this accounts for most of the processing activity at TA–55, but the discussion also applies to the many other actinides used in research at LANL.

The ease with which plutonium may be recovered depends upon the form of the material:

- *Recoverable*—Metal components, ash, sand, slag, castings, combustible and noncombustible equipment, impure oxides, sweepings, organic solutions, alloys, various salts, and filter residues
- *Difficult to recover further*—Leached metal, decontaminated components, and evaporation residues
- *Practically irrecoverable*—Vitrified material and ceramic forms

The form, recoverability, and the concentration of plutonium remaining determines whether the material will be discarded as waste or treated with further reprocessing steps. Aspects of this reprocessing capability are described below.

Actinide recovery processing typically involves dissolving materials in nitric or hydrochloric acid using the physical and chemical characteristics of the actinide (e.g., using solvent extraction or ion-exchange processes) to preferentially extract it as a high purity solution. The high-purity actinide can then be removed from the solution (through precipitation and filtration) and converted to an oxide or oxalate form. Finally, the oxides and oxalates can be converted to metal using a variety of chemical processing techniques, including high temperature oxidation and electrochemical techniques. Waste solutions from these processes are pre-treated (redistilled to reclaim acid and precipitate nitrate sludges if appropriate) before being discharged as radioactive liquid waste to TA–50 (described in section 2.1.2.14).

Tritium separation is a special type of actinide processing. Tritium sorbs into many actinide materials where it is strongly held. Tritium can be removed from these materials by heating the material in an inert atmosphere. The actinide material is then cooled and removed. The dedicated glovebox line at TA–55–4 containing the furnace and associated equipment is called the Special Recovery Line.

The hydride-dehydride process is another special type of actinide processing. This process is used in the Advanced Recovery and Integrated Extraction System and may be used in other disassembly and material recovery processes. This process converts plutonium metal to plutonium hydride, which can be easily removed from other materials. The plutonium hydride can then be converted to either plutonium metal or oxide. The hydrogen used in this process is recycled. Although this process was designed for pits, other forms of metallic plutonium that are amenable to hydriding could also be reprocessed using this technique.

Actinide materials that emit alpha particles, such as plutonium or americium, have been intimately mixed with a material such as beryllium or beryllium oxide, to produce a strong and long-lasting source of neutrons, which is then sealed in stainless steel cladding. The U.S. Government provided about 20,000 of these neutron sources to universities, industry, and governmental agencies, which are licensed through the U.S. Nuclear Regulatory Commission (NRC) to utilize such materials. Most of these sources are no longer in use and, through an agreement with the NRC, they are being returned to DOE for reprocessing (using actinide recovery processes) at LANL. At present, plutonium-239/beryllium sources are being reprocessed at TA–55, but the capability could be used to reprocess americium-241/ beryllium sources as well.

In addition, this actinide reprocessing capability includes research into new recovery and decontamination techniques, research regarding the fundamental properties of actinides, analytical and nondestruction measurement of actinides (including development of new techniques), and research regarding nuclear fuels.

Fabrication of Ceramic Based Fuels. LANL develops and demonstrates ceramic based nuclear reactor fuel fabrication technologies. LANL has demonstrated the ability to produce such fuel, including prototype mixed oxide (MOX) fuel from plutonium and uranium. This demonstration involves processing of metals and oxides. Plutonium and uranium oxides are mixed together, and made into a ceramic form which is pressed into pellets. The pellets are sealed in cladding materials as a fuel rod. Fuel rods can be bundled together into fuel assemblies.

Plutonium-238 Research, Development, and Applications. Plutonium-238 has the interesting properties of being minimally fissile (making it more difficult to sustain a chain reaction) yet producing a large amount of heat through radioactive decay. This isotope is used to provide a long-term reliable source of heat that can be used directly and can be converted into electricity when assembled into radioisotopic thermoelectric generators (RTGs). The electricity produced by the RTGs has been used to operate mechanical devices, instruments, and communications on remote sensing devices such as spacecraft and to activate switches in some nuclear weapons designs. RTGs and units called milliwatt generators have been produced, tested, and reprocessed at the Plutonium Facility for many years, and RTG research and development (including design), fabrication, and testing activities continue. Plutonium-238 activities are kept separate from the other plutonium processes to avoid cross-contamination of isotopes. After the RTGs are produced, they are extensively tested for integrity, resistance to mechanical shocks, and heat generation rate.

Aqueous reprocessing of plutonium-238 material uses the same processing techniques as used for other actinides as discussed above.

Storage, Shipping, and Receiving. Under this activity, LANL stores, packages, measures (using variety of destructive and nondestructive techniques), ships, and receives nuclear materials. These activities are housed throughout TA–55–4, with storage currently in the TA–55–4 vault and projected in NMSF upon completion of the renovation project.

2.2.2.2 *Tritium Facilities (TA–16, TA–21)*

Tritium is a radioactive isotope of hydrogen. LANL tritium operations are primarily conducted at three facilities: Weapons Engineering Tritium Facility (WETF), Tritium Systems Test Assembly (TSTA) Facility, and Tritium Science and Fabrication Facility (TSFF) (see Figures 2.2.2.2–1 and 2.2.2.2–2 and Table 2.2.2.2–1). WETF is located at TA–16; TSTA and TSFF are located at TA–21. Operations involving the removal of tritium from actinide materials are conducted at LANL's TA–55 Plutonium Facility. These operations are described in section 2.2.2.1. Limited research, instrument calibration, analytical, and storage activities involving tritium are conducted at other LANL facilities; however, the primary potential environmental impacts from tritium operations at LANL reside with the three tritium facilities listed above. These facilities support several tritium-related programs at LANL and play an important role in DOE's energy research and nuclear weapons programs.

At various times, DOE has considered whether to consolidate TA–21 tritium operations and activities at the TA–16 WETF site; most recently, this was discussed as a potential project to begin in the year 2000 and be completed by the year 2006. However, any consolidation of tritium operations and activities is speculative at this time and for this reason is not included in SWEIS analyses. If such a project were proposed by DOE, additional NEPA analysis would be pursued, tiering from the SWEIS. There will continue to be movement of tritium operations and activities among the tritium operations facilities in order to optimize use of equipment and personnel and to increase programmatic efficiency.

Description of Facilities

The Weapons Engineering Tritium Facility, a Hazard Category 2 nuclear facility, is located in Building 16–205, in the southeast section of TA–16. Planning for WETF began in 1981 with construction occurring between 1982 and 1984. WETF began operation in 1989. Construction of an addition to WETF was started in 1993 and completed in 1994. Except for the mezzanine area in Building 205, WETF is a single-level structure with approximately 7,885 square feet (732 square meters) of floor area. The equipment in the building includes gas transfer and pumping systems, gloveboxes, a glovebox exhaust system, a system of monitors and alarms, and subsystems to contain any leaked tritium gas and tritiated wastewater.

Tritium-related activities occur in the contiguous tritium-handling-areas, which are served by a ventilation system that exhausts to a 60-foot (18-meter) stack. The stack, which is northeast of 16–205, is equipped with continuous air monitors that are equipped with a tritium bubbler system for determining tritiated water and gas ratios in the effluent air stream. There is no liquid discharge from Building

TABLE 2.2.2.2–1.—*Principal Buildings and Structures of the Tritium Facilities*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–16	Weapons Engineering Tritium Facility Processing Building: 16–205 Formerly the Weapons Components Test Facility: 16–450
TA–21	Tritium Systems Test Assembly Facility: 21–155 Tritium Science and Fabrication Facility: 21–209

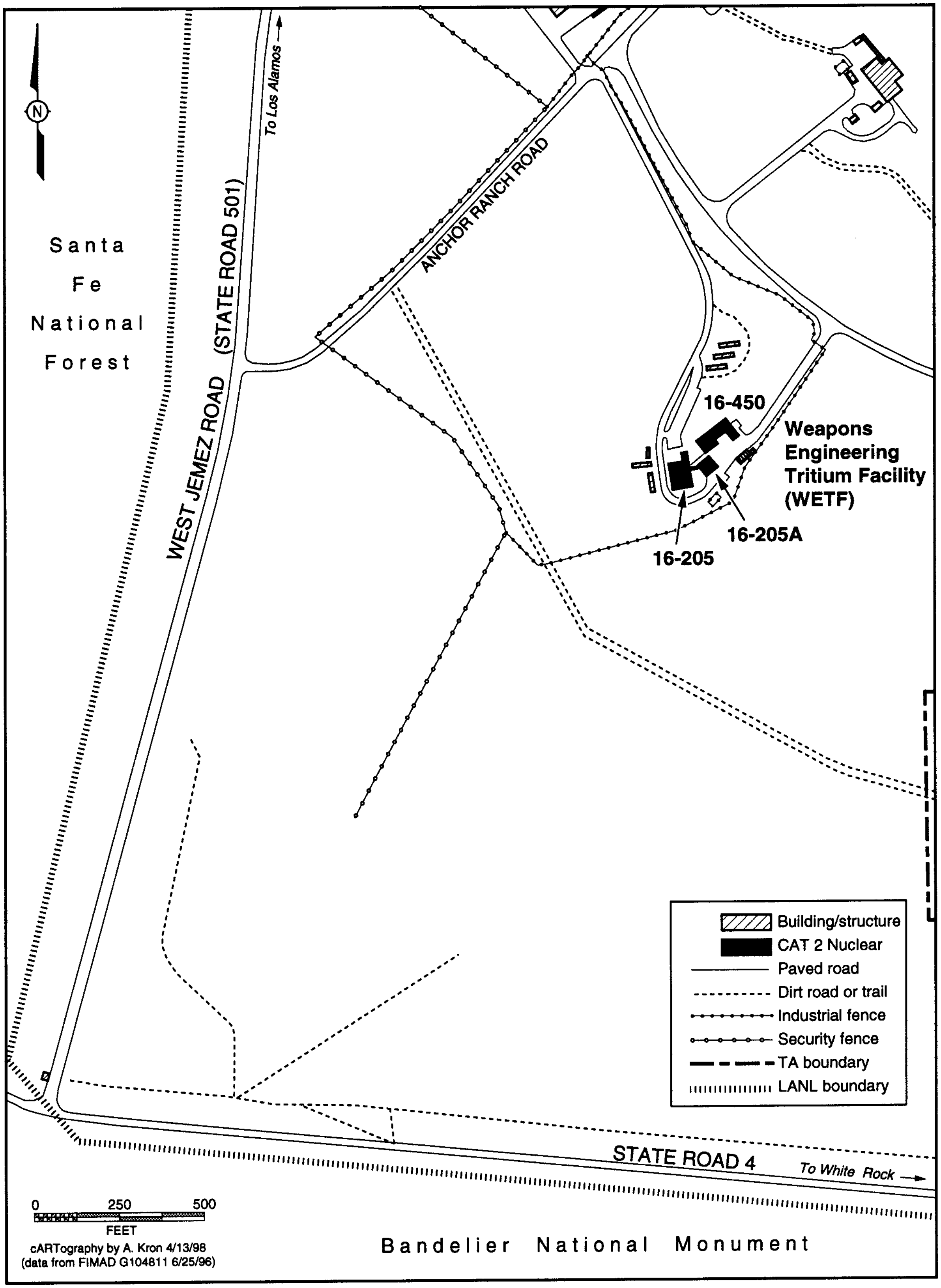


FIGURE 2.2.2.2–1.—*TA–16 Tritium Facilities (WETF).*

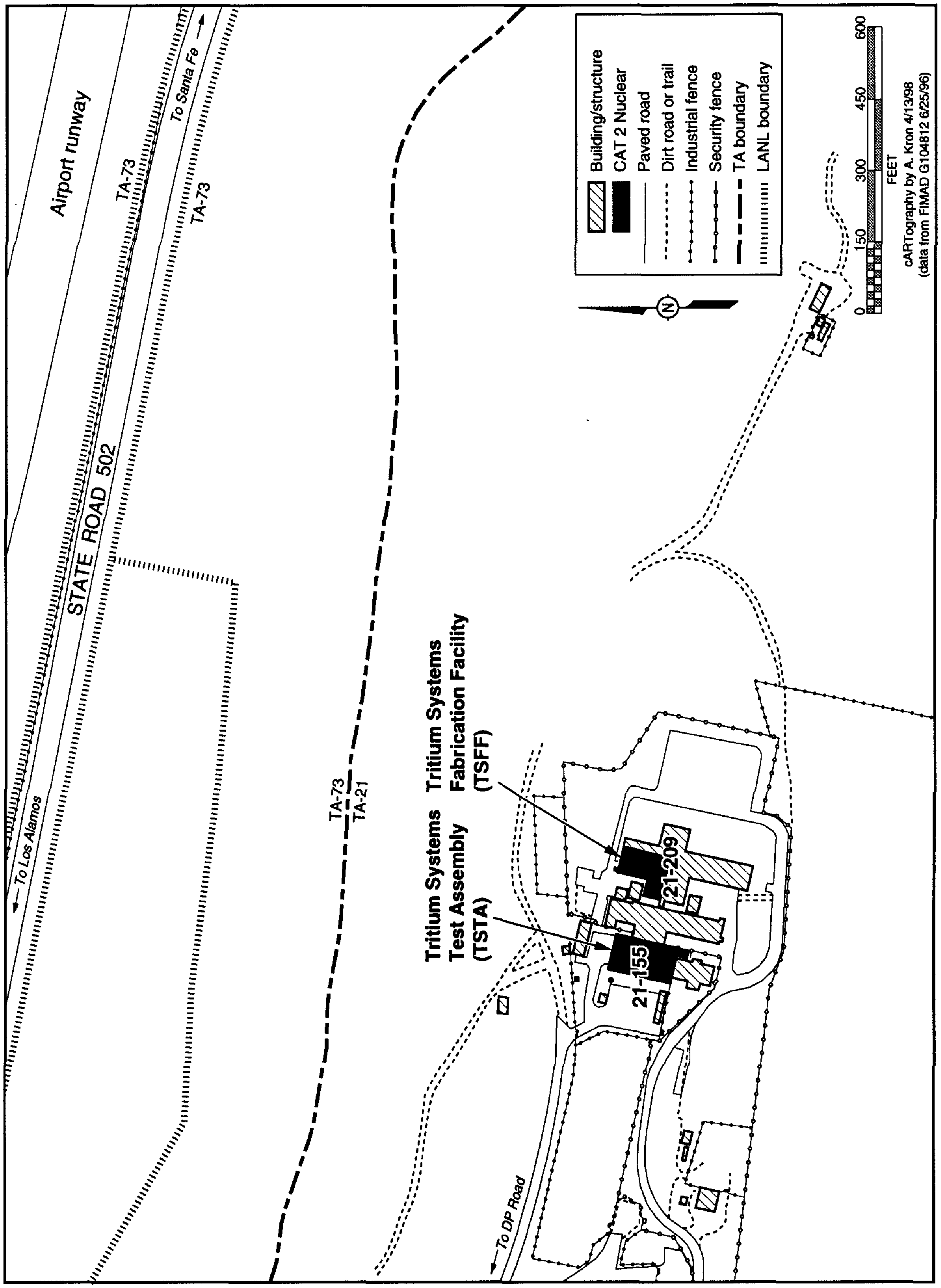


FIGURE 2.2.2.2–2.—*TA–21 Tritium Facilities (TSTA and TSFF).*

16–205 to a National Pollutant Discharge Elimination System (NPDES) outfall or directly to the Radioactive Liquid Waste Treatment Facility (RLWTF); the small amounts of contaminated mop water are collected and stored in a tank at the facility, then transported by radioactive liquid waste tanker truck to the RLWTF. The facility is functionally divided into multiple areas including an operations control area, tritium-handling areas, and support areas. Walls, roofs, and air locks separate the tritium handling areas from the rest of the facility. The support areas include offices, restrooms, and rooms that house equipment. An adjacent building (TA–16–450) will be connected to WETF, along with a new exhaust air stack, change room, and mechanical building. These changes are scheduled during the late 1990's for neutron tube target loading (NTTL) operations and related research (DOE 1995a). This building will receive a hazard category designation when it is authorized by DOE to operate.

Planning for the Tritium Systems Test Assembly facility at TA–21 began in 1977 after LANL was chosen to develop, demonstrate, and integrate technologies related to the deuterium-tritium fuel cycle for large-scale fusion reactor systems. Construction was completed and pre-tritium testing initiated in 1982. TSTA is a Hazard Category 2 nuclear facility. The TSTA facility is located at TA–21 (also called DP Site). TA–21 has two primary research areas: DP West and DP East. The DP West area is currently under decontamination and decommissioning. The TSTA facility is located at the DP East research area.

An existing building (21–155N) was modified to accommodate TSTA. The main experimental tritium area (Room 5501) has 3,700 square feet (344 square meters) of floor area. Two small laboratories are connected to the 5501 ventilation system, which also services the main experimental tritium area. In the same building, but in the area surrounding the main experimental area, there is an additional 5,993 square feet (557 square meters) of floor space that is used for the Control Room, Support Center, office area, equipment rooms, and a diesel generator. Another existing building (21–155S), which has 3,819 square feet (355 square meters) of floor area, is used for office and shop space.

In addition to the main building, there is 1,506 square feet (140 square meters) of storage space in a metal warehouse (Building 21–213) located north of the main experimental area. The east end of this building has been sectioned off and is used as a storage area for tritium contaminated equipment. There is also a portable building (Building 21–369) located on the west side of the main laboratory, which adds an additional 753 square feet (70 square meters) of office space. One stack, which is located at the northwest corner of TA–21–155N, services the TSTA tritium experimental areas.

The TSFF, a Hazard Category 2 nuclear facility, is a tritium research and development facility located in Building 209 at TA–21. The TSFF facility is located east of the TSTA facility at the DP East research area. The building was built in 1964 as a chemistry process building and modified in 1974 to accommodate tritium operations associated with nuclear weapons development and test programs. TSFF is a 3,228-square-foot (300-square-meter) block-walled area within the Building 21–209, which is a one-story building with a basement. TSFF is serviced by a process exhaust air treatment system that discharges into an exhaust ventilation system that discharges room air and treated process air to a 75-foot (23-meter) high exhaust air stack.

The radioactive materials used at WETF, TSTA, and TSFF are primarily tritium gas and metal hydride storage beds, some of which contain depleted uranium powder. Several nonradioactive toxic and hazardous substances, such as methanol and acetone, are used in small quantities to clean and maintain processing equipment at the three facilities. These are common solvents and cleaners found in most modern chemistry laboratories.

Description of Capabilities

The principal activities conducted at WETF, TSTA, and TSFF are described below. The manner in which these activities will vary among the alternatives is described in chapter 3.

High-Pressure Gas Fills and Processing (WETF). High-pressure gas fills and processing operations for research and development and nuclear weapon systems are performed at WETF at TA–16–205. High-pressure gas containers (reservoirs) are filled with tritium/deuterium gas mixtures to specified pressures in excess of 10,000 pounds per square inch. This capability is also used for filling experimental devices (e.g., small inertial confinement fusion [ICF] targets that require high pressure tritium gas).

Gas Boost System Testing and Development (WETF). Modern nuclear weapons are equipped with gas boost systems that use hydrogen isotopes including tritium. These systems and their components need ongoing maintenance, testing, development, gas replacement, and modifications to maintain safety and reliability. WETF provides highly specialized boost system function testing and experimental equipment. Also, more efficient and effective boost systems are under development and tested at WETF.

Cryogenic Separation (TSTA). To separate pure gas species from gaseous mixtures, a distillation technique is used, known as cryogenic distillation. The technique combines super cooling and high vacuum technologies for separating gaseous mixtures. This capability is used to separate gaseous tritium from other gases at TSTA. It is possible that other tritium facilities, such as WETF, at LANL could use this technique in the future.

Diffusion and Membrane Purification (WETF, TSTA, TSFF). Different gaseous species of elements move (diffuse) through membranes and other barriers at rates that depend on their molecular weight. Also, gaseous species penetrate (pass through) certain membranes differently based on their molecular size. Gas separation and purification techniques have been developed based on these two characteristics of the gaseous species. Currently, several systems exist that utilize a multi-step membrane diffusion process for effective and efficient gas separations.

All three LANL tritium facilities currently possess or plan to have the operational capability to separate and purify tritium from gaseous mixtures using diffusion and membrane purification techniques.

Metallurgical and Material Research (WETF, TSTA, TSFF). Tritium handling capabilities at the WETF, TSTA, and TSFF facilities accommodate a wide variety of metallurgical and material research activities. One example of this type of research is the investigation into the ability of various containers to remove hydrogen isotopes (including tritium) from a flowing stream of nitrogen and other inert gases. In application, this capability may be used to clean up exhaust air streams and the air in tritium containment areas without generating tritiated water, a more hazardous form of tritium.

Thin Film Loading (TSFF, WETF). The thin film loading process capability involves chemically bonding a radioactive gas, tritium, to a metallic surface. These operations are currently conducted at TSFF, but are being moved to WETF.

Tritium for the NTTL thin film loading operations are contained within a small hydride collection bed, which is refilled periodically. The hydride bed collects the tritium gas in a metal hydride form and holds it until the bed is heated to a temperature of 1,110 degrees

Fahrenheit (°F) (600 degrees Celsius [°C]). Hence, the release of tritium from the bed is a well-controlled process and the tritium cannot be released from the bed at normal temperatures. The process is conducted under vacuum conditions in an inert atmosphere.

The NTTL thin film loading system is constructed in a modular fashion. The basic modules include the loader itself, several control racks, a glovebox and hood with all internal and external attachments, a gas purifier, a chiller, and several oil-free vacuum pumps.

Gas Analysis (WETF, TSTA, TSFF). It is essential for nuclear material control and accountability, as well as experimental purposes, to have the capability to measure the composition and quantities of the gases used. Mass spectrometers are common laboratory measurement instruments used at the three LANL tritium facilities to measure the composition of gas samples. Also, Raman spectrometry is used for real time gas analysis. Other techniques such as beta scintillation counting are also used for real time and batch gas analysis. The amount of gas, including tritium, that is needed for any of these measurement techniques is small.

Calorimetry (WETF, TSTA, TSFF). Calorimetry is a well established nondestructive method used for measuring the amount of tritium in a container. This method is based on the measurement of heat flow from a container. The radioactive decay of tritium gives off heat at a rate that is directly proportional to the amount of tritium contained in gas containers. No tritium leaves the container in the performance of calorimetry measurements.

Solid Material and Container Storage (WETF, TSTA, TSFF). Safe storage of hydrogen isotopes including tritium is an important capability of all three LANL tritium facilities. Tritium in gaseous form may be stored in either specially designed dual wall containers or certified shipping containers. Tritium gas may also be safely stored in metal hydride form contained in dual wall containers. The metal hydride that forms when tritium reacts with the metallic powder in the container is a very stable compound. Tritium can be released from this compound by heating the container to several hundred degrees Celsius. Accountable quantities of tritium are stored in these ways in designated areas that have been approved for such storage.

Tritium oxide (tritiated water) can also be stored in solid form when it is adsorbed (gathered on a surface in a condensed layer) on molecular sieves. Molecular sieves are made with materials that adsorb tritiated water in the fine pores on their surface, thus forming a solid material that can be stored in containers. Tritiated water adsorbed on molecular sieves is physically stable. Tritiated water is released from the molecular sieve when the temperature is raised above the boiling point for water.

2.2.2.3 *Chemistry and Metallurgy Research Building (TA–3–29)*

The CMR Building (TA–3–29) was designed within TA–3 as an actinide chemistry and metallurgy research facility (Table 2.2.2.3–1). The main corridor with seven wings was constructed in 1952 (Figure 2.2.2.3–1). In 1960, a new wing (Wing 9) was added for activities that must be performed in hot cells (a hot cell is an enclosed area that allows for the

TABLE 2.2.2.3–1.—*Principal Buildings and Structures in the Chemical and Metallurgy Research Building*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–3	CMR Laboratory: 3–29
	Hot Waste Pump House: 3–154

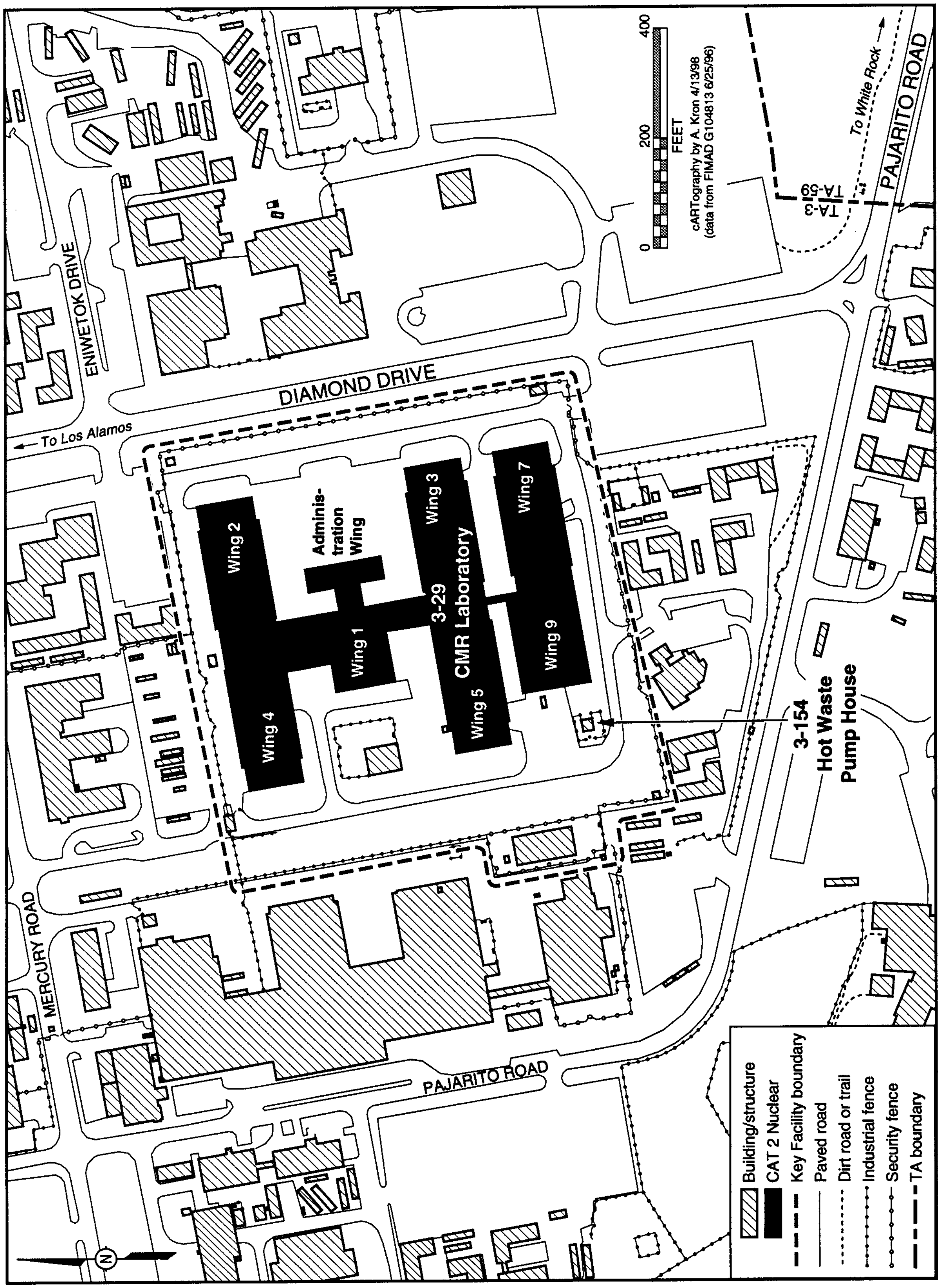


FIGURE 2.2.2.3–1.—*TA–3 Chemistry and Metallurgy Research Building.*

remote handling of highly radioactive materials). Wings 6 and 8 were never constructed. The three-story building now has eight wings connected by a spinal corridor and contains a total of 550,000 square feet (51,097 square meters) of space. It is a multiple-user facility in which specific wings are associated with different activities. It now is the only LANL facility with full capabilities for performing SNM analytical chemistry and materials science.

Description of Facility

CMR facilities include hot cells and SNM vaults. Waste treatment and pretreatment conducted within the facility is sufficient to meet waste acceptance criteria for receiving facilities, on site or off site. In addition, these facilities are used to support various activities at other LANL locations. TA–55 (described in section 2.2.2.1) provides support to CMR in the areas of materials control and accountability, waste management, and SNM storage.

The aqueous waste from radioactive activities and other non-hazardous aqueous chemical wastes from the CMR Building are discharged into a network of drains from each wing specifically designated to transport waste solutions to the RLWTF in TA–50 (described in section 2.2.2.14) for treatment and disposal. The primary sources of radioactive inorganic waste at the CMR Building include laboratory sinks, duct wash-down systems, and overflows and blowdowns from circulating chilled-water systems. The facility infrastructure is designed with air, temperature, and power systems that are operational nearly 100 percent of the time. Power to these systems is backed up with an uninterruptable power supply. The CMR Building has one NPDES outfall, which discharges seasonally into Mortandad Canyon at a rate of one gallon per minute. This outfall is slated for waste stream corrections as part of LANL's outfall reduction plan. The CMR Building was constructed in the early 1950's to the industrial building code standards in effect at that time. Over the intervening years, DOE has systematically identified and corrected some deficiencies and upgraded some systems to address changes in standards or improve safety performance. Beginning in 1970, these included:

- Ventilation system upgrades (1973 to 1974)
- Fire protection system upgrades (1978)
- Surety facility upgrades (1981, 1992)
- Asbestos repair and removal (1984 to present)
- Acid drain line replacement (1984)
- Evacuation system—public address system and alarms (1984)
- Curbing installed around equipment (1985)
- Vacuum system for continuous air monitors (1987)
- Exhaust duct cool-down system (1987)
- Heating, ventilation, and air conditioning controls (1987)
- Main storage vault (1987 to 1994)
- Alarm monitors (1988)
- PCB transformer replacement (1989)
- Removal of natural gas service from the building (1990)
- Stack emissions monitoring system (1991)
- Air sampling probes (1991)
- SNM waste assay facility (1991)

However, these upgrades have not kept up with the aging of the building or increasingly stringent safety standards. A more comprehensive series of upgrades was identified and authorized by DOE addressing specific safety, reliability, consolidation, and safeguards issues. These were prioritized, with the highest priority being assigned to equipment replacements and activities essential to maintain the minimum safe operating conditions for an interim period of 5 to 10 years, while more comprehensive upgrades were developed. These upgrades were identified by DOE as routine maintenance work, having no significant potential for environmental consequences and not intended to prolong the useful life of the facility. These "Phase I" upgrades were categorically excluded by DOE from the need for further NEPA analysis. The proposed work and the status of completion as of March 1998 includes:

- Augmenting and replacing continuous air monitors in building wings (95 percent complete)
- Replacing some heating, ventilation, and air conditioning blowers (95 percent complete)
- Upgrading basic wing electrical systems (80 percent complete)
- Upgrading power distribution system (55 percent complete)
- Replacing the stack monitoring systems (75 percent complete)
- Installing an uninterruptable power supply for the stack monitoring systems in the laboratory wings (90 percent complete)
- Making limited (interim) improvements to the duct washdown system (89 percent complete)
- Improvements to acid vents/drains (41 percent complete)
- Modifying the sanitary sewer system (completed)
- Performing a fire hazard analysis (completed)
- Preparing an Engineering Assessment and Conceptual Design Report (CDR) (completed)

In addition to the highest priority (Phase I) upgrades, the CMR Building was recognized to require additional upgrading if it is to continue to perform the essential analytical chemistry and metallurgy operations for LANL's existing assignments in a safe, secure, and environmentally sound manner for an additional 20 to 30 years. These further upgrades are not intended to increase the capabilities of the facility nor allow new missions or functions to be located there. These Phase II Upgrades, analyzed in the *Environmental Assessment for the Proposed CMR Building Upgrades* (DOE 1997a) (and also presented in a Capital Asset Management Process Report [LANL 1996c]), include:

- *Seismic and Tertiary Confinement Upgrades.* Diagonal braces from walls to roof, exterior bracing from second floor to ground, internal vertical bracing, strengthening exterior columns, filling in window openings, and adding bracing to the Wing 9 hot cell supports would allow the CMR Building to meet seismic (earthquake resistance) criteria for a Hazard Category 2 facility.
- *Security Upgrades.* Building doorways and other openings would be changed to make human entry other than through the security stations much more difficult.
- *Ventilation Confinement Zone Separation in Wings 1, 3, 5, 7, and 9.* The ventilation systems in these wings would be improved by adding one-way flow baffles and liners in the ventilation ducts, installing better doors and vestibules, adding a new filter tower to Wing 3, and installing a separate glovebox exhaust system. These upgrades are intended to prevent backflow of air carrying radioactive materials and chemical fumes from contaminated areas such as gloveboxes to uncontaminated laboratories, corridors, and offices.
- *Standby Power and Communications Systems.* This upgrade would provide standby electrical power in case a power failure caused the ventilation system to fail. This back up power would maintain negative pressure in the laboratories of Wings 3, 5, 7, and 9, reducing the likelihood that contamination from a laboratory would be spread into other areas. A small generator will provide standby power to the ventilation system and the emergency communication system.
- *Wing 1 Upgrades.* Wing 1 will be decontaminated and a new heating, ventilation, and air conditioning system will

be installed to improve worker health and safety.

- *Operations Center Upgrades.* All building monitoring and control systems will be reported at a central location. This will include continuous air monitors (CAMs), stack monitors and alarms, fire alarm panels, heating, ventilation, and air conditioning and other building utilities, electrical substation switchgear, and glovebox sensors.
- *Chilled Water in Wings 3, 5, and 7.* The 40-year-old evaporative coolers in each wing will be replaced with refrigeration units. Chilled water is supplied to cool process equipment. A chilled water plant will be constructed outside the CMR Building, just west of Wing 1.
- *Main Vault CAMs and Dampers.* Detection capability for radioactive contamination will be enhanced by installing new CAMs in the main vault. The CAMs will be monitored in the CMR Building Health Physics Office. In addition, seismically qualified dampers will be installed in the vault ventilation ducts.
- *Acid Vents and Drains in Wings 3, 5, and 7.* The current acid vents and drains do not rinse or drain completely, allowing radioactive liquid waste residues to stand in nearly horizontal sections of the piping. These systems would be replaced to provide greater slope and better drainage. These wastes are discharged to the RLWTF.
- *Fire Protection Upgrades.* To improve the fire protection system, backflow preventers, fire dampers, and new fire alarm system panels will be installed throughout the CMR Building.
- *Operations Center Standby Power.* A standby generator will provide power to the Operations Center in the event the main system electrical power is lost.
- *Exhaust Duct Washdown Recycle System in Wings 3, 5, and 7.* This planned upgrade is a waste minimization initiative whereby the duct washdown system would be fitted with a system to recycle up to 80 percent of the water used to rinse away materials from the air exhaust that fall out on the duct surfaces. This upgrade is anticipated to decrease the volume of radioactive liquid waste from the duct washdown system by about 450,000 gallons per year (1,700,000 liters per year), to about 120,000 gallons per year (454,300 liters per year).
- *Wings 2 and 4 Safe Standby.* Wings 2 and 4, unneeded to accomplish current mission element assignments, would be placed in safe standby, meaning that loose contamination and some equipment would be removed and the remaining equipment would be placed in a safe and stable condition such that it could not be used.

In its finding of no significant impact regarding the CMR Phase II Upgrades, DOE stated that two potential upgrade designs were encompassed within the environmental assessment (DOE 1997a) analyses: upgrading Wings 3, 5, and 7 without moving office space currently located on the perimeter of each wing; and relocating the office space away from the laboratory functions while upgrading the laboratory space in those wings. In the latter case, two wings would be reconfigured as laboratory space and the third would be put into safe standby condition.

The CMR Phase II Upgrades are funded, and construction is expected to begin in mid 1998. These upgrades were originally scheduled for completion in 2004.

In early 1997, it became apparent that the costs of ongoing (Phase I) upgrades at the CMR Building would overrun the budgeted 1997 costs for that construction project. After considering budget, schedules, and project management issues, LANL, with DOE concurrence, suspended CMR Building Upgrades Project activities pending a thorough budget and project management review (Whiteman 1997). During 1997, several audit and assessment activities were completed by LANL and DOE in which root causes and corrective measures required to address project management issues were identified. Throughout the second half of 1997 and 1998, LANL and DOE have been implementing a series of corrective actions related to improving project management performance on the CMR Building Upgrades Project to allow project activities to resume.

In addition to the information discussed above regarding ongoing and planned upgrades, additional developments occurred during 1997 regarding CMR Building operations. These are highlighted here as contextual information. These developments are consistent with responsibilities and approaches regarding safe operations at LANL, as discussed in section 2.1.3.

On September 2, 1997, in response to safety considerations, LANL temporarily suspended operations within the CMR Building pending an in-depth review of all operations and procedures being implemented within the building to support ongoing LANL activities. During the period from September 1997 through April 1998, operations were resumed in a phased manner as work control and work authorization procedures were verified for each set of operations within the building (Gancarz 1997). Full resumption of CMR Building operations was authorized by DOE on April 17, 1998. To further improve operation of the CMR facility within a safe operating envelope for nuclear facilities, LANL Director Browne announced a new integrated management organization for the CMR Building in which the technical, operations, and facility management of the CMR Building would be integrated with that of TA–55. This reorganization became effective in January 1998 (Browne 1997).

In September 1997, DOE and LANL decided to develop a "Basis for Interim Operations" (BIO) at the CMR facility in lieu of a Safety Analysis Report in order to establish the safety authorization basis for the facility. This effort was completed in October 1998, with the issuance of the BIO and associated technical safety requirements (TSRs) that must be implemented according to a DOE/LANL approved plan over the next 2 years[1]. With the authorization basis established through the BIO, the CMR Building Upgrades Project is responding to meeting the TSR implementation requirements to ensure safe operations with the facility. TSR implementation requires certain facility modifications be completed. Throughout 1998, the CMR Building Upgrades Project was integrated into the BIO/TSR development process. On March 24, 1998, a workshop was held to evaluate CMR Building upgrades required to support BIO/TSR implementation. A second workshop was held on July 17, 1998, to further refine BIO/TSR implementation upgrades and additional upgrades related to safe, reliable operations within the CMR Building.

Based on the above information, the CMR Building Upgrades Project has resumed, and the first priority is the completion of CMR facility modifications required to implement the BIO/TSRs and satisfy compliance requirements. Formal restart of CMR Building Upgrades Project activities commenced on April 13, 1998, with DOE authorizing LANL to initiate activities in support of BIO/TSR implementation that are within the scope of the CMR Building Upgrades Project. Since April 1998, additional project activities have been authorized (repriortized, but within the original scope) by the DOE. Authorized CMR Building Upgrades Project activities since resumption include:

1. The approved CMR BIO includes a comprehensive accident analysis section, including a wing-wide fire scenario that is similar to an accident evaluated in this SWEIS. These analyses were compared, and it was found that, although modeling assumptions and methods varied significantly, the estimated consequences and frequency demonstrated a good agreement. See appendix G, section G.5.6.16, for further details.

- Fire protection panel replacement
- Transient combustible loading reduction
- Motor control centers replacement (completed)
- Duct washdown system refurbishment in Wings 3, 5, and 7
- Interim project management activities

Additional project activities under review or consideration currently include:

- Air compressor replacement
- Hood washdown system installation
- Heating, ventilation and air conditioning (HVAC) DP indicator installation
- Wing 9 ventilation system upgrades
- Emergency personnel accounting system installation
- Stack monitoring upgrades
- Hot cell upgrades, Wing 9 (several subprojects)

A crosswalk between the approved CMR Building Upgrades Project (Phases I and II) baseline and the authorized or under review work in support of the BIO/TSR implementation activities is given in Table 2.2.2.3–2.

All of the above-listed project activities were developed and reviewed during the March and July 1998 workshops. The DOE and LANL are continuing to define all required facility modifications based on ongoing evaluations of site or facility conditions and program requirements to support a rebaselining of the overall CMR Building Upgrades Project during 1999.

In 1996 through 1998, LANL geologists conducted detailed geologic studies in and around TA–3 and TA–55 and geologic trenching studies on the Pajarito Fault. Results from these studies indicate that a possible connection exists between the Pajarito, Rendija

TABLE 2.2.2.3–2.—*CMR Building Upgrades Project Crosswalk Between Phases I and II and 1998 Scope of Work Authorized or Under Review*

BASELINE DESCRIPTION	AUTHORIZED (A) OR UNDER REVIEW (R)
Fire protection upgrades, Phase II	• Fire protection panel replacement (A) • Transient combustible loading reduction (A)
Upgrading basic wing electrical systems, Phase I	Motor control centers replacement (A)
Duct washdown upgrade, Phase I[a]	Condition assessment upgrade (A) Duct washdown system refurbishment, Wings 3, 5, 7[b] (R)
Ventilation confinement zone separation upgrades, Phase II	• Air compressor replacement subsystems controlling HVAC dampers (R) • HVAC delta pressure indicator installation subsystem monitoring HVAC negative pressure (R) • Wing 9 Ventilation system upgrades (R)
Communications upgrades, Phase II	Emergency personnel accounting system (R)
Stack monitors upgrade, Phase I	Stack monitoring upgrades (R)
--	Hot cell upgrades - Wing 9 (R)

[a] Hood washdown upgrades may be addressed under facility operations administrative controls and is currently not included as a subproject.
[b] Only condition assessments for duct washdown have been authorized. Separate authorization will be issued for construction upon completion of assessments.

Canyon, and Guaje Mountain faults, which may increase the likelihood for fault rupture within TA–3 should a seismic event occur (see chapter 4, section 4.2.2.2, and appendix I). The earthquake accident frequencies utilized in appendix G have been compared to that which would be derived considering the results from the geologic mapping and trenching studies. Potential building seismic damage has been addressed for ground shaking and fault rupture, where appropriate, from earthquakes (volume III, appendix G, Table G.5.4–3). The seismic failure frequencies that were used in the accident analysis do not increase significantly as a result of seismic ground rupture. The basis for this conclusion is that the return period (the inverse of frequency) for a damaging fault rupture is significantly greater than the return periods used for damaging ground motion in the accident analysis. Because additional damage could result should a fault rupture occur at the CMR Building, a sensitivity study is performed for this scenario as part of the earthquake analysis (appendix G, SITE–03).

The DOE has decided not to implement the seismic upgrades as part of the CMR Building Upgrades Project, Phase II. This is a result of: (1) new seismic studies published after the draft SWEIS was released that indicated the additional hazard of a seismic rupture at the CMR Building (chapter 4, section 4.2.2.2, and appendix I) and (2) DOE's postponement of the decision to implement the pit manufacturing capability beyond 20 pits per year in the near future. Although the seismic rupture risk does not have a substantial effect on the overall seismic risk, it is an aspect of risk that cannot be cost-effectively mitigated through engineered structural upgrades. Given that assessment, the DOE is considering more substantial actions that are not yet ripe for analysis in the SWEIS (e.g., replacement of aging structures). The overall goal of DOE's evaluation is to ultimately reduce the risk associated with seismic event, should one occur. In the meantime, DOE is taking actions to mitigate seismic risks through means other than seismic upgrades (e.g., minimizing material at risk and putting temporarily inactive material in process into more sturdy containers).

Description of Capabilities

The operational CMR capabilities include both radioactive and nonradioactive substances. Work involving radioactive material (including uranium-235, depleted uranium, thorium-231, plutonium-238, and plutonium-239) is performed inside hoods, hot cells, and gloveboxes. Chemicals such as various acids, carcinogenic materials, and organic-based liquids are used in small quantities, generally in preparation of radioactive materials for processing or analysis.

The principal activities conducted at the CMR Building are described below. The manner in which these activities will vary among the alternatives is described in chapter 3.

Analytical Chemistry. Analytical chemistry capabilities involving the study, evaluation, and analysis of radioactive materials reside at the CMR Building. These activities support research and development associated with various nuclear materials programs, many of which are performed at other LANL locations on behalf of or in support of other sites across the DOE complex (e.g., Hanford Reservation, Savannah River Site, Sandia National Laboratories). Sample characterization activities include assay and determination of isotopic ratios of plutonium, uranium, and other radioactive elements; major and trace elements in materials; the content of gases; constituents at the surface of various materials; and methods to characterize waste constituents in hazardous and radioactive materials.

Uranium Processing. Operations essential for the stewardship of uranium products are conducted at this facility. They include uranium processing (casting, machining, and reprocessing operations, including research and development of process improvements and characteristics of uranium and uranium compounds), and the handling and storage of high radiation materials. The facility also provides limited backup to support the nuclear materials management needs for activities at TA–55 and also provides pilot-scale unit operations to back up the uranium technology activities at the Sigma Complex (described in section 2.2.2.5), other LANL facilities, and other DOE sites.

Destructive and Nondestructive Analysis. Destructive and nondestructive analysis employs analytical chemistry, metallographic analysis, measurement on the basis of neutron or gamma radiation from an item, and other measurement techniques. These activities are used in support of weapons quality, component surveillance, nuclear materials control and accountability, SNM standards development, research and development, environmental restoration, and waste treatment and disposal.

Nonproliferation Training. LANL utilizes measurement technologies at the CMR Building and other LANL facilities to train international inspections teams for the International Atomic Energy Agency. Such training may use SNM.

Actinide Research and Processing. Actinide research and processing at the CMR Building typically involves solids, or small quantities of solution. However, any research involving highly radioactive materials or remote handling may use the hot cells that are in Wing 9 of the CMR Building to minimize personnel exposure to radiation or other hazardous materials. CMR actinide research and processing may include separation of medical isotopes from targets, processing of neutron sources (DOE 1995d), and research into the characteristics of materials, including the behavior or characteristics of materials in extreme environments (e.g., high temperature or pressure).

Fabrication and Metallography. Fabrication and metallography at the CMR Building involves a variety of materials, including hazardous and nuclear materials. Much of this work is done with metallic uranium. The CMR Building can fabricate and analyze a variety of parts, including targets, weapon components, and parts used for a variety of research and experimental tasks.

2.2.2.4 *Pajarito Site: Los Alamos Critical Experiments Facility (TA–18)*

The Los Alamos Critical Experiments Facility (LACEF) and other experimental facilities are located at TA–18, which is known as Pajarito Site. TA–18 facilities are 3 miles (4.8 kilometers) from the nearest residential area, White Rock, and 0.25 miles (400 meters) from the closest technical area (Figure 2.2.2.4–1 and Table 2.2.2.4–1). These facilities are in a canyon near the confluence of Pajarito Canyon and Threemile Canyon. Some natural shielding is afforded by the surrounding canyon walls that rise approximately 200 feet (61 meters) on three sides.

Description of Facility

The facility consists of a main building, three outlying remote-controlled critical assembly buildings known as kivas, and several smaller laboratory, nuclear material storage, and support buildings. Kivas #1, #2, and #3 are Category 2 nuclear facilities. Each kiva is surrounded by a fence to keep personnel at a safe distance during criticality experiments, and the entire site is bounded by a security fence to aid in physical safeguarding of SNM. Site access is through a guarded portal.

The main laboratory building (Building 30) houses offices for group management, staff, and health physics personnel. There are several radioactivity counting rooms, an electronic

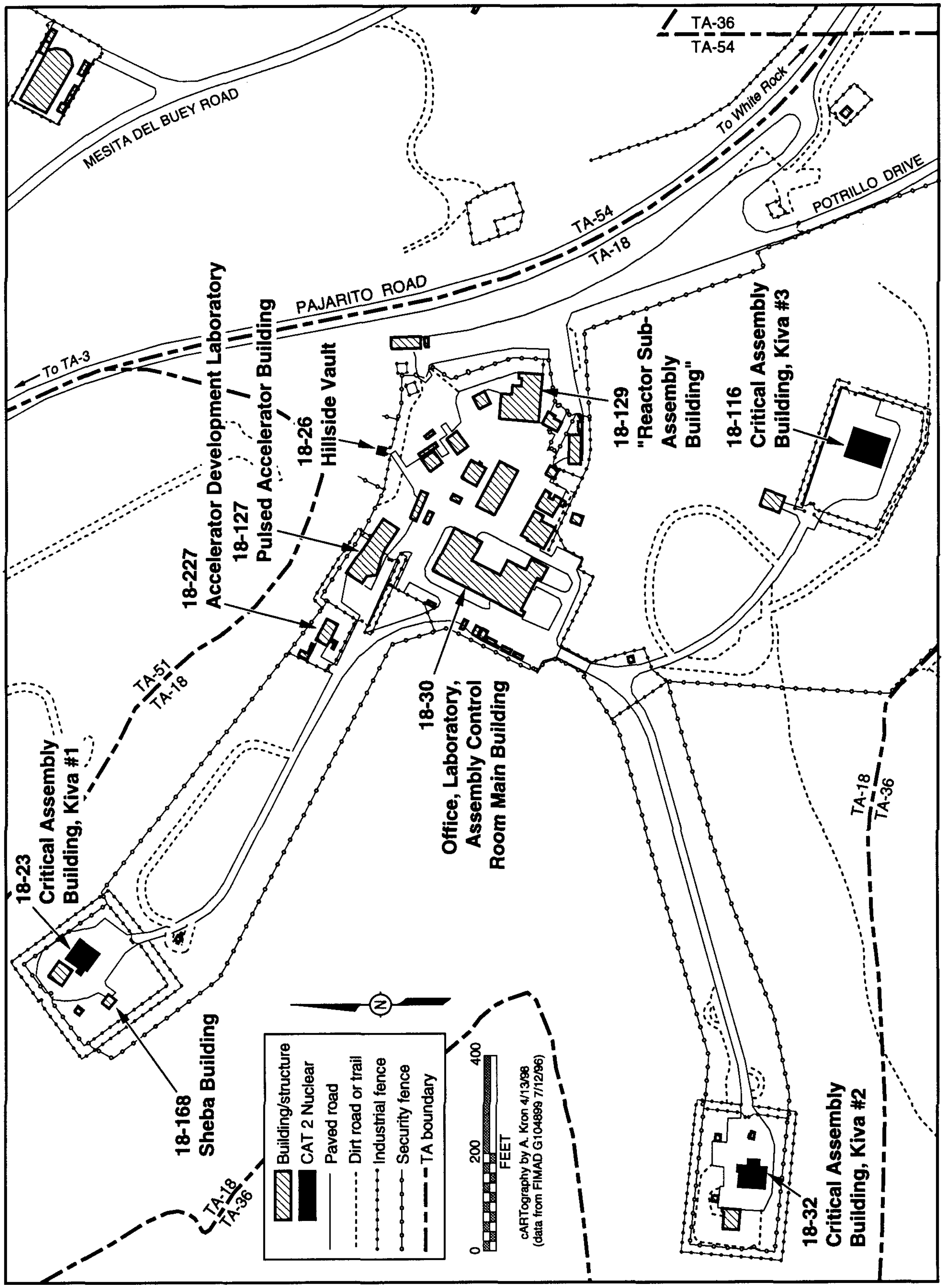


FIGURE 2.2.2.4–1.—*TA–18 Pajarito Site.*

TABLE 2.2.2.4–1.—*Principal Buildings and Structures of the Pajarito Site*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–18	Warehouse: 18–28 Main Building: 18–30 Pulsed Accelerator Building: 18–127 Reactor Subassembly Building[a]: 18–129 Critical Assembly Kivas: 18–23, 18–32, 18–116 Vault: 18–26 Sheba Building: 18–168 Accelerator Development Laboratory: 18–227

[a] This is a historical name. This building is currently used for detector development and calibration and has never housed a nuclear reactor.

assembly area, the site machine shop, and the critical assembly control rooms in Building 30. Other support buildings are the Hillside Vault (Building 26) for nuclear material storage, the Pulsed Accelerator Building (Building 127) for projects requiring a "clean" radiation environment, and Building 129 for detector development and calibration.

Description of Capabilities

The principal TA–18 activities are the design, construction, research, development, and applications of critical experiments (that is, experiments having to do with nuclear criticality). These are conducted using five types of assemblies:

- Benchmark critical assemblies
- General purpose assembly machines
- Solution assemblies (which use fissile solutions)
- Prototype low power reactor assemblies (these do not need heat rejection systems)
- Fast-burst assemblies for producing fast-neutron pulses

TA–18 activities also include development, training, and applying nuclear diagnostic and accountability techniques. Nuclear materials control and handling, waste characterization, and criticality experiments are areas of particular interest. The Nuclear Emergency Search Team, Strategic Defense Initiative Program, and the Strategic Arms Reduction Treaty Verification Group all utilize TA–18 in fulfilling their program requirements. The TA–18 staff trains personnel from a variety of occupations and several countries in criticality safety as well as radiation detection and instrumentation.

Since 1948, thousands of criticality experiments and measurements have been performed at LACEF on assemblies using uranium-233, uranium-235, and plutonium-239 in various configurations, including nitrate, sulfate, and oxide compounds as well as solid, liquid, and gas forms. Critical assemblies at LACEF are designed to operate at low-average power and at temperatures well below phase change transition temperatures (which sets them apart from normal reactors) with low fission production and a minimal inventory. These assemblies are very flexible in terms of fuel loading, configuration, and the types and forms of material that can be used for experiments. Since these assemblies do not require forced convection cooling, a potential source of stored energy and fission products is eliminated. Post-shutdown cooling is unnecessary, and experiments are "walk-away" safe. Machine designs are relatively simple with the prime requirement being that operations are remotely controlled from a control room in Building 30 or from behind thick shielding.

Experiments employ fissile species such as uranium-233, uranium-235, and plutonium-239. Between experiments, these special nuclear materials are stored in designated storage areas at kivas or in the Hillside Vault.

Nuclear material is moved by truck to and from TA–18 over public roads in U.S. Department of Transportation (DOT)-approved shipping containers or using road closures on an as-required (infrequent) basis. The on-site TA–18 nuclear materials inventory is relatively stable, and consists primarily of isotopes of plutonium and uranium. The bulk of the plutonium is solid and is either clad or encapsulated; plutonium oxide is doubly canned. The use of toxic and hazardous chemicals is limited.

The criticality experiments generate very small amounts of fission products and there is essentially no radioactive waste. Criticality experiments do not release significant emissions to the atmosphere at the site.

The principal sets of experimental activities conducted at TA–18 are described below. The manner in which these activities would vary under each of the alternatives is described in chapter 3.

Dosimeter Assessment and Calibration. TA–18 critical assemblies are used to evaluate the performance of personnel radiation dosimeters. Nuclear accident dosimetry studies are conducted using the critical assembly radiation to simulate criticality accident radiation. The facility hosts national dosimetry intercomparison studies involving personnel and dosimeters from DOE and private nuclear facilities.

Detector Development. TA–18 personnel have developed and built nuclear materials detection instruments used to monitor pedestrians and vehicles, as well as hand-held and field-deployable neutron and gamma-ray detectors. TA–18 personnel also operate a simulation facility in which nuclear materials can be configured to develop and validate instruments and methods used in nuclear nonproliferation programs.

A new method of monitoring alpha-particle-emitting nuclear materials is undergoing development at TA–18 along with the development of detectors that can help assess potential threats from terrorist organizations. TA–18 personnel also train nuclear emergency search team personnel in the use of these instruments.

Materials Testing. The TA–18 facilities are used to characterize and evaluate materials, primarily by measuring the nuclear properties of these materials. The materials evaluated are typically structural materials or those to be used as shielding or neutron absorbers. Materials testing typically involves use of radiation sources or critical assemblies as radiation generators and measurement of radiation levels under a variety of conditions.

Subcritical Measurements. Subcritical measurements are those done on arrays of fissile material that are below the critical mass for material in a given form. Subcritical experiments may vary any or all of the factors that influence criticality (mass, density, shape, volume, concentration, moderation, reflection, neutron absorbers, enrichment, and interactions). Associated measurement techniques involve measuring some aspect of the neutron or gamma population in the material to assess its criticality state.

Fast-Neutron Spectrum. TA–18 has bare and reflected metal critical assemblies that operate on a fast-neutron spectrum. These assemblies typically have irradiation cavities in which flux foils, small replacement samples, or small experiments can be inserted. Typical experiments include evaluation of the reactivity of material samples, irradiation of novel neutron and gamma measuring instrumentation, and testing and calibrating radiation dosimeters.

Dynamic Measurements. Two fast-pulsed assemblies at TA–18 produce controlled, reproducible pulses of neutron and gamma radiation from tens of microseconds to several tens of milliseconds in duration. These pulses are useful for applications such as neutron physics measurements, instrumentation development, dosimetry, and materials testing.

Skyshine Measurements. The study of skyshine (radiation transported point to point without a direct line of sight) is a component of dosimetry primarily applicable to neutron producing processes and facilities. TA–18 uses critical assemblies to produce radiation fields to mimic those found around nuclear weapons production and dismantlement facilities, in storage areas, and in experimental areas.

Vaporization. The fast-pulsed assemblies at TA–18 have the capability of vaporizing fissile materials placed in a thermalizing material next to the assembly or in an internal cavity. These vessels are placed inside multiple containment vessels to prevent leakage of vaporized materials and fission products. This capability is useful for testing materials, measuring the properties of fissile materials, and testing reactor fuel materials in simulated accident conditions.

Irradiation. Several critical assemblies at TA–18 can have varying spectral characteristics in both steady state and pulsed modes. These assemblies are typically used for irradiating fissile materials and other materials with energetic responses for the purposes of testing and verifying computer code calculations.

2.2.2.5 *Sigma Complex (TA–3–66, TA–3–35, TA–3–141, and TA–3–159)*

The Sigma Complex consists of the main Sigma Building (Building 66) and its associated support structures, including the Beryllium Technology Facility (Building 141), the Press Building (Building 35), and the Thorium Storage Building (Building 159) (see Figure 2.2.2.5–1 and Table 2.2.2.5–1).

The Sigma Complex supports a large, multi-disciplinary technology base in materials fabrication science. This facility is used mainly for materials synthesis and processing, characterization, fabrication, joining, and coating of metallic and ceramic items. These capabilities are applied to a variety of materials, including uranium (depleted uranium and enriched uranium), lithium, and beryllium; the Sigma Complex is equipped to handle such materials safely. The current activities focus on limited production of special (unique or unusual) components, test hardware, prototype fabrication, and materials research in support of DOE programs in national security, energy, environment, industrial competitiveness, and strategic research. The Sigma Complex also provides support to research and development activities conducted elsewhere at LANL by constructing special pieces of equipment and test items.

Description of Facilities

The Sigma Building is designated as a Hazard Category 3 nuclear facility. The Sigma Building was built in 1958 and 1959, with an addition constructed in the late 1980's. It contains four levels and approximately 168,200 square feet of floor space (15,626 square meters). The Sigma Building is composed of four sectors. Three sectors built in the late 1950's were not constructed to current seismic design criteria (seismic upgrades are included in all alternatives). The fourth sector,

TABLE 2.2.2.5–1.—*Principal Structures and Buildings in the Sigma Complex*

TECHNICAL AREA	PRINCIPAL STRUCTURES AND BUILDINGS
TA–3	Sigma Building: 3–66 Press Building: 3–35 Beryllium Technology Facility: 3–141 Thorium Storage Building: 3–159

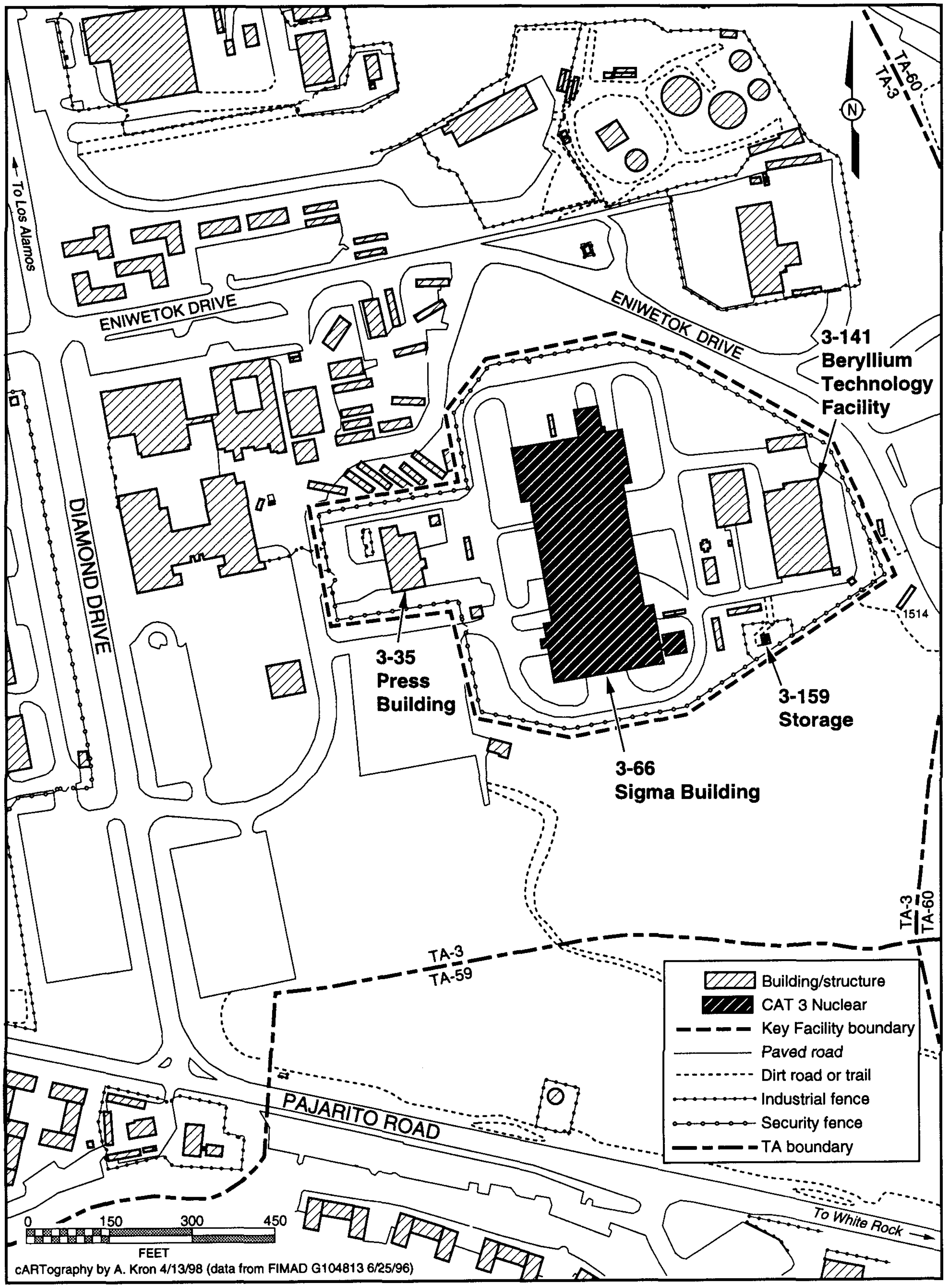


FIGURE 2.2.2.5–1.—*The Sigma Complex in TA–3.*

built in the late 1980's, meets current seismic design criteria. Hazardous chemicals such as concentrated acids and caustic solutions are used and stored at the Sigma Building. Sigma Building air exhausts through six major exhaust stacks and through numerous roof exhausts. Aqueous waste from enriched uranium processing and liquid chemical waste are routed to the RLWTF at TA–50 (described in section 2.2.2.14). Most of the liquid waste from the Sigma Complex is generated from the electroplating operation at the Sigma Building. Electrodeposition solutions are now vacuum distilled and re-used; the sludges are managed as RCRA wastes.

The Beryllium Technology Facility (3-141), formerly called the Rolling Mill Building, was built in the early 1960's and encompasses approximately 20,213 square feet (1,878 square meters) on three levels. This building does not have a hazard designation. The two sectors of the building meet current seismic design criteria. The building houses powder metallurgy activities, filament welding, ceramics research and development, and rapid solidification research. Fabrication work using beryllium and uranium/graphite fuels is performed here. The beryllium area has a permitted, monitored stack equipped with a HEPA filtered exhaust air system.

The Press Building (3-35) was built in 1953 and contains approximately 9,860 square feet (916 square meters) of space located on one floor and a partial basement. This building does not have a hazard designation and was not evaluated for seismic capability. A 5,000-ton (4,536-metric-ton) hydraulic press used for work with depleted uranium is operated here. One stack exhausts through HEPA filters. The exhaust stream is monitored for radioactive emissions. Aqueous waste from uranium processing and other nonhazardous operations is routed, via a pipeline, to the RLWTF at TA–50.

The Thorium Storage Building is designated as a Hazard Category 3 nuclear facility. Thorium is stored here, in both ingot and oxide form. This building is very small and was not evaluated for seismic capability.

Description of Capabilities

The primary activities conducted within the Sigma Complex are described below. The manner in which these activities would vary under each of the alternatives is described in chapter 3.

Research and Development on Materials Fabrication, Coating, Joining, and Processing. Materials synthesis and processing work addresses research and development on making items out of materials that are difficult to work with. The processes include applying coatings and joining materials using plasma, arc welding and other techniques. The materials used in fabrication are also reprocessed (i.e., separated into pure forms for reuse or storage).

Characterization of Materials. Materials characterization work includes understanding the properties of metals, metal alloys, ceramic-coated metals, and other similar combinations along with the effects on these materials and properties brought about by aging, chemical attack, mechanical stresses, and other agents.

Fabrication of Metallic and Ceramic Items. Materials fabrication includes work with metallic and ceramic materials, and combinations thereof. Items are fabricated out of uranium, both depleted and enriched in uranium-235. Stainless steel, lithium, various ceramics, and beryllium items are also fabricated. Items are fabricated on a limited production basis as well as one-of-a-kind and prototype pieces. One specific set of applications for this technology is the fabrication of nonnuclear weapons components. The responsibility for production of these components was assigned to LANL on the basis of the *Nonnuclear Consolidation*

Environmental Assessment (DOE 1993). This environmental assessment (EA) addressed the upgrades an interior modifications necessary for this assignment, and these upgrades and modifications are expected to continue through completion under all of the SWEIS alternatives (as identified in chapter 3).

2.2.2.6 *Materials Science Laboratory (TA–3–1698)*

The Materials Science Laboratory (MSL, TA–3–1698) is located in an unrestricted access area at the southeastern edge of TA–3 (Figure 2.2.2.6–1 and Table 2.2.2.6–1). The facility is a two-story modern laboratory of approximately 55,360 square feet of floor space (5,143 square meters) arranged in an H-shape. It is designed to accommodate scientists and researchers, including participants from academia and industry whose focus is on materials science research. The *Environmental Assessment for the Materials Science Laboratory* (DOE 1991) details the impacts of the new facility. The completion of the top floor of the MSL was planned and was included in the environmental assessment, but not funded in 1992. Completion of this floor is still desired but is not currently scheduled.

Description of Facilities

The MSL consists of 27 laboratories, 15 support rooms, 60 offices, 21 distinct materials research areas, and several conference rooms that are used by technical staff, visiting scientists and engineers, administrative staff, and building support personnel. It is constructed of precast concrete panels sealed to a structural framework, with concrete floors, drywall interior, casework, hoods, and a utility infrastructure. Safety controls throughout the complex include a wet-pipe sprinkler system, automatic fire alarms, chemical fume hoods, gloveboxes, HEPA-filtered heating, ventilation, and air conditioning, and safety showers.

TABLE 2.2.2.6–1.—*Principal Buildings and Structures of Materials Science Laboratory*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–3	Materials Science Laboratory: 3–1698

Limited quantities of radioactive isotopes are used at MSL. These include small quantities of solid sodium, zirconium, and depleted uranium. Because of the diversity of research within MSL, a large variety of small quantities of nonradioactive, toxic, and hazardous materials are also used. This is similar to the corrosive and reactive chemicals typically used to synthesize and clean materials in wet chemistry or mechanical property laboratories. For example, semiconductor additives such as tantalum metal and tungsten compounds, along with chromic acid and perchloric acid for metallography activities, are used in gloveboxes or fume hoods. Other acids such as hydrofluoric, phosphoric, and sulfuric, are used in various materials preparation activities and in laser operations. Small amounts of typical laboratory organic chemicals such as acetone, methyl alcohol, and methyl ethyl ketone are also used in MSL activities.

Description of Capabilities

There are four major types of experimentation supported at MSL: materials processing, mechanical behavior in extreme environments, advanced materials development, and materials characterization. These four areas, each of which are described below, contain over 20 capabilities that support materials research for DOE programs. Collaboration with private industry is also an important feature of much of the work performed at MSL. The manner in which these activities vary among the alternatives is described in chapter 3.

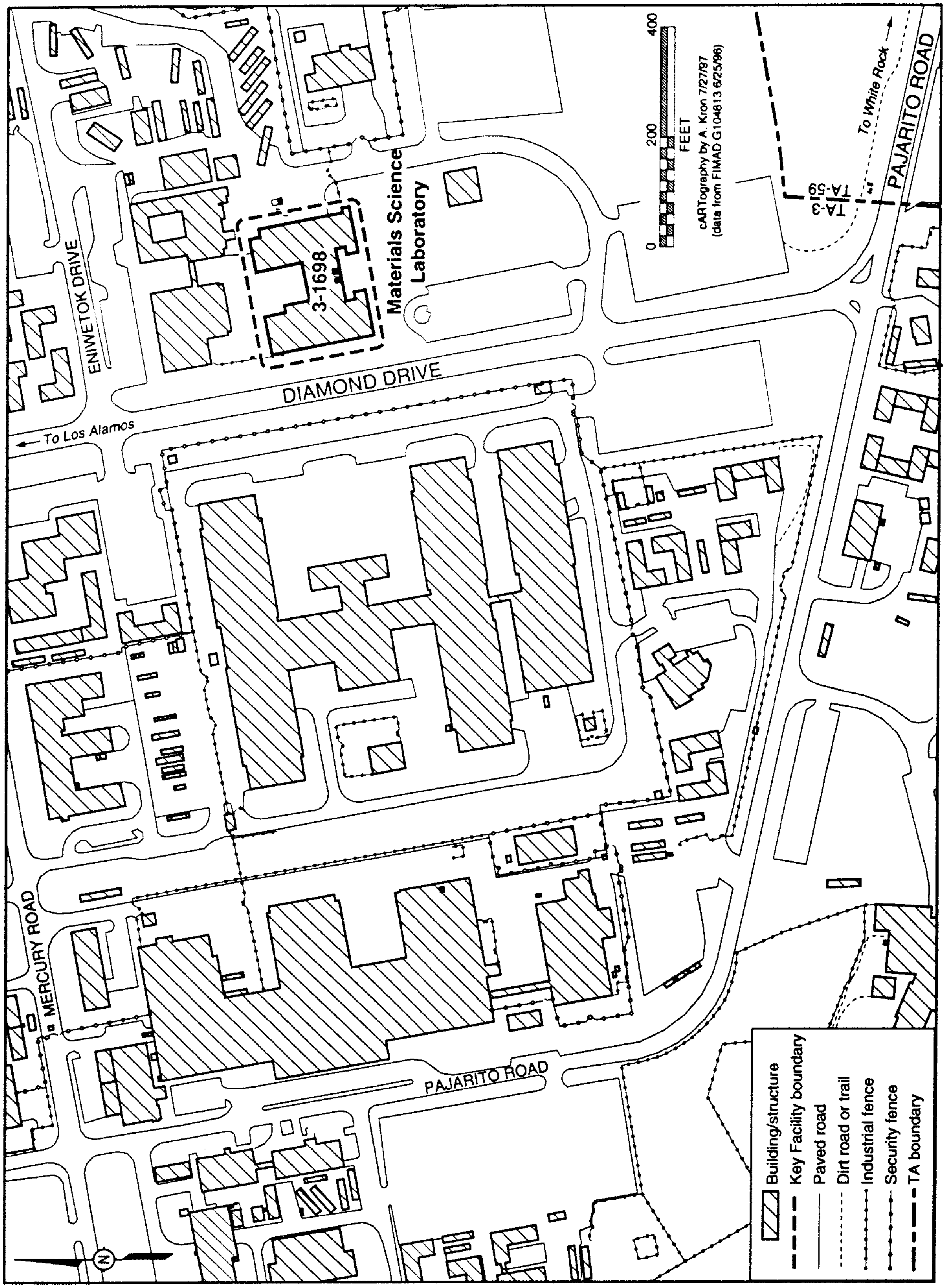


FIGURE 2.2.2.6–1.—*Materials Science Laboratory.*

Materials Processing. MSL supports the formulation of a wide range of useful materials through the development of materials fabrication and chemical processing technologies. The following synthesis and processing techniques represent some of the capabilities available in MSL for this area of research: wet chemistry, thermomechanical processing, materials handling, microwave processing, heavy equipment materials processing, single crystal growth synthesis, amorphous alloys, tape casting, inorganic synthesis, and powder processing.

Some of the laboratories, housing heavy equipment for novel mechanical processing of powders and non-dense materials, are configured to explore net shape and zero-waste manufacturing processes. Several laboratories are dedicated to the development of chemical processing technologies, including recycling and reprocessing techniques to solve current environmental problems.

Mechanical Behavior in Extreme Environments. The mechanical testing laboratories contain equipment for subjecting materials to a broad range of mechanical loadings to study their fundamental properties and characterize their performance. The laboratories utilized for this major area of materials science include dedicated space for mechanical testing; mechanical fabrication, assembly and machining research; metallography; and dynamic testing.

The mechanical testing laboratory offers capabilities to study multiaxial, high temperature, and high load behaviors of materials. The assembly areas consist of metalworking and experimental assembly areas that house a variety of electrically or hydraulically powered machines that twist, pull, or compress samples. The most energetic of these is a gas launcher, which projects a sample against an anvil at very high velocities. The MSL dynamic materials behavior laboratory is utilized by researchers for the study of high deformation rate behaviors. The dynamic testing equipment allows materials to be subjected to high rate loadings, including impact up to 1.2 miles (2 kilometers) per second. The metallography area contains equipment for sectioning, mounting, polishing, and photographing samples.

Advanced Materials Development. The various laboratories are configured for the exploration of new materials for high strength and high temperature applications. Many of the laboratories support synthesis and characterization of single crystals, nanophase, and amorphous materials, as well as providing areas for ceramics research including solid state, inorganic chemical studies involving materials synthesis. A substantial amount of effort in this area is dedicated to producing new high-temperature superconducting materials. MSL also provides facilities for synthesis and mechanical characterization of materials systems for bulk conductor applications.

Materials Characterization. Materials characterization provides the ability to understand the properties and processing of materials and to apply that understanding to materials development. MSL contains a collection of spectroscopy, imaging, and analysis tools for characterizing advanced materials. The electron microscopy laboratory area has four microscopes to characterize subnanometer to micrometer structures, including chemical analysis and high resolution electron holography. The optical spectroscopy laboratory allows ultrafast and continuous wave tunable resonance Raman scattering spectroscopy, high-resolution Fourier Transform Infrared absorption, and ultraviolet (UV) visible to near infrared (IR) absorption spectroscopy. The x-ray laboratory allows for the study of samples at temperatures up to 4,892°F (2,700°C) and pressures up to 80 kilobar. A metallography and ceramography support laboratory has the latest equipment for optical characterization. A laboratory area is provided to support surface-science study and corrosion characterization of materials.

2.2.2.7 *Target Fabrication Facility (TA–35)*

The Target Fabrication Facility (TFF) is approximately 61,000 square feet (5,667 square meters) of floor space with approximately 48,000 square feet (4,459 square meters) of laboratory area and 13,000 square feet (1,208 square meters) of office area (Figure 2.2.2.7–1 and Table 2.2.2.7–1). TFF is a two-story structure sited at TA–35 (Building 213) immediately to the east of TA–55, directly north of TA–50. Laboratories and offices occupy both the ground (lower) floor and the upper floor. In general, the structure is reinforced concrete. Vibration sensitive areas are supported on isolated concrete slabs. The HVAC system maintains a negative pressure (i.e., a pressure that is less than the pressure of the atmosphere outside the building) in the laboratories with both room air and hood exhaust vented to the atmosphere through filtered and, until 1995, monitored exhaust stacks. In 1995, monitoring was terminated when it was determined through analyses that monitoring was not required because of low facility chemical and radioactive material inventories. Sanitary waste is piped to the sanitary waste disposal plant near TA–46. Radioactive liquid waste and liquid chemical waste are shipped to TA–50 using a direct pipeline.

TABLE 2.2.2.7–1.—*Principal Buildings and Structures of Target Fabrication Facility*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–35	Target Fabrication Facility: 35–213

Description of Facilities

TFF maintains a beryllium machining capability used to manufacture structural shapes from beryllium. TFF is not a nuclear facility. Tritium was removed from the facility in 1993; however, operations involving tritium-contaminated materials are ongoing. Tritium contamination levels are low and are controlled below levels that would make this a nuclear facility. Depleted uranium coatings are no longer applied at TFF. Although a large number of chemicals are used, they are used in small quantities. TFF is designated as a moderate hazard chemical facility. The design for earthquake loads is in accordance with current applicable standards. Transportation in and out of the TFF consists of occasional deliveries and waste pickup typical of a research and development facility.

TFF houses the equipment and personnel for precision machining, physical vapor deposition, chemical vapor deposition, polymer sciences, and assembly of targets for inertial confinement fusion and physics experiments. These capabilities are complemented by personnel and equipment capable of performing high-technology material science, effects testing, characterization, and technology development.

Description of Capabilities

The three primary activities located at TFF are described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

Precision Machining and Target Fabrication. Precision machining operations produce sophisticated devices consisting of very accurate part shapes and often optical quality surface finishes. A variety of processes are used to produce the final parts, which include conventional machining, ultra-precision machining, lapping, and electron discharge machining. Dimensional inspections are performed during part production using a

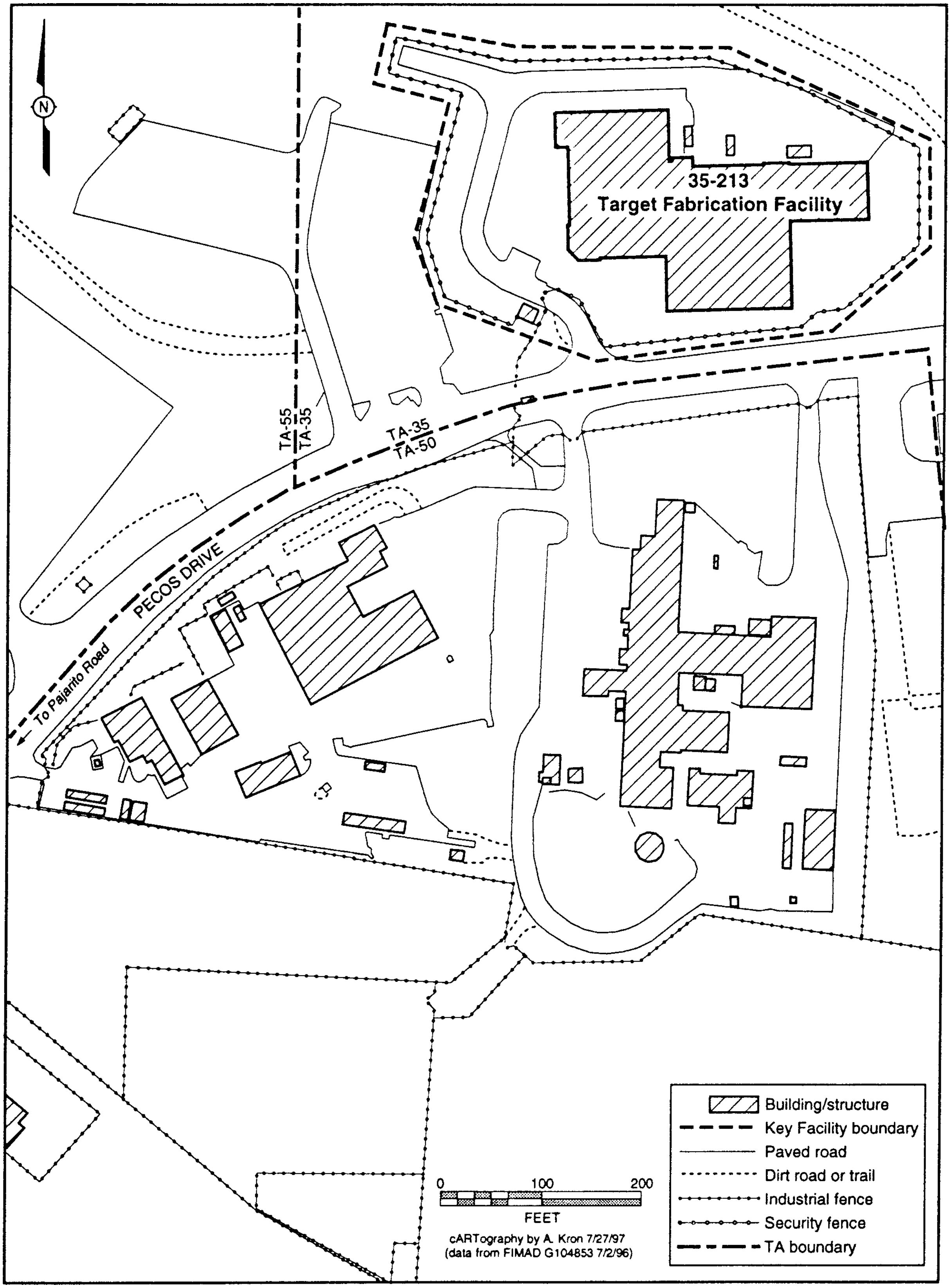


FIGURE 2.2.2.7–1.—*Target Fabrication Facility.*

variety of mechanically and optically based inspection techniques.

Polymer Synthesis. Polymer synthesis science formulates new polymers, studies their structure and properties, and fabricates them into various devices and components. Capabilities exist at TFF for developing and producing polymer foams by organic synthesis, liquid crystalline polymers, polymer host dye laser rods, microfoams and composite foams, high energy density polymers, electrically conducting polymers, chemical sensors, resins and membranes for actinide and metal separations, thermosetting polymers, and organic coatings. The materials and devices are typically prepared using solvents at temperatures ranging from 68° to 302°F (20° to 150°C) or by melt processing at temperatures from room temperature up to 572°F (300°C). A wide variety of analytical techniques are used to determine the structure and behavior of polymers, including spectroscopy, microscopy, x-ray scattering, thermal analysis, chromatography, rheology, and mechanical testing.

Chemical and Physical Vapor Deposition. Chemical vapor deposition (CVD) and chemical vapor infiltration (CVI) are processes used to produce metallic and ceramic bulk coatings, various forms of carbon (including pyrolytic graphite, amorphous carbon, and diamond), nanocrystalline films, powder coatings, thin films, and a variety of shapes up to 3.5 inches (9 centimeters) in diameter and 0.5 inches (1.25 centimeters) in thickness. CVD and CVI coating processes are routine operations that use a variety of techniques such as thermal hot wall, cold wall and fluidized bed techniques, laser assisted, laser ablation, radio frequency and microwave plasma techniques, direct current glow discharge and hollow cathode, and organometallic CVD techniques. The CVD process is used to produce thin film metallic, carbide, oxide, sulfide and nitride coatings. TFF scientists have also studied infiltrated materials using isothermal, thermal gradient, forced flow and plasma techniques. Polymer processing and extensive characterization is performed in conjunction with this work and occasionally, highly toxic substances such as nickel carbonyl, iron carbonyl, or arsenic hydride are handled.

Physical Vapor Deposition capabilities at TFF can apply layers of various materials on sophisticated devices with high precision. These layers, applied by various coating techniques, include a wide range of metals and metal oxides as well as some organic materials. Beryllium coatings applied to substrates by magnetron sputtering (performed in a specially ventilated vacuum chamber with HEPA filtered exhaust) is an example of physical vapor deposition performed at TFF.

2.2.2.8 *Machine Shops (TA–3)*

The main machine shops complex consists of two structures in the southwestern quadrant of TA–3: TA–3–39 and TA–3–102 (Figure 2.2.2.8–1 and Table 2.2.2.8–1). The two buildings are connected by a 125-foot (38-meter) long corridor. The machine shops provide special (unique or unusual) parts in support of other activities throughout LANL.

Description of Facilities

Building TA–3–39, the Beryllium Shop, was constructed in 1953, has a total floor space of approximately 134,000 square feet (12,449 square meters), and contains a variety of milling machines, vertical and horizontal lathes, surface grinders, internal and external grinders and assorted saws, laser cutter with

TABLE 2.2.2.8–1.—*Principal Buildings and Structures of Main Machine Shops*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–3	Machine Shops: 3–39
	Machine Shops: 3–102

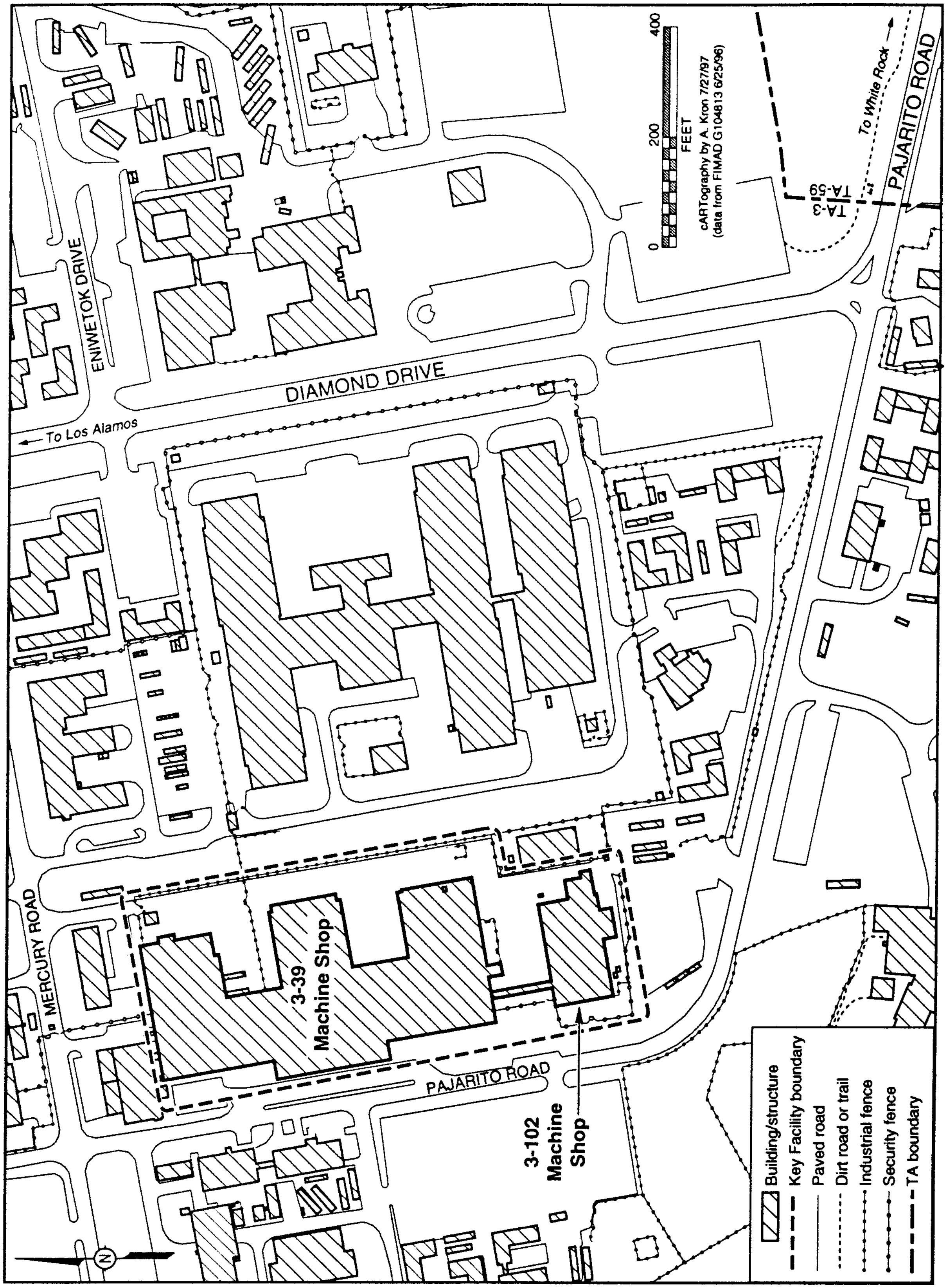


FIGURE 2.2.2.8–1.—*Main Machine Shops.*

welders, welding operations, and measuring equipment (Table 2.2.2.8–1). The Uranium Shop, TA–3–102, constructed in 1957, has a total floor space of approximately 12,500 square feet (1,161 square meters) and, like TA–3–39, contains a variety of metal fabrication machines.

The turnings and fines from depleted uranium fabrication result in a limited volume of radioactive waste. The use of depleted uranium is restricted to Building TA–3–102. While depleted uranium represents the bulk of the materials used, many other potentially hazardous materials (with toxic and pyrophoric characteristics) are used in this facility. These include materials such as beryllium and lithium compounds.

Description of Capabilities

Historically, LANL has maintained a prototype capability in support of research and development for nearly all of the components (parts) in nuclear weapons that are designed at LANL. The capabilities at the machine shops complex are: fabrication of specialty components, fabrication using unique or exotic materials, and dimensional inspection of the fabricated components. Each of these activities is described below. The manner in which these activities would vary among the alternatives are described in chapter 3.

Fabrication of Specialty Components. The fabrication of specialty components is the primary purpose for the existence of the machine shops complex. Specialty components are unique, unusual, or one-of-a-kind parts, fixtures, tools, or other equipment. These include components or equipment used in the destructive testing, replacement parts for the Stockpile Management Program, and gloveboxes for a variety of applications.

Fabrication Using Unique Materials. Fabrication using unique or exotic materials is one of the more important features of the machine shops complex. The list of unusual or unique materials routinely used includes depleted uranium, beryllium, and lithium (an extremely reactive material) and its compounds.

Dimensional Inspection of Fabricated Components. Dimensional inspection of the finished component is a standard step in the fabrication process and involves numerous measurements to ensure that the component is of the correct size and shape to fit into its allotted space and perform its intended function.

2.2.2.9 *High Explosives Processing*

The High Explosives (HE) Research and Development and Processing Facilities are located in parts of TA–8, TA–9, TA–11, TA–16, TA–22, TA–28, and TA–37 (Figures 2.2.2.9–1 through 2.2.2.9–8). These facilities were originally designed and built for production-scale operations during the early and mid 1950's and produced HE components for nuclear weapons in the U.S. stockpile reserve for several years (Table 2.2.2.9–1). LANL has historically upgraded and modernized processing equipment in these facilities to provide prototype HE components to meet the needs of the Nevada Test Site (NTS) program, hydrodynamic tests at LANL, detonator design and production, and other HE activities. Over the last few years, LANL has typically fabricated an average of 1,000 to 1,500 HE parts a year. With reductions in funding, many operations are being consolidated to reduce the number of buildings that must be maintained and the number of workers required.

Description of Facilities

TA–9 facilities with over 60,000 square feet (5,574 square meters) of floor space support HE synthesis, formulation, and characterization operations, as well as HE-related analytical chemistry, safety testing, process development, and stockpile surveillance. TA–16 facilities with over 280,000 square feet

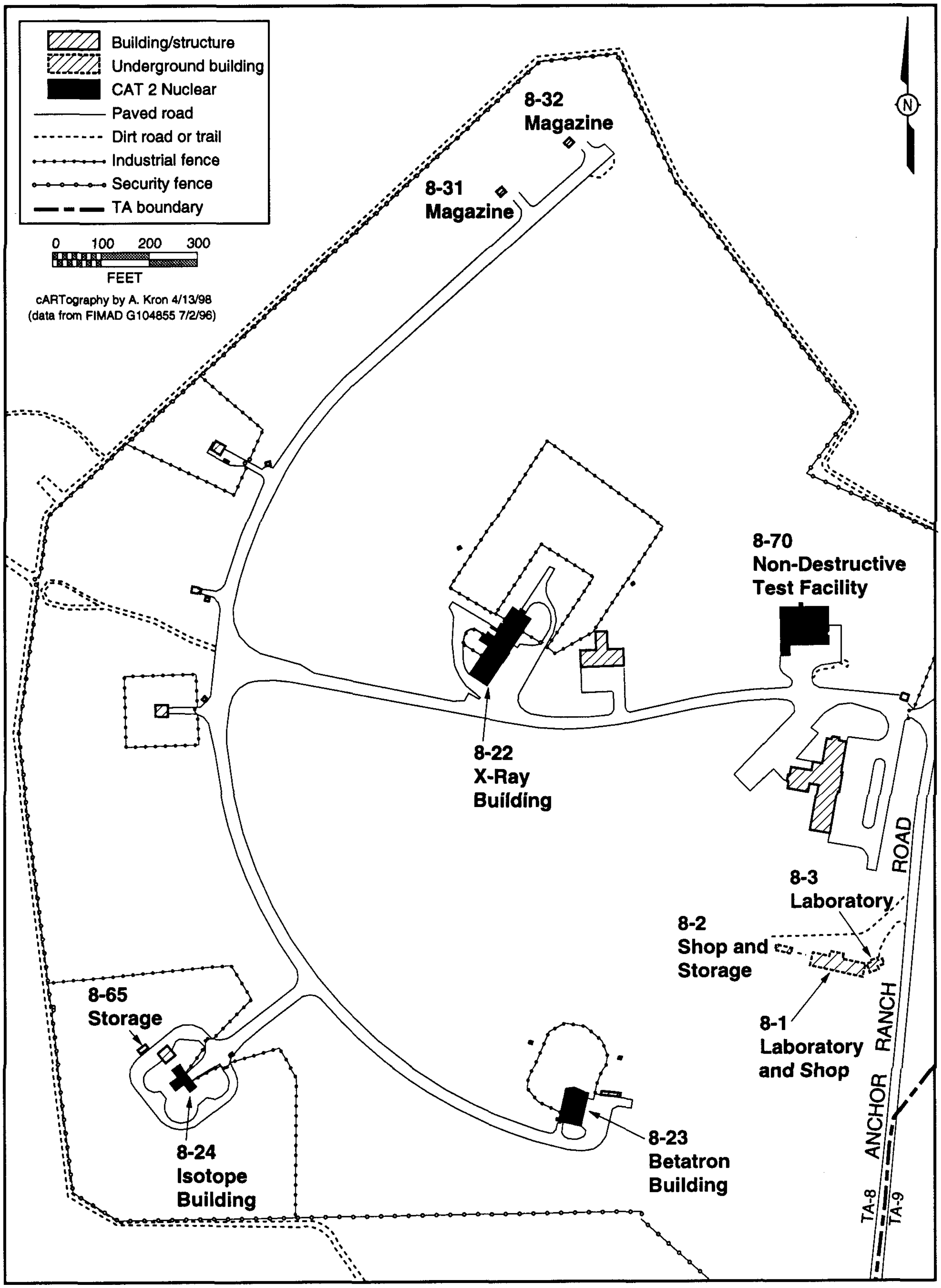


FIGURE 2.2.2.9–1.—*TA–8 High Explosives Processing.*

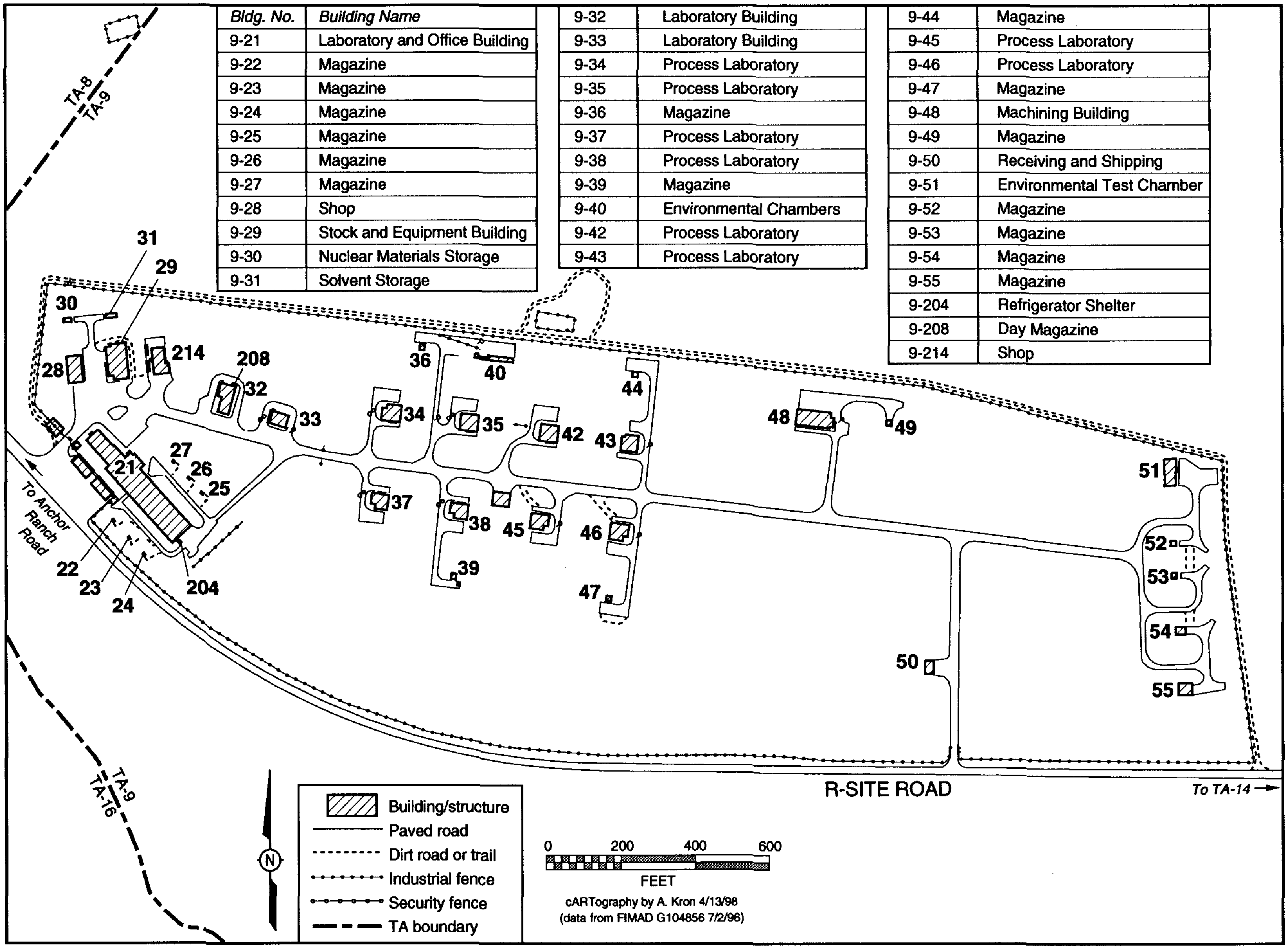


FIGURE 2.2.2.9–2.—*TA–9 High Explosives Processing.*

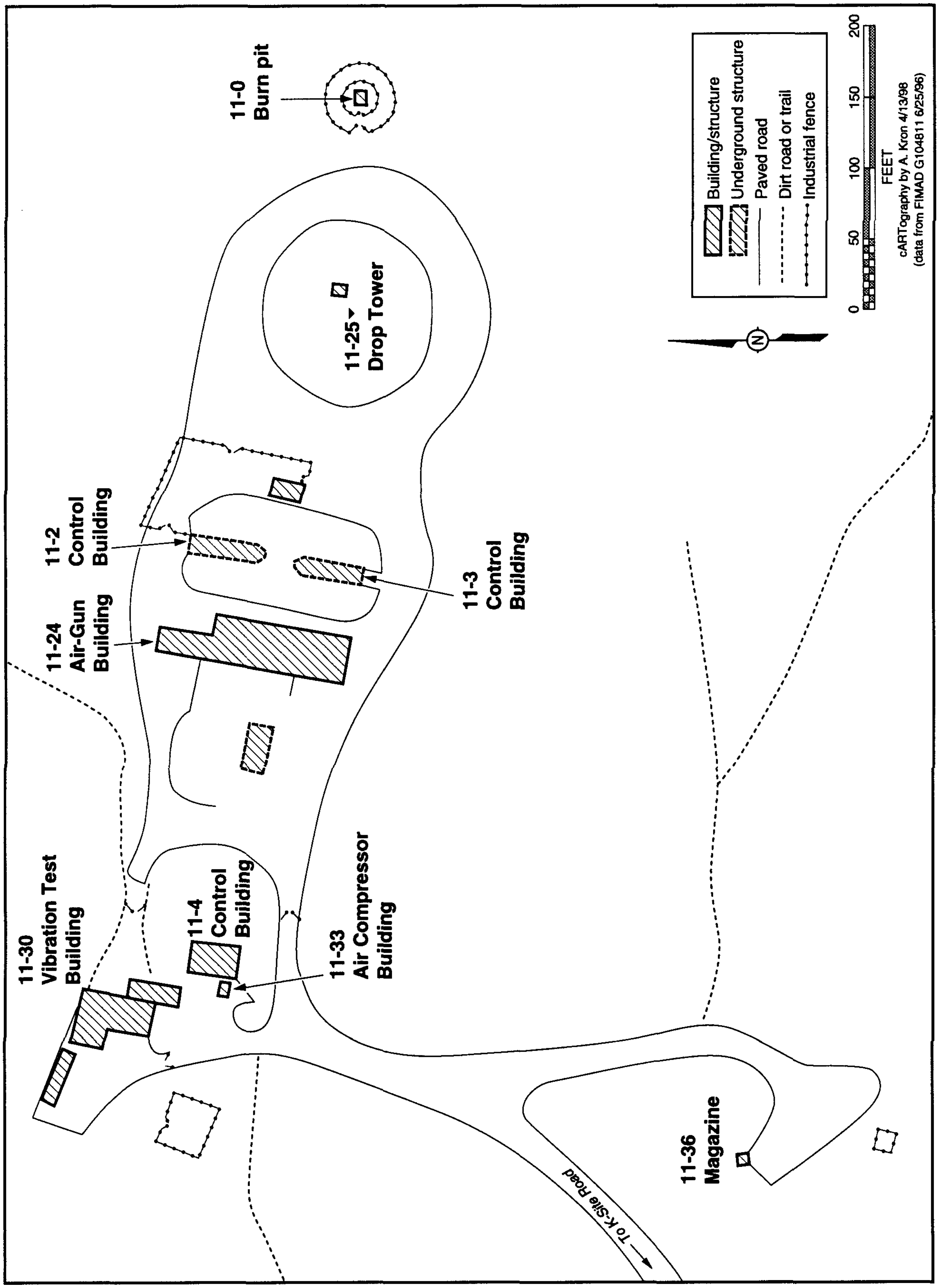


FIGURE 2.2.2.9–3.—*TA–11 High Explosives Processing.*

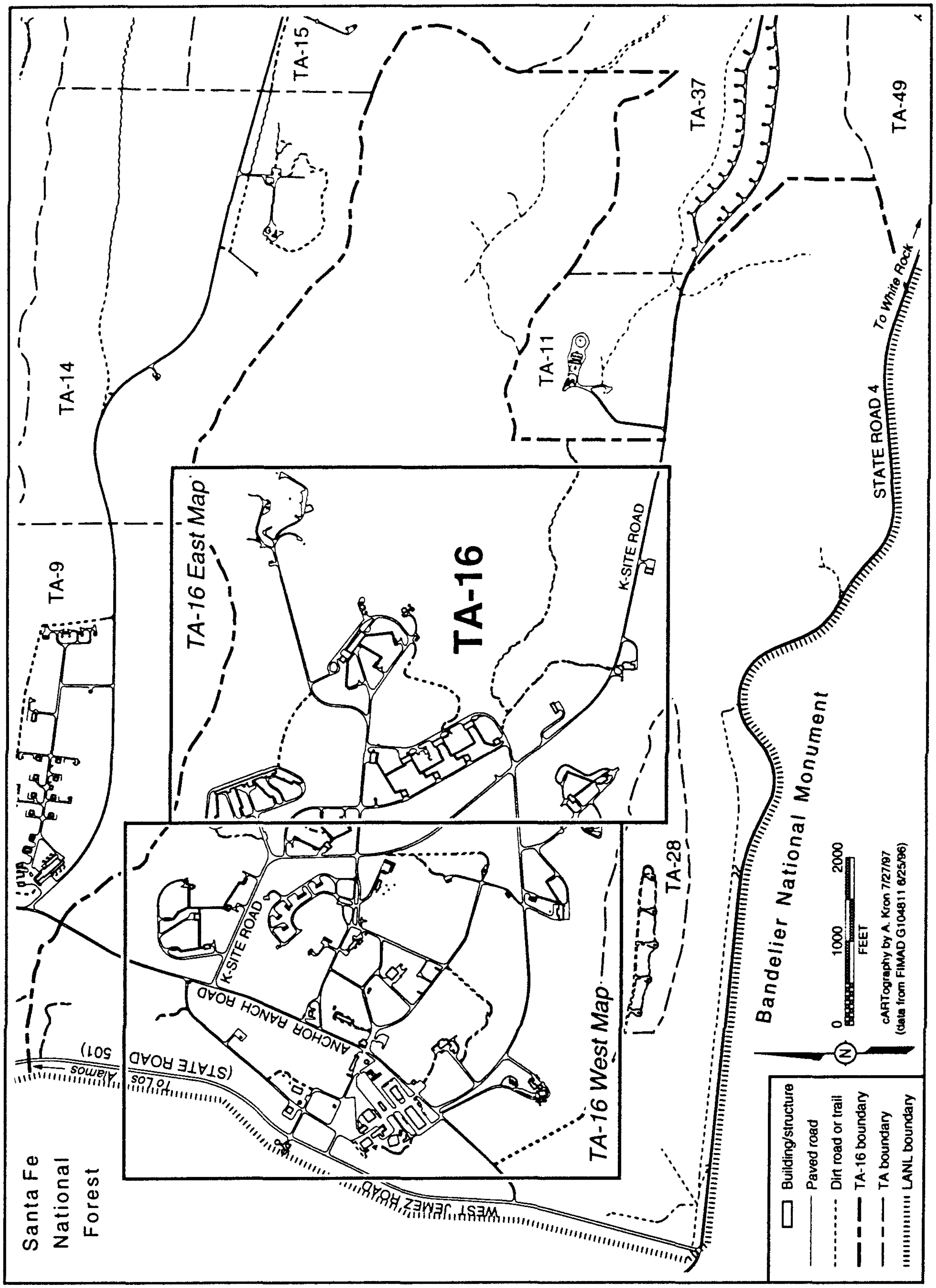
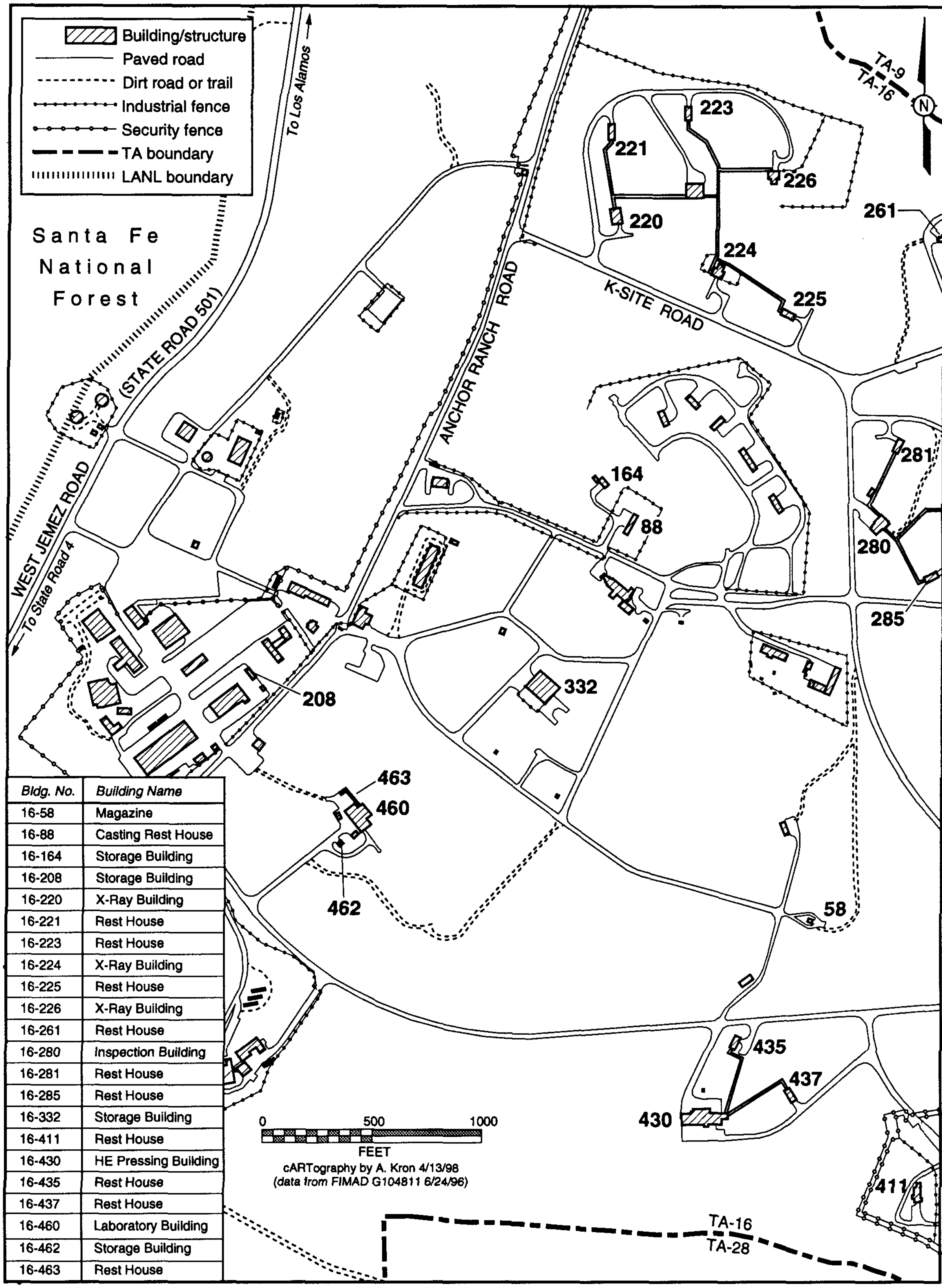
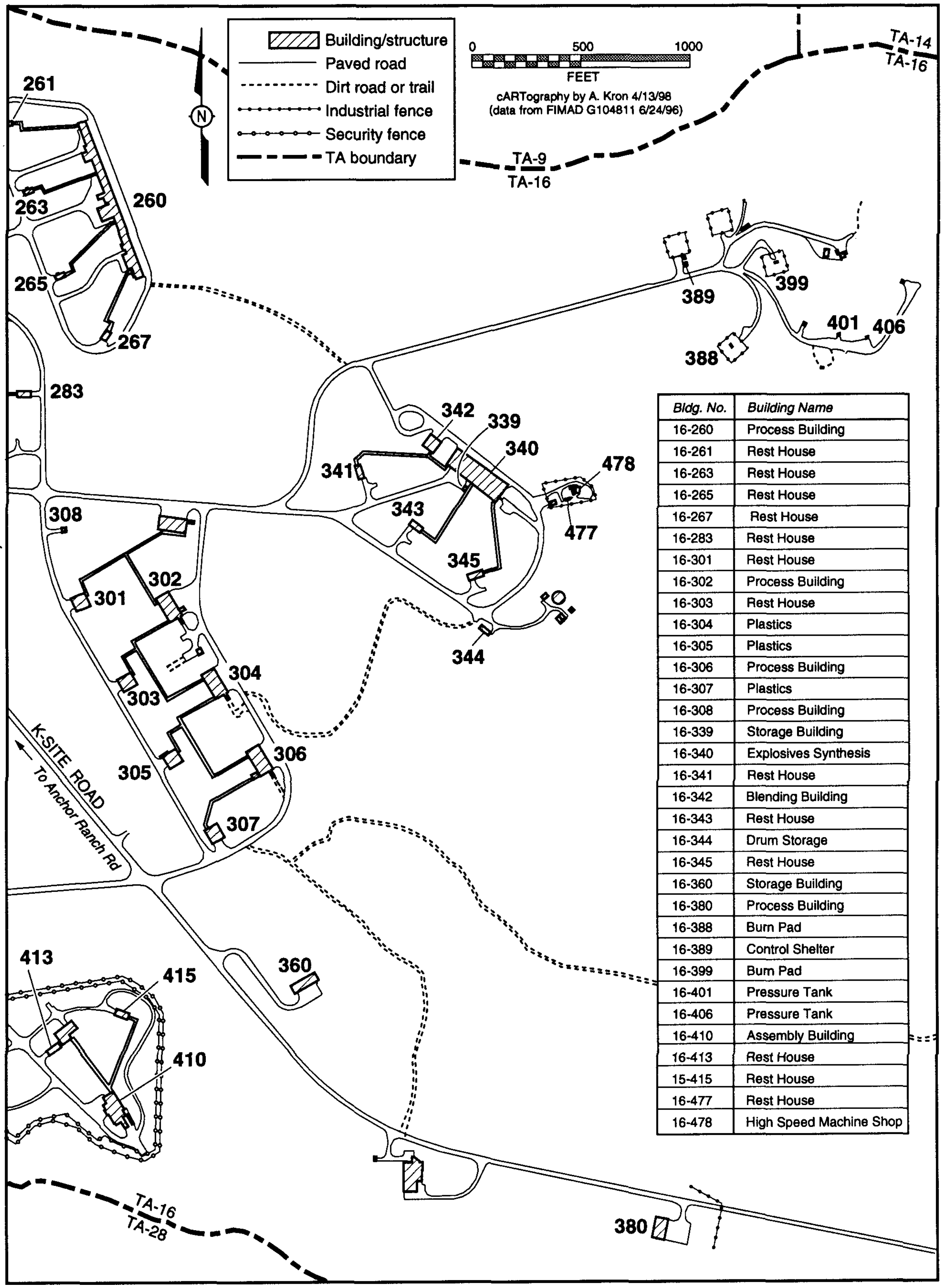


FIGURE 2.2.2.9–4.—*TA-16 High Explosives Processing.*



Bldg. No.	Building Name
16-58	Magazine
16-88	Casting Rest House
16-164	Storage Building
16-208	Storage Building
16-220	X-Ray Building
16-221	Rest House
16-223	Rest House
16-224	X-Ray Building
16-225	Rest House
16-226	X-Ray Building
16-261	Rest House
16-280	Inspection Building
16-281	Rest House
16-285	Rest House
16-332	Storage Building
16-411	Rest House
16-430	HE Pressing Building
16-435	Rest House
16-437	Rest House
16-460	Laboratory Building
16-462	Storage Building
16-463	Rest House

FIGURE 2.2.2.9–5.—*TA–16 West High Explosives Processing.*



Bldg. No.	Building Name
16-260	Process Building
16-261	Rest House
16-263	Rest House
16-265	Rest House
16-267	Rest House
16-283	Rest House
16-301	Rest House
16-302	Process Building
16-303	Rest House
16-304	Plastics
16-305	Plastics
16-306	Process Building
16-307	Plastics
16-308	Process Building
16-339	Storage Building
16-340	Explosives Synthesis
16-341	Rest House
16-342	Blending Building
16-343	Rest House
16-344	Drum Storage
16-345	Rest House
16-360	Storage Building
16-380	Process Building
16-388	Burn Pad
16-389	Control Shelter
16-399	Burn Pad
16-401	Pressure Tank
16-406	Pressure Tank
16-410	Assembly Building
16-413	Rest House
15-415	Rest House
16-477	Rest House
16-478	High Speed Machine Shop

FIGURE 2.2.2.9–6.—*TA–16 East High Explosives Processing.*

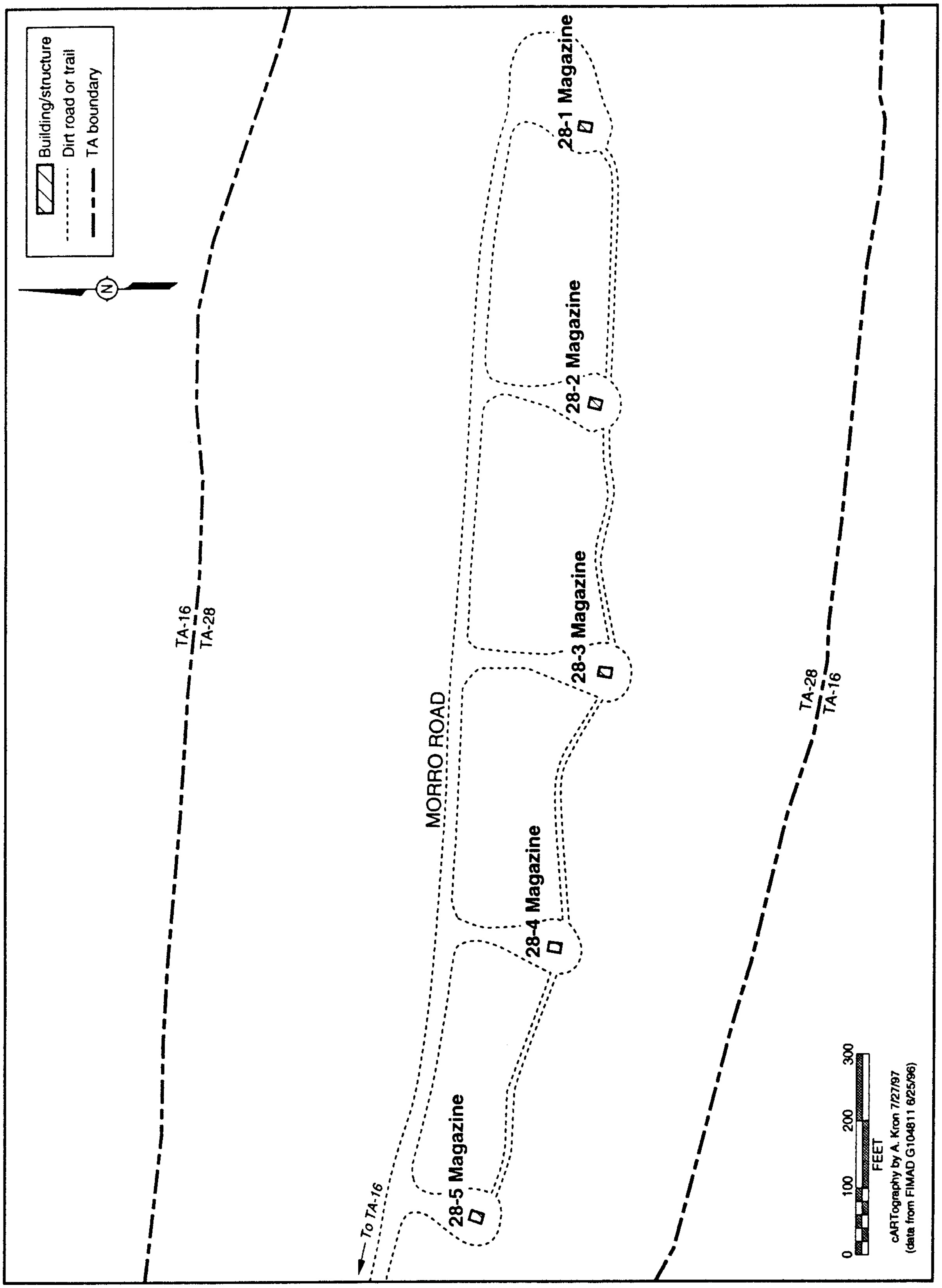


FIGURE 2.2.2.9–7.—*TA–28 High Explosives Processing.*

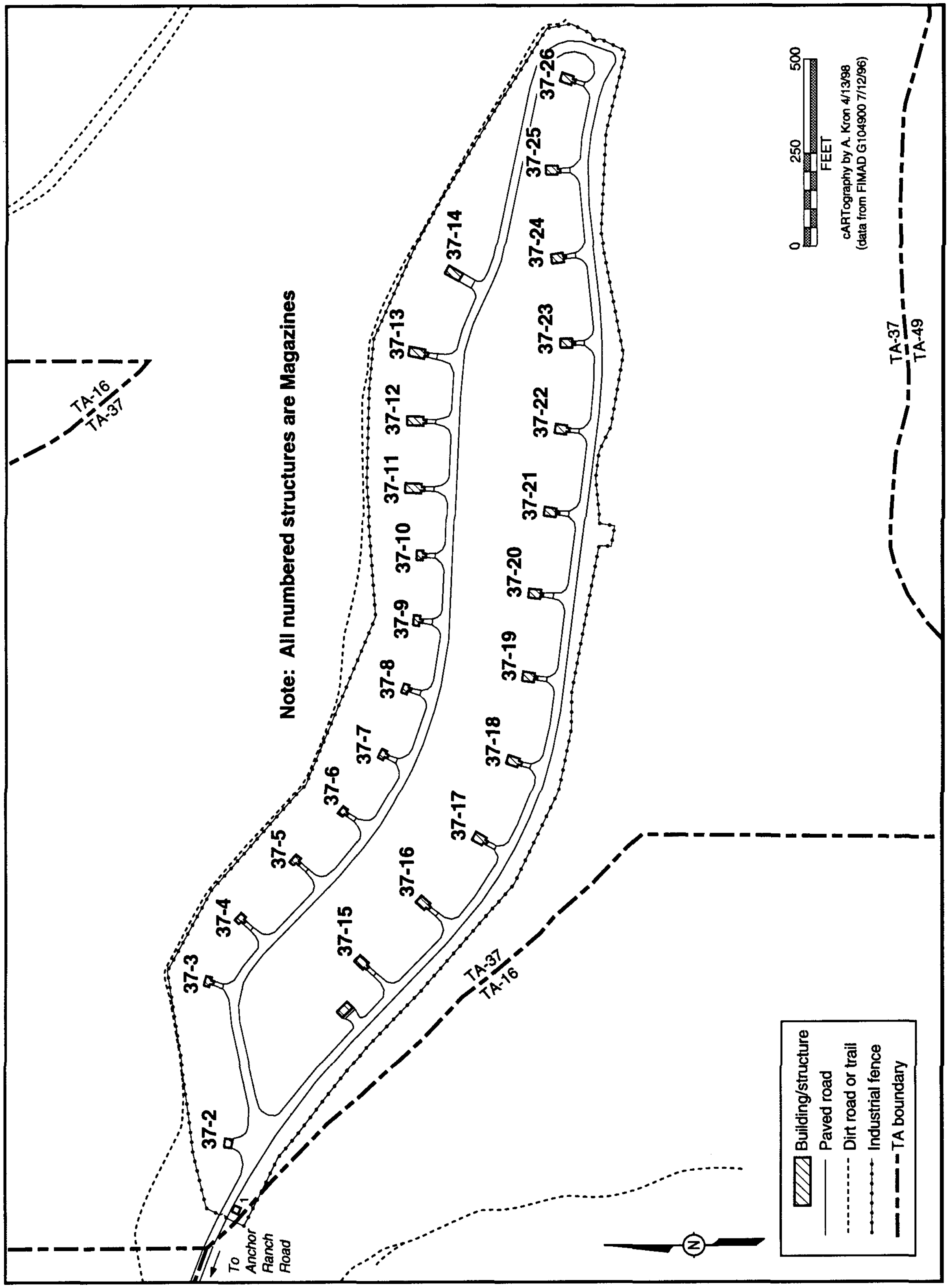


FIGURE 2.2.2.9–8.— *TA–37 High Explosives Processing.*

TABLE 2.2.2.9–1.—*High Explosives Processing Facilities: Identification of Principal Buildings/Structures*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–8	Nondestructive Testing/Radiography: 8–22, 23, 24, 70 Storage, Radiography Sources: 8–65
TA–9	Offices, Laboratories: 9–21, 32, 33, 34, 35, 37, 38, 42, 43, 45, 46 Service Magazines: 9–22, 23, 24, 25, 26, 27, 208 Shop Buildings: 9–28, 214 Nuclear Materials Storage: 9–30 Solvent Storage: 9–31 Magazines: 9–36, 39, 44, 47, 49, 52, 53, 54, 55, 204 Thermal Cycle Facility: 9–40 HE Machining Building: 9–48 Receiving and Shipping Building: 9–50 Detonator Storage: 9–51
TA–11	Control Buildings: 11–2, 3, 4 Air Gun Building: 11–24 Drop Tower: 11–25 Vibration Test Building: 11–30 Air Compressor Building: 11–33 Magazine: 11–36 Weapon Burn Test Facility: 11–0
TA–16	Instrumentation, Testing: 16–54 Magazine: 16–58 Storage Buildings: 16–164, 208, 332 Dark Room: 16–222 Process Buildings: 16–260, 306 Rest Houses (HE Magazines): 16–261, 263, 267 HE Assembly/Rest House: 16–265 Inspection Building: 16–280 Rest House/HE Shipping: 16–281 Rest House/Museum: 16–283 Rest House/HE Receiving: 16–285 Mock Explosives Prep (being vacated): 16–300 Rest House/HE Environmental Testing: 16–301 Process Building (being vacated): 16–302 Rest House (being vacated): 16–303 Plastics Buildings: 16–304, 305, 307 Solvent Storage: 16–339 Explosives Process Building: 16–340 Rest Houses: 16–341, 345, 411, 413, 415, 435, 437
TA–22	Detonation Systems Laboratory 22-90, 91, 93 Solvent Storage Shed 22-95 HE Storage Building 22-66, 67, 68, 69 Advanced Development Laboratory 22-34 HE Process Building 22-8 Magazines 22-7, 22–15, 16, 17, 18, 19, 20, 21, 22, 23
TA–28	Magazines, Protective Force: 28–1, 2, 3 Magazine, Explosives: 28–4 Magazine: 28–5
TA–37	Standard HE Magazines: 37–2 through 26

(26,013 square meters) of space support formulation, casting, pressing, machining, assembly, and a range of quality assurance operations. In addition, two beryllium operations are performed at TA–16. TA–11 comprises 12 buildings with 9,300 square feet (864 square meters) in which various environmental and safety tests are performed. The four principal buildings at TA–22, known as Los Alamos Detonator Facility (LADF), contain 50,000 square feet (4,650 square meters) supporting fabrication, testing, and surveillance of explosive detonation systems. In addition, LADF provides DOE-wide support for packaging and transportation of electro-explosive devices. TA–28 and TA–37 are magazine storage areas. The HE facilities at TA–8 occupy buildings with 14,500 square feet (1,347 square meters) in which nondestructive testing operations are performed.

All existing HE fabrication structures meet current applicable earthquake standards. Structures containing HE and those in which HE operations are conducted are constructed with 2-foot (0.6-meter) thick, steel-reinforced concrete walls designed to mitigate the effects of an accidental explosion. Most facilities include support areas for offices; break rooms; restrooms; electrical equipment; heating, ventilation, and air conditioning equipment; maintenance; and in-process staging for materials, components, tooling, and supplies.

TA–16 is categorized as a moderate hazard facility because of the presence of chlorine and a tritium facility. (WETF, described in section 2.2.2.2, is a separate “key” facility but is in the same TA as some of the HE processing facilities described here.) Two projects related to HE operations during the next 5 to 10 years were analyzed in the *Relocation of the Weapons Components Testing Facility Environmental Assessment* (DOE 1995b) and in the *Environmental Assessment, High Explosive Wastewater Treatment Facility* (DOE 1995d) (operational in October 1997). Another project is the TA–16 Steam Plant Conversion, a maintenance and refurbishment project that was completed and operational in September 1996.

Several permitted outfalls exist at TA–8, TA–9, TA–11, and TA–16. These outfalls are slated for modification as stated in the *Effluent Reduction Environmental Assessment* (DOE 1996c). Six of the outfalls will be eliminated completely, four outfalls are slated for waste stream consolidation, two outfalls are slated for outfall reduction, and one will decrease discharge rates as stated in the HE Wastewater Treatment Facility EA, and four will be decontaminated, but will continue to discharge. The disposition of the remaining outfalls will not change.

The HE processing facilities include support infrastructure for shipping, receiving, storage, packaging, and transportation. All receiving activities are conducted at TA–16, with storage at TA–28 and TA–37.

These facilities also include disposal facilities that are permitted by the State of New Mexico for disposal of HE waste and HE contaminated materials. A large flash pad is used to thermally remove HE contamination from other materials prior to burial. Two aboveground burning trays are used to destroy HE scrap and residue. Two sand filters remove water from sump sludge for drying and burning. One aboveground tray burns oil contaminated with HE. An incinerator is available for disposal of trash from the HE areas; such trash is presumed to be contaminated with HE due to association with HE processes. All water is filtered for HE and treated with activated carbon for solvent removal. Chemical oxygen demand, suspended solids, and acidity (pH) are measured prior to authorizing release to the environment. Non-HE hazardous wastes and LLW are trucked to the LANL waste management facilities.

Description of Capabilities

The major HE processing activities and their principal locations are described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

High Explosives Synthesis and Production. These activities include explosive-manufacturing capabilities such as synthesizing new explosives and manufacturing pilot-plant quantities of raw explosives and plastic-bonded explosives. These operations allow LANL to develop and maintain expertise in explosive materials and processes that are essential for long-term maintenance of stockpile weapons and materials. Most of the HE synthesis and small-scale production activities are conducted at TA–9. War Reserve detonator testing and production is conducted at TA–22, as discussed below under Research, Development, and Fabrication of High-Power Detonators.

High Explosives and Plastics Development and Characterization. These activities provide characterization data for any explosives application in nuclear weapons technology. Information on initiation and detonation properties of HE coupled with non-HE component information for modeling is essential to the design and safety analysis of a weapon. These activities are conducted at TA–9 and TA–40. A wide range of plastic and composite materials are used in nuclear weapons such as adhesives, potting materials, flexible cushions and pads, thermoplastics and elastomers. It is also necessary to have a thorough understanding of the chemical and physical properties of these materials to model weapons behavior. Most of the materials characterization work is conducted at TA–9, TA–16, and TA–40.

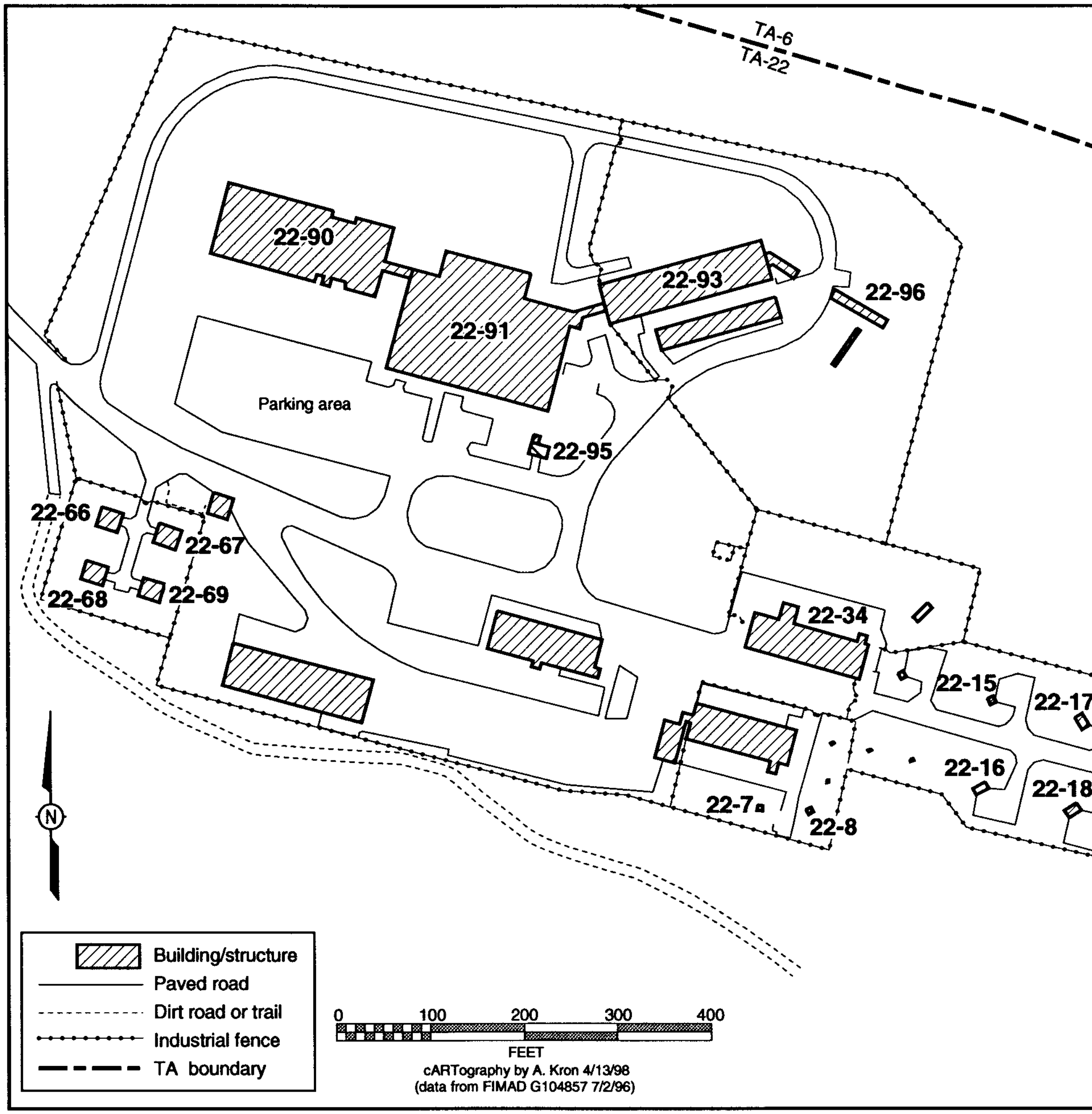
High Explosives and Plastics Fabrication. HE powders are typically compacted into solid pieces and machined to final specified shapes. Some small pieces are pressed into final shapes, and some powders, based upon their properties, are melted into stock pieces. Fabrication of plastic materials and components is a core capability associated with HE processing. Efforts are focused on weapons needs, but a wide variety of plastic and composite materials may be fabricated. Most of the HE and plastics fabrication is performed at TA–9 and TA–16.

Test Device Assembly. Test devices are assembled, ranging from full-scale nuclear explosive-like assemblies (where fissile material has been replaced by inert material) to material characterization tests. Assembly operations for the largest test devices are performed in TA–16. Smaller test assemblies may be prepared at the explosives testing support facilities at TA–9, TA–22, and TA–40. Radiography examinations of the final assembly are done at TA–8.

Safety and Mechanical Testing. Capabilities exist for measuring mechanical properties of explosives samples, including tensile, compression, and creep properties (i.e., change of materials shapes over time). Test assemblies can be instrumented with strain gages, pressure gages, or other diagnostic equipment. Safety testing, such as HE handling tests, drop tests, and impact tests, are used to evaluate abnormal conditions. Accelerated aging tests are conducted at TA–9. Most safety, mechanical, and environmental testing is conducted in laboratory and test buildings at TA–9, TA–11, and TA–16.

Research Development and Fabrication of High-Power Detonators. Capabilities at TA–22 include detonator design; printed circuit manufacture; metal deposition and joining; plastic materials technology; explosives loading, initiation, and diagnostics; lasers; and safety of explosives systems design, development, and manufacture. Detonators, cables, and firing systems for tests are built in this program. This also includes support to the DOE complex for packaging and transportation of electro-explosive devices.

The LADF (Figure 2.2.2.9–9) (Buildings 90, 91, 93, and 34) houses the research, development, and fabrication capabilities for detonation systems. This facility consists of three



Bldg. No.	Building Name
22-7	Magazine
22-8	HE Process Building
22-15	Magazine
22-16	Magazine
22-17	Magazine
22-18	Magazine
22-19	Magazine
22-20	Magazine
22-21	Magazine
22-22	Magazine
22-23	Magazine
22-24	Magazine
22-34	Advanced Development Laboratory
22-35	Magazine
22-66	HE Storage Building
22-67	HE Storage Building
22-68	HE Storage Building
22-69	HE Storage Building
22-90	Detonation Systems Laboratory
22-91	Detonation Systems Laboratory
22-93	Detonation Systems Laboratory
22-95	Solvent Storage Shed
22-96	Magazine

FIGURE 2.2.2.9–9.—*TA–22 Los Alamos Detonator Facility.*

connected buildings, one of which, Building 90, is an office wing connected to Building 91 by a corridor. Building 91 is designated as the inert half of the facility, meaning there are no high explosives processed there. The printed circuit manufacturing, cable fabrication, and electronics work is done in this facility.

In Buildings 93 and 34, bulk explosive powder is formed into detonator subassemblies and incorporated into final assemblies that are then measured, inspected, and prepared for storage or test firing. The area around the HE building (93 and 34) is enclosed by a fence with a locked gate, and access to the building is limited to authorized personnel. Small-scale testing activities are also performed in Building 34.

A facility may be constructed in the future as a separate detonator production facility. This action, which was analyzed in the Nonnuclear Consolidation EA (DOE 1993), was delayed from its original schedule; it is currently uncertain when this action might be undertaken.

2.2.2.10 *High Explosives Testing: TA–14 (Q-Site), TA–15 (R-Site), TA–36 (Kappa-Site), TA–39 (Ancho Canyon Site), and TA–40 (DF-Site)*

The facilities that make up the explosives testing operations are used primarily for research, development, test operations, and detonator development and testing related to DOE's stockpile stewardship and management programs (Figures 2.2.2.10–1 through 2.2.2.10–7). The firing sites specialize in experimental studies of the dynamic properties of materials under conditions of high pressure and temperature. The firing site facilities, occupying approximately 22 square miles (57 square kilometers) of land area, represent at least half of the total land area occupied by LANL (see Table 2.2.2.10–1).

Various radioactive and nonradioactive materials are used in the firing sites operations. Depleted uranium and plutonium metal are used in some of the operations (plutonium in such operations is contained to prevent release). Nonradioactive toxic or hazardous materials may include beryllium, copper, aluminum, and heavy metals. Other materials used are solvents such as acetone, chlorinated hydrocarbons, toluene, xylene, or 1,1,1–trichloroethane. Sulfur hexafluoride is used as an insulating gas in specialized high-voltage equipment.

There are 13 permitted NPDES outfalls located at the firing site operations. DOE plans to eliminate one of these outfalls as described in the *Environmental Assessment for Effluent Reduction* (DOE 1996c).

An ongoing construction project related to the TA–15 firing site operations is the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, analyzed in the *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement* (DOE 1995c). The first axis for this facility is currently being installed and is expected to be operational by the end of 1999. The second axis is expected to be operational by the end of 2002.

Description of Facilities

HE testing activities are conducted in five TAs, having a total of 13 associated firing sites. (This number can change slightly over time.) All of the firing areas are located in remote locations on the Pajarito Plateau or within canyons of the plateau. Four of the areas are located on or just below Threemile Mesa. The nearest private residences to these four firing areas are in the Royal Crest Trailer Park north of Sandia Canyon located approximately 2 miles (3.2 kilometers) to the north, and White Rock, approximately 4 to 6 miles (6.4 to 9.7 kilometers) to the southeast. The following paragraphs contain descriptions of the five firing areas.

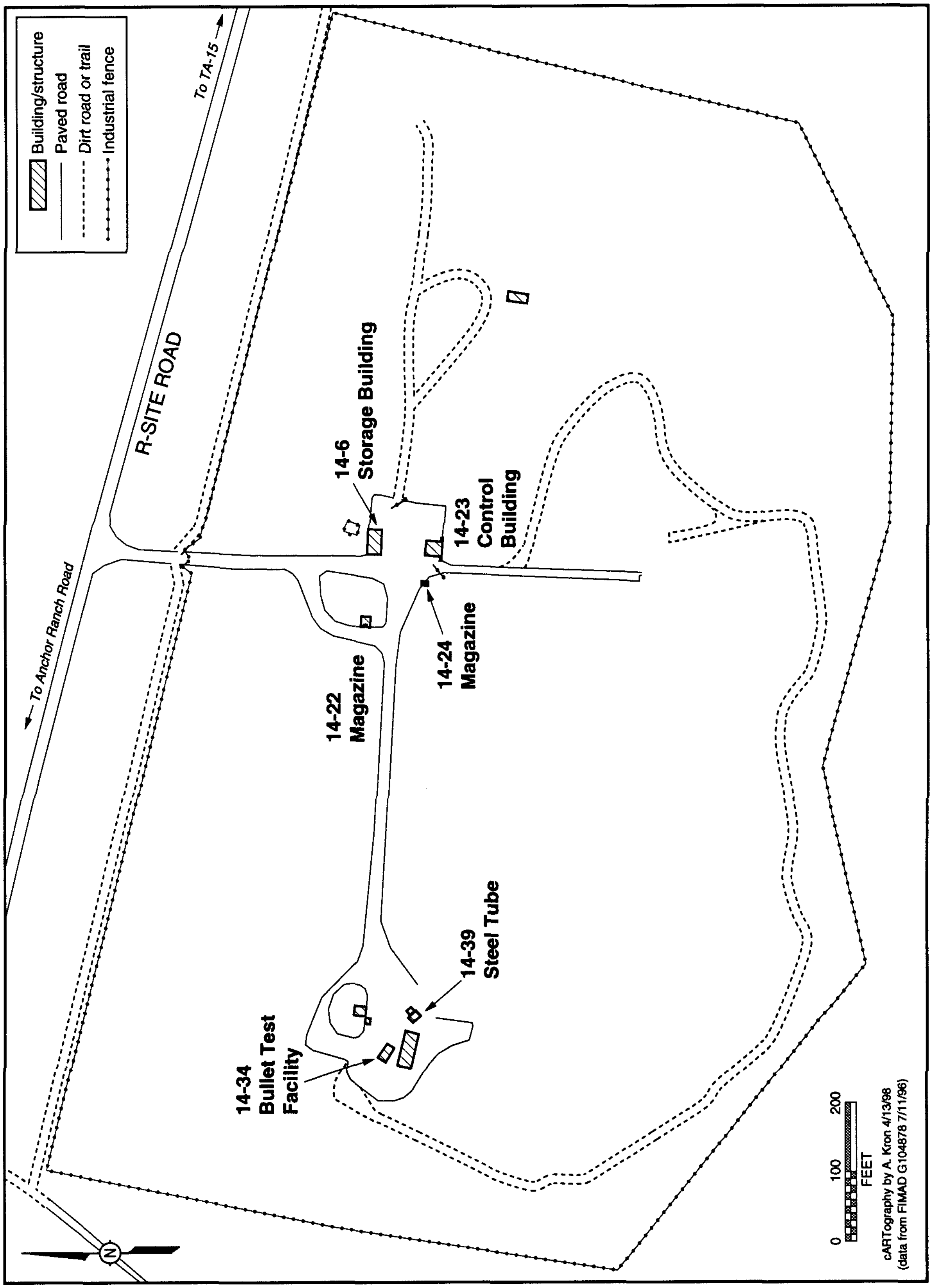


FIGURE 2.2.2.10–1.—*TA–14 High Explosives Testing.*

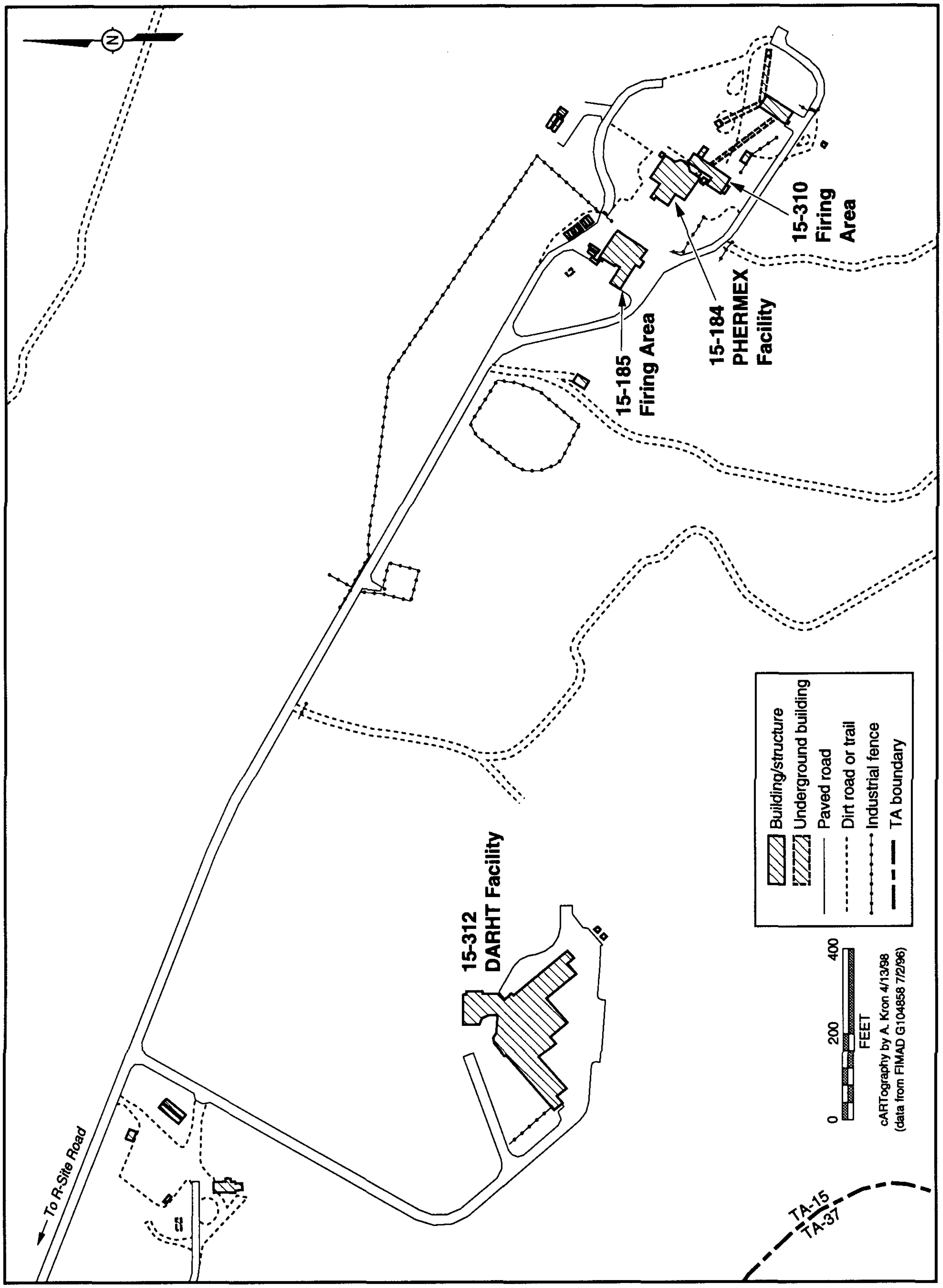


FIGURE 2.2.2.10–2.—*TA–15 West High Explosives Testing.*

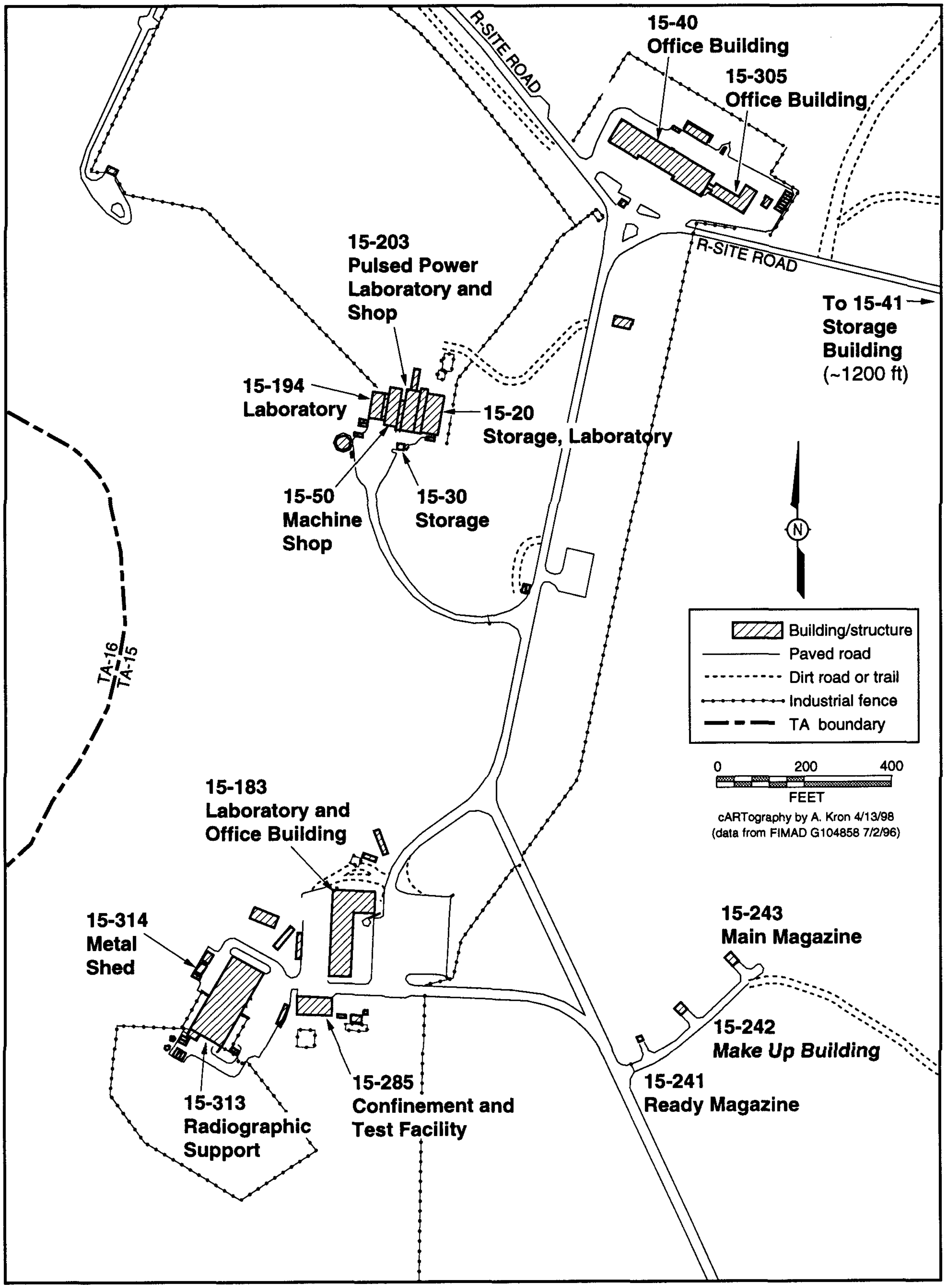


FIGURE 2.2.2.10–3.—*TA–15 Central High Explosives Testing.*

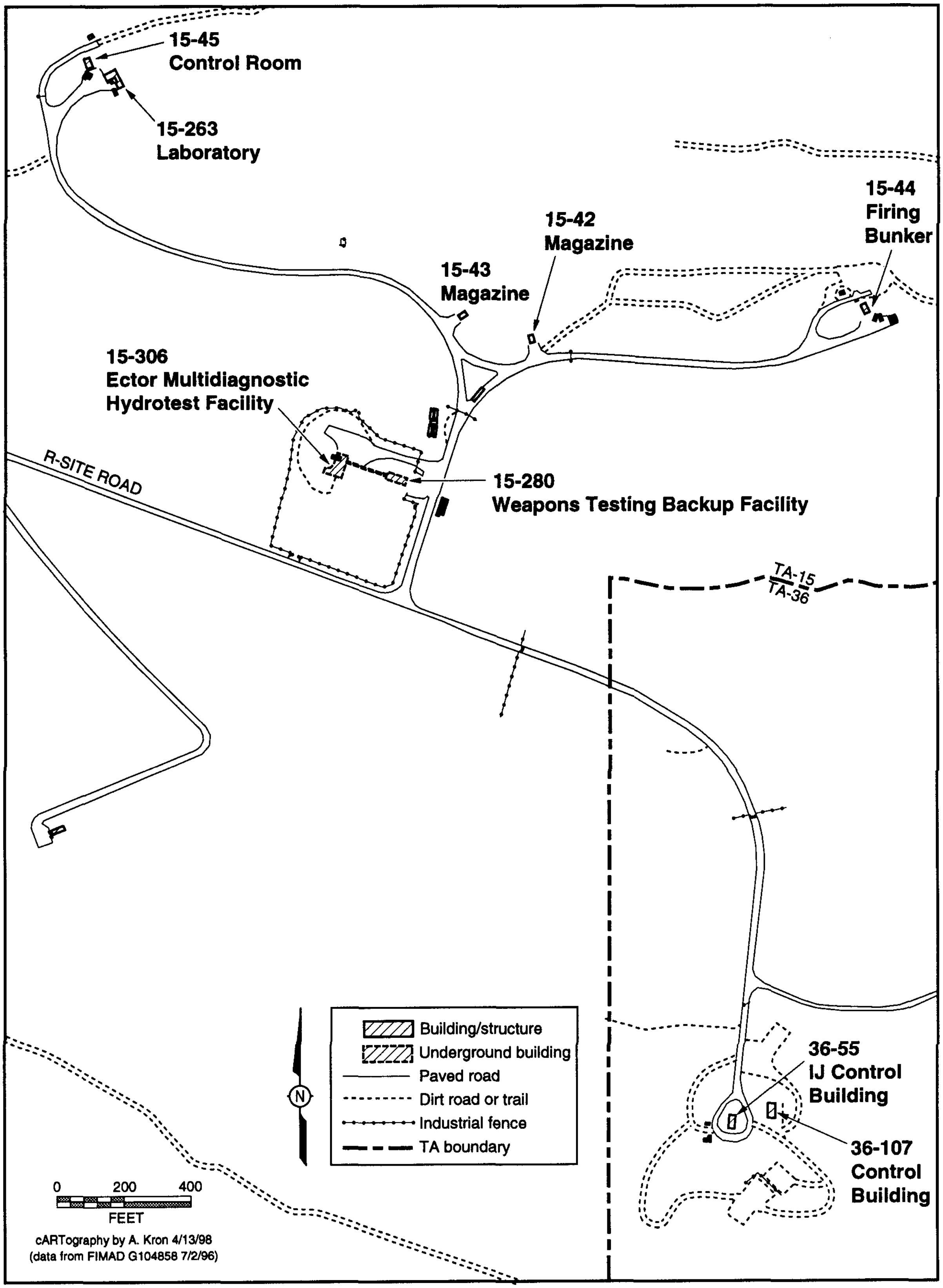


FIGURE 2.2.2.10–4.—*TA–15 East and TA–36 West High Explosives Testing.*

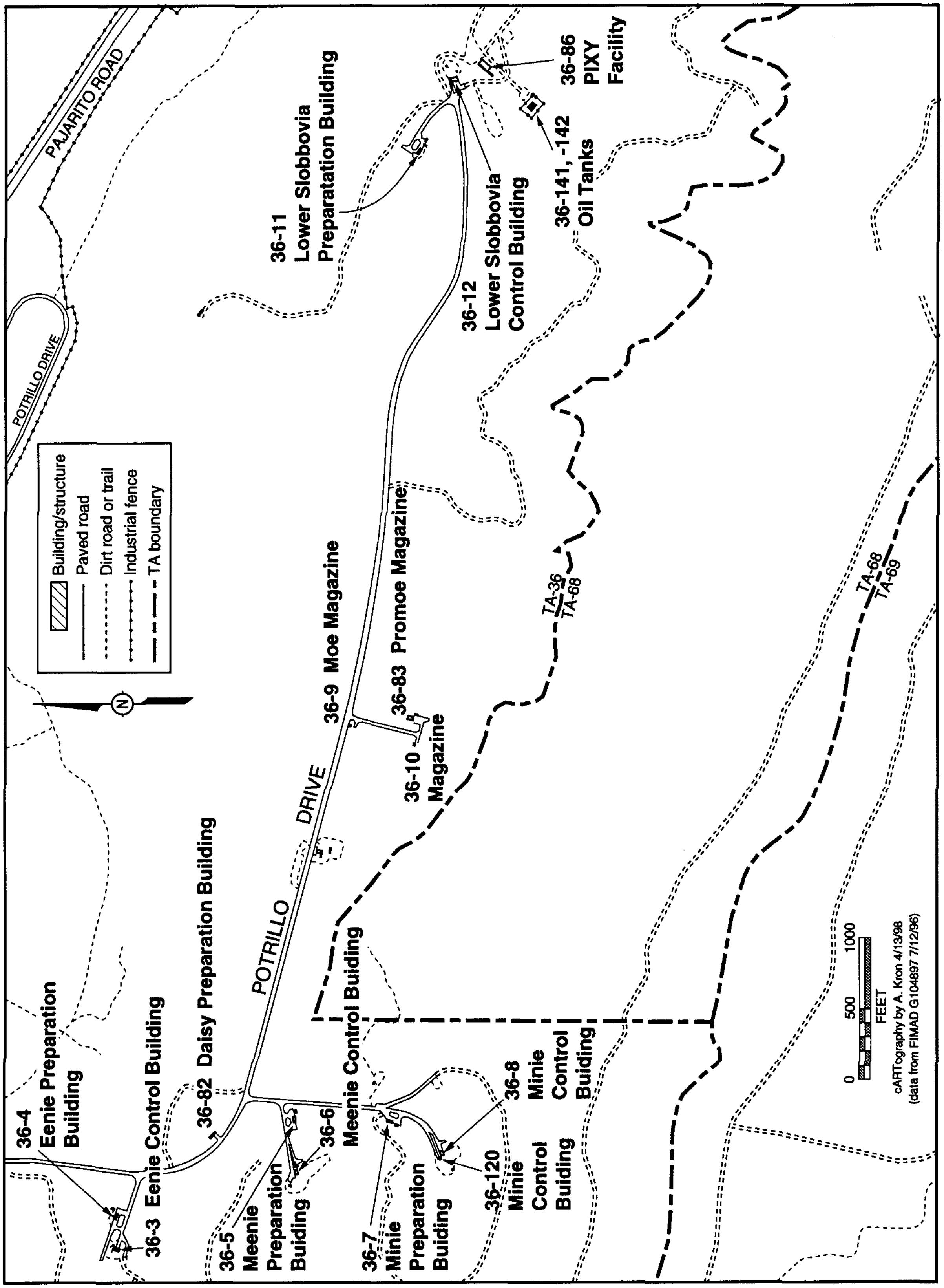


FIGURE 2.2.2.10–5.—*TA–36 East High Explosives Testing.*

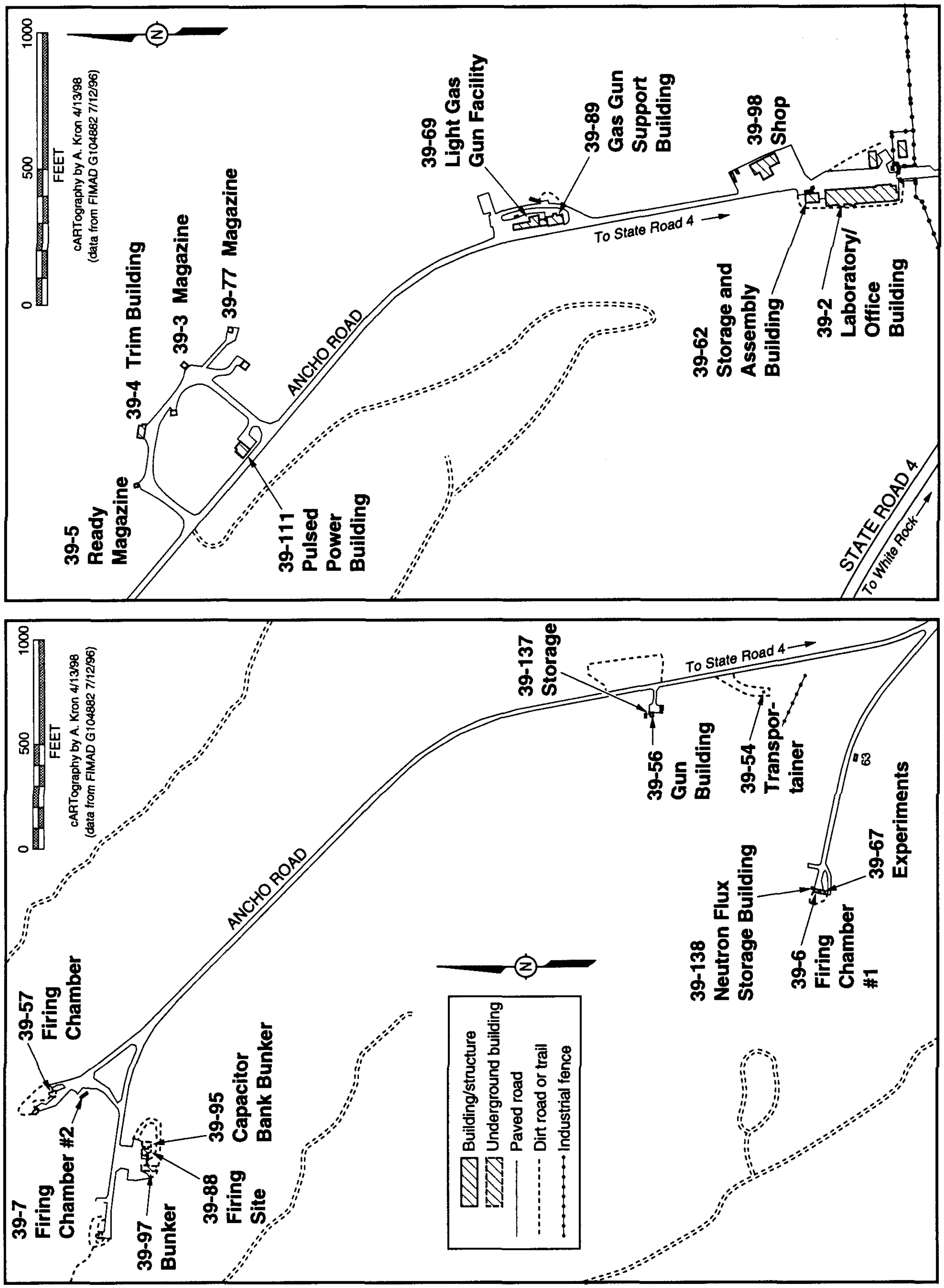
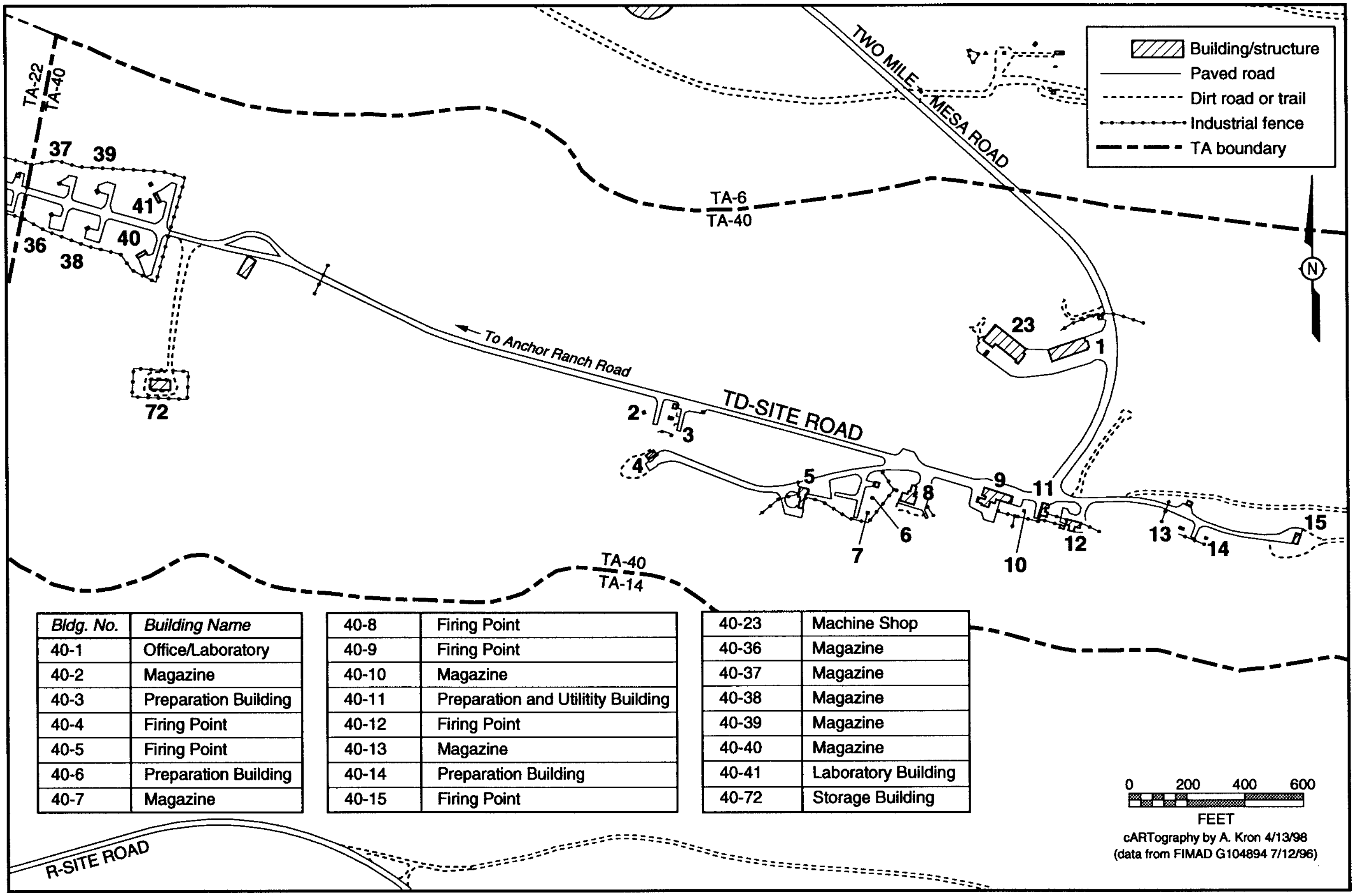


FIGURE 2.2.2.10–6.—*TA–39 High Explosives Testing.*



Bldg. No.	*Building Name*
40-1	Office/Laboratory
40-2	Magazine
40-3	Preparation Building
40-4	Firing Point
40-5	Firing Point
40-6	Preparation Building
40-7	Magazine
40-8	Firing Point
40-9	Firing Point
40-10	Magazine
40-11	Preparation and Utilitity Building
40-12	Firing Point
40-13	Magazine
40-14	Preparation Building
40-15	Firing Point
40-23	Machine Shop
40-36	Magazine
40-37	Magazine
40-38	Magazine
40-39	Magazine
40-40	Magazine
40-41	Laboratory Building
40-72	Storage Building

FIGURE 2.2.2.10–7.—*TA–40 East High Explosives Testing.*

TABLE 2.2.2.10–1.—*Principal Buildings and Structures of High Explosives Testing Facilities*

TECHNICAL AREAS	PRINCIPAL BUILDINGS AND STRUCTURES
TA–14 (Q-Site)	Warehouse: 14–6 Magazines: 14–22, 24 Control Room, Make-Up Room, Laboratory: 14–23
TA–15 (R-Site)	Firing Areas: 15–184, 185, 310 Weapons Testing Backup Facilities: 15–280 Ector Multidiagnostic Hydrotest Facility: 15–306 Firing Bunker: 15–44 Control Room: 15–45 Weapons Storage and Preparation: 15–41 Magazines: 15–42, 43, 241, 243 Make-Up Building, Short-Term Storage: 15–242 Storage, Laboratory: 15–20 Machine Shop: 15–50 Laboratory: 15–194 Storage: 15–30 Pulsed-Power Laboratory and Shop: 15–203 Offices Buildings: 15–40, 183, 305
TA–36 (Kappa-Site)	Offices, Laboratories: 36–1, 48, 84 Control Buildings: 36–3, 6, 8, 12, 107, 120 Preparation Buildings: 36–4, 5, 7, 11, 82 Magazines: 36–9, 10, 83 Firing Box: 36–21 Pixy Facility: 36–86 Oil Tanks: 36–141, 142
TA–39 (Ancho Canyon Site)	Main Office, Laboratories, Shops: 39–2 Magazines: 39–3, 5, 77 Trim Building: 39–4 Firing Sites: 39–6, 57, 88 Gas Gun Facility: 39–56 Storage and Assembly Building: 39–62 Gun Room, Instrument Room: 39–69 Gas Gun Support Building: 39–89 Shop: 39–98 Pulsed-Power Building: 39–111 Storage: 39–137, 138 Bunkers: 39–56, 95, 97 Experiments: 39–67
TA–40 (DF-Site)	Offices, Laboratories: 40–1 Machine Shops: 40–23 Gas Gun Facility: 40–9 Firing Sites: 40–4, 5, 8, 9, 15 Preparation Rooms: 40–3, 6, 11, 12, 14 Magazines: 40–2, 7, 10, 13, 36, 37, 38, 39, 40 Laboratory Building: 40–41

The major use of the TA–14, Q-Site, firing area is testing quantities of energetic materials (such as HE) that exceed the safety limits for these materials indoors at TA–9. Two firing sites are available at the Q-Site firing area. Up to 100 pounds (45.4 kilograms) of HE per test may be fired at this area. Characterization tests to determine the chemical and physical properties of energetic materials used to model weapons behavior are conducted at this site. DOE has applied for a RCRA permit for the disposal of explosives and explosives-contaminated materials at Q-Site by either detonation or by burning. Currently, waste disposal is performed under RCRA interim status requirements by either detonation or by burning.

TA–15, R-Site, contains three firing sites: Pulsed High-Energy Radiation Machine Emitting X-Rays (PHERMEX) facility, DARHT Facility, and R306, a general purpose firing site. The PHERMEX facility is capable of producing high-resolution x-ray pictures of very dense, fast-moving materials and is used primarily for weapons studies. The PHERMEX firing site is used for full-scale, multidiagnostic hydrodynamic tests and for smaller scale experiments, such as the study of HE or materials driven by HE that might require fast, high-resolution, high-intensity radiography. The firing site can handle up to 154 pounds (70 kilograms) of explosives on the firing runway in front of machines. Charges up to 1,600 pounds (730 kilograms) or more of explosives may be detonated at points east of the runway (at greater distance from the PHERMEX machine). All of the buildings adjacent to the firing site are constructed of heavily reinforced concrete.

The DARHT facility is currently under construction near the PHERMEX firing site. When completed, the DARHT facility will provide dual axis, multiple exposure radiographs at the highest penetration and resolution available for the study of devices and materials under hydrodynamic conditions. This facility will be used primarily in support of DOE's Stockpile Stewardship and Management Programs.

The third firing site at TA–15 is located at building R306. Currently, the R306 firing site is used for nonradiographic studies. This firing site and the nearby IJ firing site are current candidates for redevelopment and would probably continue to be used only for electrical, mechanical, and optical studies in the future. The IJ site is currently in safe standby.

Both open-air and contained explosives tests are performed at TA–15 as described in the DARHT EIS (DOE 1995c) and ROD (60 FR 53588).

TA–36, Kappa-Site, contains four active firing sites. A variety of diagnostic equipment is available at the four firing sites. A number of 2.3-million electron volts, 600-kiloelectronvolts, 450-kiloelectronvolts, and 150-kiloelectronvolts flash radiographic systems are also available. (These radiographic systems may also be used at other firing sites.) In addition to providing support for DOE nuclear weapons programs, the explosives testing and firing facilities at TA–36 are often used for a wide variety of nonnuclear ordnance testing for the U.S. Department of Defense (DoD). These tests may include warhead development, armor and armor-defeating mechanisms, explosives vulnerability to projectile and shaped-charge attack, warhead lethality studies, and the safety implication of shock waves on explosives and propellants. A total of 700 to 1,200 experimental firings are performed annually, using up to 5,000 pounds (2,270 kilograms) of explosives in a single test.

The Ancho Canyon Site, TA–39, is used for studying high-energy-density properties in experiments using explosives-driven pulsed power. Various phenomenological aspects of explosives, interactions of explosives, and explosions acting on other materials are also investigated. Gas guns are located at Ancho

Canyon for the testing of inert materials. Typically, open air detonation is used, and up to 4,400 pounds (2,000 kilograms) of explosives may be used in a single test. In the past, contained testing involving plutonium was performed here. DOE may perform such testing again in the future.

Firing sites TA–39–6 and TA–39–88 typically support high-explosives-driven, pulsed-power experiments to study high-energy-density and high magnetic fields for stockpile stewardship, basic research, or other applications. These firing sites also can be used for other HE experiments in materials phenomenology. The pulsed-power experiments usually involve HE detonations and high-voltage, energy-storage capacitor bank discharges. Currently, for operational efficiency TA–39–6 is the principal firing site used for HE experiments for the National High Magnetic Field Laboratory, though both sites can be used for such experiments. The firing sites at TA–39 and the gas guns are used to measure the characteristics of weapons materials driving by HEs. Tests associated with proliferation control and verification activities are performed here also. Equation-of-state experiments may also be carried out at TA–39 to determine the properties of materials at extreme conditions.

Three separate firing sites at TA–40, DF Site, are used for general testing of explosives or other materials and in the development of special detonators to initiate HE systems. One site is used for the characterization of energetic materials using two gas guns normally located at TA–40. Another site employs a containment system in the study of small-scale experiments (less than 22 pounds [10 kilograms] of HE). The third site includes a laboratory for growth of long HE crystals used to study the properties of explosives. The TA–40 facility has been used for many years for the testing of HE and physics experiments related to the nuclear weapons programs.

Some experiments at TA–40 include detonation of assemblies and configurations contributed by other groups at LANL. Experimental assemblies containing up to 55 pounds (25 kilograms) of explosives in various diagnostic configurations are routinely constructed and fired, while detonation of charges of up to 110 pounds (50 kilograms) can be studied.

Description of Capabilities

The major categories of HE testing activities across the firing sites are described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

Hydrodynamic Tests. A hydrodynamic test is a dynamic, integrated systems test of a mock-up nuclear package during which the high explosives are detonated and the resulting motions and reactions of materials and components are observed and measured. The explosively generated high pressures and temperatures cause some of the materials to behave hydraulically (like a fluid). Surrogate materials are used to replace the actual weapons materials in the mock-up nuclear weapons package, to ensure that there is no potential for a nuclear yield. Most hydrodynamic tests will be conducted at TA–15, with some being conducted at TA–36.

Dynamic Experiments. A dynamic experiment is an experiment to provide information regarding the basic physics of materials or characterize the physical changes or motion of materials under the influence of HE detonations. Some dynamic experiments involve SNM. Most dynamic experiments will be conducted at TA–15 and TA–36, with some experiments being conducted at TA–39 and TA–40. In the past, DOE has conducted dynamic experiments using plutonium metal. DOE may perform such studies again in the future at PHERMEX, DARHT, and other facilities. As a matter of policy, dynamic experiments involving plutonium would always be conducted inside containment vessels.

Explosives Research and Testing. Explosives research and testing activities are conducted primarily to study the properties of the explosives themselves as opposed to explosive effects on other materials. Examples include tests to determine the effects of aging on explosives, the safety and reliability of explosives from a quality assurance point of view, and fire resistance of explosives. Select explosive research and testing activities may be performed at any of the HE testing sites.

Munitions Experiments. Munitions experiments are those tests conducted to study the influence of external stimuli on explosives (i.e., projectiles or other impacts). These studies include work on conventional munitions for DoD. Most of the munitions experiments are expected be performed at TA–36, yet any of the other firing sites may be used as required.

High Explosives Pulsed-Power Experiments. High explosives pulsed-power experiments are those tests conducted to develop and study new concepts based on the use of explosively driven electromagnetic power systems. These experiments will be conducted primarily at TA–39.

Calibration, Development, and Maintenance Testing. Calibration, development, and maintenance testing are those experiments conducted primarily to prepare for more elaborate tests, and include tests to develop, evaluate, and calibrate diagnostic instrumentation or other systems. The calibration, development, and maintenance testing activities will be concentrated at TA–15 and TA–36, but may involve any of the HE testing sites.

Other Explosives Testing. Other explosives testing includes such activities as development of advanced HE and/or work to improve weapons evaluation techniques. Any of the HE testing sites may be used for select testing activities.

2.2.2.11 *Los Alamos Neutron Science Center (TA–53)*

LANSCE is the name applied to a group of facilities located at TA–53 (Figures 2.2.2.11–1 through 2.2.2.11–3). Initial construction of the original facility (then called the Los Alamos Meson Physics Facility, or LAMPF) was completed in 1970, and it remains one of the highest powered and largest research accelerators in the world. The LANSCE facility is located on a 750-acre (303-hectare) mesa top area, contains approximately 400 buildings and other structures, and houses about 700 personnel (Table 2.2.2.11–1). The number of personnel can increase by several hundred when the accelerator is in operation, as additional scientists are on site to monitor and participate in experiments.

LANSCE is LANL's major accelerator research and development complex. The facility produces intense proton beams and sources of pulsed spallation neutrons for neutron research and applications. The facility is composed of a high-power 800-million electron volt proton linear accelerator (linac), a proton storage ring (PSR), production targets at the Manuel Lujan Neutron Scattering Center (Manuel Lujan Center), and the Weapons Neutron Research (WNR) facility, and a variety of associated experiment areas and spectrometers. This facility uses particle beams to conduct basic and applied research in the areas of condensed matter science, materials science, nuclear physics, particle physics, nuclear chemistry, atomic physics, and defense-related experiments. LANSCE also produces medical radioisotopes. As a National User Facility for research in condensed matter sciences, LANSCE hosts scientists from universities, industry, LANL, and other research facilities from around the world.

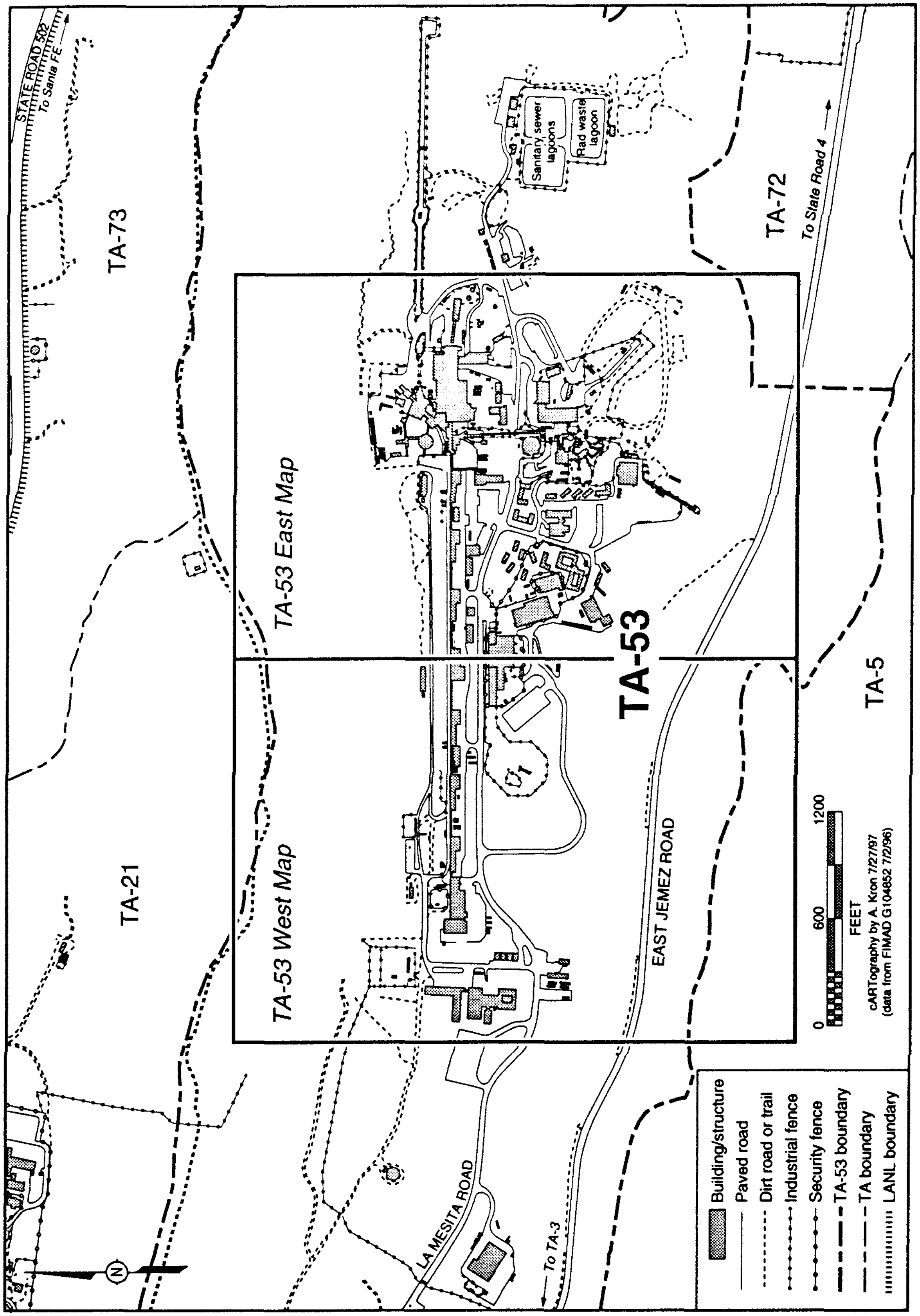


FIGURE 2.2.2.11–1.—*TA–53 Los Alamos Neutron Science Center.*

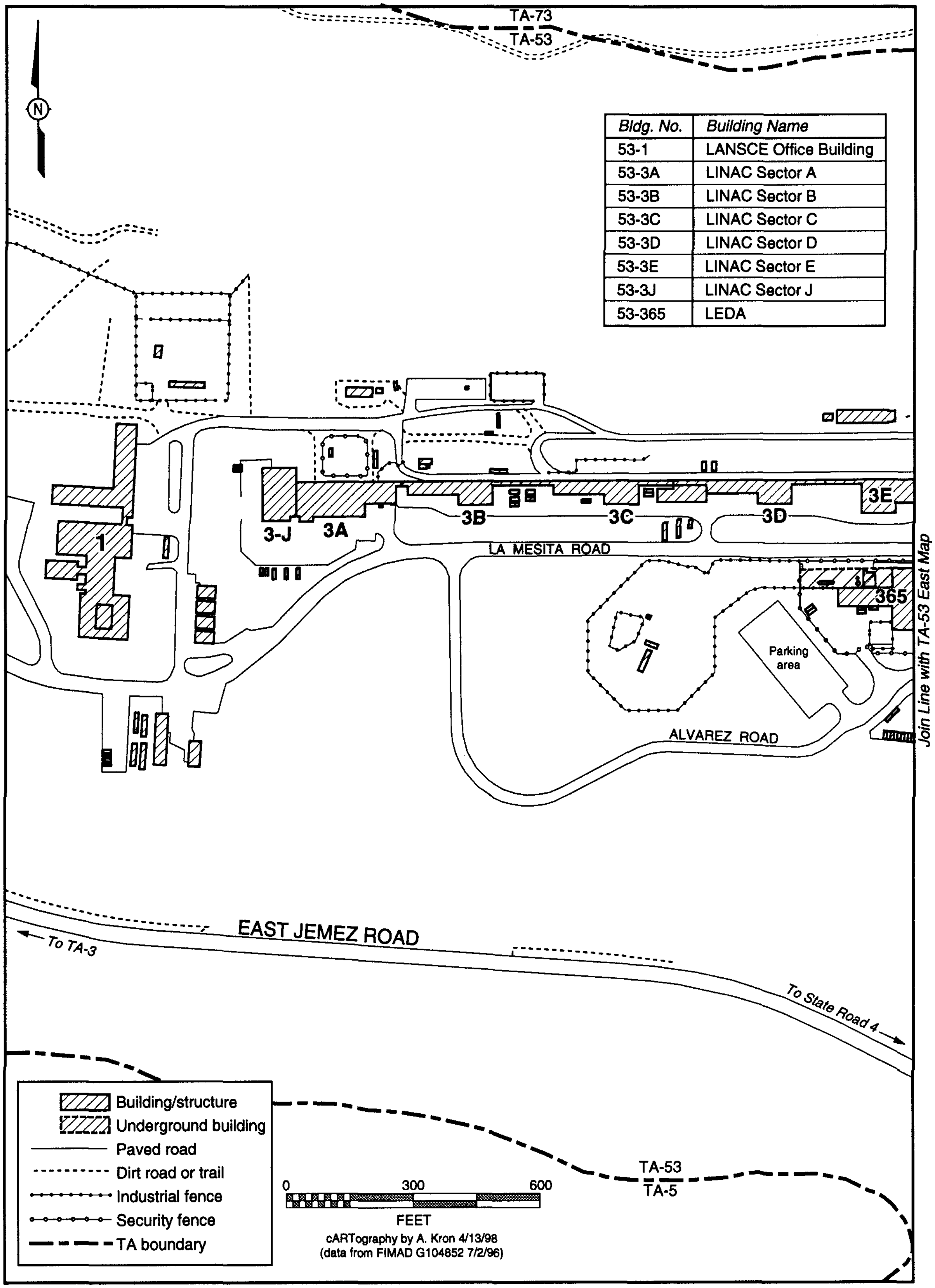


FIGURE 2.2.2.11–2.—*TA–53 Los Alamos Neutron Science Center West.*

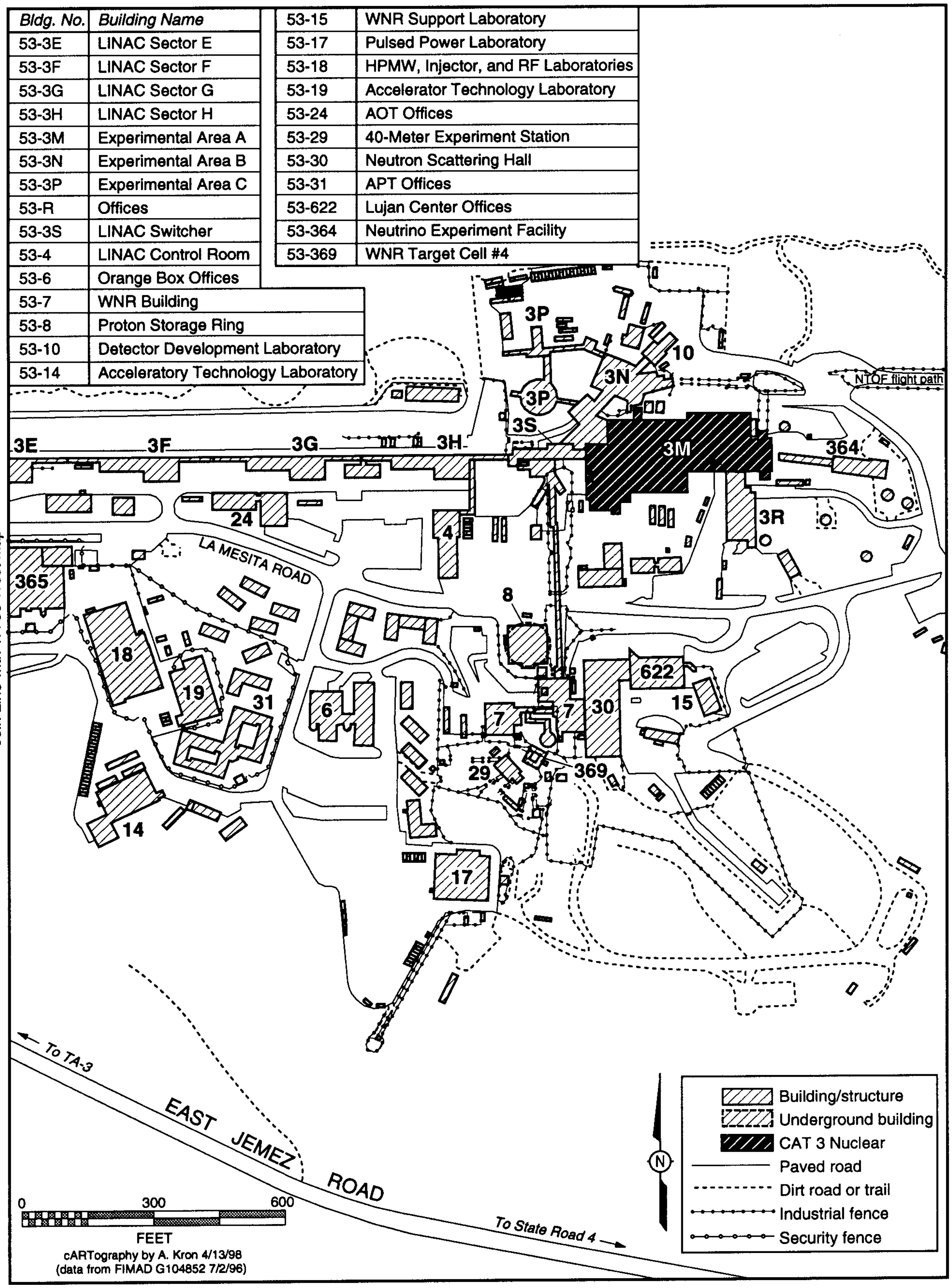


FIGURE 2.2.2.11–3.—*TA–53 Los Alamos Neutron Science Center East.*

TABLE 2.2.2.11–1.—*Principal Buildings and Structures of Los Alamos Neutron Science Center*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–53	**Accelerators:**
	Linear Accelerator Injector: 53–003J
	Proton Beam Linear Accelerator: 53–003A through H
	Linear Accelerator Switchyard: 53–003S
	Accelerator Control Room: 53–004
	Low Energy Demonstration Accelerator: 53–365
	Experimental Areas:
	Experimental Area A: 53–003M
	Experimental Area B: 53–003N
	Experimental Area C: 53–003P
	Neutrino Experiment Facility: 53–364
	Short-Pulse Spallation:
	Proton Storage Ring: 53–008
	Proton Storage Ring Equipment: 53–028
	Manuel Lujan Center Target, ER–1, Weapons Neutron Research Target #2: 53–007
	40-Meter Experiment Station: 53–029
	Manuel Lujan Center ER–2: 53–030
	Weapons Neutron Research Target #4: 53–369
	Major Laboratories:
	High-Resolution Accelerator Beam, Detector Development Laboratory: 53–010
	Accelerator Technology Laboratory (High-Powered Microwave and Advanced Accelerator): 53–014
	Weapons Neutron Research Support Laboratory: 53–015
	Pulsed-Power and Structures Laboratories: 53–017
	High-Powered Microwave, Injector and RF Laboratories: 53–018
	Accelerator Technology Laboratory: 53–019
	Other:
	LANSCE Office Building: 53–001
	Equipment Maintenance and Test Shop: 53–002
	“Orange Box” Office Building: 53–006
	Office Building: 53–024
	Office Building: 53–031
	Manuel Lujan Center Office Building: 53–622

LANSCE has 375 administrative, technical, physical support, and other buildings and structures assigned a no hazard classification. LANSCE also has 27 low hazard facilities. Twenty-one of these are classified as low hazard because of their radionuclide inventory and five due to potentially hazardous energy sources. LANSCE also contains one Hazard Category 3 nuclear facility, the isotope production facility within Building 53–003M (refer to Figure 2.2.2.11–3).

LANSCE accounts for more than 90 percent of all radioactive air emissions from LANL. These emissions come predominantly (greater than 95 percent) from stack ES–3, which ventilates Building 53–003, the linear accelerator and adjacent experimental stations. Additional emissions come from stack ES–2, which exhausts the PSR and experimental stations at the Manuel Lujan Center and WNR buildings. Both ES–2 and ES–3 are equipped with continuous monitoring equipment.

TA–53 contains six NPDES-permitted and NPDES-monitored outfalls. All of these outfalls discharge cooling tower blowdown. Three of the outfalls discharge into Los Alamos Canyon. The three remaining outfalls discharge into Sandia Canyon, one of which is slated for outfall reduction as part of LANL’s Outfall Reduction Program. Effluent from two of the outfalls and from a former outfall has created three wetland areas in TA–53.

Low-level radioactive liquid wastes produced at LANSCE are collected and allowed to decay in four underground tanks prior to discharge to a lined lagoon. Two unlined wastewater lagoons (no longer used) collected sanitary wastes prior to construction of the sanitary waste treatment facility at TA–46. Traces of both radioactive and hazardous wastes have been discovered in the sludges in these lagoons, and they now require a formal closure under RCRA. Radioactive solid wastes such as beam line components and scrap metals, papers, and plastics are also produced at LANSCE. Small quantities of hazardous and toxic wastes such as liquid solvents, solvents on wipes, lead, and solder are produced from accelerator maintenance and development.

Support activities at TA–53 provide for facility and plant operating and engineering services, environment, safety, and health services and oversight, site and building physical security, visitor control, and facility specific training.

Description of Facilities

The heart of TA–53 is the linear accelerator, or linac, itself, Building 53–003. It is more than 0.5 mile (0.8 kilometer) in length, and has 316,000 square feet (29,390 square meters) of floor space. The building contains equipment to form hydrogen ion beams (protons and negative hydrogen ions), and to accelerate them to 84 percent of the speed of light. Ancillary equipment is used to transport the ion beams, maintain vacuum conditions in the beam transport system, and provide ventilation and cooling. Creating and directing the ion beam requires large amounts of power, much of it ultimately removed as excess heat. The beam tunnel itself is located 35 feet (11 meters) below grade (i.e., below the ground) to provide radiation protection. Above-surface structures house radio frequency power sources used to accelerate the beam.

In the linear accelerator, an 800-million electron volt proton beam is generated in three stages. The linear accelerator has the capability to simultaneously accelerate both H^+ and H^- ion beams. In the first stage, three injectors (Building 53–003J) generate ionized H^+ or H^- beams, which are accelerated to 4 percent of the speed of light (corresponding to an energy level of 0.75 million electron volts).

The second stage (Building 53–003A) consists of a 203-foot (62-meter) series of drift-tube linear accelerator sections. By alternately exposing the proton ion beam to, and shielding it from, an externally generated electromagnetic field, ions are accelerated and exit this second stage at 43 percent of the speed of light (corresponding to an energy level of 100 million electron volts).

The third stage (Buildings 53–003B through 53–003H) consists of a 2,400-foot (731-meter) long side-coupled cavity accelerator. Ions exit at 84 percent of the speed of light with an energy level of 800 million electron volt (Allred and Talley 1987, pp. 10-13).

The ion beam then enters a switchyard (Building 53–003S), where the H^+ and H^- beams are split and directed to Experimental Areas A, B, C, WNR Building, and/or the PSR. The PSR converts the negatively charged beam into short (250 nanoseconds) intense pulses of protons. These pulses are delivered to the Manuel Lujan Center neutron production target at a rate of 20 per second.

At present, the 800-million electron volt linear accelerator is the only operating proton beam at TA–53. This will change when the Low-Energy Demonstration Accelerator (LEDA) becomes operational in late 1998. The environmental impacts of this facility were analyzed in the *Low-Energy Demonstration Accelerator Environmental Assessment* (DOE 1996b). LEDA will generate lower-energy protons (40-million electron volts as compared to the 800-million electron volt beam discussed above), but at a much higher beam current (200 milliamps versus 1). LEDA operations will be conducted in Building 53–365.

Description of Capabilities

The major categories of LANSCE activities are described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

Accelerator Beam Delivery, Maintenance, and Development. Generation and delivery of the proton ion beams requires significant development and maintenance capabilities for all components of the 800-million electron volt accelerator, including the ion sources and injectors, the mechanical systems in the accelerator (including cooling water), all systems for the PSR and its associated transfer lines, and beam diagnostics in the accelerator and transfer lines. Beam development activities include beam dynamics studies, and design and implementation of new capabilities. This activity requires the coordination of many disciplines, including accelerator physics, high-voltage and pulsed-power engineering, mechanical engineering, materials science, radiation shielding design, digital and analog electronics, high vacuum technology, mechanical and electronics design, mechanical alignment, hydrogen furnace brazing, machining, and mechanical fabrication. These activities take place throughout Building 53–003 (800-million electron volt accelerator), and in Buildings 53–008/028 (PSR), 53–365 (LEDA), 53–002 (equipment maintenance and test shop), and Line D (Manuel Lujan Center and WNR).

The short-pulse spallation source enhancement will result in higher neutron flux and greater beam availability from experimenters in WNR and the Manuel Lujan Center. (This project was categorically excluded from further NEPA review.) The upgrade would enhance the existing H^+ beam and the PRS to operate at 200 microamps and 30 hertz (versus the current 70 microamps at 20 hertz) and will add from five to seven new neutron-scattering instruments to the Manuel Lujan Center. All modifications will occur within existing buildings.

Experimental Area Support. Experiments using proton and neutron beams are conducted by personnel from the LANSCE and Physics Divisions, other LANL organizations, and other users such as scientists from universities, other laboratories, and the international scientific community. These beam users require support from TA–53 personnel, whether preparing for, performing, or closing out their experiments. This support capability focuses on the maintenance, improvement and operational readiness of the high intensity beam line (Line A) and associated secondary beam lines and experimental areas at LANSCE. This requires the specification, engineering, design utilizing computer-aided design (CAD), fabrication (often using computer-aided manufacturing), installation, and checkout and maintenance of various beam line components (and their controls and interlocks) including: particle production targets, uncooled and water-cooled devices such as magnets, beam stops, vacuum enclosures and beam collimators (fixed and movable), and absorbers.

Support also includes: the design, operation, and maintenance of remote handling systems for highly activated components; the handling and transportation (usually for disposal) of highly activated components; and the specification, engineering, design and installation of radiation shielding. Shielding activities include Monte Carlo shielding calculations and heavy equipment (bridge cranes and forklifts) operation.

Support activities occur in all of the experimental support areas: A (Building 53–003M), B (53–003N), C (53–003P), Manuel Lujan Center (53–007, 53–029, and 53–030), WNR (53–007 and 53–369), and the neutrino experiment hall (53–364).

Radiofrequency Technology and Operation. The 800-million electron volt and LEDA accelerators require large power sources, and both are supplied at TA–53 by radiofrequency (RF) power sources. The capability to design, fabricate, operate, and maintain RF systems for accelerators and other applications is an important support function for LANSCE operations. This capability also provides the RF systems, including state-of-the-art fast feedback controls and high-power klystron amplifiers used in electron accelerator projects and other advanced accelerator concepts at TA–53. RF technology development also supports microwave materials processing and RF system design. Design work includes determining optimal systems for very high-power continuous-duty systems for applications such as accelerator production technology.

RF power generation for the 800-million electron volt accelerator primarily occurs in the above-surface portions of Building 53–003, Sectors A through H, and will occur in Building 53–365 for LEDA.

Neutron Research and Technology. Fundamental research is conducted on the interaction of neutrons with various materials, molecules, and nuclei to advance condensed matter science (including material science and engineering and aspects of bioscience), nuclear physics and LANL's capability in the study of dynamic phenomena in materials. Applied neutron research is conducted to provide scientific and engineering support to weapons stockpile stewardship and nonproliferation surveillance. Efforts include resonance neutron spectroscopy and neutron radiography. (Radiography using protons rather than neutrons is discussed below under Subatomic Physics Research.) Research is also performed to develop instrumentation and diagnostic devices by scientists from universities, other federal laboratories, and industry.

Accelerator-Driven Transmutation Technology. This research area probes the use of a fundamentally different approach to the management of nuclear waste by using an accelerator beam to convert plutonium and high-level radioactive wastes into safer elements. Planned experimental progression will start by performing tests to establish a technology base for materials handling and operation of liquid lead spallation neutron targets, including the assembly and testing of a Russian built lead/bismuth target (using a 1-megawatt target/blanket, expected to be categorically excluded from further NEPA review by May 1, 1998). This liquid lead technology could then be used to construct a target/blanket assembly for low-power (up to 5 megawatts) experiments with representative fission products and fissionable materials. These experiments will allow measurement of the production and removal of spallation products and fission products, and the testing of transmutation effectiveness in different configurations.

Subatomic Physics Research. Historically, a wide variety of subatomic physics research was conducted at this accelerator facility. Currently, experiments are conducted at the Liquid Scintillator Neutrino Detector Facility (Building 53–364) in conjunction with several universities. Atomic parity nonconservation experiments are conducted in Area A. These use a thin target to produce unstable isotopes, and detectors to measure their properties. Research built on subatomic physics techniques and knowledge is also developing the technology for, and use of, neutron and proton radiography for stockpile stewardship applications. Experiments to date have been directed at radiographing static objects using WNR and small, contained dynamic experiments in Line B, utilizing appropriate locations for access to the proton beam. These experiments have demonstrated the utility of the technique and provide data on explosives behavior. Experiments take place in Line C, which allows room for continued dynamic materials research studies and technique development. This research includes development and demonstration of advanced detectors.

Medical Isotope Production. The 800-million electron volt accelerator proton beam is used to produce radioisotopes used by the medical community for diagnostic procedures, therapeutic treatment, clinical trials, and biomedical research. Nearly 40 different medical radioisotopes have been produced and shipped in the 20 years of production at LANL. During 1995, for example, 75 shipments were made to user facilities in nine countries, including France, Germany, and Australia.

Isotopes are currently produced at the Isotope Production Facility (IPF), at the linear accelerator beam stop in Area A (Building 53–003M). The IPF currently makes use of that portion of the proton beam that is not consumed by and used for proton and neutron experiments and research. The IPF has nine independent stringers or target stations. A small amount of target material is loaded onto each movable stringer, and the stringer is inserted into the proton beam path. Remote handling equipment and water-cooled targets are required due to the high radiation levels (up to 50,000 roentgen per hour) and temperatures (up to 1,832^{o}F [1,000^{o}C]) generated by the spallation process. Isotope production and facilities will be relocated to a new 100-million electron volt station in an add-on to Building 53–003B. This change will result in more selective and more efficient isotope production and the generation of fewer byproduct isotopes (as compared to the current use of the 800-million electron volt beam).

are transported from TA–53 to the Radiochemistry Facility in TA–48 (described in section 2.2.2.13) for recovery of the desired radioisotopes from the target material.

High-Power Microwaves and Advanced Accelerators. High-power microwave research and experiments, mostly conducted in Buildings 53–014 and 53–018, occur in a number of technology areas: (1) high-power microwave, RF, and electromagnetic pulse sources that typically use multi-kiloampere, relativistic electron beams; (2) future linac power sources and directed energy; (3) explosively driven high-power microwave and RF systems for defense applications; (4) intense beam physics and modeling for application to high-power microwave source development; (5) high-power, free-electron lasers based on high-brightness electron accelerators; (6) high-brightness accelerator as a driver for an extreme UV source for lithography; (7) high-performance ground penetrating radar for environmental remediation; (8) application of high-power microwaves to industrial processing, such as chemical catalysis and environmental remediation; (9) microwave and electromagnetic pulse vulnerability and effects testing of weapons systems; (10) novel high-power microwave sources based on shock compression of solid materials; (11) advanced pulsed-power modulator development; (12) development of room-temperature and superconducting RF linac structures; and (13) development of advanced electron accelerators. Research also will be conducted to support development of the spallation neutron source (as discussed in chapter 1, section 1.5.9).

2.2.2.12 *Health Research Laboratory (TA–43)*

The Health Research Laboratory (HRL) complex within TA–43 includes the main HRL and 13 support buildings and facilities (Figure 2.2.2.12–1 and Table 2.2.2.12–1). The Life Sciences Division is the primary occupant of TA–43 and is responsible for management, and safety measures, procedures, and most of the research and experimental science activities at HRL. Three of the support buildings and structures have low hazard classifications. HRL is designated a low hazard as a radioactive material source and low hazard as a chemical source facility. One transportable building houses lasers and is designated low hazard as an energy source, and a safety storage shed where chemical waste is stored is assigned a low hazard as a chemical source. The other buildings have no hazard classification.

TABLE 2.2.2.12–1.—*Principal Buildings and Structures of the Health Research Laboratory*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–43	Offices, Laboratories: 43–1, 20, 24, 37 Sewage Lift Station: 43–10 Storage: 43–12, 28, 36, 46 Cooling Tower: 43–44 Computer/Instrument Assembly Building: 43–45 Chemical Storage Sheds: 43–47, 49, 61

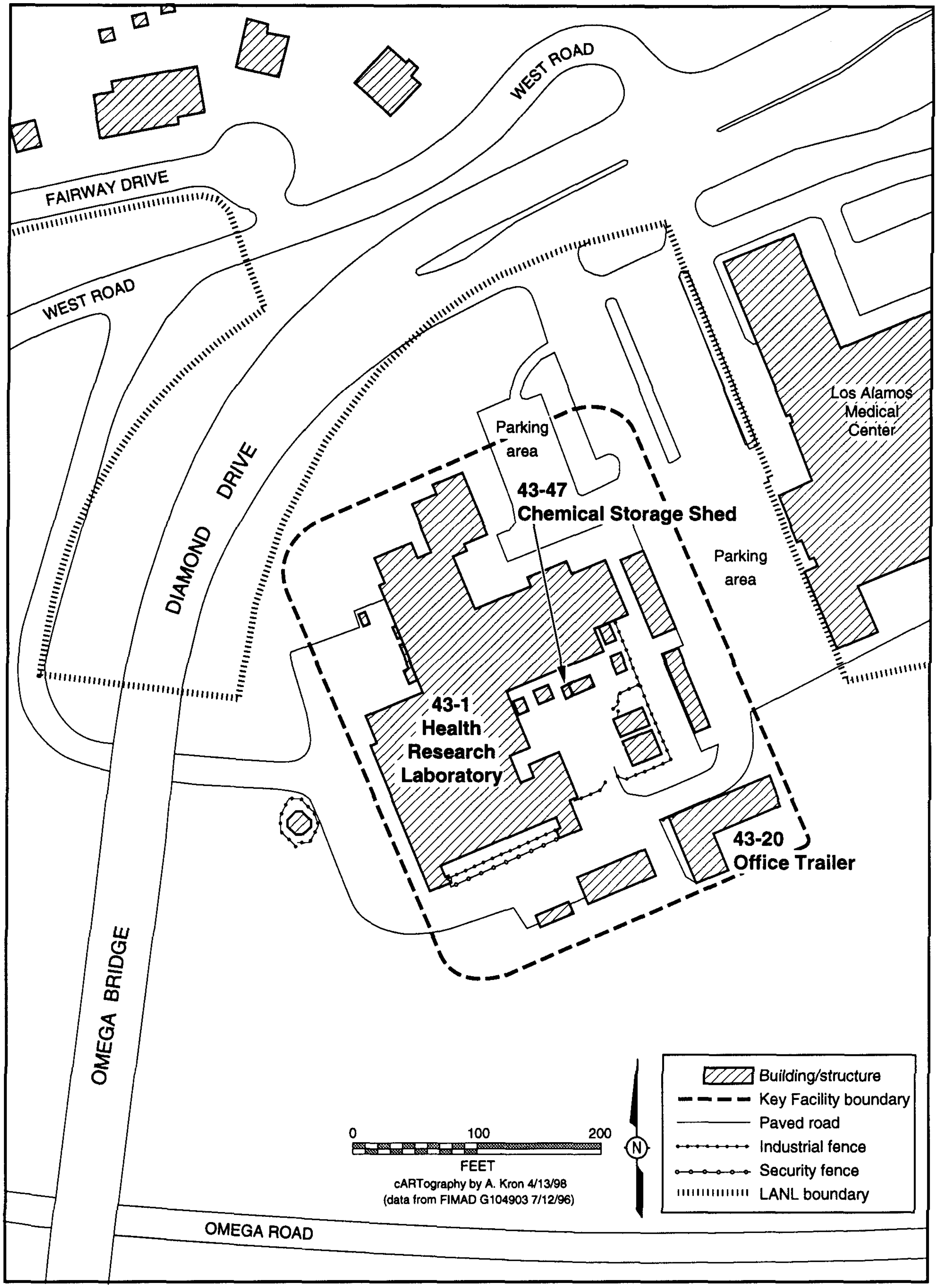


FIGURE 2.2.2.12–1.—*TA–43 Health Research Laboratory.*

Description of Facilities

Research areas in HRL focus on trying to understand the relationships between energy and health by studying the effects of different types of radiation and chemicals on cells and subcellular components. This research is important to DOE because of its work in nuclear fission and fossil fuels, both of which generate byproducts that can affect human health by damaging deoxyribonucleic acid (DNA) and can lead to carcinogenesis.

Small quantities of many toxic and hazardous chemicals are transported to and used in research projects at HRL. They include solvents, flammable materials, dilute suspect carcinogens, certain recombinant biological preparations, and compressed gasses. There are four low-level radioactive sources used for the irradiation of samples: two cesium-137 sources, one cobalt-60 source, and one plutonium-238 source. In addition, several sealed sources of depleted uranium (uranium-238) are used to check personnel monitoring equipment. Radioisotope-labeled compounds are also used in small volume operations and include phosphorus-32, phosphorus-33, and sulfur-35. All are short-lived (half lives in days) beta emitting radionuclides. Radioactive wastes are typically allowed to decay before being discarded. Operations at HRL may involve samples that contain radionuclides as well as dilute suspect carcinogens and other hazardous chemicals.

Chemical and radiological wastes produced at HRL are disposed of through LANL's waste management system. Animal tissues and carcasses are identified as infectious medical wastes and are disposed of as medical wastes (biohazard) through an off-site commercial firm that destroys such waste. All cells, subcellular materials, and culture media are sterilized and then disposed of along with solid wastes at the Los Alamos County Landfill. Wastes from the animal colony are also disposed of as administrative wastes in the Los Alamos County Landfill because the animals are not used as hosts for disease organisms and intact animals are not treated with radioactive materials (the animal colony has rats, mice, rabbits, and similar small mammals, but no primates or large mammals). Wastewater from animal colony cleaning operations is disposed of into the sanitary sewage system. All of the research activities at HRL produce low volumes of waste.

There is one outfall associated with HRL, and it discharges cooling water from lasers into Los Alamos Canyon. The Life Sciences Division is considering the elimination of this outfall and discharging cooling water instead to the Los Alamos County Sewage Treatment Facility. Further NEPA review would be prepared for any such proposal.

Because of its location, utilities (gas, water, and electricity) are delivered to HRL from Los Alamos County distribution systems. These delivery systems are metered, unlike most of the other facilities at LANL.

Description of Capabilities

The capabilities at HRL are described below.

Genomic Studies. These studies are directed at understanding the organization, replication, and regulation of complex genomes.

Cell Biology. Activities are directed at understanding how whole cells respond to insults from the environment, including ionizing radiation and oxidants.

Cytometry. Activities focus on developing, refining, and applying laser-based techniques for imaging and analyzing biological materials such as whole cells and subcellular organelles.

DNA Damage and Repair. Studies involve how DNA is damaged and how it is repaired.

Environmental Effects. Studies involve the ecology of microbes and how the DNA and protein components in microbes are changed as a result of changes that humans introduce into the environment.

Structural Cell Biology. These are activities to understand the structure, functions, and interactions of subcellular structures and biological macromolecules.

Neurobiology. These activities include studies of the functions of the human brain, using magnetic waves generated by the brain to map the areas that become active as the brain receives certain sensory stimuli and goes through thinking/reasoning activities.

In-Vivo Monitoring. This activity provides a service to other LANL operations. Extremely sensitive detection equipment measures photons emitted by the bodies of workers to determine whether they have inhaled any radioactive material.

2.2.2.13 *Radiochemistry Facility (TA–48)*

The Radiochemistry Facility at TA–48 was constructed from 1955 through 1957. The entire TA covers 116 acres (47 hectares), but the main buildings are enclosed behind a security fence on 8.6 acres (3.5 hectares) (Figure 2.2.2.13–1). TA–48 contains five research buildings: the Radiochemistry Laboratory (48–1), the Isotope Separator Facility (48–08), the Diagnostic Instrumentation and Development Building (48–28), the Advanced Radiochemical Diagnostics Building (48–45), and the Analytical Facility (48–107) (Table 2.2.2.13–1).

TABLE 2.2.2.13–1.—*Principal Buildings and Structures of the Radiochemistry Facility*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–48	Radiochemistry Laboratory: 48–1 Isotope Separator Facility: 48–8 Diagnostic Instrumentation and Development Building: 48–28 Advanced Radiochemical Diagnostics Building: 48–45 Analytical Chemistry Facility: 48–107

The Radiochemistry Facility is a research facility that fills three roles. Research supports environmental management projects (e.g., Yucca Mountain Project, plutonium stabilization), catalysis, basic energy, and other scientific endeavors. Chemistry research is performed in the areas of inorganic, actinide, organometallic, environmental, geochemistry and nuclear chemistry. The Radiochemistry Facility is also a production facility, using the hot cell in Building 48–01 to separate and package radioisotopes needed and used by researchers, physicians, hospitals, and pharmaceutical companies all over the world. In a typical year, the LANL isotopes program makes more than 150 shipments of up to 30 different isotopes, some of which are available only from LANL. In addition, the facility provides services to other LANL organizations (e.g., samples are analyzed at TA–48 as part of the environmental surveillance program).

Description of Facilities

Building 48–01 is a Hazard Category 3 nuclear facility, and the other four laboratory buildings are classified as low-level radiological hazard. Twenty-six other structures are classified as no hazard, including trailers, transportable buildings, metal sheds, office buildings, and storage facilities.

The Radiochemistry Laboratory is a single-story building with a basement and a penthouse. With slightly more than 100,000 square feet (9,300 square meters) of floor space, Building 48–01 is divided into several wings for differing types of research:

- Laboratory wings for light chemical analysis and research

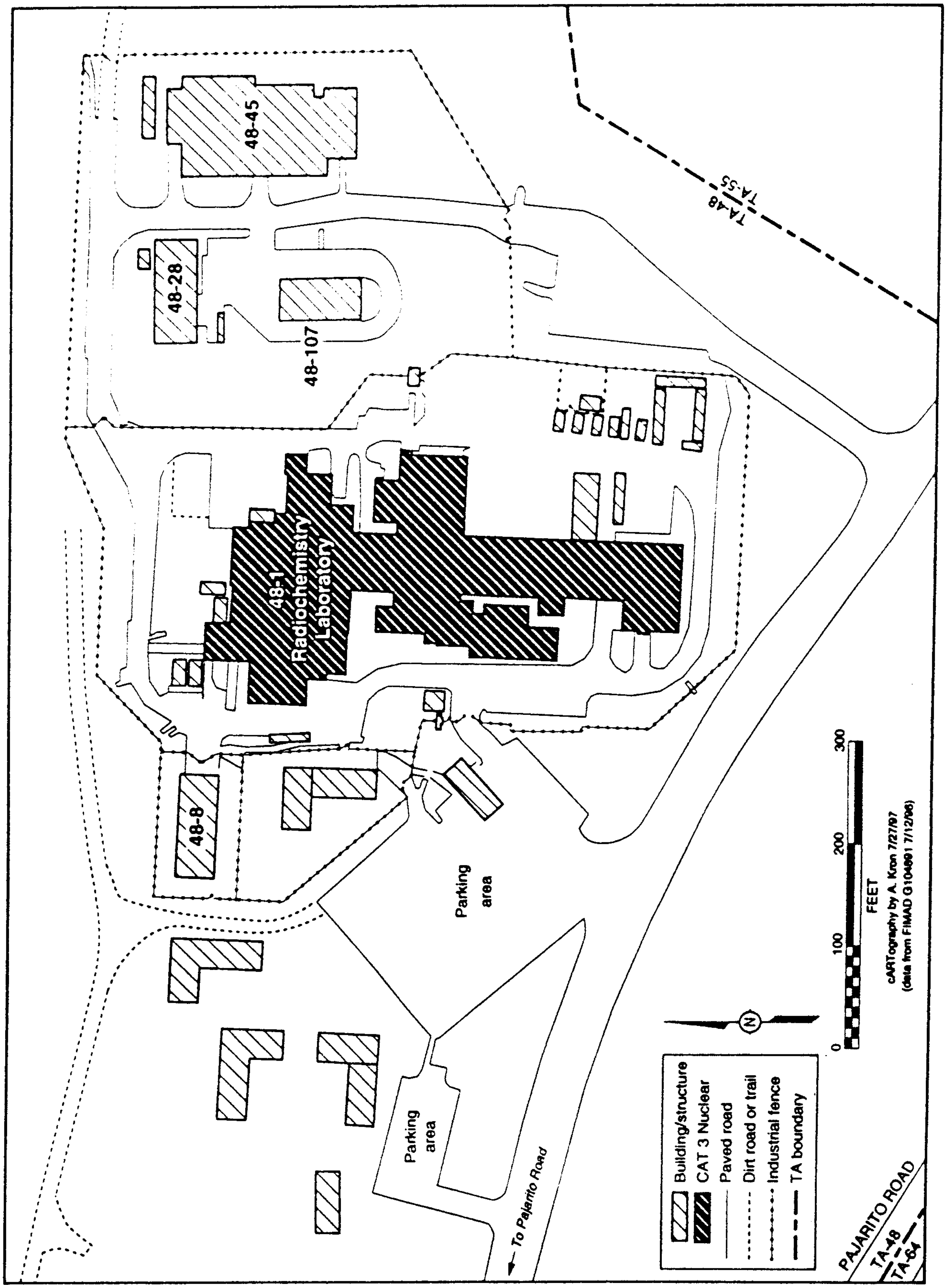


FIGURE 2.2.2.13–1.—*TA–48 Radiochemistry Facility.*

- A hot cell for the separation, packaging, and shipment of radioisotopes to medical facilities, research institutions, and pharmaceutical firms
- An alpha wing for research with plutonium and other alpha-emitting radionuclides
- A counting wing, which houses detectors and equipment for the assay of radioactive samples. There is also an office wing and a secure wing for historical weapons data. Most radiochemical research is conducted on the main floor, although a few laboratories are located in the basement. The basement also houses utilities, support systems, and ventilation exhaust fans and ductwork. Ventilation intake fans and heating and cooling units are located in the penthouse.

Three exhaust stacks at Building 48–01 are continuously sampled for radioactive emissions in accordance with requirements of the EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP): FE–7 (hot cell), FE–54 (the alpha wing), and FE–60 (hot cell dilution bench). Building 48–01 also discharges cooling tower waters through three outfalls into Mortandad Canyon.

Research at the Isotope Separator Facility (48–08) includes the separation and collection of radioactive isotopes for analytical quantification and the development of equipment used for isotope separation. Building 48–28 has two laboratories; one houses five laser systems and two mass spectrometers used for environmental research experiments, and the other is used to analyze radioactive water samples.

The Advanced Radiochemical Diagnostics Building (48–45) contains 11 chemistry and 7 instrument laboratories. These laboratories are clean rooms designed to minimize the effect of environmental factors on the accuracy of isotope measurements for experiments in solar physics, geosciences, biology, and atmospheric science.

The Analytical Chemistry Facility (48–107) contains four light chemistry laboratories and a laser laboratory and is used to support environmental research, catalysis research, and inorganic chemistry.

Description of Capabilities

There are several services and capabilities available at TA–48: radionuclide transport studies, environmental restoration support, ultra-low-level measurements, nuclear and radiochemistry, high-level beta/gamma chemistry, actinide TRU chemistry, data analysis, inorganic chemistry, structural analysis, and sample counting. Each of these is described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

Radionuclide Transport. Numerous chemical and geochemical investigations are undertaken that address concerns about hydrologic flow and transport of radionuclides. Areas of study include the sorption (binding) of actinides, fission products, and activation products in minerals and rocks, and the solubility and speciation of actinides in various chemical environments (e.g., environments associated with waste disposal). These studies are paired with the development of models to evaluate, for example, the parameters for performance assessment of mined geologic disposal systems.

Environmental Remediation. Environmental remediation capabilities at TA–48 fall into two categories: characterization and remediation of soils contaminated with radionuclides and toxic metals; and data analysis and integrated site-wide assessment. In characterizing and remediating soils contaminated with radionuclides and toxic metals, a major objective is to minimize the generation of large volumes of metal- and radionuclide-contaminated soils. The objective of data analysis and integrated side-wide assessment is to accelerate remediation through improved sampling schemes, clearer and more efficient evaluation of characterization data, and more effective tools for assigning priority to cleanup targets.

Ultra-Low-Level Measurements. Isotopic tracers and high-sensitivity measurement technologies have been developed to support the U.S. nuclear weapons program. The isotopic tracers can include both radioactive and nonradioactive isotopes, with emphasis on the nonradioactive. Some are commercially available, and some can be produced at LANL. The research staff also specializes in developing analytical techniques for a variety of problems in nuclear, environmental, and biological sciences.

Mass spectrometers detect and analyze samples as small as one-thousandth of one-billionth of a gram. Chemical separation procedures to isolate the element to be measured are conducted in a chemistry laboratory specially designed to keep the sample from being contaminated by natural or man-made sources. This technique can determine both the source and the amount of radioactive contamination. For example, these efforts allow determination of whether radiation in an environmental sample results from contamination from a nearby nuclear reactor or from radioactive fallout from global weapons testing. LANL researchers can also trace the migration of radioactive contamination through the environment.

Nuclear/Radiochemistry. Activities under this capability include developing radiation detectors, conducting radiochemical separations, and performing nuclear chemistry. Development, calibration, and use of radiation detectors include the use of off-the-shelf systems for routine measurement of radioactivity and development of new radiation detection systems for a number of special applications. LANL conducts both routine and special separations of radioactive materials from other radioactive species and stable impurities. These experiments have provided support to Hanford waste tank treatment activities and production of medical isotopes. Separations are based on traditional approaches that use commercially available ion-exchange media, extractants, and other reagents. LANL also develops new separations based on experimental chemical systems, using radioactive tracers to synthesize the chemicals and to characterize their performance.

Nuclear chemistry efforts use exotic laser-based atom traps for probing the interactions of energy and atoms in energy regimes not easily accessed by other techniques. This work requires conducting extensive laser spectroscopy, handling of radioactive materials, and interpreting the resulting data. In other nuclear chemistry efforts, targets are irradiated and isotopes are captured at LANSCE (described in section 2.2.2.11) or at off-site reactors to produce specific radioactive isotopes. These isotopes are then separated from impurities, and their neutron capture cross sections are measured at TA–48.

Isotope Production. This capability produces, chemically separates, and distributes isotopes to the medical and industrial user communities. TA–48 activities include preparing the target packages that will be irradiated to make isotopes, transporting these packages to the LANSCE accelerator (described in section 2.2.2.11), inserting them into the proton beam, retrieving them from the beam, and transporting them back to TA–48. Once the target packages arrive back at TA–48, they are disassembled and the target material is moved to a chemistry hot cell for processing to recover the desired isotopes. Post-irradiation activities associated with these targets must be carried out using remote handling techniques. Separated isotopes are packaged for shipment and are distributed to customers throughout the world.

Actinide/Transuranic Chemistry. The activities in the alpha wing are essentially the same as the radiochemical separations carried out in the rest of the facility. The materials handled are actinides and transuranics (elements with an atomic weight greater than that of uranium [92]) that require the special safe-handling environment provided in this wing.

Data Analysis. Data analysis is the process of taking information learned from all of the measurements made on a material and putting it into the context of the experimental design. This process is a paper exercise that turns data into useful information that will help answer experimenters' questions.

Inorganic Chemistry. Inorganic chemistry work at TA–48 includes two main categories of activities: (1) synthesis, catalysis, and actinide chemistry and (2) development of environmental technology. The former category includes chemical synthesis of new organometallic complexes, structural and reactivity analysis, organic product analysis, reactivity and mechanistic studies, and synthesis of new ligands for radiopharmaceuticals. Development of environmental technology includes designing and synthesizing ligands for selective extraction of metals, soil washing, development of membrane separators, photochemical processing, and ultrafiltration. Other work involves oxidation reduction studies on uranium and other metals for both environmental restoration and advanced processing.

Structural Analysis. Structural analysis at TA–48 includes the synthesis, structural analysis, and x-ray diffraction analysis of actinide complexes in both single-crystal and powder form. This capability supports programs in basic energy sciences, materials characterization, stockpile stewardship, and environmental management.

Sample Counting. Sample counting, the measurement of the quantity of radioactivity present in a sample, is accomplished with a variety of radiation detectors, each customized to the type of radiation being counted and the expected levels of radioactivity. All samples counted in the counting facility are sealed items that are placed inside appropriate detectors for a specified period of time. At the end of the count, the data are automatically processed through the computer system and results are presented to the users. Other activities in the counting room include system calibration, quality checks on system performance, and corrective action when problems occur.

2.2.2.14 *Radioactive Liquid Waste Treatment Facility (TA–50)*

TA–50 is located near the center of LANL (see Figure 2.2.2.14–1 and Table 2.2.2.14–1). Its 62 acres (25 hectares) are the home for 33 total waste management structures, including office trailers, tanks, storage sheds, and four buildings. Approximately 110 people participate in the following waste management activities:

- Treatment of radioactive liquid wastes
- Decontamination of respirators, equipment, instruments, vehicles, and waste items
- Size reduction of TRU waste
- Characterization of TRU waste

As discussed in the SWEIS Notice of Intent, the DOE had, at one time, proposed a construction project to replace the aging RLWTF. Given the

TABLE 2.2.2.14–1.—*Principal Buildings and Structures of the Radioactive Liquid Waste Treatment Facility*

TECHNICAL AREA	PRINCIPAL STRUCTURES AND BUILDINGS
TA–50	Radioactive Liquid Waste Treatment Facility: 50–1 Decontamination Trailer: 50–185

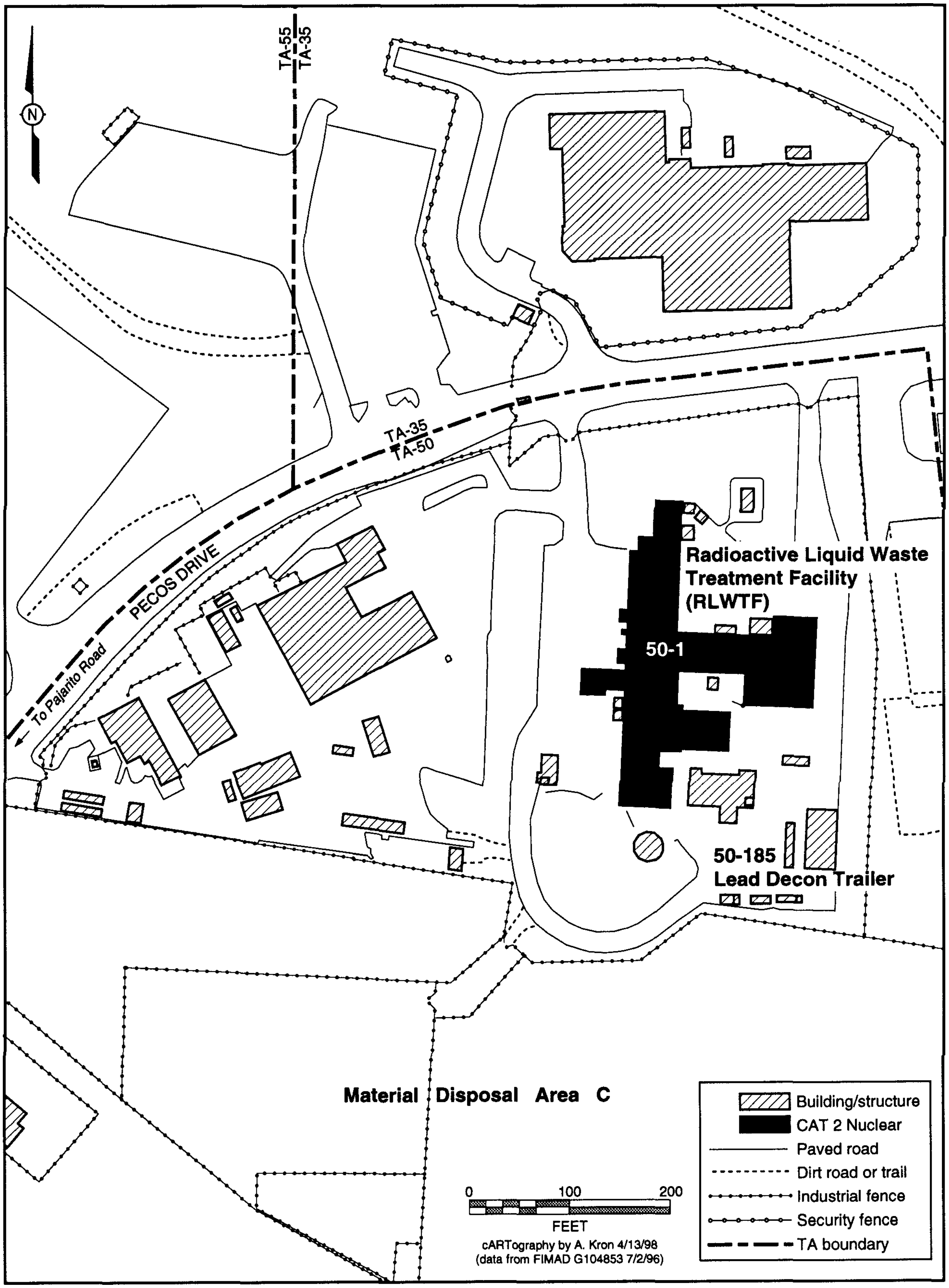


FIGURE 2.2.2.14–1.—*TA–50 Radioactive Liquid Waste Treatment Facility.*

cost of such a replacement facility, DOE withdrew that project and initiated studies to benchmark the "best in class" private-sector radioactive liquid waste treatment options. The DOE currently is considering various options for future liquid waste treatment, including the benefits of a centralized versus a decentralized approach (at the point of generation). In recognition of potential environment, safety, and human health issues associated with operations in an aging facility, as well as compliance issues regarding the effluent from the RLWTF, the DOE has been upgrading the facility and treatment technologies utilized. Upgrades have included retrofitting to upgrade or replace tanks and pipes (which are now double-walled), ventilation and air monitoring systems, and a treatment system (discussed later in this section). Future upgrades or replacement proposals would be subject to NEPA reviews tiered from this SWEIS.

Description of Facilities

Waste management operations at TA–50 principally take place at three facilities: the RLWTF, the Radioactive Materials Research, Operations, and Demonstration (RAMROD) Facility, and the Waste Characterization, Reduction, and Repackaging (WCRR) Facility. Activities in the RAMROD and WCRR facilities are associated with TRU wastes, and are described as part of the Solid Radioactive and Chemical Waste Facility (described in section 2.2.2.15).

RLWTF (Building 50–01) is the largest structure at TA–50 with 40,000 square feet (3,720 square meters) under roof. It is a Hazard Category 2 nuclear facility. Liquid wastes from the plutonium facility at TA–55 (described in section 2.2.2.1) are pre-treated in Room 60, then added to influent tanks that collect radioactive liquid waste from other LANL facilities. These combined liquid wastes are processed, then collected in tanks, and, if in compliance with regulatory standards, discharged into Mortandad Canyon. Improvements in treatment technology (ultrafiltration/reverse osmosis) are planned to come online by early 1999. LLW sludge from the chemical treatment step is drummed and sent to TA–54 for disposal, while TRU sludge is solidified and sent to TA–54 for storage pending eventual disposal (described in section 2.2.2.15).

The south wing of the basement of Building 50–01 houses equipment for the decontamination of personnel respirators from LANL operations, vehicles, equipment, portable instruments, precious metals, and scrap metal. Decontamination solutions are drained to influent tanks for radioactive liquid waste and LLW treatment operations. Decontamination allows re-use of respirators and equipment, and recycle of materials such as precious metals and scrap metals. It also reduces the volume of wastes that must be disposed.

The Lead Decontamination Trailer, Building 50–185, is located just behind the RLWTF. Here, contaminated lead bricks are subjected to a grit blast and subsequent water wash to remove radioactive contamination. Bricks are then re-used within the laboratory. Spent grit is packaged as solid LLW or TRU waste and sent to TA–54 for disposal or storage. Wash solutions are drummed, sampled, and transported to RLWTF for treatment.

There are seven concrete underground storage tanks (USTs) adjacent to RLWTF. These range in size from 2,600 to 75,000 gallons (9,840 to 283,875 liters). However, two of three existing influent USTs were replaced by four aboveground steel tanks. This 1.4-million-dollar modification to the tank farm (Building 50–02) was completed in 1997. The total influent holding capacity remains at 50,000 gallons (190,000 liters).

Each of the three major buildings at TA–50 has a stack for the discharge of equipment and/or process room air. Each of these stacks is equipped with a continuous air sampling device. Buildings 50–01 and 50–69 also have two additional ventilation stacks each that are not continuously sampled.

Approximately 5 million gallons (20 million liters) of treated effluent are discharged annually from RLWTF into Mortandad Canyon via NPDES Outfall #051. Discharges from RLWTF into Mortandad Canyon have created a small wetland area near this outfall.

An estimated 3.68 million cubic feet (103,000 cubic meters) of chemical, radioactive, and mixed solid wastes were buried from 1948 to 1974 in 7 pits and 108 shafts in former Material Disposal Area (MDA) C. MDA C covers 11.8 acres (4.78 hectares), is completely fenced in, and is being investigated as part of LANL's ER Project. Disposal pits and shafts lie 1,300 feet (397 meters) above the main aquifer. Surface waters drain to the northeast into Ten Site Canyon, a branch of Mortandad Canyon. There is no evidence of migration of wastes from Area C (LANL 1992).

In response to the November 1997 report of the DOE Inspector General on the RLWTF (DOE 1997b), DOE prepared a "make or buy" analysis of radioactive liquid waste collection and treatment at LANL, focusing on possible privatization of the RLWTF. The DOE concluded that the continued operation of the RLWTF by LANL was the appropriate course of action (Gurule 1998).

Description of Capabilities

Capabilities and operations performed at the RLWTF include: waste characterization, packaging, and labeling; waste transport, receipt, and acceptance; waste storage; liquid waste pre-treatment and treatment; and material decontamination. Each of these is described below. The manner in which these activities would vary among the alternatives is described in chapter 3.

Waste Characterization, Packaging, and Labeling. Waste characterization is the process of identifying and quantifying constituents of concern in waste streams, accomplished in one of three ways. The first, process knowledge, uses information in lieu of sampling and analysis to characterize the waste. The second, radiological testing, employs techniques such as gamma spectroscopy, liquid scintillation, and passive/active neutron scanning to determine types and quantities of radionuclides in a waste.

The third is waste sampling and analysis, which depends on the ability to obtain representative samples and on analytical reproducibility. The three methods may also be used together when characterizing a waste stream.

DOT regulations specify what types of containers are acceptable for transporting each type of waste and labeling requirements for each type of container. Waste generators perform the initial packaging and labeling operations, but waste management personnel sometimes perform two other packaging operations. Waste may be overpacked to ensure container integrity (e.g., by placing a 55-gallon drum into an 85-gallon drum). Wastes can also be repackaged to reduce storage and transportation costs. In this operation, waste management personnel either combine the waste from a number of smaller containers into a single container, or place smaller containers of waste into a larger container.

Waste Transport, Receipt, and Acceptance. Liquid wastes travel from generator facilities to the RLWTF at TA–50 by one of thee modes. Most radioactive liquid wastes are sent via an underground pipeline system that transfers liquids directly to RLWTF influent tanks. Other generators, not connected by the underground pipeline system, transfer their wastes into a special tanker truck for delivery to the RLWTF. Generators of small quantities of radioactive liquid wastes drum their wastes, then truck the drums to TA–50.

Waste receipt and acceptance occurs with every shipment of waste to a waste management facility. Activities typically include visual inspection of vehicle and container, cross-checking container labels and shipment manifests, radiation surveys of the vehicle and containers, and weighing of vehicles, and/or containers.

Waste Storage. Liquid and solid chemical, radioactive, and mixed wastes are stored at both TA–50 and TA–54. At TA–50, wastes are stored within the RAMROD Facility, adjacent to the WCRR Facility, and within influent storage tanks at the RLWTF.

Radioactive Liquid Waste Pre-Treatment. Radioactive liquid wastes from TA–21 (described in section 2.2.2.2) are pre-treated at Building 21–257 using pH adjustment (using sodium hydroxide), flocculation (using calcium hydroxide, ferric sulfate, and a polymer), settling, and filtration. Radioactive liquid wastes from TA–55 (described in section 2.2.2.1) are pre-treated in the same fashion in Room 60 of the RLWTF at TA–50. Pre-treated streams are added to similar radioactive liquid wastes from all other LANL generators, then treated in the main process line of the RLWTF.

Radioactive Liquid Waste Treatment. Beginning in early 1997, the main process for treatment of radioactive liquid wastes employs ultrafiltration and reverse osmosis. Ultrafiltration typically removes solids and dissolved materials as small as 10 nanometers in diameter, while reverse osmosis will remove materials less than 1 nanometer in size. The newer technology also reduces the amounts of most chemicals required by the pre-treatment process (calcium hydroxide, ferric sulfate, and polymers are not required, and sodium hydroxide use is approximately halved). Once treated, effluent is discharged via NPDES Outfall 051. Solid wastes generated from treatment processes are shipped to TA–54 for appropriate storage or disposal. In the summer of 1998, process equipment for nitrate reduction will be installed to ensure compliance with recent changes to groundwater discharge limits. The new process will use biological denitrification to reduce nitrate concentrations to 10 parts per million or lower. The new process is expected to become operational in mid 1999.

Decontamination Operations. Decontamination is performed by waste management personnel either to enable re-use of an item or to re-classify the waste type. Both activities are used primarily to achieve waste volume reduction. An example of the former activity is the removal of radioactive surface contamination from lead bricks, thus enabling the bricks to be re-used as shielding. An example of the second activity is the sorting and segregating of a waste item or package into its components (e.g., hazardous and radioactive) so that the waste is no longer a mixed waste. Decontamination operations take place in Buildings 50–01 and 50–185.

2.2.2.15 Solid Radioactive and Chemical Waste Facilities (TA–54 and TA–50)

TA–50 houses some solid waste facilities (Figure 2.2.2.15–1) in addition to the radioactive liquid waste facilities described in section 2.2.2.14. At 943 acres (382 hectares), TA–54 is one of the larger technical areas at LANL (Figures 2.2.2.15–1 through 2.2.2.15–4). There are 120 structures within TA–54, of which 101 house waste management personnel and operations (Table 2.2.2.15–1). Approximately 130 workers are needed to perform these treatment, storage, and disposal operations. A variety of wastes are managed at TA–54, including industrial, toxic, hazardous, LLW, TRU, and mixtures of the above. Waste forms are solid except for small quantities of gaseous or liquid hazardous, toxic, and mixed wastes. Storage, disposal, and some treatment operations are conducted.

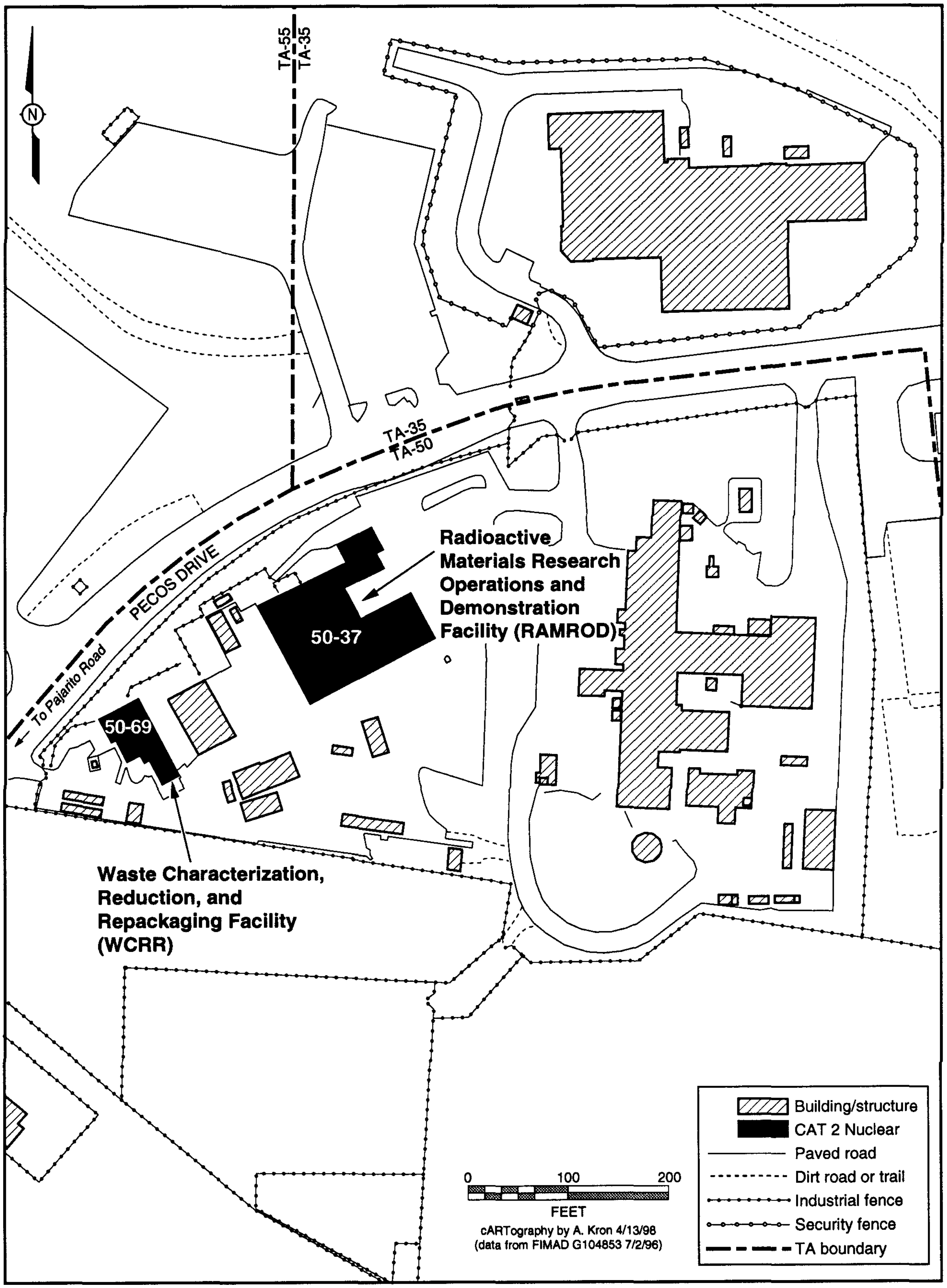


FIGURE 2.2.2.15–1.—*TA–50 Solid Radioactive and Chemical Waste Facilities.*

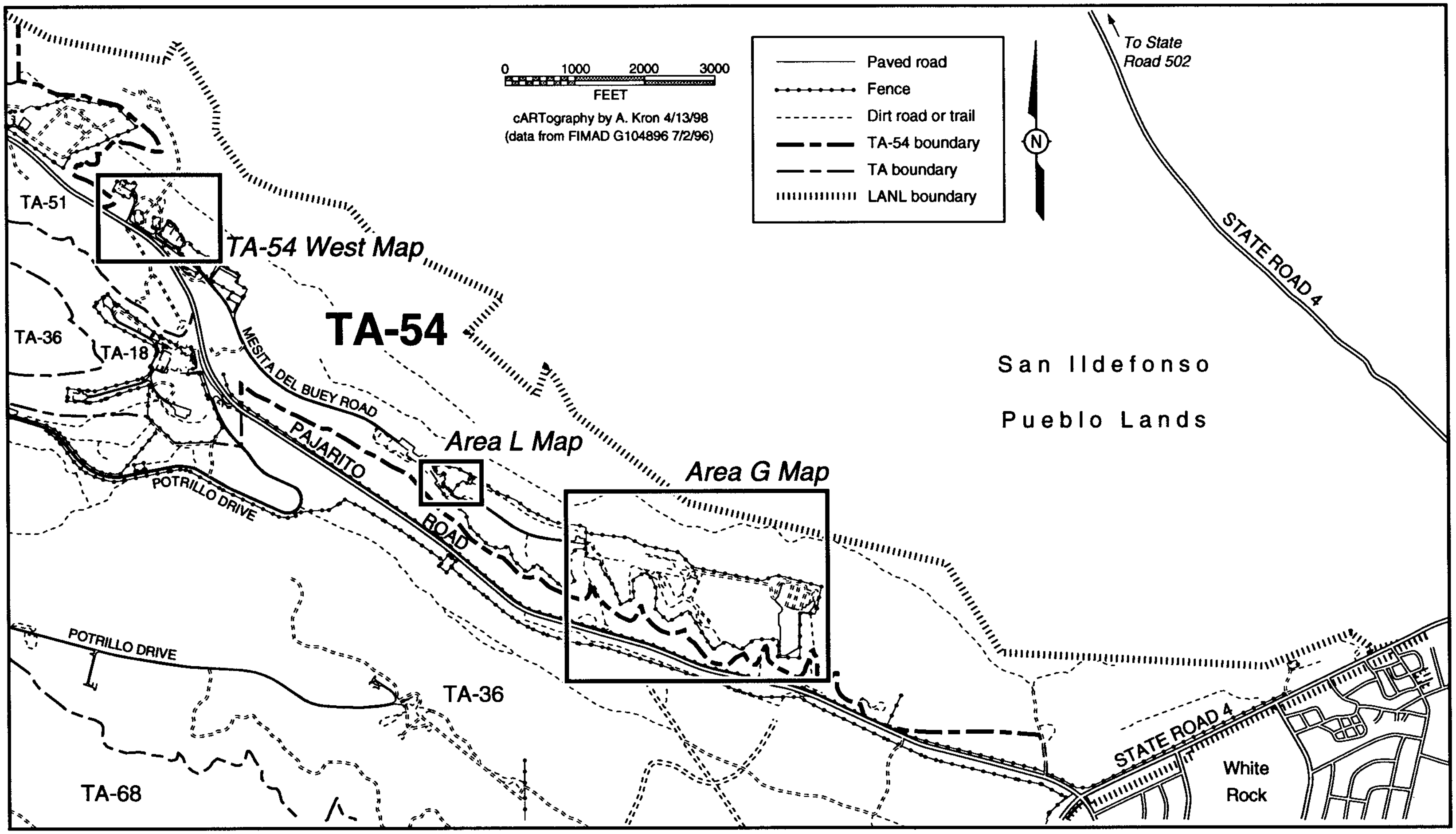


FIGURE 2.2.2.15–2.—*TA–54 Solid Radioactive and Chemical Waste Facilities.*

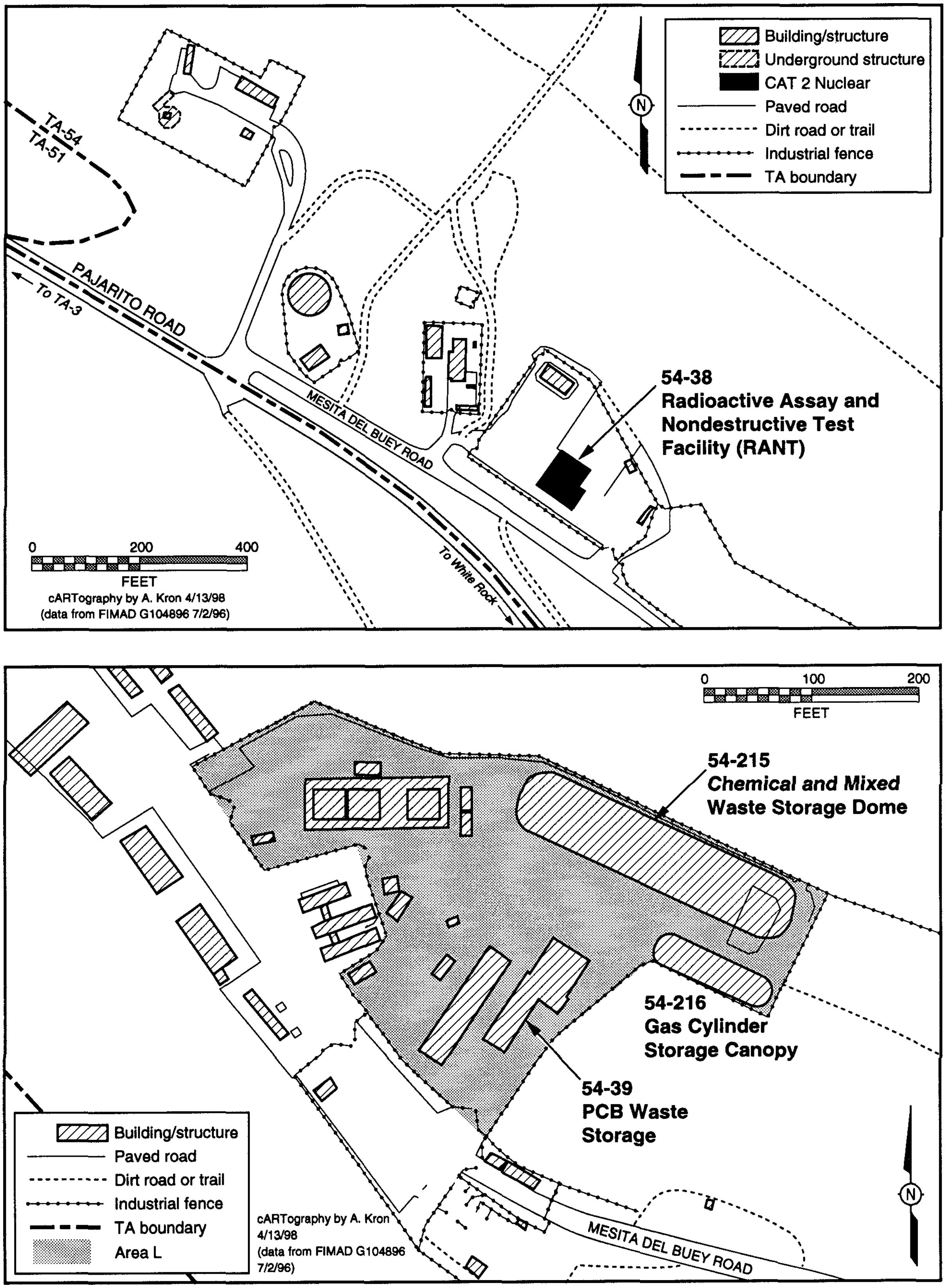


FIGURE 2.2.2.15–3.—*TA–54 Solid Radioactive and Chemical Waste Facilities.*

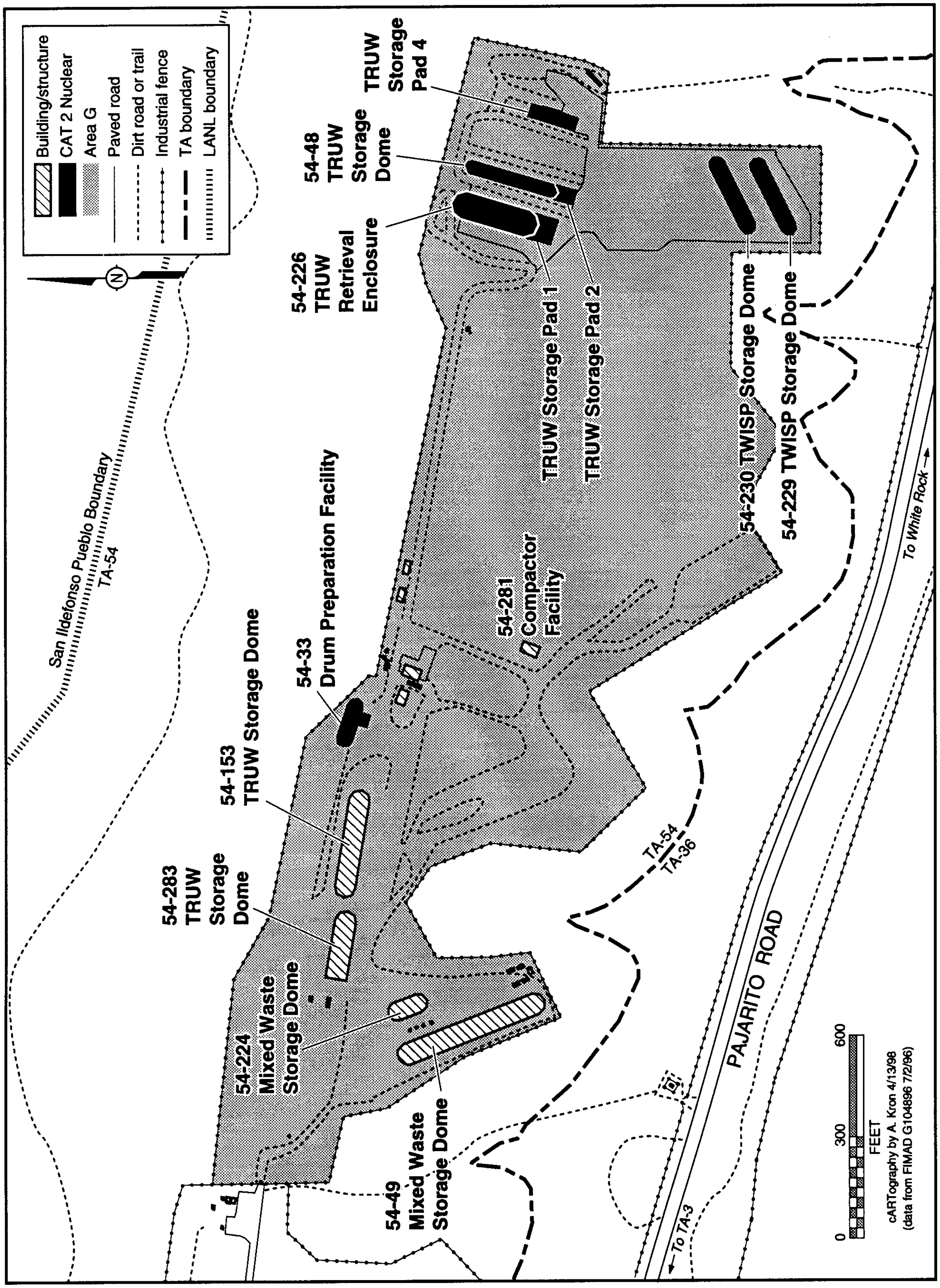


FIGURE 2.2.2.15–4.—*TA–54 Solid Radioactive and Chemical Waste Facilities.*

TABLE 2.2.2.15–1.—*Principal Buildings and Structures of the Solid Radioactive and Chemical Waste Facilities*

TECHNICAL AREA	PRINCIPAL BUILDINGS AND STRUCTURES
TA–50	Radioactive Materials Research, Operations, and Demonstration Facility: 50–37 Waste Characterization, Reduction, and Repackaging Facility: 50–69
TA–54	Drum Preparation Facility: 54–033 Radioactive Assay and Nondestructive Test (RANT) Facility: 54–038 PCB Storage Building: 54–039 TRU Waste Storage Domes: 54–048, 153, 283 Mixed Waste Storage Domes: 54–049, 215, 224 TRU Waste Retrieval Enclosure: 54–226 TRU Waste Storage Domes: 54–229, 230 Gas Cylinder Storage Canopy: 54-216 Earth-Covered Drums of TRU Waste: Pads 1, 2, 4 Compactor Facility: 54–281 Storage Dome for Supplies: 54–282

Description of Facilities

TA–54 West. The far west portions of TA–54 are the location for environment, safety, and health offices (Buildings 54–1001 through 54–1004), a research and development laboratory (Building 54–1009), and a potable water pumping station and chlorination facilities. None of these are waste management operations. TA–54 West is also the location of the Radioactive Assay and Nondestructive Test (RANT) Facility, Building 54–038, which is a Hazard Category 2 nuclear facility. This 6,900-square-foot (640-square-meter) structure is used to verify characterization data for unopened containers of TRU waste and solid LLW. Verification steps include container contamination surveys, container weighing, passive/active neutron assay to determine radionuclide content, and real-time radiography to confirm physical contents. RANT will also serve as the loading station for shipments of TRU waste to WIPP.

Area H. Radioactive wastes were disposed of in nine shafts between May 1960 and August 1986. (Historical information is insufficient to determine whether these wastes would be considered LLW or TRU waste under current classifications.) This 0.3-acre (0.12-hectare) site is now a Solid Waste Management Unit (SWMU) under the ER Project. Each shaft is 6 feet (1.8 meters) in diameter and 60 feet (18 meters) deep (with a capacity to hold 1,714 cubic feet [48 cubic meters] of wastes). This area was used for the disposal of classified wastes. Tritium contamination has been detected in soils adjacent to some of the shafts (LANL 1992). There are no aboveground structures at Area H.

Area J. Area J is 2.65 acres (1.07 hectares) in size and has been used since 1961 for the disposal of industrial solid wastes. The area has six disposal cells and four disposal shafts. Cells 1 and 2 are filled and capped with soil. Cell 3 is filled and capped with asphalt, and an asbestos transfer station is located on the asphalt. Cells 4, 5, and 6 are open. Two of the four shafts are filled and capped with concrete. Shafts 3 and 4 are less than 10 percent filled. Shafts are 6 feet (1.8 meters) in diameter and 60 feet (18 meters) deep, while pits vary in size (LANL 1992).

Disposal operations have interim status under RCRA, subtitle D, from the State of New Mexico. Five waste management operations are conducted at Area J:

- Administratively controlled industrial solid wastes (e.g., paper trash containing personnel information or contracts) are disposed. Three disposal cells are open; three have been filled to date. Waste volumes have been shrinking the past several years, and there is enough disposal capacity in the three unfilled cells for at least another 8 years of operation.
- Previously hazardous wastes. In the past, barium-contaminated soils were neutralized at TA–54, Area L, then disposed of at Area J in the same cells as industrial wastes. The last such disposal occurred in October 1993.
- Classified industrial wastes are disposed in shafts. There are four shafts, each 60 feet (18 meters) deep and 5 feet (1.5 meters) in diameter. Two of the shafts are filled and two nearly empty.
- Asbestos wastes are stored prior to shipment to a permitted asbestos disposal facility. Two roll-off containers are used to store friable asbestos wastes; nonfriable asbestos wastes are stored on an asphalt pad.
- Oil-contaminated soils are land farmed under an interim permit from the State of New Mexico. Soil is turned periodically, and soils are sampled for hydrocarbon content. The land farm covers an area of 8,200 square feet (763 square meters) (0.2 acre [0.08 hectare]) between Cells 1 and 6. Oil-contaminated soils have not been added to the land farm area since September 1992.

There are a number of storage sheds and a storage dome (Building 54–282) at the entrance gate to Area J. These hold supplies for all waste management operations at TA–54.

Area L. Area L is a 2.65-acre (1.07-hectare) operations site that is paved and fenced. Formerly used for the disposal of chemical wastes, the area is now used for receipt, storage, and shipment of *Toxic Substances Control Act* (TSCA), RCRA, and mixed wastes. These include hazardous waste (HW) (gaseous, liquid, and solid), PCB wastes (solid and liquid), liquid LLMW, and irradiated lead stringers from TA–53 (described in section 2.2.2.11).

Important structures within Area L are discussed below.

- *Liquid LLMW Storage Building 54–215.* This is a large (16,000-square-foot [1,490-square-meter]), new structure used for storing drums of LLMW. The building has a bermed asphalt floor, an unfiltered exhaust stack, interior lighting, and an overhead fire suppression system.
- *Gas Cylinder Canopy 54–216.* This one-walled, roofed facility (4,000 square feet [370 square meters]) is used to store gas cylinders until they can be shipped off site for treatment and disposal.
- *PCB Building 54–039 and Attached Canopy.* Liquid and solid PCB wastes are stored until they are shipped off site for treatment and disposal. Some of the waste liquids are also contaminated with hazardous and/or radioactive wastes.
- *Liquid Chemical Waste Storage Canopy 54–032*. Drums of liquid chemical wastes are segregated for compatibility, then stored in the appropriate section of this open structure.
- *Laboratory Pack Storage Units 54–068, 54–69, and 54–70*. Small quantities of HW are placed in 5-gallon (19-liter) laboratory packs. Laboratory packs are segregated for compatibility, then stored in these small sheds until shipped for treatment and disposal. Storage units are equipped with secondary containment.

- *Sampling, Shipment, and Treatment Canopies 54–058, 54–36, 54–35*. These sheltered pads have an overhead covering, but no sides. Canopy 54–035 contains two treatment tanks that are currently not in use. Canopy 54–036 holds equipment used to survey and sort mixed wastes.

Because Area L is covered with asphalt, stormwater is directed to a single outfall that discharges into Cañada del Buey at the northeast corner of the liquid LLMW storage dome 54–215. An overflow weir is used to measure discharge flow rates and volumes.

Chemical wastes were disposed of at Area L from the 1950's until December 1986. Inactive disposal units include 1 cell, 3 surface impoundments, and 34 shafts, with a total disposal capacity of 71,540 cubic feet (2,004 cubic meters) (LANL 1992). Noncontainerized solids and drummed, but without absorbent, liquids were disposed of in the unlined pit and shafts. Unlined surface impoundments B and C were used to evaporate treated salt solutions such as ammonium bifluoride and electroplating waste solutions. Unlined impoundment D was used to react lithium hydride with water and also served as secondary containment for waste oil tanks. This area is now being investigated under the LANL ER Project as part of Operable Unit 1148. To date, cadmium, chromium, and volatile organics have been detected in subsurface soils.

Area G. Area G is used principally for the disposal of solid LLW and the storage of TRU waste. Some LLMW is also currently stored in one part of Area G. Also, Area G has EPA approval for disposal of PCB waste (greater than 50 parts per million) in either disposal cells or shafts. However, only solid radioactively contaminated PCB waste may be disposed in Area G. Stabilized PCB waste also may be disposed, provided it has been stabilized in accordance with EPA requirements. Some treatment of LLW and TRU waste also takes place (e.g., compaction or other nondestructive volume reduction technologies). The legacy inventory buried at Area G includes TRU waste disposed of prior to 1971 and LLMW disposed of prior to the promulgation of RCRA in 1986. Important structures within Area G are presented in the PSSC analysis of the Expansion of Area G (see volume II, section I.1) and summarized below.

Disposal Cells and Shafts. At present, subsurface disposal units include 35 cells, approximately 260 shafts, and 4 trenches (Krueger 1994). The Area G disposal facility (Figure 2.2.2.15–5) has been a disposal site for LANL's solid radioactive waste since 1957, and is currently the only active disposal site for LLW.

Five cells (15, 31, 37, 38, 39) are currently in use. These five have a remaining disposal capacity of about 928,200 cubic feet (26,000 cubic meters). The existing footprint for Area G disposal operations has space for new cells that would add capacity for about another 357,000 cubic feet (10,000 cubic meters) of wastes. Continued disposal at TA–54 would require expansion of disposal operations beyond the current footprint. Alternatively, wastes would have to be packaged and shipped for off-site disposal.

Temporary Retrieval Dome, Building 54–226. This large (approximately 21,000 square feet [1,950 square meters]) fabric-covered dome structure is the site of the TRU Waste Inspectable Storage Project (TWISP), a multi-year project in which approximately 17,000 earth-covered containers of TRU waste will be retrieved, characterized, and placed into aboveground storage facilities. The dome provides an enclosure and weather protection for workers and is equipped with a ventilation system and HEPA filters. It will be dismantled and re-erected as retrieval operations proceed through TRU waste storage Pads 1, 2, and 4.

Drum Preparation Facility, Building 54–33. This facility has bays for steam cleaning and for

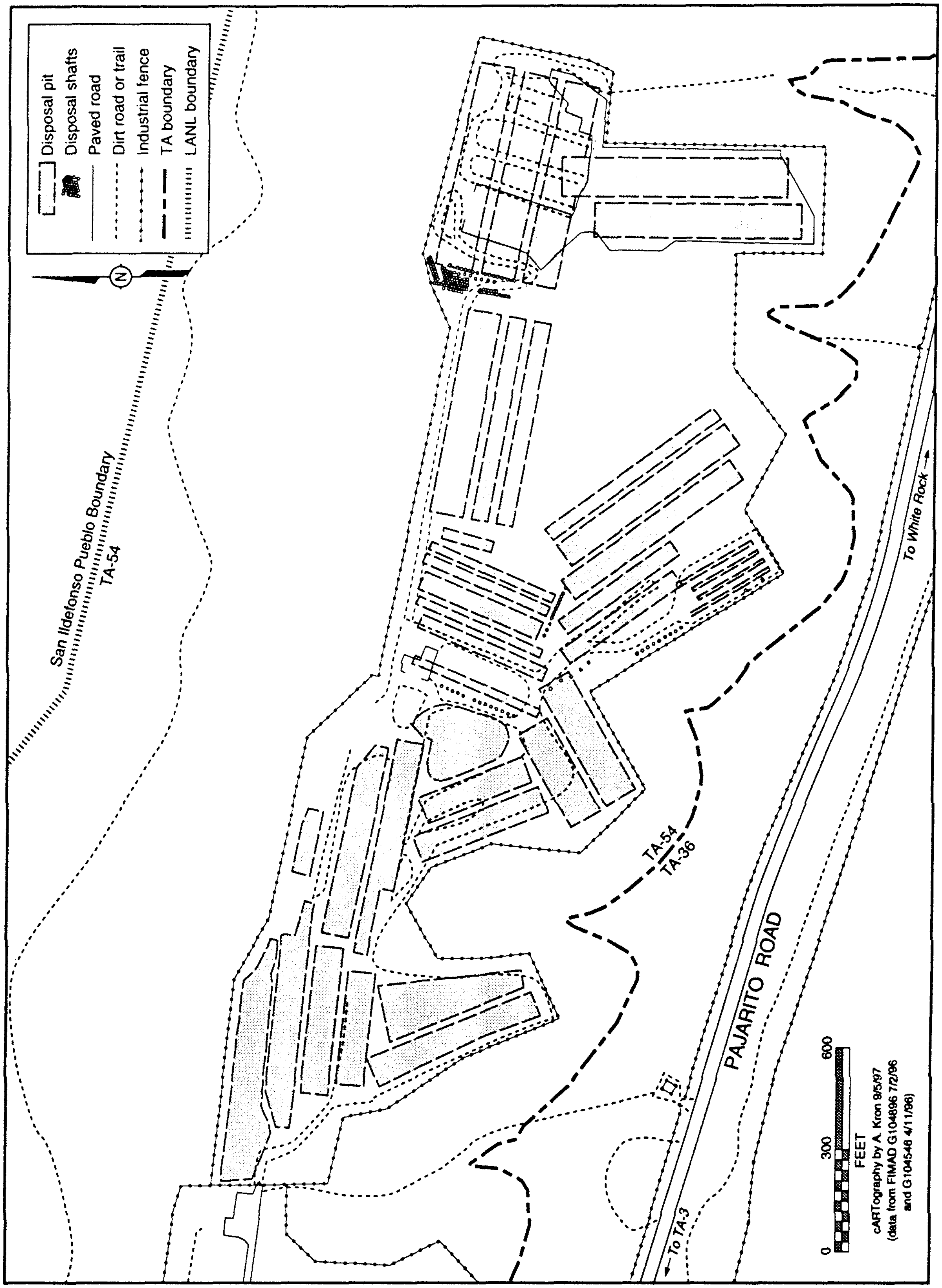


FIGURE 2.2.2.15–5.—*TA–54 Area G Disposal Cells.*

painting drums of TRU waste retrieved during TWISP, associated water sedimentation pits and collection tanks, a drum venting system to safely puncture and vent retrieved drums of TRU waste, and a general treatment bay with modular containment for size reduction of gloveboxes and similar large waste items, and for waste segregation.

Compactor Facility, Building 50–281. This building houses a waste compactor with 200 tons (180 metric tons) of compressive force, which can achieve volume reductions as great as 8 to 1. Compacting waste helps to conserve disposal space and minimizes soil subsidence at the disposal cell. A smaller compactor is used to crush items such as empty drums.

Waste storage facilities. Area G also includes:

- Tension Support Buildings 54–049 and 54–224 for solid LLMW
- Sheds 54–144, 145, 146, and 177 for mixed tritiated wastes
- Tension Support Buildings 54–048, 153, and 283 for newly generated TRU waste
- Storage Domes 54–229 and 230 (16,000 square feet [1,488 square meters] each) for legacy TRU waste retrieved during TWISP

Storage Pads 1, 2, and 4. These asphalt pads hold legacy TRU waste in drums and other containers. Pads and containers were covered with earth during the 1970's and 1980's. Wastes are to be retrieved and placed into above-surface storage domes so that RCRA inspection requirements can be met and so that wastes and containers are in a form suitable for disposal. A total of six storage domes will be required; two were constructed in 1995 and four more are planned. The domes are 280 feet (85 meters) long, 60 feet (18 meters) wide, and 40 feet (12 meters) high and can store about 3,000 drums of waste. (This action was categorically excluded from further NEPA review.)

An asphalt pad adjacent to Building 54–049 is used for the outdoor storage of pyrophoric uranium waste chips.

Other structures at TA–54 include:

- *54–002*—maintenance shop
- *54–011*—offices and a personnel decontamination shower facility
- *54–020, 54–079, and 54–092*—equipment shelter canopies

TA–50. TA–50 is the location of RLWTF for the treatment of radioactive liquid wastes as described in section 2.2.2.14. TRU wastes, however, are processed in two facilities in TA–50 and then transported to TA–54 for storage.

WCRR Facility, Building 50–069. This is a nuclear facility that is used to size reduce large TRU waste items such as gloveboxes. Waste items are stored outdoors, brought into the building through a vehicle air lock, then introduced into a cutting enclosure (glovebox). A plasma cutting torch is used to section large waste items and the smaller pieces are loaded into standard waste boxes. Clean-up liquids are piped to the RLWTF in Building 50–01 through a filter and storage system that allows characterization of the liquids prior to transfer. A second operation is the visual inspection of the contents of TRU waste drums that have already been characterized. This visual inspection is performed on a statistical percentage of drums and provides a quality assurance overcheck of the TRU waste characterization program.

RAMROD Facility, Building 50–037. An incinerator for PCBs and combustible hazardous wastes was formerly housed in this facility. Re-named the RAMROD Facility, Building 50–037 is a candidate Hazard

Category 2 nuclear facility. Equipment for the characterization of TRU waste has been installed and is expected to be operational by mid 1998. The RAMROD Facility is also a general host for any other process that requires the containment and controls of a nuclear facility.

Description of Capabilities

Capabilities required for the management of solid radioactive and chemical wastes include waste characterization, packaging, and labeling; waste transport, receipt, and acceptance; and waste storage and disposal. In addition, compaction, size reduction, waste retrieval, and other treatment operations are performed. Each of these activities is described below. (Additional information on waste management facilities and operations is included in *Waste Management Strategies for LANL* [LANL 1998b]). The manner in which they would vary among the alternatives is described in chapter 3.

The RAMROD Facility is being considered as an alternative for Lead Test Assembly and inspection operations in the *Surplus Plutonium Disposition Environmental Impact Statement* (DOE 1998a; section 1.5.8). This activity includes the receipt and inspection of MOX fuel rods that would be fabricated at the Plutonium Facility Complex (described in section 2.2.2.1), assembled into bundles, inspected, and shipped off site. Such operations would constitute a new capability at RAMROD. The impacts associated with implementing this proposal are described in chapter 5, section 5.6. This addition would change the amount of material in the facility (plutonium/uranium MOX) and increase shipments of nuclear materials to and from LANL, as compared to the SWEIS Expanded Operations Alternative.

Waste Characterization, Packaging, and Labeling. This is similar to the activities described under this heading in section 2.2.2.14. At TA–54, this activity includes characterizing and certifying that TRU wastes comply with waste acceptance criteria (WAC) for WIPP. Activities specific to WIPP WAC include drum venting, core sampling, and visual inspection.

Drum Venting. Drums containing TRU-contaminated hydrogenous materials such as plastic and cellulose could accumulate hydrogen gas through radiolytic decomposition of the waste matrix or packaging material. Accordingly, WIPP WAC specify that all waste packages be vented with one or more specified filters. Nondegraded drums retrieved during the TWISP are processed through the drum venting system at the Drum Preparation Facility, Building 54–33. The system safely vents containers up to 55 gallons (208 liters) in size and installs a filter vent in each.

Core Sampling. In a glovebox in the RAMROD Facility, samples will be cored from solidified TRU waste in order to analyze the chemical composition of wastes that have been solidified.

Visual Inspection. At the WCRR Facility, waste packages are opened, sampled, and examined, and the condition of the packages themselves is evaluated. Any items determined to be noncompliant are removed. A similar glovebox will be placed into operation in the RAMROD Facility. This characterization step is performed on a percentage of already-certified TRU waste packages to verify stated contents.

Compaction. Solid LLW is compacted in Building 54–281 at Area G. The compactor uses a hydraulic piston to generate 200 tons (180 metric tons) of compressive force, achieving waste volume reductions as great as 8-to-1. Compacting provides improved waste package integrity, minimizes soil subsidence at the disposal pit, and conserves disposal space. The process also confirms that there are no trapped or interstitial liquids within the waste package. Building 54–281 is also equipped with a smaller compactor that can be used to crush items such as empty drums.

Size Reduction. Size reduction operations occur within the WCRR Facility at TA–50 and the Drum Preparation Facility at TA–54. The WCRR Facility is operated for the purpose of sectioning (to reduce volume) and repackaging bulky TRU-contaminated metallic waste into containers approved for shipment to WIPP. The interior of the WCRR Facility consists of a large (6,790-cubic-foot [190-cubic-meter]) ventilated enclosure in which discarded gloveboxes and other TRU waste items are cut apart with a plasma torch. Waste items are staged in an outside storage area, brought into the building through an air lock, unpacked, and then moved into the main enclosure. At the Drum Preparation Facility, modular containment is used for size reduction operations.

Waste Transport, Receipt, and Acceptance. Containers for transport of solid wastes vary widely, and depend upon the waste, its destination, and transport regulations. Solid radioactive wastes, for example, are transported on site in drums, dumpsters, crates, or specially designed shielded packages. Periodically, containers other than DOT-specified containers may be used for some on-site shipments, provided the transport route is controlled (i.e., by road closure) during transport. Off-site transport of waste may require additional preparations. DOT-specified packages must be used for off-site transport, and waste must be certified to meet the WAC of the receiving facility.

Waste receipt and acceptance activities typically include visual inspection of the vehicle and the container, cross-checking container labels and shipment manifests, radiation surveys of the vehicle and containers, and weighing of vehicles and/or containers. These activities include receipt and acceptance of small quantities of off-site LLW and TRU waste.

Waste Storage. At TA–50, wastes are stored within the RAMROD Facility and adjacent to the WCRR Facility. At TA–54, chemical wastes are stored at Areas J and L until sufficient quantities are accumulated for a shipment to off-site treatment, storage, and disposal facilities. Because they are used only to store items prior to processing or shipping, however, these storage areas are small in comparison to those at TA–54 for storage of LLMW and TRU waste. LLMW and TRU waste represent the vast majority of wastes in storage and are stored in large fabric-covered domes within Area L (Dome 54–215) and Area G (seven domes). This activity includes the storage of small quantities of waste from off site.

Waste Retrieval. Between 1979 and 1991, LANL stored packages of TRU waste on three pads at the east end of Area G, then placed the containers under earthen cover. Because some of these packages contained mixed TRU waste, they are subject to RCRA and its requirements for periodic container inspection and response to emergency conditions. Accordingly, LANL has developed the facilities and capability to retrieve these wastes, repackage and characterize them, and place the wastes into new, aboveground storage domes.

The operation begins with the construction of the retrieval enclosure (Building 54–226) atop a storage pad. Containers are removed as earth is cleared away. Degraded containers will be overpacked, repaired, or secured by wrapping in plastic or by banding with metal straps. Nondegraded drums are transported to the adjacent Drum Preparation Facility (Building 54–33), where they will be vented using the drum vent system and then steam-cleaned, re-painted, and re-labeled as needed. Retrieved containers will then be characterized and certified to meet the WIPP WAC.

Other Waste Processing. Several treatment operations occur periodically or in small scale at LANL facilities for solid radioactive and chemical wastes. Solidification of TRU sludges is performed at the RLWTF (described in section 2.2.2.14). Sludges are mixed with cement in 55-gallon (208-liter) drums, allowed to cure, then transported to Area G for storage (prior to eventual shipment to WIPP).

Stabilization of pyrophoric uranium chips is periodically performed in a permacon on the asphalt pad adjacent to Building 54–049 in Area G. Chips, and the oil in which they are immersed, are mixed with a chemical agent to produce a gel. Thus stabilized, the uranium is then disposed of in disposal cells at Area G.

Electrochemical treatment of LLMW is performed at RAMROD. This is a demonstration project involving two pilot-scale treatment units. Solutions containing low levels of metals, nitrates, sulfides, and/or organics will be subjected to electric current. Metals will be electrochemically deposited on cathodes; sulfides will precipitate out of solution; and organics will oxidize to carbon dioxide and water. The remaining solution will contain low levels of radioactivity and be managed as a radioactive liquid waste. Other research and development on possible treatments for LLMW, including electrochemical and other currently undefined technologies, may also be performed at RAMROD as demonstration projects. Pilot-scale treatment units will be used, and small quantities of wastes will be processed.

Limited treatment of hazardous wastes is performed at Area L. This typically consists only of chemically treating characteristic hazardous wastes. Treatment of cylinders of gases has also been performed in the past.

As discussed under "Description of Facilities" earlier in this section, land farming of oil-contaminated soil is performed at Area J.

Disposal. Disposal operations are performed only at Area G and Area J. Solid LLW is disposed of at Area G in cells and shafts. Solid industrial wastes are disposed of at Area J.

At Area G, cells are generally rectangular excavations to a depth of 66 feet (20 meters), constructed in accordance with guidelines established by the U.S. Geological Survey and the Area G Performance Assessment (LANL 1998d). Each layer of waste is covered with a layer of backfill that is 6 to 12 inches (15 to 30 centimeters) thick. When nearly full, the upper 2 meters of each cell is filled with crushed tuff, mounded over with topsoil, and then re-vegetated. Approximately 20 to 25 percent of the pit volume is filled with LLW, and the remainder is either void space or tuff/soil backfill. Five cells are currently open and in use. Four of these receive solid LLW and one receives asbestos wastes that have radioactive contamination.

At Area G, shafts range from 1.0 to 8 feet (0.3 to 2.5 meters) in diameter and up to 66 feet (20 meters) in depth and are covered with a concrete plug. Shafts, readily capped until the next shipment of waste is received, are dedicated to specific types of waste such as solid LLW with activity greater than 1 rem per hour, tritiated wastes with activity greater than 20 microcuries per cubic meter, radioactive biological wastes, radioactive PCB wastes, radioactive beryllium wastes, and radioactive classified wastes.

Lesser volumes of administratively controlled industrial solid wastes and formerly characteristic wastes are disposed at the Area J landfill. The majority of these wastes are disposed in cells, where wastes are daily covered with backfill. Nonradioactive classified wastes are disposed in shafts in Area J.

Disposal activities include the disposal of small quantities of LLW from off-site locations (discussed further in section 4.9.3).

While LANL does not currently have any sites designated for disposal of LLMW, the WM PEIS (DOE 1997c) considers LANL as an alternative regional disposal site for this type of waste. If selected, LANL would have to establish a LLMW disposal capability, as well as WAC for LLMW and would identify candidate sites for disposal. The WM PEIS indicates that up to 2,263,000 cubic feet (64,100 cubic meters) of such waste could be designated for disposal at LANL over the next 20 years. The actual amount that would be disposed of at LANL, if selected, is highly dependent on the WAC, actual waste generation, and the sites identified that would ship such waste to LANL. As such, the siting and sizing of such a capability is highly uncertain and is not analyzed in the SWEIS.

2.2.3 Nuclear and Moderate Hazard Facilities Not Analyzed as Key Facilities

This section identifies LANL facilities that are designated as nuclear or moderate hazard facilities, but that do not meet the criteria for key facilities described in section 2.2.2 of the SWEIS. These facilities include those that are operating and several that are surplus and awaiting decontamination and decommissioning following removal of SNM and hazardous materials. No substantial change is anticipated in the future operations or impacts associated with these facilities.

As noted previously, there are no Hazard Category 1 nuclear facilities at LANL. Hazard Category 2 nuclear facilities (those for which a hazard analysis shows the potential for significant on-site consequences) that did not meet the criteria for key facilities are discussed in section 2.2.3.1. Hazard Category 3 nuclear facilities (those for which a hazard analysis shows the potential for only significant localized consequences) that did not meet the criteria for key facilities are discussed in section 2.2.3.2. Nonnuclear moderate hazard facilities that do not meet the criteria for key facilities are discussed in section 2.2.3.3

2.2.3.1 *Hazard Category 2 Nuclear Facilities*

The Source Storage Building (TA–3 Building 65) was given a Hazard Category 2 classification because of the presence of encapsulated radioactive materials and SNM used for research and measurement activities. All radioactive sources and SNM are sealed in steel containers that are never opened.

In addition, the Omega West Reactor (TA–2 Building 1) has been placed in permanent shutdown. All SNM and hazardous materials have been removed from the facility. The facility is surplus and was reclassified from a Category 2 nuclear facility to a low hazard radiological facility.

2.2.3.2 *Hazard Category 3 Nuclear Facilities*

The following are Hazard Category 3 nuclear facilities that do not meet the criteria for key facilities:

- *Calibration Building (TA–3 Building 130)*—The Calibration Facility is designated as a Hazard Category 3 nuclear facility due to the radioactive source inventories stored in the building. The primary functions of this facility are performing radiation evaluation studies involving sealed radiation sources; calibrating instrumentation; and evaluating the response of various detectors to x-ray, gamma, beta, and neutron emissions. Activities do not include processing of nuclear material because radioactive sources are sealed at all times.
- *Portion of Physics Building (TA–3 Building 40)*—The Health Physics Instrument Calibration facilities, located within the Physics Building, are designated a Hazard Category 3 nuclear facility because of the radioactive materials and SNM used in the laboratories for instrument calibration, as

well as the radioactive and SNM source inventories that are stored in the two storage vaults. The primary function of this facility is the calibration and evaluation of all types of radiation detection instrumentation used throughout the laboratory. The instrumentation includes alpha, beta-gamma, neutron, and tritium gas detectors.

- *High Pressure Tritium Facility (TA–33 Building 86)*—This building is an old high-pressure tritium handling facility that is currently in safe shutdown mode pending decontamination and decommissioning. Upon completion of decontamination and decommissioning activities, the facility is expected to have radionuclide inventories below threshold quantities, which, in turn, will result in the facility being downgraded from its current Hazard Category 3 classification.
- *Nuclear Safeguards Research Facilities (TA–35 Buildings 2 and 27)*—These facilities are classified as Hazard Category 3 nuclear facilities because each facility contains an SNM storage vault. All radioactive sources and SNM are encapsulated or in sealed containers that prevent contamination to the workers and facility. Uranium is singly contained, while plutonium is doubly contained within this facility. The primary mission of both facilities is to support nonproliferation and international security activities; however, other research and development activities include various studies of radiation effects on materials in support of fusion, ceramic science, and technology programs.

2.2.3.3 *Nonnuclear Moderate Hazard Facilities*

The following are nonnuclear moderate hazard facilities that do not meet the criteria for key facilities:

- *Various Chlorination Stations (TA–0 Buildings 1109, 1110, 1113, 1114; TA–16 Building 560; TA–54 Building 1008; TA–72 Building 3; TA–73 Building 9)*—These facilities are designated moderate chemical hazards because they are all gas chlorination stations where the potable water supply for the Los Alamos townsite and LANL is chlorinated.
- *Sewage Treatment Plants (TA–46, Building 340)*—The sewage plants are designated as moderate chemical hazard facilities because of the historical use of chlorine gas to disinfect plant effluent prior to its release to holding ponds. (Building 340 is a chlorine storage building.) These are being replaced currently by a new process not requiring the use of gaseous chlorine.
- *Liquid and Compressed Gas Facility (TA–3 Building 170)*—All toxic materials have been removed from this facility. A reclassification to a low chemical hazard status is pending.
- *Laboratory (TA–21 Buildings 3 and 4)*—Current activity at this facility includes radiochemistry operations in the laboratory areas of Buildings 3 and 4 North. Buildings 3 and 4 South had decontamination and decommissioning activities begin in 1994, with eventual decontamination and decommissioning activity to be performed at Building 3 North pending funding.
- *Laboratory Building (TA–41 Building 4)*—The facility is a laboratory called the Icehouse, where past operations included the handling and storage of materials such as uranium, tritium, deuterium, and liquid nitrogen. All nuclear materials were removed from this facility in 1995. The work currently performed in this facility consists of nonradiological work related to weapons engineering.

2.3 THE ROLE OF THE UNIVERSITY OF CALIFORNIA IN LANL ACTIVITIES

The U.S. Government, through DOE, owns all the land, buildings, and equipment at DOE facilities, including LANL. DOE contracts with commercial and academic entities for facility operations, a relationship referred to as government owned, contractor operated. The UC manages LANL for DOE and has continuously operated this facility since its creation during World War II. As LANL is managed by a nonprofit entity, UC, its operating budget is not subject to state or local gross receipts taxes.

The management and operating contract between DOE and UC has been renegotiated numerous times. The most recent 5-year contract was signed in October 1997.

The UC contract contains specific performance measures (i.e., criteria by which DOE evaluates the success of the operator). These performance criteria are reviewed and modified annually. Based on the results of performance appraisals for LANL and two other DOE sites (Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory), UC will receive a performance fee that can be used for any operating costs from these laboratories not otherwise reimbursed by the government or for discretionary research by or at these laboratories.

The UC contract is administered by DOE through the DOE Los Alamos Area Office and the Albuquerque Operations Office. Major subcontractors to UC under this contract include Johnson Controls World Services, Inc., Protection Technology Los Alamos, and Bechtel Nevada.

In response to DOE requests for information, UC has provided data projections and descriptive information that has been relied upon as source material for this SWEIS. This includes background information on the history of LANL, information regarding funding, information regarding the buildings at LANL and their hazards, and detailed information regarding the operations within each of the key facilities. UC has compiled such information in several documents that were published to correspond with the publication of the draft SWEIS. These documents are cited throughout the SWEIS (particularly in chapter 5) and are available in hard copy at the LANL Community Outreach Center in Los Alamos. The titles, LANL document numbers, and web site of those documents are:

- *Waste Management Strategies for Los Alamos National Laboratory - 1997*, LA-UR-97-4764, http://lib-www.lanl.gov/la-pubs/00412794.pdf (LANL 1998b)
- *Overview of Los Alamos National Laboratory - 1997*, LA-UR-97-4765, http://lib-www.lanl.gov/la-pubs/00412795.pdf (LANL 1998a)
- *Description of Technical Areas and Facilities at Los Alamos National Laboratory - 1997*, LA-UR-97-4275 (LANL 1998c)
  — Part I: http://lib-www.lanl.gov/la-pubs/00412796.pdf
  — Part II: http://lib-www.lanl.gov/la-pubs/00412797.pdf

A popular Los Alamos publication web site is http://lib-www.lanl.gov/pubs/la-pubs.htm.

2.4 RECENT LANL FUNDING LEVELS

Table 2.4–1 shows recent and projected funding levels for DOE and non-DOE activities by major budget category. This information, requested by commentors through the scoping process, is provided for context to indicate current sponsors and users of LANL facilities and expertise. While funding levels for programs may change, the expertise and types of operations are expected to remain relatively constant.

TABLE 2.4–1.—*LANL Consolidated Funding Summary (Fiscal Year 1994 to Fiscal Year 1998)*

PROJECTS	CONSOLIDATED FUNDING (MILLIONS)				
	ACTUAL COSTS				FUNDING PROJECTIONS
	1994 (9/30/94)	1995 (9/30/95)	1996 (9/30/96)	1997 (9/30/97)	1998 (3/04/98)
DOE OPERATING FUNDS					
Defense Activities	430	446	488	563	631
Nonproliferation/International Security	85	77	88	101	112
Materials Disposition[a]	0	0	10	21	28
Environmental Restoration and Waste Management	217	210	148	134	154
Energy Research	95	92	65	71	65
Nuclear Energy	13	17	18	18	14
Civilian Radioactive Waste[b]	17	10	0	0	0
Energy Efficiency	15	14	11	13	11
Science Education and Technology	1	1	1	0	0
Other DOE	9	14	12	8	10
Subtotal DOE	882	881	841	929	1,025
REIMBURSABLE OPERATING FUNDS					
DoD	82	71	52	54	44
U.S. Nuclear Regulatory Commission	3	2	2	3	1
Intelligence	18	14	10	12	10
Remaining Reimbursable Work[c]	70	113	103	108	108
Subtotal Reimbursable Work	173	200	167	177	163
Total Operating Funds[d]	1,055	1,081	1,008	1,106	1,188
CAPITAL/CONSTRUCTION FUNDS					
Total	109	102	102	143	149

[a] Prior to 1996, funding in this area was included in Defense Activities funding.
[b] Included in Remaining Reimbursable Work after 1995.
[c] Includes DOE Reimbursable Work.
[d] Operations that are capitalized are included in Capital/Construction Funds.

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DOE 1996a	*Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*. U.S. Department of Energy. DOE/EIS-0236. Washington, D.C. September 1996.
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CHAPTER 3.0
ALTERNATIVES FOR THE CONTINUED OPERATION OF THE LOS ALAMOS NATIONAL LABORATORY

This chapter describes the four alternatives DOE has analyzed in detail regarding the continued operation of LANL. Specifically, it describes the activities at LANL's key facilities that vary among the alternatives and the activities that are common to all alternatives. In addition, the chapter identifies the alternatives DOE considered, but has not analyzed in detail because they were not reasonable. The chapter concludes with a comparison of the environmental consequences of the four alternatives.

DOE is considering four alternatives for the continued operation of LANL to support its existing and potential future program assignments (described in SWEIS chapter 1, section 1.1). These alternatives are:

- No Action Alternative (section 3.1)
- Expanded Operations Alternative and Preferred Alternative (section 3.2)
- Reduced Operations Alternative (section 3.3)
- Greener Alternative (section 3.4)

The first three alternatives present differing operational levels of the same types of activities, with the No Action Alternative representing the currently planned levels of operation. The fourth (the Greener Alternative) emphasizes use of LANL capabilities in nonweapons missions, such as nonproliferation and nonweapons research. Some activities in the Greener Alternative are the same as in the No Action or Reduced Operations Alternatives. In other facilities, operations under the Greener Alternative are the same as those under the Expanded Operations Alternative, but they are conducted for nonproliferation, waste management, or other nonweapons purposes.

In the draft SWEIS, the DOE's Preferred Alternative was the Expanded Operations Alternative. In this final SWEIS, the Expanded Operations Alternative remains the Preferred

Alternatives Analyzed

No Action*—LANL operations would continue at their currently planned level.*

Expanded Operations*—implements all current DOE mission element assignments to LANL, including full implementation of those made in recent programmatic EIS (PEIS) Records of Decision, at the highest foreseeable levels of activity.*

Reduced Operations*—conducts the minimal levels of activities necessary to maintain the capabilities necessary to support DOE missions.*

Greener*—uses LANL capabilities to maximize support to DOE nonproliferation, basic science, and materials recovery/stabilization mission elements, and minimizes support to DOE defense and nuclear weapons mission elements.*

Preferred Alternative*—DOE has identified the Preferred Alternative as the Expanded Operations Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year, in the near term.*

Alternative with one modification, as noted below. The modification to the Preferred Alternative involves the level at which pit manufacturing will be implemented at LANL. Under the Expanded Operations Alternative, DOE would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels, including the full implementation of pit manufacturing up to the capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts). However, as a result of delays in the implementation of the Capability Maintenance and Improvement Project (CMIP) and recent additional controls and operational constraints in the Chemistry and Metallurgy (CMR) Building (instituted to ensure that the risks associated with the CMR Building operations are maintained at an acceptable level), DOE has determined that additional study of methods for implementing the 50 pits per year production capacity is warranted. In effect, because DOE has postponed any decision to expand pit manufacturing beyond a level of 20 pits per year in the near future, the revised Preferred Alternative would only implement pit manufacturing at this level. This postponement does not modify the long-term goal announced in the Record of Decision (ROD) for the Stockpile Stewardship and Management Programmatic EIS (SSM PEIS) (up to 80 pits per year using multiple shifts).

LANL's direct-funded and support activities are described in general terms in SWEIS chapter 2, sections 2.1.1 and 2.1.2, respectively. In addition, the operations of 15 key facilities are described in section 2.2.2. Those direct-funded and support activities that occur outside of the key facilities will not change among the alternatives (outside the expected variability due to the dynamic nature of research and development, as discussed in section 2.1). Thus, the alternatives for continued operations of LANL focus on four differing levels of operation at the key facilities.

Some Terminology Notes

Activities*—The specific research and development, experimentation, and studies conducted at LANL under assignment from DOE or through DOE by assignment from other government entities, industries, or organizations. This definition includes facility or technical area operations, as well as studies, monitoring, and other actions DOE may cause to be undertaken to manage and maintain LANL.*

Operations*—This term is used in two senses in this document. The first is the overall continuing use of the capabilities of LANL. The second sense is specific to facilities and technical areas (TAs), the subset of activities undertaken. Examples are accelerator operations or activities that are procedure-controlled such as movement of appreciable quantities of special materials, including special nuclear materials, through process lines such as gloveboxes resulting in one or more products and waste.*

Facility*—One or more buildings in a technical area of LANL that house specific activities.*

Capability*—The combination of equipment, facilities, infrastructure, and expertise required to undertake types or groups of activities and to implement assignments. Using a capability results in facility or technical area operations (see the second use of operations above).*

Many of these key facilities are primarily engaged in supporting the national security mission. Additionally, the key facilities include those that may be upgraded and modified to implement the ROD of the programmatic NEPA documents addressing stockpile stewardship and management, waste management, and disposition of weapons-usable fissile materials. Other key facilities are engaged in neutron science and research and development efforts such as materials research, radiochemistry, and health research. By using this approach, DOE has examined in the greatest detail the LANL facilities and activities that are critical to meeting mission element assignments at LANL, could result in the most significant health and/or environmental impacts, are of most interest or concern to the public, and are the most subject to change across the alternatives due to recent programmatic decisions.

For clarity and brevity, the descriptions of the alternatives in the text (sections 3.1, 3.2, 3.3, and 3.4) and in the tables (section 3.6) in this chapter focus on significant "markers" to characterize the variation of activities across alternatives. More complete descriptions of the activities at LANL are provided by facility in chapter 2 (section 2.2), and all of these activities were projected and used in evaluating the impacts of each alternative.

Key Facilities in the SWEIS

While the SWEIS analyzes the ongoing and future (reasonably foreseeable within the next 10 years) activities throughout LANL, DOE has identified 15 key facilities that account for a large majority of the issues and impacts addressed in the SWEIS. Alternatives analyzed for continued operations at LANL focus on differing levels of activities conducted in the key facilities. Alternative operating levels of key facilities are analyzed in detail because such operations are critical to meeting assignments at LANL, and: they could result in the most significant health or environmental impacts; or they are of most interest or concern to the public; or they are the most subject to change due to recent programmatic decisions. Descriptions of key facilities and their operations are presented in *section 2.2.2. However, a large amount of the research and development and experimental work conducted at LANL does not occur in the key facilities and, for the purposes of this analysis, is not expected to change outside of the variation that is typical of research and development activities.*

Where consolidation of operations is appropriate in a specific alternative, the cleanup of the excess facilities or space is reflected in the description of that alternative. At a minimum, estimates were made of consequences of activities undertaken to place such facilities in a "secure safe shutdown" condition. These facilities retain negligible inventories of radioactive or hazardous materials and await decontamination or renovation for other use of the space. A few of these are already scheduled for decommissioning as part of the LANL Environmental Restoration (ER) Project, described in chapter 2, section 2.1.2.5.

All of the alternatives include the activities or projects for which NEPA analysis and documentation already exist and on which DOE has already made a decision. DOE is not revisiting any programmatic decisions made through its NEPA process, such as those addressing weapons complex consolidation and reconfiguration, materials disposition, or waste management.

Although DOE is not addressing changes to LANL's mission element assignments, it does analyze the site-specific implementation of assignments that were analyzed in other programmatic NEPA documents. Specifically, the SWEIS evaluates the impacts of continuing and planned activities, representing a range of operational levels that could be reasonably implemented in the 10-year time frame of the SWEIS analysis. Inclusion of these activities in the SWEIS is intended to provide DOE, and the public, with a better understanding of the total consequences of the alternatives for continued operations of LANL.

For a variety of reasons (including the variability inherent in research and development activities), no one condition and time was simultaneously typical of all LANL activities. Therefore, an index was established for operations in each key facility and for each parameter used to evaluate impacts. The index contains the best data set from historical records that could be used to describe conditions associated with activities expected in the future. This index was used as a base to project levels of activity with associated impact parameters for the various alternatives.

As noted above, sections 3.1, 3.2, 3.3, and 3.4 present the four SWEIS alternatives. Section 3.5 describes other alternatives that DOE considered, but did not analyze in detail in the SWEIS. Section 3.6 provides a comparison of the changes across the alternatives and of the environmental impacts associated with each of the alternatives.

3.1 NO ACTION ALTERNATIVE

The Council on Environmental Quality (CEQ) NEPA implementing regulations (40 CFR 1500 through 1508) require analysis of the No Action Alternative to provide a benchmark against which the impacts of the other alternatives can be compared. In the SWEIS, the No Action Alternative is a projection over the next 10 years, from the index established for past operations, of a level of activity for facility operations that would implement current management plans for assigned programs.

These planned actions include: continued support of major DOE programs including defense programs, nuclear energy, fissile material disposition, environmental management, and energy research; projects to maintain existing facilities and capabilities; and projects previously receiving NEPA reviews resulting in decisions (e.g., the CMR Building Phase I and Phase II Upgrades). The plans utilized in preparing the description of the No Action Alternative include the Capital Assets Management Process, DOE Program Plans, Site Development Plans for LANL, interagency agreements between DOE and the U.S. Department of Defense (DoD), PEISs, Presidential Directives, and the DOE Work for Others proposals and guidance. The planned activities reflected in this alternative include an increase in some LANL operations and activities over the actions in previous years (e.g., the suspension of underground nuclear testing results in increased stockpile stewardship activities at LANL).

> ***Organization of SWEIS Chapter 3***
>
> ***Sections 3.1 through 3.4*** *describe the activities that would occur at each of the key facilities under each of the four alternatives.*
>
> ***Section 3.5*** *describes alternatives that DOE considered, but did not analyze in detail because they are unreasonable.*
>
> ***Section 3.6*** *compares the environmental consequences of the alternatives.*

The No Action Alternative also includes continued scientific, engineering, technology research and development, and support activities throughout LANL, including those at the SWEIS key facilities. By the very nature of research and development, specific activities are expected to vary and evolve through time. However, they can be sufficiently characterized to assure the analysis of their consequences in the SWEIS. (For the non-key facilities, chapter 2, section 2.1 provides this description.) This alternative includes foreseeable construction projects that are required to maintain facilities necessary for currently authorized activities, and this SWEIS is the entire NEPA review for these activities.

3.1.1 Plutonium Facility Complex

The Plutonium Facility (PF) Complex (TA–55) is described in chapter 2, section 2.2.2.1. Under the No Action Alternative, the following activities would occur at this complex.

Plutonium Stabilization. LANL would recover, process, and store its existing plutonium residue inventory in 8 years.

Manufacturing Plutonium Components. LANL would produce up to 14 plutonium pits per year (its existing capacity), as well as fabricate parts and samples for research and development activities (including parts for subcritical experiments).

Surveillance and Disassembly of Weapons Components. LANL would disassemble up to 40 plutonium pits per year (including up to 20 pits that would be destructively examined). In addition, up to 20 pits per year would be nondestructively examined.

Actinide Materials Science and Processing Research and Development. Research, as described in chapter 2 (section 2.2.2.1), would continue to be conducted on plutonium (and other actinide) materials, including metallurgical and other characterization of samples and measurements of mechanical and physical properties. This would include continued operation of the 40-millimeter Impact Test Facility and other apparatus. Research also would be conducted to develop new techniques useful for such research or for enhanced surveillance. In addition, LANL would perform research supporting development and assessment of technology for manufacturing and fabrication of components, including activities in areas such as welding bonding, fire resistance, and casting, machining, and other forming technologies.

LANL would demonstrate the disassembly/ conversion of 1 to 2 pits per day (up to 40 pits total) using hydride-dehydride processes. Up to 1,000 curies of neutron sources (plutonium-239/ beryllium and americium-241/beryllium) and up to 220 pounds (100 kilograms) of actinides would be processed each year. LANL would process up to 12 items per year (1 to 2 items per month) through tritium separation and would perform decontamination (to remove plutonium) of 15 to 20 uranium components per month.

Research on the physical and chemical characteristics of actinides and in support of DOE's actinide cleanup activities and on actinide processing and waste activities at DOE sites would be conducted. In addition, LANL would stabilize minor quantities of specialty items and residues from other DOE sites, fabricate and study small amounts of nuclear fuels used in terrestrial and space reactors, fabricate and study prototype fuel for lead test assemblies, develop safeguards instrumentation for plutonium assay, and analyze samples.

Fabrication of Ceramic-Based Reactor Fuels. LANL would make prototype mixed oxide (MOX) fuel and continue research and development on other fuels.

Plutonium-238 Research, Development, and Applications Processing. LANL would process, evaluate, and test up to 55 pounds (25 kilograms) of plutonium-238 per year in production of materials and parts to support space and terrestrial uses. In addition, up to 22 pounds (10 kilograms) of plutonium-238 per year would be processed to recover material from heat sources and milliwatt generators, research and development, and safety testing.

Storage, Shipping, and Receiving. As under all alternatives, the Nuclear Material Storage Facility (NMSF) is to be renovated to perform as originally intended: to serve as a centralized receiving area and vault for the interim storage of up to 7.3 tons (6.6 metric tons) of the LANL special nuclear material (SNM) inventory, mainly plutonium. This is expected to be an adequate capacity to allow the PF-4 vault to return to its intended use as a working vault and to accommodate the projected inventory growth at LANL (approximately 287 pounds [130 kilograms] per year under all alternatives—refer to volume III, appendix F, section F.5.3). The NMSF renovation is included in all alternatives. Once renovation is complete, nuclear materials will be moved to the NMSF from other LANL vaults and from other DOE facilities as necessary to support tasks assigned to LANL. Nondestructive assays would be conducted on SNM at the NMSF to verify and identify the content of stored containers. Material stored would be limited to nuclear material in metal or oxide forms. Nuclear material solutions and tritium would not be stored in NMSF, although some may be accepted at the receiving area and redirected to other facilities within the same day.

Under all alternatives, the Plutonium Facility would be renovated to ensure the continued availability of existing capabilities under all alternatives. Activities to be included in all alternatives as renovation that will ensure continued availability of the Plutonium Facility's existing capabilities are:

- Improvements to utilities that increase reliability
- Emergency lighting and interior improvements to meet fire and life safety code requirements
- Replacement of components in the process waste treatment systems
- Replacement of outdated laboratory equipment
- Improvements to communication and fire alarm systems
- Electrical system improvements

It is recognized that project plans can change over time. If this alternative is selected, the construction projects proposed under this alternative, as described above, would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.1.2 Tritium Facilities

The Tritium Facilities are described in chapter 2 (section 2.2.2.2). Under the No Action Alternative, the following activities would occur at these facilities.

High Pressure Gas Fills and Processing. LANL would handle and process tritium gas in quantities of up to 3.53 ounces (100 grams) at the Weapons Engineering Tritium Facility (WETF) approximately 25 times per year.

Gas Boost System Testing and Development. Approximately 20 times per year, LANL would conduct gas boost system research, development, and testing and gas processing operations at WETF involving quantities of up to 3.53 ounces (100 grams) of tritium.

Cryogenic Separation. At the Tritium Systems Test Assembly (TSTA), LANL would purify and process tritium gas in quantities of up to 7.06 ounces (200 grams) approximately 3 times per year using cryogenic separation.

Diffusion and Membrane Purification. LANL would conduct research on tritium movement and penetration through materials, including major experimental efforts, approximately 2 to 3 times per month.

Metallurgical and Material Research. LANL would also conduct metallurgical and materials research involving tritium, including research and application studies regarding tritium storage.

Thin Film Loading. LANL would use its thin film loading capability (involving chemically bonding tritium to a metallic surface) for tritium loading of neutron tube targets, processing approximately 800 units per year.

Gas Analysis. LANL's activities to measure the composition and quantities of gases used would continue in support of tritium operations under this alternative.

Calorimetry. LANL would also continue its calorimetry measurements (a nondestructive method of measuring the amount of tritium in a container) in support of tritium operations under this alternative.

Solid Material and Container Storage. Tritium would continue to be stored on site in WETF, TSTA, and the Tritium Science and Fabrication Facility (TSFF). Storage of tritium occurs in process systems, process samples, inventory for use, and waste.

Under all alternatives, LANL would remodel Building 16-450 and connect it to WETF in support of neutron tube target loading, as discussed in chapter 2 (section 2.2.2.2).

3.1.3 Chemistry and Metallurgy Research Building

The CMR Building is described in section 2.2.2.3. Under the No Action Alternative, the following activities would occur at this facility.

Analytical Chemistry. LANL would provide sample analysis in support of actinide research and processing activities, processing approximately 5,200 samples per year.

Uranium Processing. LANL would conduct activities to recover, process, and store LANL's highly enriched uranium inventory over the next 8 years.

Destructive and Nondestructive Analysis. Up to a total of 10 secondary assemblies over the next 10 years (an average of 1 each year) would be evaluated through destructive and nondestructive analysis and disassembly.

Nonproliferation Training. LANL would conduct nonproliferation training using SNM.

Actinide Research and Processing. LANL would process up to 3,600 curies of plutonium-238/beryllium neutron sources and up to 500 curies of americium-241/beryllium neutron sources per year. In addition, up to 1,000 plutonium-238/beryllium and americium-241/beryllium neutron sources would be staged in CMR Building Wing 9 floor holes. LANL would retain its capability for research and development activities on spent nuclear fuels. Further, LANL would characterize approximately 50 samples per year using metallurgical microstructural/chemical analysis and would conduct compatibility testing of actinides and other metals in order to study long-term aging and other material effects. LANL would also conduct analysis of transuranic (TRU) waste disposal related to the validation of Waste Isolation Pilot Plant (WIPP) performance assessment models, characterize TRU waste, and analyze gas generation such as that which could occur during transportation to WIPP. LANL would continue to develop, demonstrate, and test nondestructive assay and evaluation equipment.

Fabrication and Metallography. LANL would produce 1,080 targets per year for production of molybdenum-99, with each target containing approximately 0.71 ounces (20 grams) of uranium-235. In addition, LANL would support highly enriched uranium processing, research and development, pilot operations, and casting and fabrication of metal shapes using from 2.2 to 22 pounds (1 to 10 kilograms) of highly enriched uranium in each operation, with an annual throughput of approximately 2,200 pounds (1,000 kilograms) (which would remain in the LANL material inventory).

Four construction or facility modification projects are currently in development or implementation at the CMR Building and are included in all alternatives (all have previously been reviewed under NEPA), as discussed in section 2.2.2.3:

- CMR Building Phase I Upgrades (ongoing)
- CMR Building Phase II Upgrades (DOE 1997)
- Medical Radioisotope Target Fabrication (DOE 1996c)
- Radioactive Source Recovery Program (DOE 1995d)

3.1.4 Pajarito Site (Los Alamos Critical Experiments Facility)

The Pajarito Site is described in detail in section 2.2.2.4. Under the No Action Alternative, the following activities would occur at this facility.

LANL would continue to conduct experiments and tests in all areas described in chapter 2, section 2.2.2.4. In 1997, up to 570 experimental operations would be expected; annual growth of about 5 percent is anticipated over the next 10 years to meet the planned research and development needs of DOE and other sponsors.

In addition, LANL would develop safeguards instrumentation and research and development activities for SNM, light detection and ranging experiments, materials processing, interrogation techniques, and field systems.

3.1.5 Sigma Complex

The Sigma Complex is described in section 2.2.2.5. Under the No Action Alternative, the following activities would occur at this complex.

Research and Development on Materials Fabrication, Coating, Joining, and Processing. LANL would continue to fabricate items from metals, ceramics, salts, beryllium, enriched uranium, depleted uranium, and other uranium isotope mixtures. Activities include casting, forming, machining, polishing, coating, and joining.

Characterization of Materials. LANL would continue research and development activities on properties of ceramics, oxides, silicides, composites, and high-temperature materials; analyze up to 24 tritium reservoirs per year; and develop a library of aged non-SNM materials from stockpiled weapons and develop techniques to test and predict changes. Up to 250 non-SNM samples, including uranium, would be stored and characterized.

Fabrication of Metallic and Ceramic Items. LANL would, on an annual basis, fabricate stainless steel and beryllium components for approximately 50 plutonium pits, 50 to 100 reservoirs for tritium, components for up to 50 secondary assemblies (of depleted uranium, depleted uranium alloy, enriched uranium, deuterium, and lithium), nonnuclear components for research and development (30 major hydrotests and 20 to 40 joint test assemblies, beryllium targets, targets and other components for accelerator production of tritium research, test storage containers for nuclear materials stabilization, and nonnuclear (stainless steel and beryllium) components for up to 20 plutonium pit rebuilds.

In addition, all of the alternatives include construction, renovation, and modification projects that are underway and planned in the near term for the purpose of maintaining the availability and viability of the Sigma Complex:

- *Sigma Building Renovation.* These renovations, described further below, are required to keep the building in good operating condition for current missions.
- *Nonnuclear Consolidation/Pit Support and Beryllium Technology Support.* This was previously reviewed under NEPA (DOE 1993), as discussed in section 2.2.2.5.

Typical activities to be included for the Sigma Building (SM–66) in all alternatives to ensure continued availability of the existing capabilities are:

- Perform seismic upgrades including adding shear walls and reinforcements.
- Replace the roof.
- Replace and upgrade the graphite collection systems.
- Replace the cooling water pump and piping.

- Modify the industrial drain system.
- Replace and upgrade electrical components.
- Perform site work such as relocating a fire hydrant, repairing the dock area, and removing unneeded exterior equipment.

In addition, at one of the shops (SM–106), the baghouse on the ventilation system will be replaced with new ductwork and a high-efficiency particulate air (HEPA) filter system.

It is recognized that project plans can change over time. If this alternative is selected, the construction projects proposed under this alternative, as described above, would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.1.6 Materials Science Laboratory

The Materials Science Laboratory (MSL) is described in chapter 2 (section 2.2.2.6). Under the No Action Alternative, the following activities would occur at this facility.

Materials Processing. LANL would continue research at the MSL at current levels of operation, including synthesis and processing techniques, wet chemistry, thermomechanical processing, microwave processing, heavy equipment materials, single crystal growth, amorphous alloys, and powder processing.

Mechanical Behavior in Extreme Environments. LANL would continue mechanical testing, dynamic testing, and fabrication and assembly research at current levels of operation.

Advanced Materials Development. LANL would continue research in materials, synthesis and characterization, ceramics, and superconductors at current levels of operation.

Materials Characterization. LANL would also continue activities in these six areas at current levels of operation: surface science chemistry, corrosion characterization, electron microscopy, x-ray, optical metallography, and spectroscopy.

3.1.7 Target Fabrication Facility

The TFF described in section 2.2.2.7. Under the No Action Alternative, TFF materials research, development, effects studies, and characterization work would continue at current levels, along with the following activities.

Precision Machining and Target Fabrication. LANL would provide targets and specialized components for approximately 1,200 laser and physics tests per year, including a 10 percent annual growth in operations for the next 10 years.

Polymer Synthesis. LANL would produce polymers for targets and specialized components for approximately 1,200 laser and physics tests per year, including a 10 percent annual growth in operations for the next 10 years.

Chemical and Physical Vapor Deposition. LANL would coat targets and specialized components for approximately 1,200 laser and physics tests per year, including a 10 percent annual growth in operations for the next 10 years. This would also support plutonium pit manufacturing operations (as discussed in section 3.1.1).

3.1.8 Machine Shops

The Machine Shops are described in chapter 2 (section 2.2.2.8). Under the No Action Alternative, the following activities would occur at these facilities.

The Machine Shops would provide fabrication support for the dynamic experiments program and explosive research studies, support up to 30 hydrodynamic tests annually, manufacture 20 to

40 joint test assembly sets annually, and provide general laboratory fabrication support as requested. LANL would also continue its fabrication activities using unique and unusual materials and provide appropriate dimensional inspection of these activities.

3.1.9 High Explosives Processing Facilities

The High Explosives Processing Facilities are described in chapter 2 (section 2.2.2.9). The operations listed below are expected to require a total of 46,750 pounds (21,200 kilograms) of explosives annually and 1,590 pounds (720 kilograms) of mock explosives. (This is considered an appropriate indicator of overall activity levels for this key facility.) Under the No Action Alternative, the following activities would occur at these facilities.

High Explosives Synthesis and Production. LANL would continue its current level of high explosives synthesis and production research and development, produce new materials and formulate plastic-bonded explosives as needed. Process development would increase over current levels and materials would be produced for research and stockpile applications.

High Explosives and Plastics Development and Characterization. LANL would evaluate stockpile returns and increase efforts in development and characterization of new plastics and high explosives for stockpile improvement. LANL would also improve its predictive capabilities and conduct research into high explosives waste treatment methods.

High Explosives and Plastics Fabrication. LANL would continue its traditional stockpile surveillance and process development and would supply parts to Pantex for surveillance, war reserve (WR) rebuilds, and joint test assemblies. Fabrication for hydrodynamic and environmental testing would be increased over current levels.

Test Device Assembly. Operations would be increased over current levels to support stockpile related hydrodynamic tests, joint test assemblies, environmental and safety tests, and research and development activities. Approximately 30 major hydrodynamic test devices would be assembled annually.

Safety and Mechanical Testing. Safety and environmental testing related to stockpile assurance would be increased over current levels and predictive models would be improved. Approximately 12 safety and mechanical tests would be conducted annually.

Research, Development, and Fabrication of High-Power Detonators. LANL would increase efforts to support SSM activities, manufacture up to 20 major product lines per year, and support DOE-wide packaging and transportation of electro-explosive devices.

3.1.10 High Explosives Testing

High explosives testing is described in section 2.2.2.10. The No Action Alternative includes approximately 600 experiments per year of varying degrees and types at the high explosives testing firing sites. Up to 30 of these would be characterized as major hydrodynamic tests. Firing site activities would include expenditures of materials, which are considered to be useful indicators of overall test activity. Under this alternative, about 2,900 pounds (1,320 kilograms) of depleted uranium would be expended annually. This is considered to be the minimum level required for the maintenance of capabilities, including staff expertise and equipment, and the recertification of the safety and reliability of the nuclear weapons stockpile. The operation of the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility is included in all alternatives, using phased containment as described in the Final DARHT EIS (DOE 1995c).

Under the No Action Alternative, the following activities would occur.

Hydrodynamic Tests. LANL would conduct hydrodynamic tests, develop containment technology, and conduct tests of weapons configurations. Up to 30 of these per year would be characterized as major hydrodynamic tests.

Dynamic Experiments. LANL would conduct dynamic experiments to study properties and enhance understanding of the basic physics and equation of state and motion for materials used in nuclear weapons, including some experiments with SNMs.

Explosives Research and Testing. High explosives tests would be conducted to characterize explosive materials.

Munitions Experiments. LANL would continue to support the DoD with research and development on conventional munitions, conducting experiments with projectiles, and studying other effects of munitions.

High Explosives Pulsed-Power Experiments. LANL would conduct high explosives pulsed-power experiments and development tests.

Calibration, Development, and Maintenance Testing. LANL would conduct tests to provide calibration data, instrumentation development, and maintenance of image processing capability.

Other Explosives Testing. LANL would also conduct advanced high explosives or weapons evaluation studies.

3.1.11 Los Alamos Neutron Science Center

The Los Alamos Neutron Science Center (LANSCE) is described in chapter 2 (section 2.2.2.11). Under the No Action Alternative, the following activities would occur at this facility.

Accelerator Beam Delivery, Maintenance, and Development. LANSCE would deliver a linear accelerator beam to Areas A, B, and C; the Weapons Neutron Research (WNR) buildings; Manuel Lujan Center; radiography firing sites; and a new Isotope Production Facility (IPF) for 8 months each year (5,100 hours). The H^+ beam current would be 1,000 microamps, and the H^- beam current would be 200 microamps. The beam delivery and support equipment would be reconfigured to support new facilities, upgrades, and experiments.

A 40-million electron volt low-energy demonstration accelerator (LEDA) would be built and operated in an existing facility (TA–53–365) for 6 years, operating up to approximately 6,600 hours per year. LEDA would be used to demonstrate the practicality of using continuous-wave accelerator beam technology to produce tritium, as an alternative to the historical use of nuclear reactors. This facility would be located in existing Building 53–365, as described in section 2.2.2.11.

The LEDA building consists of two major parts: an underground, shielded beam tunnel (16,200 square feet [1,500 square meters]) and a four-story, steel-frame building (53,800 square feet [5,000 square meters]). The heating, ventilation, and air conditioning system would allow short-lived radioisotopes to decay in the beam tunnel prior to release via the 82-foot-high (25-meter-high) exhaust stack.

The construction and operation of LEDA was analyzed under NEPA in an environmental assessment that supported a finding of no significant impact (DOE 1996b).

Experimental Area Support. Support activities would continue to ensure availability of the beam lines, beam line components, handling and transportation systems, and shielding, as well as radiofrequency power sources (including technology development and application). Remote handling and packaging of radioactive materials and wastes at LANSCE would be maintained at fiscal year 1994 levels.

Neutron Research and Technology. LANL would conduct 500 to 1,000 different experiments annually, using neutrons from the Manuel Lujan Center and the WNR Facility. LANL would also conduct an accelerator production of tritium target neutronics experiment for 6 months. In addition, LANL would continue to support contained weapons-related experiments using small to moderate quantities of high explosives. These experiments would include:

- Experiments with nonhazardous materials and small quantities of high explosives (up to approximately 100 per year)
- Experiments with up to 10 pounds (4.54 kilograms) of high explosives and/or depleted uranium (up to approximately 30 per year)
- Experiments with small quantities of actinides, high explosives, and sources (up to approximately 40 per year)
- Shockwave experiments involving small amounts, up to nominally 0.18 ounces (5 grams), of plutonium

In addition, LANL would provide support for static stockpile surveillance technology research and development.

Accelerator-Driven Transmutation Technology. LANL would conduct lead target tests for 2 years at the Area A beam stop, establish a 1-megawatt target/blanket experimental area at one existing target area in Area A, and conduct low-power (less than 1 megawatt) experiments during the 8 months of accelerator operations per year for 4 years.

Subatomic Physics Research. LANL would conduct five to ten physics experiments annually at the Manuel Lujan Center and WNR and conduct proton radiography experiments. Proton radiography experiments would include contained experiments using small to moderate quantities of high explosives, similar to those discussed above under Neutron Research and Technology.

Medical Isotope Production. Up to approximately 40 targets per year would be irradiated for medical isotope production.

High-Power Microwaves and Advanced Accelerators. Research and development would be conducted for advanced accelerator concepts, high-power microwaves, room-temperature and superconducting linear accelerator structures, and in support of the Spallation Neutron Source Program. Research and development also would be conducted in microwave chemistry for industrial and environmental applications.

Under all alternatives, the following facilities would be constructed and operated based on previous NEPA reviews, as discussed in chapter 2 (section 2.2.2.11):

- The LEDA would be constructed.
- Proton radiography and neutron spectroscopy facilities (for neutron research and technology) would be constructed within existing buildings and would house photographic equipment and experiments contained within closed vessels.
- IPF (for medical isotope production) and equipment would be relocated to a new 100-million electron volt station, instead of using the full 800-million electron volt beam as is currently done.
- The short-pulse spallation source (SPSS) enhancement will result in higher neutron flux and greater beam availability for experimenters in WNR and the Manuel Lujan Center.

It is recognized that project plans can change over time. If this alternative is selected, the construction projects proposed under this alternative, as described above, would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.1.12 Health Research Laboratory

The Health Research Laboratory (HRL) is described in section 2.2.2.12. Under the No Action Alternative, the following activities would occur at this facility.

Genomic Studies. LANL would continue to conduct research at current levels using molecular and biochemical techniques to analyze the genes of animals, particularly humans. Specifically, personnel are developing strategies to analyze the nucleotide sequence of individual genes, especially those associated with genetic disorders, and to identify their map genes and/or genetic diseases to locations on individual chromosomes. Part of this work is to map each nucleotide, in sequence, of each gene in all 46 chromosomes of the human genome.

Cell Biology. LANL would continue to conduct research at current levels using whole cells and cellular systems, both in-vivo and in-vitro, to investigate the effects of natural and catastrophic cellular events such as response to aging, harmful chemical and physical agents, and cancer.

Cytometry. LANL would also conduct research utilizing laser imaging systems to analyze the structures and functions of subcellular systems.

DNA Damage and Repair. LANL would conduct research using isolated cells to investigate deoxyribonucleic acid (DNA) repair mechanisms.

Environmental Effects. LANL would conduct research that identifies specific changes in DNA and proteins in certain microorganisms that occur after events in the environment.

Structural Cell Biology. LANL would conduct research utilizing chemical and crystallographic techniques to isolate and characterize the three dimensional shapes and properties of DNA and protein molecules.

Neurobiology. LANL would conduct research using magnetic fields produced in active areas of the brain to map human brain locations associated with certain sensory and cognitive functions.

In-Vivo Monitoring. LANL would also continue to conduct 1,500 whole-body scans annually as a service that supports operations with radioactive materials conducted elsewhere at LANL.

3.1.13 Radiochemistry Facility

The Radiochemistry Facility is described in chapter 2 (section 2.2.2.13). Overall, levels of activity under this alternative would remain at current levels. Because much of the work here is research and development work, one indicator of activity levels is employment. This alternative would be expected to utilize about 170 full-time equivalent employees (FTEs) to perform the activity below. Under the No Action Alternative, the following activities would occur at this facility.

Radionuclide Transport. LANL would conduct 45 to 80 of these studies annually.

Environmental Remediation. Environmental remediation activities would continue to provide field support at current levels.

Ultra-Low-Level Measurements. These activities would continue at current levels.

Nuclear/Radiochemistry. These operations would also continue at current levels.

Isotope Production. LANL would conduct target preparation, irradiation, and processing to recover medical and industrial application isotopes at current levels.

Actinide/Transuranic Chemistry. LANL would perform radiochemical separations at the current level of operations.

Data Analysis. LANL would continue to re-examine archive data and measure nuclear process parameters of interest to weapons radiochemists at current levels.

Inorganic Chemistry. LANL would conduct these activities at current levels.

Structural Analysis. LANL would continue these activities at current levels of operation.

Sample Counting. LANL's sample counting activity to measure the quantity of radioactivity in samples would continue at current levels.

3.1.14 Radioactive Liquid Waste Treatment Facility

The Radioactive Liquid Waste Treatment Facility (RLWTF) is described in chapter 2 (section 2.2.2.14). Under the No Action Alternative, the following activities would occur at this facility.

Waste Characterization, Packaging, and Labeling. LANL would support, certify, and audit generator characterization programs and maintain the waste acceptance criteria (WAC) for the RLWTF.

Waste Transport, Receipt, and Acceptance. LANL would collect radioactive liquid waste from generators and transport it to the RLWTF in TA–50.

Radioactive Liquid Waste Pretreatment. LANL would pretreat 185,000 gallons (700,000 liters) of radioactive liquid waste per year at TA–21; 7,900 gallons (30,000 liters) of radioactive liquid waste per year at TA–50; and solidify, characterize, and package 71 cubic feet (2 cubic meters) of TRU waste sludge per year at TA–50.

Radioactive Liquid Waste Treatment. LANL would install equipment for nitrate reduction in mid 1999, treat 6,600,000 gallons (25 million liters) of radioactive liquid waste (RLW) per year; dewater, characterize, and package 247 cubic feet (7 cubic meters) of low-level radioactive waste (LLW) sludge per year; and solidify, characterize, and package 812 cubic feet (23 cubic meters) of TRU waste sludge per year.

Decontamination Operations. LANL would:

- Decontaminate personnel respirators for reuse (approximately 500 per month).
- Decontaminate air-proportional probes for reuse (approximately 200 per month).
- Decontaminate vehicles and portable instruments for re-use (as required).
- Decontaminate precious metals for resale (acid bath).
- Decontaminate scrap metals for resale (sand blast).
- Decontaminate 6,710 cubic feet (190 cubic meters) of lead for reuse (grit blast).

Three modifications were recently completed or are planned for the RLWTF: an upgrade to the influent tank system, installation of a new process for treatment of RLW, and installation of additional treatment steps for removal of nitrates. These have all been previously reviewed under NEPA and are included in all of the SWEIS alternatives (these are discussed further in section 2.2.2.14).

3.1.15 Solid Radioactive and Chemical Waste Facilities

The Solid Radioactive and Chemical Waste Facilities are described in chapter 2 (section 2.2.2.15). Under the No Action Alternative, the following activities would occur at these facilities.

Waste Characterization, Packaging, and Labeling. LANL would support, certify, and audit generator characterization programs and maintain the WAC for LANL waste management facilities. At the Solid Radioactive and Chemical Waste facilities, LANL would characterize 26,830 cubic feet (760 cubic meters) of legacy low-level radioactive mixed waste (LLMW); characterize 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste; verify characterization data at the Radioactive Assay and Nondestructive Test (RANT) Facility for unopened containers of LLW and TRU waste; maintain the WAC for off-site treatment, storage, and disposal facilities; and overpack and bulk waste containers.

LANL would also perform coring and visual inspection of a percentage of TRU waste packages, ventilate 16,700 drums of TRU waste retrieved during the TRU Waste Inspectable Storage Project (TWISP), and maintain the current version of the WIPP WAC and coordinate with WIPP operations.

Compaction. LANL would compact up to 614,000 cubic feet (17,400 cubic meters) of LLW.

Size Reduction. In addition, 91,800 cubic feet (2,600 cubic meters) of TRU waste would be reduced in size at the Waste Characterization, Reduction, and Repackaging (WCRR) Facility in TA–50 and the Drum Preparation Facility in TA–54.

Waste Transport, Receipt, and Acceptance. LANL would collect chemical and mixed wastes from LANL generators and transport them to TA–54. LANL would ship 31,960 tons (29,000 metric tons) of chemical wastes and 126,700 cubic feet (3,590 cubic meters) of LLMW for off-site treatment and disposal in accordance with EPA land disposal restrictions. In addition, LANL would ship 1,437,000 cubic feet (40,700 cubic meters) of LLW for off-site disposal. Beginning in 1999, 318,00 cubic feet (9,010 cubic meters) of legacy TRU waste would be shipped to WIPP. LANL would also ship 86,800 cubic feet (2,460 cubic meters) of TRU waste generated as a result of future operations and research to WIPP and 100,600 cubic feet (2,850 cubic meters) of LLMW in environmental restoration soils for off-site solidification and disposal.

Waste Storage. Prior to shipment to off-site treatment, storage, and disposal facilities, LANL would store chemical and mixed wastes. LANL would also continue to: store legacy TRU waste until WIPP is open for disposal; LLMW until treatment facilities are available; and LLW uranium chips until sufficient quantities were accumulated for stabilization campaigns.

Waste Retrieval. LANL would retrieve 165,900 cubic feet (4,700 cubic meters) of TRU waste from Pads 1, 2, and 4 by 2004.

Other Waste Processing. LANL would demonstrate treatment (e.g., electrochemical) of LLMW liquids, land farm oil-contaminated soils at Area J, stabilize 14,500 cubic feet (410 cubic meters) of uranium chips and provide special case treatment for 23,650 cubic feet (670 cubic meters) of TRU waste.

Disposal. LANL would dispose of 3,530 cubic feet (100 cubic meters) of LLW in shafts at Area G, 1,271,000 cubic feet (36,000 cubic meters) of LLW and small quantities of radioactively contaminated polychlorinated biphenyls (PCBs) in disposal cells at Area G, approximately 3,530 cubic feet (100 cubic meters) of administratively controlled industrial solid wastes in cells at Area J annually, and nonradiological classified wastes in shafts at Area J.

In addition, under all alternatives, LANL would construct TRU Waste Inspectable Storage Project storage domes for TRU wastes recovered from Pads 1, 2, and 4, as described in section 2.2.2.15. This proposal has been reviewed under NEPA and is included under all four alternatives.

3.2 EXPANDED OPERATIONS ALTERNATIVE

The Expanded Operations Alternative for the SWEIS reflects the implementation of assignments at higher levels of operations through much of LANL. This alternative includes full implementation of new mission element assignments as defined in RODs of DOE programmatic NEPA documents such as the SSM PEIS (DOE 1996a). This activity level is a projection from the index established for past operations and represents a level that is possible to attain within a 10-year period, given an increased level of funding for programs, consistent with current and newly assigned LANL missions. DOE's Preferred Alternative is the Expanded Operations Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year in the near term.

New facilities and modifications to existing facilities that are necessary to support projected capabilities and operations levels considered in this alternative are also analyzed. Specifically, construction and/or modifications are analyzed that could be required to optimize facilities for increased levels of operations and to increase capabilities or capacities where necessary.

The construction and upgrade projects associated with the Expanded Operations Alternative are identified in the descriptions of activities under this alternative for each of the key facilities. This SWEIS constitutes the entire NEPA review for these projects.

In particular, the Expanded Operations Alternative includes the project-level analyses for the Expansion of TA–54/Area G and for the Enhancement of Pit Manufacturing (to implement the pit production mission element assignment at LANL), including the siting and construction analyses detailed in volume II of this SWEIS. While the full implementation of the pit production mission at LANL is expected to continue beyond the period of time covered in this SWEIS, the impacts are projected based on the best available information. The first phase of this proposed action (establishing pit production at a 20 pits per year rate, DOE's Preferred Alternative) is discussed in this alternative, and the impacts associated with that level of operation are presented in chapter 5 of this SWEIS, as are the impacts of full implementation of pit production at the 80 pits per year level (using multiple shifts).

The selection of the Preferred Alternative as the Expanded Operations Alternative, but only at pit manufacturing rate of 20 pits per year, is influenced by several factors, including:

- DOE's obligation to assure a safe and reliable nuclear weapons stockpile
- The unique capabilities (facilities, equipment, instrumentation, and expertise) at LANL that support DOE's obligation to assure a safe and reliable nuclear weapons stockpile
- The continued consolidation and downsizing of the DOE weapons complex, increasing demands on the remaining facilities and capabilities
- The U.S. policy decision to suspend underground nuclear testing, increasing dependence upon modeling and experimentation with enhanced diagnostics and instrumentation to provide for continued stockpile confidence
- The continued emphasis on applying the resources and technologies developed within DOE national laboratories to improve the U.S. technological position and competitiveness
- The unique capabilities at LANL to support DOE's basic science mission

These factors will continue to influence DOE budget requests, management practices, and decisions. While future budget allocations cannot be predicted with accuracy, DOE is preparing for the future based on expressed national policies and the factors noted above. Thus, DOE expects that future demands on the unique capabilities at LANL are best addressed by the levels of operations described in the Expanded Operations Alternative, but at the 20 pits per year level.

It should be noted that the implementation of the 50 to 80 pits per year production capacity is more than 10 years into the future. While this level is the long-term goal, DOE's proposed action in the near term (next 10 years) is to achieve the 20 pits per year production level.

3.2.1 Plutonium Facility Complex

The Plutonium Facility Complex (TA–55) is described in chapter 2 (section 2.2.2.1). Under the Expanded Operations Alternative, the following activities would occur at this complex.

Plutonium Stabilization. LANL would recover, process, and store its existing plutonium residue inventory in 8 years.

Manufacturing Plutonium Components. LANL would produce up to 80 plutonium pits per year in multiple shift operations (up to 50 pits per year in single-shift operations). This would be implemented in a phased manner, with the near-term objective of establishing this capability at a 20 pits per year rate (Preferred Alternative). Under longer-term objectives, the 80 pits per year (using multiple shifts) capability would be established. In addition, LANL would fabricate parts and samples for research and development at a higher level than under the No Action Alternative (within the existing capacity of TA–55–4).

Surveillance and Disassembly of Weapons Components. LANL would continue to examine and disassemble plutonium pits, but the existing equipment and the responsibility for this activity would be moved to the CMR Building to make room for the expanded pit production capability needed at the Plutonium Facility. (A detailed analysis of the alternatives considered to address the need for additional space for pit production is included in the project-specific siting and construction [PSSC] analysis in the SWEIS, volume II. To bound the impact analysis, PSSC "CMR Building Use" Alternative, relocation of some activities to the CMR Building is assumed because it does not create new nuclear space.) This relocation would result in increased transportation between the Plutonium Facility and the CMR Building, causing increases in road closures (and increased inconvenience to motorists) or in increased packaging costs and risks to the public if U.S. Department of Transportation (DOT)-approved packaging without road closures is used. The DOE has included the environmental impacts to establish a dedicated road for transport between the Plutonium Facility and the CMR Building in the Expanded Operations Alternative. However, the road would not be constructed to establish the 20 pits per year capability (Preferred Alternative). Also, under the Preferred Alternative, the pit manufacturing process activities would not be moved to the CMR Building.

Actinide Materials Science and Processing Research and Development. Research would continue to be conducted on plutonium (and other actinide) materials, as described in chapter 2 (section 2.2.2.1) at a higher level than under the No Action Alternative (but within the existing capacity of TA–55–4). LANL would demonstrate the disassembly/conversion of plutonium pits as under the No Action Alternative and would also develop expanded disassembly capacity, processing up to 200 pits per year (including a total of 250 pits over 4 years as part of disposition demonstration activities) (DOE 1998). Up to 5,000 curies of neutron sources (plutonium-239/beryllium and americium-241/beryllium) would be processed at TA–55. Up to 880 pounds (400 kilograms) of actinides would be processed each year between

TA–55 and the CMR Building. LANL would also process neutron sources other than sealed sources. Although LANL would continue to process items through the Special Recovery Line (tritium separation), that activity would also move to the CMR Building to make room for the expanded pit production at the Plutonium Facility. LANL would perform oralloy decontamination of 28 to 48 uranium components per month in the TA–55 Plutonium Facility.

Research in support of DOE's actinide clean-up activities and on actinide processing and waste activities at DOE sites would be conducted at a level higher than that under the No Action Alternative. In addition, LANL would stabilize larger quantities of specialty items and residues from other DOE sites (including plutonium salts from the Rocky Flats Environmental Technology Site [RFETS]); fabricate and study larger amounts of nuclear fuels used in terrestrial and space reactors; fabricate and study larger amounts of prototype fuel for lead test assemblies; develop safeguards instrumentation for plutonium assay at a level increased from that of the No Action Alternative; and analyze samples. Half of the sample analysis would be conducted at the Plutonium Facility, with the remainder moved to the CMR Building (again, to make room for expanded pit production at the TA–55 Plutonium Facility).

Fabrication of Ceramic-Based Reactor Fuels. LANL would make prototype MOX fuel and would build test reactor fuel assemblies. LANL also would continue research and development on other fuels.

Plutonium-238 Research, Development, and Applications. LANL would process, evaluate, and test up to 55 pounds (25 kilograms) of plutonium-238 per year in production of materials and parts to support space and terrestrial uses. In addition, LANL would recover, recycle, and blend up to 40 pounds (18 kilograms) per year of plutonium-238.

Storage, Shipping, and Receiving. NMSF is to be renovated to perform as originally intended: to serve as a vault for the interim storage of up to 7.3 tons (6.6 metric tons) of the LANL SNM inventory, mainly plutonium. Storage, shipping, and receiving activities would be similar to those under the No Action Alternative, with the differences in shipping activity, as presented in volume III (appendix F, section F.5), increasing the amount of shipping and receiving activity (but not requiring a change in the storage capacity for TA–55).

Under all alternatives, the Plutonium Facility would be renovated to ensure the continued availability of existing capabilities, as described under the No Action Alternative, section 3.1.1. Under the Expanded Operations Alternative, additional upgrades would be performed to support newly assigned missions. Additional upgrades to support newly assigned missions under the Expanded Operations Alternative could include reconfiguration of interior space and installation of new equipment (see volume II, part II, for additional information on these upgrades) in support of expanded activities, as described above.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative as described above, would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.2.2 Tritium Facilities

The Tritium Facilities are described in chapter 2 (section 2.2.2.2). Under the Expanded Operations Alternative, the following activities would occur at these facilities.

High Pressure Gas Fills and Processing. LANL would handle and process tritium gas in quantities of up to 3.53 ounces (100 grams) at WETF approximately 65 times per year.

Gas Boost System Testing and Development. Approximately 35 times per year, LANL would conduct gas boost system research, development, and testing and gas processing operations at WETF involving quantities of up to 3.53 ounces (100 grams) of tritium.

Cryogenic Separation. At TSTA, LANL would purify and process tritium gas in quantities of up to 7.06 ounces (200 grams) approximately 5 to 6 times per year using cryogenic separation.

Diffusion and Membrane Purification. Significantly increasing from the No Action Alternative level, LANL would conduct research on tritium movement and penetration through materials including major experimental efforts approximately 6 to 8 times per month, accompanied by continuous use for effluent treatment.

Metallurgical and Material Research. LANL's metallurgical and materials research capability would be expanded above the No Action Alternative level, although the amount of tritium used would remain the same.

Thin Film Loading. LANL would use its thin film loading capability (involving chemically bonding tritium to a metallic surface) for tritium loading of neutron tube targets, processing approximately 3,000 units per year using small quantities of tritium.

Gas Analysis. LANL's activity to measure the composition and quantities of gases used would increase from the No Action Alternative level in support of increased tritium operations under this alternative.

Calorimetry. LANL's calorimetry measurements (a nondestructive method of measuring the amount of tritium in a container) would also increase from the No Action Alternative level in support of increased tritium operations under this alternative.

Solid Material and Container Storage. Tritium would continue to be stored on site in WETF, TSTA, and TSFF at approximately 10 times the amount to be stored under the No Action Alternative level.

Under all alternatives, LANL would remodel Building 16-450 and connect it to WETF in support of neutron tube target loading.

3.2.3 Chemistry and Metallurgy Research Building

The CMR Building is described in chapter 2 (section 2.2.2.3). Under the Expanded Operations Alternative, the following activities would occur at this facility.

Analytical Chemistry. LANL would provide expanded sample analysis in support of actinide research and processing activities, processing approximately 11,000 samples per year (including actinide sample analysis relocated from the Plutonium Facility).

Uranium Processing. LANL would conduct activities to recover, process, and store LANL's highly enriched uranium inventory over the next 8 years (same as No Action Alternative).

Destructive and Nondestructive Analysis. Up to 10 secondary assemblies per year would be evaluated through destructive and nondestructive analysis and disassembly.

Nonproliferation Training. LANL would also conduct more nonproliferation training using SNM than would be conducted under the No Action Alternative, and would possibly use different types of SNM in that training.

Actinide Research and Processing. LANL would process up to 5,000 curies of neutron sources (both plutonium-238/beryllium and americium-241/beryllium sources) per year at the CMR Building and would process neutron sources other than sealed sources. In addition, up to a total of 1,000 plutonium-238/beryllium and americium-241/beryllium neutron sources would be staged in CMR Building Wing 9 floor holes. LANL would begin a research and development effort on spent nuclear fuels related to long-term storage and would analyze materials from spent and partially spent fuels. Further, LANL would characterize approximately 100 samples per year using metallurgical microstructural/chemical analysis, would conduct compatibility testing of actinides and other metals in order to study long-term aging and other material effects, and would conduct research and development activities in hot cells on plutonium pits exposed to high temperatures. LANL would also conduct analysis of TRU waste disposal related to the validation of WIPP performance assessment models, characterize TRU waste, and analyze gas generation such as that which could occur during transportation to WIPP. Further, LANL would demonstrate decontamination technologies for actinide-contaminated soils and materials and develop an actinide precipitation method to reduce mixed wastes in LANL effluents.

Under the Expanded Operations Alternative, some actinide activities currently housed in the Plutonium Facility Complex (at TA–55) would move to the CMR Building to make room in TA–55–4 for increased plutonium pit production. Up to 400 kilograms of actinides would be processed per year between TA–55 and the CMR Building, and hydrodynamic testing and tritium separation activities would be supported at the CMR Building.

Fabrication and Metallography. LANL would produce 1,320 targets per year for production of molybdenum-99, with each target containing approximately 20 grams of uranium-235. LANL would separate fission products from the irradiated targets to provide molybdenum-99 (and other isotopes); this capability would produce up to 3,000 6-day curies of molybdenum-99 per week. (A 6-day curie is defined as the amount of product, in curies, remaining 6 days after the product is delivered to the radiopharmaceutical company.) In addition, LANL would retain the capability to fabricate metal shapes using highly enriched uranium (as well as the related uranium processing activities), with an annual throughput of approximately 2,200 pounds (1,000 kilograms).

Surveillance and Disassembly of Weapons Components. The CMR Building would also be used to disassemble approximately 65 plutonium pits per year (including 40 pits destructively examined). Up to 20 pits per year would be nondestructively examined, with additional testing conducted under the Expanded Operations Alternative (as compared to the No Action Alternative). This activity would move to the CMR Building from the TA–55 Plutonium Facility.

The Expanded Operations Alternative also includes the upgrades necessary to accommodate activities displaced from the Plutonium Facilities Complex to the CMR Building as a result of implementing enhanced pit fabrication. These upgrades are addressed in the PSSC analysis for the enhancement of plutonium pit manufacturing in this SWEIS, volume II.

In addition, under the Expanded Operations Alternative, modifications to CMR Building Wing 9 hot cells would be undertaken to provide for the safety testing of pits in a high-temperature environment (to assess the fire resistance of pits). These changes would place a glovebox and a furnace into one of the hot cells, as well as introduce additional instrumentation and equipment for controlling, monitoring and measuring such tests.

In addition, the four projects currently in development or implementation at the CMR Building are included in all alternatives as described under the No Action Alternative, section 3.1.3.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.2.4 Pajarito Site (Los Alamos Critical Experiments Facility)

The Pajarito Site is described in chapter 2 (section 2.2.2.4). Under the Expanded Operations Alternative, the following activities would occur at this facility.

LANL would continue to conduct experiments and tests in all of the areas described in section 2.2.2.4. These activities would increase by about 25 percent from the No Action Alternative levels of operation, and the nuclear materials inventory would increase by about 20 percent over No Action Alternative levels. As under the No Action Alternative, LANL would also develop safeguards instrumentation and perform research and development activities for SNM, light detection and ranging experiments, materials processing, interrogation techniques, and field systems.

3.2.5 Sigma Complex

The Sigma Complex is described in chapter 2 (section 2.2.2.5). Under the Expanded Operations Alternative, the following activities would occur at this complex.

Research and Development on Materials Fabrication, Coating, Joining, and Processing. Under the Expanded Operations Alternative, as under the No Action Alternative, LANL would continue to fabricate items from metals, ceramics, salts, beryllium, enriched uranium, depleted uranium, and other uranium isotope mixtures. Activities include casting, forming, machining, polishing, coating, and joining.

Characterization of Materials. LANL would continue research and development activities on properties of ceramics, oxides, silicides, composites, and high-temperature materials at a level slightly increased over that for the No Action Alternative. In addition, LANL would analyze up to 36 tritium reservoirs per year; and develop a library of aged non-SNM materials from stockpiled weapons and develop techniques to test and predict changes. Up to 2,500 non-SNM samples, including uranium, would be stored and characterized.

Fabrication of Metallic and Ceramic Items. LANL would, on an annual basis, fabricate stainless steel and beryllium components for approximately 80 plutonium pits, 200 reservoirs for tritium, components for up to 50 secondary assemblies (of depleted uranium, depleted uranium alloy, enriched uranium, deuterium, and lithium), nonnuclear components for research and development (50 to 100 major hydrotests and 50 joint test assemblies, beryllium targets at a slightly increased level over the No Action Alternative, targets and other components for accelerator production of tritium research, test storage containers for nuclear materials stabilization, and nonnuclear (stainless steel and beryllium) components for up to 20 plutonium pit rebuilds.

In addition, all of the alternatives include construction, renovation, and modification projects that are underway and planned in the near term for the purpose of maintaining the availability and viability of the Sigma Complex, as described under the No Action Alternative, section 3.1.5.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.2.6 Materials Science Laboratory

The MSL is described in chapter 2 (section 2.2.2.6). Under the Expanded Operations Alternative, the following activities would occur at this facility.

Materials Processing. LANL would maintain seven of eight materials processing activities at current levels of research; these activities are: wet chemistry, thermomechanical processing, microwave processing, heavy equipment materials, single crystal growth, amorphous alloys, and powder processing. LANL would expand its materials synthesis/processing activity to develop cold mock-up of weapons assembly and processing and to develop environmental and waste management technologies.

Mechanical Behavior in Extreme Environments. In addition, LANL would continue mechanical testing, fabrication, and assembly at current levels of research. Dynamic testing would be expanded to include research and development on the aging of weapons materials, and a new research capability in machining technology would be developed.

Advanced Materials Development. LANL would continue activities in materials, synthesis and characterization, ceramics, and superconductors at current levels of research.

Materials Characterization. LANL would also continue four of its six materials characterization activities at current levels of operation. These are: surface science chemistry, x-ray, optical metallography, and spectroscopy. Corrosion characterization would be expanded to develop surface modification technology and electron microscopy would be expanded to develop plasma source ion implantation.

3.2.7 Target Fabrication Facility

The Target Fabrication Facility is described in chapter 2 (section 2.2.2.7). Under the Expanded Operations Alternative, the following activities would occur at this facility.

Precision Machining and Target Fabrication. LANL would provide targets and specialized components for approximately 2,400 laser and physics tests per year, including a 10 to 20 percent annual growth in DoD and high explosives pulsed-power target operations for the next 10 years. This level of operations would include a 20 percent increase (over No Action Alternative levels) in high explosives pulsed-power target operations and approximately 100 high-energy density physics tests per year.

Polymer Synthesis. LANL would produce polymers for targets and specialized components for approximately 2,400 laser and physics tests per year, including a 10 to 20 percent annual growth in DoD and high explosives pulsed-power target operations for the next 10 years. This level of operations would include a 20 percent increase (over No Action Alternative levels) in high explosives pulsed-power target operations and approximately 100-high energy density physics tests per year.

Chemical and Physical Vapor Deposition. LANL would coat targets and specialized components for approximately 2,400 laser and physics tests per year, including a 10 to 20 percent annual growth in DoD and high explosives pulsed-power target operations for the next 10 years. This level of operations would include a 20 percent increase (over No Action Alternative levels) in high explosive pulsed-power target operations and approximately 100 high-energy density physics tests per year. This also would support plutonium pit manufacturing operations (as discussed in section 3.2.1).

3.2.8 Machine Shops

The Machine Shops are described in section 2.2.2.8. Under the Expanded Operations Alternative, the following activities would occur at these facilities.

The Machine Shops would provide fabrication support for the dynamic experiments program and explosive research studies, support up to 100 hydrodynamic tests annually, manufacture 50 joint test assembly sets annually, and provide general laboratory fabrication support as requested. LANL would also continue its fabrication activities using unique and unusual materials and provide appropriate dimensional inspection of these activities at a level up to 3 times that of the No Action Alternative. In addition, LANL would undertake additional types of measurements and inspections in its dimensional inspection of fabricated components.

3.2.9 High Explosives Processing Facilities

The High Explosives Processing Facilities are described in chapter 2 (section 2.2.2.9). Activities under this alternative would require an estimated 82,700 pounds (37,500 kilograms) of explosives and 2,910 pounds (1,320 kilograms) of mock explosives annually (this is an indicator of overall activity levels in this key facility). Under the Expanded Operations Alternative, the following activities would occur at these facilities.

High Explosives Synthesis and Production. LANL would increase by 50 percent over the No Action Alternative level of high explosives synthesis and production research and development, produce new materials, and formulate plastic-bonded explosives as needed. Process development would increase over the No Action Alternative level and materials would be produced for research and stockpile applications.

High Explosives and Plastics Development and Characterization. LANL would evaluate stockpile returns and increase by 40 percent (over No Action Alternative levels) efforts in development and characterization of new plastics and high explosives for stockpile improvement. LANL would also increase its efforts to improve its predictive capabilities and conduct research into high explosives waste treatment methods over No Action Alternative levels.

High Explosives and Plastics Fabrication. LANL would increase its stockpile surveillance and process development by 40 percent and double the supply of parts to Pantex for surveillance and WR rebuilds and joint test assemblies over No Action Alternative levels. Fabrication for hydrodynamic and environmental testing would be increased by 50 percent over No Action Alternative levels.

Test Device Assembly. Operations would be increased over current levels to support stockpile related hydrodynamic tests, joint test assemblies, environmental and safety tests, and research and development activities. Approximately 100 major hydrodynamic test device assemblies would be supported annually.

Safety and Mechanical Testing. Safety and environmental testing related to stockpile assurance would be increased by 50 percent over No Action Alternative levels and predictive models would be improved. Approximately 15 safety and mechanical tests would be conducted annually.

Research, Development, and Fabrication of High-Power Detonators. LANL would increase efforts to support SSM activities, manufacture up to 40 major product lines per year, and support DOE-wide packaging and transportation of electro-explosive devices.

3.2.10 High Explosives Testing

High explosives testing is described in section 2.2.2.10. This alternative includes about 1,800 experiments per year, 100 of which would be characterized as major hydrodynamic tests. In addition to smaller quantities of other materials, up to 6,900 pounds (3,130 kilograms) of depleted uranium would be expended in experiments annually. As these numbers indicate, overall high explosives test activity would be about three times that under the No Action Alternative. Under the Expanded Operations Alternative, the following activities would occur.

Hydrodynamic Tests. LANL would increase the number of hydrodynamic tests (over the No Action Alternative), develop containment technology, and conduct tests of weapons configurations. These would include up to 100 major hydrodynamic tests per year.

Dynamic Experiments. LANL would increase these experiments by approximately 50 percent (over No Action Alternative levels) the number of dynamic experiments to study properties and enhance understanding of the basic physics of state and motion for materials used in nuclear weapons, including some experiments with SNMs.

Explosives Research and Testing. Up to twice as many high explosives tests would be conducted as under the No Action Alternative to characterize explosive materials.

Munitions Experiments. As under the No Action Alternative, LANL would continue to support DoD in conventional munitions, conducting experiments with projectiles and studying other effects of munitions.

High Explosives Pulsed-Power Experiments. LANL would conduct up to twice as many high explosives pulsed-power experiments and development tests.

Calibration, Development, and Maintenance Testing. LANL would conduct up to twice as many tests to provide calibration data, instrumentation development, and maintenance of image processing capability.

Other Explosives Testing. LANL would conduct 50 percent more advanced high explosives or weapons evaluation studies than under the No Action Alternative.

The operation of the DARHT facility is included in all alternatives.

3.2.11 Los Alamos Neutron Science Center

LANSCE is described in chapter 2 (section 2.2.2.11). Under the Expanded Operations Alternative, the following activities would occur at this facility.

Accelerator Beam Delivery, Maintenance, and Development. LANSCE would deliver a linear accelerator beam to Areas A, B, and C; the WNR buildings; the Manuel Lujan Center; the dynamic test facility; and a new Isotope Production Facility for 10 months each year (6,400 hours). The H^+ beam current would be 1,250 microamps and the H^- beam current would be 200 microamps. The beam delivery and support equipment would be reconfigured to support new facilities, upgrades, and experiments.

A 40-million electron volt LEDA would be built and operated in an existing facility (TA–53–365) for 10 to 15 years, operating up to approximately 6,600 hours per year, as described under the No Action Alternative, section 3.1.11.

Experimental Area Support. Support activities would continue, consistent with the levels of operation under this alternative (same activities as those described under the No Action Alternative). Remote handling and packaging of radioactive materials and wastes at LANSCE would increase to handle waste generation that results from the facility construction and modifications at LANSCE under this alternative (as discussed later in this section).

Neutron Research and Technology. LANL would conduct 1,000 to 2,000 different experiments annually, using neutrons from the Manuel Lujan Center, WNR, and the Long-Pulse Spallation Source (LPSS). The LPSS would be a new experimental facility that would provide advanced capabilities for neutron scattering and subatomic physics using cold and ultracold neutrons. Together with the SPSS at the Manuel Lujan Center, the LPSS would provide U.S. scientists with a complementary pair of neutron sources for research in materials, biological, and nuclear science.

The LPSS neutron production system, which would be located in Area A, would consist of a tungsten target, moderators, and a reflector surrounded by a large iron and concrete biological shield. The Area A building has 100,000 square feet (9,300 square meters) of space and a usable height of 45 feet (14 meters). No modifications would be required to the building or floor of Area A, but existing experimental stations and other equipment in Area A would have to be dismantled and removed, including Area A experimental stations, the Neutrino Scintillation Detector Station, and Area A shielding. This removal of existing experimental stations, instrumentation, and related hardware would generate an estimated 118,000 cubic feet (3,300 cubic meters) of suspect contaminated concrete that would be disposed at TA–54/Area G (8,400 tons [7,620 metric tons], 420 shipments), and another 48,000 cubic feet (1,350 cubic meters) of activated metals and debris (for which 200 Type B cask shipments would be required, and 900 low specific activity and Type A shipments, all to TA–54).

As part of the LPSS project, the linear accelerator would be upgraded to deliver an average proton current of 1.25 milliampere (versus 1.0 at present), for a power of 1.0 megawatt (versus 0.8 at present). This upgrade would increase LANSCE electricity and cooling water requirements.

The LPSS design would use an evacuated target cell that would largely eliminate short-lived activation products. This newer design would decrease radioactive air emissions by an order of magnitude (per unit basis of microampere-hours of linear accelerator operation). This design would result in LPSS operations contributing no more than 1 millirem per year to the dose received by the maximally exposed individual defined for LANSCE. (The term "maximally exposed individual" is discussed in the Air Quality sections of chapters 4 and 5).

The LPSS target, moderators, and hot cell would be constructed inside Building 53–003M, and would thus require no additional land disturbance. There would be no change from the current industrial use of these disturbed areas.

LANL also would construct and operate a Dynamic Experiment Laboratory (DEL) to provide both neutron and proton radiography and resonance neutron spectroscopy of materials for the study of dynamic materials phenomena under a single roof. Such techniques are currently employed for experiments at LANSCE but in varying locations; they complement x-ray radiographic and other techniques for dynamic materials studies used at LANL and other DOE facilities. The DEL also would provide improved support for these experiments and some added capabilities. It would provide more effectively utilized physical space and dedicated infrastructure for these experiments; it would enable proton radiography experiments to use beam from the Proton Storage Ring, thereby reducing interference of these experiments with other LANSCE uses and increasing the beam intensity available for proton radiography; and it would incorporate gas guns to enable additional shock wave experiments and simplify some such experiments. The DEL would be constructed as a new facility adjacent to WNR. It would make use of existing LANSCE infrastructure, including the 800-million electron volt linear accelerator, the Proton Storage Ring, and existing personnel.

The proton radiography experimental program requires a containment vessel, beam tubes in the upstream and downstream lenses, three beam axes with two matching lenses and two downstream lenses on each axis, and a gas gun pointing at the center of the containment vessel. The resonance neutron spectroscopy and neutron radiography experiments require a neutron production target and moderator, a flight path about 66 feet (20 meters) in length, and a gas gun pointing at the center of the containment vessel.

A high explosives assembly area and magazine would be attached to the outside of DEL, with an explosion-proof door separating the two. Separate from DEL with its high explosives areas, a counting house and a building for support equipment (e.g., power supplies, deionized water system) would be needed. This laboratory would be established in a previously disturbed area. There would be no change from the current industrial use of these areas.

LANL would also conduct an accelerator production of tritium target neutronics experiment for 6 months. In addition, LANL would continue to support contained weapons-related experiments using small to moderate quantities of high explosives. These experiments would include:

- Experiments with nonhazardous materials and small quantities of high explosives (up to approximately 200 per year)
- Experiments with up to 10 pounds (4.54 kilograms) of high explosives and/or depleted uranium (up to approximately 60 per year)
- Experiments with small quantities of actinides, high explosives, and sources (up to approximately 80 per year)
- Shockwave experiments involving small amounts, up to nominally 1.8 ounces (50 grams), of plutonium

In addition, LANL would provide support for static stockpile surveillance technology research and development.

Accelerator-Driven Transmutation Technology. LANL would conduct lead target tests for 2 years at the Area A beam stop, as well as the 1 megawatt target/blanket experiments, as described in section 3.1.11. Once these experiments were completed, LANL would construct a 5-megawatt target/blanket experimental area (referred to as the Los Alamos International Facility for Transmutation [LIFT]) adjacent to Area A, and conduct 5-megawatt experiments for 10 months per year for 4 years.

LIFT would be used to demonstrate the practicality of using accelerator technology to transmute plutonium and high-level radioactive wastes into other elements or isotopes. LIFT would be constructed adjacent to Area A in a previously disturbed area. There would be no change from the current industrial use of these areas.

Subatomic Physics Research. LANL would conduct five to ten physics experiments annually at the Manuel Lujan Center, WNR, and LPSS and conduct proton radiography experiments. Proton radiography experiments would include contained experiments using small to moderate quantities of high explosives similar to those discussed above under Neutron Research and Technology.

Medical Isotope Production. Up to approximately 50 targets per year would be irradiated for medical isotope production and exotic and neutron rich/deficient isotopes would be produced.

In addition, LANL would establish the Exotic Isotope Production Facility in an existing facility, which would complement the 100-million electron volt IPF by using the 800-million electron volt proton beam available at the end of the half-mile-long linear accelerator to fabricate radioisotopes used by the medical community for diagnostic and other procedures. This facility would be established within an existing building and would not result in either land disturbance or a change from the current industrial land use of these areas.

Also under the Expanded Operations Alternative, Area A East would be stripped of existing contaminated and uncontaminated items so that it could be put to use as a staging area for shipments, receipts, equipment storage, and limited maintenance activities. (This portion of Experimental Area A currently houses a beam stop, shielding, and equipment related to isotope production and materials irradiation activities.) Removal of existing items would generate wastes for disposal, including an estimated 50,000 cubic feet (1,400 cubic meters) of suspect contaminated concrete, 20,000 cubic feet (560 cubic meters) of activated metal used for shielding, and another 14,000 cubic feet (400 cubic meters) of equipment and debris. Wastes would total an estimated 1,700 tons (1,540 metric tons), the disposal of which would require 200 Type B cask shipments, 530 Type A shipments, and 290 low specific activity shipments, all to TA–54.

High-Power Microwaves and Advanced Accelerators. Research and development in this area would be conducted at the same levels described under the No Action Alternative.

Under all alternatives, the following facilities (as described under the No Action Alternative, section 3.1.11 and in chapter 2, section 2.2.2.11) would be constructed and operated (based on previous NEPA reviews):

- LEDA
- Proton radiography and neutron spectroscopy facilities
- IPF relocation
- SPSS enhancement

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.2.12 Health Research Laboratory

The HRL is described in chapter 2 (section 2.2.2.12). Under the Expanded Operations Alternative, the following activities would occur at this facility.

Genomic Studies. LANL would increase genomic studies at HRL by approximately 25 percent over the No Action Alternative level.

Cell Biology. LANL would increase its research activities by approximately 40 percent above the No Action Alternative level.

Cytometry. LANL's research utilizing laser imaging systems to analyze the structures and functions of subcellular systems would increase by approximately 33 percent.

DNA Damage and Repair. Research using isolated cells to investigate DNA repair mechanisms would increase by approximately 40 percent above the No Action Alternative levels.

Environmental Effects. LANL would conduct research that identifies specific changes in DNA and proteins in certain microorganisms that occur after events in the environment at a level approximately 25 percent higher than the No Action Alternative.

Structural Cell Biology. LANL would conduct research utilizing chemical and crystallographic techniques to isolate and characterize the three-dimensional shapes and properties of DNA and protein molecules at a level approximately 50 percent higher than the No Action Alternative.

Neurobiology. LANL's activities in neurobiology, conducting research using magnetic fields produced in active areas of the brain to map human brain locations associated with certain sensory and cognitive functions, would be increased to three times that of the No Action Alternative.

In-Vivo Monitoring. LANL would conduct 3,000 whole-body scans annually as a service that supports operations with radioactive materials conducted elsewhere at LANL.

3.2.13 Radiochemistry Facility

The Radiochemistry Facility is described in chapter 2 (section 2.2.2.13). As an indicator of overall activity levels, these operations would be expected to require about 250 FTEs. Under the Expanded Operations Alternative, the following activities would occur at this facility.

Radionuclide Transport. LANL would conduct 80 to 160 of these studies annually.

Environmental Remediation. Environmental remediation activities would approximately double the No Action Alternative level of operations.

Ultra-Low-Level Measurements. These activities would be at approximately double the No Action Alternative level.

Nuclear/Radiochemistry. These operations would be slightly more than the No Action Alternative levels.

Isotope Production. LANL would conduct target preparation, irradiation, and processing to recover medical and industrial application isotopes at a level approximately double that of the No Action Alternative.

Actinide/Transuranic Chemistry. LANL would also perform radiochemical separations at approximately twice the No Action Alternative level of operations.

Data Analysis. LANL would reexamine archive data and measure nuclear process parameters of interest to weapons radiochemists at approximately twice the No Action Alternative level.

Inorganic Chemistry. LANL would conduct synthesis, catalysis, and actinide chemistry activities at a level approximately 50 percent higher than that of the No Action Alternative.

Structural Analysis. LANL would perform these activities at approximately twice the No Action Alternative level of operation.

Sample Counting. LANL's sample counting activity would be the same as the No Action Alternative.

3.2.14 Radioactive Liquid Waste Treatment Facility

The RLWTF is described in chapter 2 (section 2.2.2.14). Under the Expanded Operations Alternative, the following activities would occur at this facility.

Waste Characterization, Packaging, and Labeling. Under this alternative, as under the No Action Alternative, LANL would support, certify, and audit generator characterization programs and maintain the WAC for the RLWTF.

Waste Transport, Receipt, and Acceptance. LANL would also collect radioactive liquid waste from generators and transport it to the RLWTF in TA–50.

Radioactive Liquid Waste Pretreatment. LANL would pretreat 238,000 gallons (900,000 liters) of RLW per year at TA–21; 21,100 gallons (80,000 liters) of RLW per year at TA–50; and solidify, characterize, and package 106 cubic feet (3 cubic meters) of TRU waste sludge per year at TA–50.

Radioactive Liquid Waste Treatment. LANL would install equipment for nitrate reduction in mid 1999, treat 9.24 million gallons (35 million liters) of RLW per year; dewater, characterize, and package 353 cubic feet (10 cubic meters) of LLW sludge per year; and solidify, characterize, and package 1,130 cubic feet (32 cubic meters) of TRU waste sludge per year.

Decontamination Operations. LANL would:

- Decontaminate personnel respirators for reuse (approximately 700 per month).
- Decontaminate air-proportional probes for reuse (approximately 300 per month).
- Decontaminate vehicles and portable instruments for reuse (as required).
- Decontaminate precious metals for resale (acid bath).
- Decontaminate scrap metals for resale (sand blast).
- Decontaminate 7,060 cubic feet (200 cubic meters) of lead for reuse (grit blast).

Three modifications were recently completed or are planned for the RLWTF: an upgrade to the influent tank system, installation of a new process for treatment of RLW, and installation of additional treatment steps for removal of nitrates. These have all been previously reviewed under NEPA and are included in all of the SWEIS alternatives as described under the No Action Alternative, section 3.1.14, and in chapter 2, section 2.2.2.14.

3.2.15 Solid Radioactive and Chemical Waste Facilities

The Solid Radioactive and Chemical Waste Facilities are described in chapter 2 (section 2.2.2.15). Under the Expanded Operations Alternative, the following activities would occur at these facilities.

Waste Characterization, Packaging, and Labeling. Under this alternative, as under the No Action Alternative, LANL would support, certify, and audit generator characterization programs and maintain the WAC for LANL waste management facilities. At the Solid Radioactive and Chemical Waste Facilities, LANL would characterize 26,800 cubic feet (760 cubic meters) of legacy LLMW; characterize 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste; verify characterization data at the RANT Facility, for unopened containers of LLW and TRU waste; maintain the WAC for off-site treatment, storage, and disposal facilities; and overpack and bulk waste containers.

As under the No Action Alternative, LANL would also perform coring and visual inspection of a percentage of TRU waste packages, ventilate 16,700 drums of TRU waste retrieved during the TWISP, and maintain the current version of the WIPP WAC and coordinate with WIPP operations.

Compaction. LANL would compact up to 896,600 cubic feet (25,400 cubic meters) of LLW.

Size Reduction. In addition, 102,400 cubic feet (2,900 cubic meters) of TRU waste would be reduced in size at the WCRR Facility in TA–50 and the Drum Preparation Facility in TA–54.

Waste Transport, Receipt, and Acceptance. LANL would collect chemical and mixed wastes from LANL generators and transport them to TA–54. LANL would ship 35,260 tons (32,000 metric tons) of chemical wastes and

128,500 cubic feet (3,640 cubic meters) of LLMW for off-site treatment and disposal in accordance with EPA land disposal restrictions. Beginning in 1999, 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste would be shipped to WIPP. LANL would also ship 192,700 cubic feet (5,460 cubic meters) of TRU waste generated as a result of future operations and research to WIPP. LANL would not ship LLW or environmental restoration soils for off-site disposal.

Waste Storage. As under the No Action Alternative, prior to shipment to off-site treatment, storage, and disposal facilities, LANL would store chemical and mixed wastes. LANL would also store legacy TRU waste until WIPP is opened for disposal; LLMW until treatment facilities are available; and LLW uranium chips until sufficient quantities were accumulated for stabilization campaigns.

Waste Retrieval. LANL would retrieve 165,900 cubic feet (4,700 cubic meters) of TRU waste from Pads 1, 2, and 4 by 2004 (same level as the No Action Alternative).

Other Waste Processing. LANL would demonstrate treatment (e.g., electrochemical) of LLMW liquids, land farm oil-contaminated soils at Area J, stabilize 30,700 cubic feet (870 cubic meters) of uranium chips, provide special case treatment for 36,360 cubic feet (1,030 cubic meters) of TRU waste, and solidify 100,600 cubic feet (2,850 cubic meters) of LLMW (environmental restoration soils) for disposal at Area G.

Disposal. LANL would dispose of 14,830 cubic feet (420 cubic meters) of LLW in shafts at Area G, 4,060,000 cubic feet (115,000 cubic meters) of LLW and small quantities of radioactively contaminated PCBs in disposal cells at Area G, approximately 3,530 cubic feet (100 cubic meters) of administratively controlled industrial solid wastes in cells at Area J annually, and nonradiological classified wastes in shafts at Area J. In addition, LLW disposal operations in Area G would be expanded.

Existing disposal capacity is projected to be filled before 2000. Under the Expanded Operations Alternative, Area G would be expanded to allow continued disposal of LLW at LANL. Five siting and construction alternatives for expanded disposal operations are discussed in the PSSC analysis for Expansion of TA–54/Area G Low-Level Disposal Area in the SWEIS, volume II, part I. Expansion into Zones 4 and 6 in Area G is identified as DOE's preferred expansion alternative in that analysis.

In addition, under all alternatives, LANL would construct storage domes for TRU wastes recovered from Pads 1, 2, and 4. This is described under the No Action Alternative, section 3.1.15.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.3 REDUCED OPERATIONS ALTERNATIVE

The Reduced Operations Alternative reflects minimum levels of activity to maintain the capabilities necessary to support LANL's assigned missions. This activity level is a projection from the index established for past operations and represents a level that is possible if funding is reduced. In some cases, the selected index was the best available for most operations at LANL, but could not reasonably be adjusted from the historical record to account for capabilities insufficiently exercised during that period. In those cases, the Reduced Operations activity may reflect an increase over the index (although no greater than that under the No Action Alternative).

This alternative does not eliminate assigned missions or programs, but results in reduced technology demonstration activities and/or a decline in technological capability. In the long term, implementation of the Reduced Operations Alternative could reduce LANL capabilities below those required to fully meet its existing assigned missions.

For this alternative, LANL operations would be reduced to the minimum necessary to maintain safety and security activities such as the maintenance of nuclear materials, high explosives, or other hazardous materials in storage or use at LANL. Under this alternative, for example, plutonium processing activities would be reduced, but would occur at a level that could still support the safe, secure maintenance of the plutonium inventory.

Construction (including facility modification) projects that are required to maintain LANL activities, even at a reduced level, are included in this alternative. Some construction projects also may be required to support consolidation of some operations to fewer facilities or within a currently used facility, resulting in a reduced "footprint." These construction and upgrade activities are identified in the descriptions of activities under this alternative for each of the key facilities. This SWEIS constitutes the entire NEPA review for these projects.

3.3.1 Plutonium Facility Complex

The Plutonium Facility Complex (TA–55) is described in chapter 2 (section 2.2.2.1). Under the Reduced Operations Alternative, the following activities would occur at this complex.

Plutonium Stabilization. LANL would recover, process, and store its existing plutonium residue inventory in 10 to 15 years.

Manufacturing Plutonium Components. LANL would produce 6 to 12 plutonium pits per year in order to maintain the technical capability to understand pit characteristics and behavior. In addition, it would fabricate other parts and samples for research and development at the same levels as under the No Action Alternative.

Surveillance and Disassembly of Weapons Components. As under the No Action Alternative, LANL would disassemble up to 40 plutonium pits per year (including up to 20 pits destructively examined). Up to 20 pits would be nondestructively examined.

Actinide Materials Science and Processing Research and Development. As under the No Action Alternative, LANL would continue to conduct research on plutonium (and other actinide) materials. The types and levels of these activities are the same under this alternative as under the No Action Alternative. LANL would demonstrate the disassembly/ conversion of 1 to 2 pits per day (up to 40 pits total) using hydride-dehydride processes. Up to 500 curies of neutron sources (plutonium-239/ beryllium and americium-241/beryllium) would be processed to maintain capability; LANL would retain the capability to process actinides and undertake tritium separation from metals, but would not use these capabilities. LANL would perform decontamination of 15 to 20 uranium components per month.

Research in support of DOE's actinide clean-up activities and on actinide processing and waste activities at DOE sites would be conducted, although support to other sites would be less than under the No Action Alternative. As under the No Action Alternative, LANL would stabilize minor quantities of specialty items and residues from other DOE sites; fabricate and study small amounts of nuclear fuels used in terrestrial and space reactors; fabricate and study prototype fuel for lead test assemblies; continue to develop safeguards instrumentation for plutonium assay; and analyze samples.

Fabrication of Ceramic-Based Reactor Fuels. LANL would conduct MOX and other fuel research and development.

Plutonium-238 Research, Development, and Applications. LANL would process, evaluate, and test up to 15.4 pounds (7 kilograms) of plutonium-238 per year in production of materials and parts to support space and terrestrial uses. In addition, up to 1.1 pounds (0.5 kilograms) of plutonium-238 per year would be processed to recover material from heat sources and milliwatt generators, research and development, and safety testing.

Storage, Shipping, and Receiving. The NMSF is to be renovated to perform as originally intended: to serve as a vault for the interim storage of up to 7.3 tons (6.6 metric tons) of the LANL SNM inventory, mainly plutonium. The NMSF renovation is included in all alternatives.

Under all alternatives, the Plutonium Facility would be renovated to ensure the continued availability of existing capabilities as described under the No Action Alternative, section 3.1.1.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.3.2 Tritium Facilities

The Tritium Facilities are described in chapter 2 (section 2.2.2.2). Under the Reduced Operations Alternative, the following activities would occur at these facilities.

High-Pressure Gas Fills and Processing. LANL would handle and process tritium gas in quantities of up to 3.53 ounces (100 grams) at the WETF approximately 20 times per year.

Gas Boost System Testing and Development. Approximately 15 times per year, LANL would conduct gas boost system research, development, and testing and gas processing operations at WETF involving quantities of up to to 100 grams of tritium.

Cryogenic Separation. At TSTA, LANL would purify and process tritium gas in quantities of up to 7.06 ounces (200 grams) once per year using cryogenic separation.

Diffusion and Membrane Purification. LANL would conduct research on tritium movement and penetration through materials including major experimental efforts approximately 2 to 3 times per month.

Metallurgical and Material Research. LANL would also conduct metallurgical and materials research involving tritium including research and application studies regarding tritium storage (same as the No Action Alternative).

Thin Film Loading. In addition, LANL would use its thin film loading capability (involving chemically bonding tritium to a metallic surface) for tritium loading of neutron tube targets, processing approximately 800 units per year (same as the No Action Alternative).

Gas Analysis. LANL's activities to measure the composition and quantities of gases used would continue in support of tritium operations.

Calorimetry. LANL's calorimetry measurements (a nondestructive method of measuring the amount of tritium in a container) would also continue in support of tritium operations.

Solid Material and Container Storage. Tritium would continue to be stored on site in WETF, TSTA, and TSFF.

Under all alternatives, LANL would remodel Building 16-450 and connect it to WETF in support of neutron tube target loading.

3.3.3 Chemistry and Metallurgy Research Building

The CMR Building is described in chapter 2 (section 2.2.2.3). Under the Reduced

Operations Alternative, the following activities would occur at this facility.

Analytical Chemistry. LANL would provide sample analysis in support of actinide research and processing activities, processing approximately 5,200 samples per year (same as the No Action Alternative).

Uranium Processing. LANL would conduct activities to recover, process, and store LANL's highly enriched uranium inventory over the next 10 to 15 years.

Destructive and Nondestructive Analysis. Up to a total of 10 secondary assemblies (1 per year) would be evaluated through destructive and nondestructive analysis and disassembly (same as the No Action Alternative).

Nonproliferation Training. Reducing from the No Action Alternative level, LANL would also conduct some nonproliferation training using the same quantities of SNM as under the No Action Alternative.

Actinide Research and Processing. LANL would maintain its capabilities for plutonium-238/beryllium and americium-241/beryllium neutron source processing, but annual throughput would not exceed a total of 2,000 curies at the CMR Building. In addition, up to a total of 1,000 plutonium-238/beryllium and neutron sources would be staged in CMR Building Wing 9 floor holes. LANL would retain its capability for research and development activities on spent nuclear fuels. Further, LANL would characterize approximately 25 samples per year using metallurgical microstructural/chemical analysis and would conduct compatibility testing of actinides and other metals in order to study long-term aging and other material effects. LANL would also conduct analysis of TRU waste disposal related to the validation of WIPP performance assessment models, characterize TRU waste, and analyze gas generation such as that which could occur during transportation to WIPP.

Fabrication and Metallography. LANL would produce 50 targets per year for production of molybdenum-99, with each target containing approximately 0.71 ounces (20 grams) of uranium-235. The targets would be stored. In addition, LANL would support highly enriched uranium processing, research and development, pilot operations, and casting and fabrication of metal shapes using from 2.2 to 22 pounds (1 to 10 kilograms) of highly enriched uranium in each operation, with an annual throughput of approximately 2,200 pounds (1,000 kilograms) (which would remain in the LANL material inventory).

In addition, the four projects currently in development or implementation at the CMR Building are included in all alternatives, as described under the No Action Alternative, section 3.1.3.

3.3.4 Pajarito Site (Los Alamos Critical Experiments Facility)

The Pajarito Site is described in chapter 2 (section 2.2.2.4). Under the Reduced Operations Alternative, the following activities would occur at this facility.

Under the Reduced Operations Alternative as under the No Action Alternative, LANL would continue to conduct experiments and tests in all of the areas described in section 2.2.2.4. In 1997, as with the No Action Alternative, up to 570 experimental operations would be expected, with a 5 percent annual growth after that. LANL would also develop safeguards instrumentation and perform research and development activities for SNM, light detection and ranging experiments, materials processing, interrogation techniques, and field systems.

3.3.5 Sigma Complex

The Sigma Complex is described in section 2.2.2.5. The Reduced Operations Alternative for the Sigma Complex is the same as the No Action Alternative, as described in section 3.1.5.

3.3.6 Materials Science Laboratory

The MSL is described in section 2.2.2.6. Under the Reduced Operations Alternative, the following activities would occur at this facility.

Materials Processing. LANL would continue materials processing research at the MSL; these capabilities are: synthesis and processing techniques, wet chemistry, thermomechanical processing, microwave processing, heavy equipment materials, single crystal growth, amorphous alloys, and powder processing. However, there would be a decrease in the number of experiments conducted in these research capabilities as compared to the No Action Alternative.

Mechanical Behavior in Extreme Environments. LANL would continue mechanical testing, dynamic testing, and fabrication and assembly research, although there would be a decrease in the number of experiments conducted, as compared to the No Action Alternative.

Advanced Materials Development. LANL would continue research into materials, synthesis and characterization, ceramics, and superconductors activities, although there would be a significant decrease in the number of experiments conducted, as compared to the No Action Alternative.

Materials Characterization. LANL would also continue two of its materials characterization activities (surface science chemistry and corrosion characterization), although there would be a decrease in the number of experiments conducted, as compared to the No Action Alternative. Electron microscopy, x-ray, optical metallography, and spectroscopy capabilities would be eliminated.

3.3.7 Target Fabrication Facility

The TFF is described in chapter 2 (section 2.2.2.7). Under the Reduced Operations Alternative, the following activities would occur at this facility.

Precision Machining and Target Fabrication. LANL would provide targets and specialized components for approximately 400 laser and high-energy density physics tests per year.

Polymer Synthesis. LANL would produce polymers for targets and specialized components for approximately 400 laser and high-energy density physics tests per year.

Chemical and Physical Vapor Deposition. LANL would coat targets and specialized components for approximately 400 laser and high-energy density physics tests per year. Support for pit manufacturing operations would be the same as under the No Action Alternative.

3.3.8 Machine Shops

The Machine Shops are described in section 2.2.2.8. Under the Reduced Operations Alternative, the following activities would occur at these facilities.

The Machine Shops would provide fabrication support for the dynamic experiments program and explosive research studies, support up to 30 hydrodynamic tests annually, manufacture 20 to 40 joint test assembly sets annually, and provide general laboratory fabrication support as requested. LANL would also continue its fabrication activities using unique and unusual materials and provide appropriate dimensional inspection of these activities. (These activity levels are about the same as under the No Action Alternative.)

3.3.9 High Explosives Processing Facilities

The High Explosives Processing Facilities are described in section 2.2.2.9. Under this alternative, 19,400 pounds (8,800 kilograms) of explosives and 1,150 pounds (520 kilograms) of mock explosives would be used annually (as an indicator of overall activity levels in this key facility). Under the Reduced Operations Alternative, the following activities would occur at these facilities.

High Explosives Synthesis and Production. LANL would reduce its current level of high explosives synthesis and production research and development, production of new materials and formulation of plastic-bonded explosives by approximately 60 percent. Process development would decrease from current levels, and materials production for research and stockpile applications would continue at a reduced level (approximately 60 percent of the No Action Alternative).

High Explosives and Plastics Development and Characterization. LANL would evaluate stockpile returns and decrease efforts in development and characterization of new plastics and high explosives for stockpile improvement. LANL would also conduct research into high explosives waste treatment methods, with the overall level of effort reduced to about 60 percent of the No Action Alternative.

High Explosives and Plastics Fabrication. LANL would reduce its traditional stockpile surveillance and process development from No Action Alternative levels by approximately 60 percent. Stockpile surveillance fabrication for hydrodynamic and environmental testing would be reduced to approximately 75 percent of the No Action Alternative levels.

Test Device Assembly. Operations would be the same as the No Action Alternative levels. Approximately 30 major hydrodynamic test devices would be assembled annually.

Safety and Mechanical Testing. Safety and environmental testing related to stockpile assurance would be reduced to approximately 80 percent of No Action Alternative levels, and predictive models would be improved. Approximately 12 safety and mechanical tests would be conducted annually.

Research, Development, and Fabrication of High-Power Detonators. As with the No Action Alternative, LANL would manufacture up to 20 major product lines per year and support DOE-wide packaging and transportation of electro-explosive devices.

3.3.10 High Explosives Testing

High explosives testing is described in chapter 2 (section 2.2.2.10). The Reduced Operations Alternative for LANL's high explosives testing facilities is the same as the No Action Alternative, as described in section 3.1.10.

3.3.11 Los Alamos Neutron Science Center

The LANSCE is described in section 2.2.2.11. Under the Reduced Operations Alternative, the following activities would occur at this facility.

Accelerator Beam Delivery, Maintenance, and Development. LANSCE would deliver a linear accelerator beam to Areas A, B, and C; WNR buildings; the Manuel Lujan Center; radiography firing sites; and a new IPF for 4 months each year (2,600 hours). The H^+ beam current would be 1,000 microamps and the H^- beam current would be 200 microamps. The beam delivery and support equipment would be reconfigured to support new facilities, upgrades, and experiments.

Under the Reduced Alternative, the LEDA would be operated at 12-million electron volts to demonstrate the practicality of using continuous-wave accelerator beam technology to produce tritium, as an alternative to the historical use of nuclear reactors. It would operate for 2 years, operating up to approximately 1,000 hours per year. This facility would be constructed as described under the No Action Alternative, section 3.1.11.

Experimental Area Support. The same support activities would continue at the same levels as described under the No Action Alternative. Remote handling and packaging of radioactive wastes at LANSCE would be maintained at fiscal year 1994 levels.

Neutron Research and Technology. LANL would conduct 100 to 500 different experiments annually, using neutrons from Manuel Lujan Center and WNR. LANL would continue to support contained weapons-related experiments using small to moderate quantities of high explosives. These experiments would include:

- Experiments with nonhazardous materials and small quantities of high explosives (up to approximately 50 per year)
- Experiments with up to 10 pounds (4.54 kilograms) of high explosives and/or depleted uranium (up to approximately 15 per year)
- Experiments with small quantities of actinides, high explosives, and sources (up to approximately 20 per year)

Accelerator-Driven Transmutation Technology. LANL would conduct basic research using existing LANSCE facilities.

Subatomic Physics Research. LANL would conduct 5 to 10 physics experiments annually at the Manuel Lujan Center and WNR and conduct proton radiography experiments. Proton radiography experiments would include contained experiments using small to moderate quantities of high explosives, similar to those discussed above under Neutron Research and Technology.

Medical Isotope Production. Up to approximately 20 targets per year would be irradiated for medical isotope production.

High-Power Microwaves and Advanced Accelerators. Research and development in this area would be conducted at reduced levels (about 50 percent) as compared to the No Action Alternative levels. Microwave chemistry research for industrial and environmental applications would not be conducted.

Under all alternatives, the following facilities (as described under the No Action Alternative, section 3.1.11, and in chapter 2, section 2.2.2.11) would be constructed and operated (based on previous NEPA reviews):

- LEDA
- Proton radiography and neutron spectroscopy facilities
- IPF relocation
- SPSS enhancement

3.3.12 Health Research Laboratory

The HRL is described in chapter 2 (section 2.2.2.12). Under the Reduced Operations Alternative, the following activities would occur at this facility.

Genomic Studies. LANL would reduce genomic studies at HRL to approximately 20 percent of the No Action Alternative level.

Cell Biology. LANL would decrease research activities to approximately 30 percent of the No Action Alternative level.

Cytometry. LANL's research utilizing laser imaging systems to analyze the structures and functions of subcellular systems would be reduced to approximately 25 percent of the No Action Alternative level.

DNA Damage and Repair. LANL's research using isolated cells to investigate DNA repair mechanisms would be reduced to approximately 30 percent of the No Action Alternative levels.

Environmental Effects. LANL would conduct research that identifies specific changes in DNA and proteins in certain microorganisms that occur after events in the environment to a level approximately 40 percent of than the No Action Alternative.

Structural Cell Biology. LANL would conduct research utilizing chemical and crystallographic techniques to isolate and characterize the three-dimensional shapes and properties of DNA and protein molecules to a level approximately 20 percent of that under the No Action Alternative.

Neurobiology. LANL's activities in neurobiology, conducting research using magnetic fields produced in active areas of the brain to map human brain locations associated with certain sensory and cognitive functions, would be the same as that of the No Action Alternative.

In-Vivo Monitoring. LANL would conduct 500 whole-body scans annually.

3.3.13 Radiochemistry Facility

The Radiochemistry Facility is described in section 2.2.2.13. As an indicator of overall activity levels, these operations would be expected to require about 130 FTEs. Under the Reduced Operations Alternative, the following activities would occur at this facility.

Radionuclide Transport. LANL would conduct 18 to 36 of these studies annually.

Environmental Remediation. Environmental remediation activities would be the same as the No Action Alternative level of operations.

Ultra-Low-Level Measurements. These activities would be slightly lower than the No Action Alternative level.

Nuclear/Radiochemistry. These operations would be approximately half of the No Action Alternative levels.

Isotope Production. LANL would conduct target preparation, irradiation, and processing to recover medical and industrial application isotopes at a level approximately half that of the No Action Alternative.

Actinide/Transuranic Chemistry. LANL also would perform radiochemical separations at half the No Action Alternative level of operations.

Data Analysis. LANL would reexamine archive data and measure nuclear process parameters of interest to weapons radiochemists at a level slightly lower than the No Action Alternative level.

Inorganic Chemistry. LANL would conduct synthesis, catalysis, and actinide chemistry activities the same level as the No Action Alternative.

Structural Analysis. LANL would perform these activities at the No Action Alternative level of operation.

Sample Counting. LANL's sample counting activity would also be the same as the No Action Alternative.

3.3.14 Radioactive Liquid Waste Treatment Facility

The RLWTF is described in chapter 2 (section 2.2.2.14). Under the Reduced Operations Alternative, the following activities would occur at this facility.

Waste Characterization, Packaging, and Labeling. Under the Reduced Operations Alternative, as under the No Action Alternative, LANL would support, certify, and audit generator characterization programs and maintain the WAC for the RLWTF.

Waste Transport, Receipt, and Acceptance. LANL would also collect radioactive liquid waste from generators and transport it to the RLWTF in TA–50.

Radioactive Liquid Waste Pretreatment. LANL would pretreat 158,400 gallons (600,000 liters) of RLW per year at TA–21; 5,280 gallons (20,000 liters) of RLW per year at TA–50; and solidify, characterize, and package 71 cubic feet (2 cubic meters) of TRU waste sludge per year at TA–50.

Radioactive Liquid Waste Treatment. LANL would install equipment for nitrate reduction in mid 1999, treat 5.28 million gallons (20 million liters) of RLW per year; dewater, characterize, and package 247 cubic feet (7 cubic meters) of LLW sludge per year; and solidify, characterize, and package 671 cubic feet (19 cubic meters) of TRU waste sludge per year.

Decontamination Operations. LANL would:

- Decontaminate personnel respirators for reuse (approximately 300 per month).
- Decontaminate air-proportional probes for reuse (approximately 200 per month).
- Decontaminate vehicles and portable instruments for reuse (as required).
- Decontaminate precious metals for resale (acid bath).
- Decontaminate scrap metals for resale (sand blast).
- Decontaminate 6,700 cubic feet (190 cubic meters) of lead for reuse (grit blast).

Three modifications were recently completed or are planned for the RLWTF: an upgrade to the influent tank system, installation of a new process for treatment of RLW, and installation of additional treatment steps for removal of nitrates. These have all been previously reviewed under NEPA and are included in all of the SWEIS alternatives, as described under the No Action Alternative, section 3.1.14 and in chapter 2 (section 2.2.2.14).

3.3.15 Solid Radioactive and Chemical Waste Facilities

The Solid Radioactive and Chemical Waste Facilities are described in section 2.2.2.15. Under the Reduced Operations Alternative, the following activities would occur at these facilities.

Waste Characterization, Packaging, and Labeling. Under the Reduced Operations Alternative, as under the No Action Alternative, LANL would support, certify, and audit generator characterization programs and maintain the WAC for LANL waste management facilities. At the Solid Radioactive and Chemical Waste Facilities, LANL would characterize 26,800 cubic feet (760 cubic meters) of legacy LLMW; characterize 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste; verify characterization data at the RANT Facility for unopened containers of LLW and TRU waste; maintain the WAC for off-site treatment, storage, and disposal facilities; and overpack and bulk waste containers.

As under the No Action Alternative, LANL would also perform coring and visual inspection of a percentage of TRU waste packages, ventilate 16,700 drums of TRU waste retrieved during the TWISP, and maintain the current version of the WIPP WAC and coordinate with WIPP operations.

Compaction. LANL would compact up to 590,000 cubic feet (16,700 cubic meters) of LLW.

Size Reduction. In addition, 91,800 cubic feet (2,600 cubic meters) of TRU waste would be reduced in size at the WCRR Facility in TA–50 and the Drum Preparation Facility in TA–54 (the same level as under the No Action Alternative).

Waste Transport, Receipt, and Acceptance. LANL would collect chemical and mixed wastes from LANL generators and transport them to TA–54. LANL would ship 31,960 tons (29,000 metric tons) of chemical wastes and 126,000 cubic feet (3,570 cubic meters) of LLMW for off-site treatment and disposal in accordance with EPA land disposal restrictions. In addition, LANL would ship 2,578,000 cubic feet (73,030 cubic meters) of LLW for off-site disposal. (This corresponds to shipment of LANL LLW to an off-site [e.g., regional] disposal facility to the extent practicable.) Beginning in 1999, 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste would be shipped to WIPP. LANL would also ship 67,100 cubic feet (1,900 cubic meters) of TRU waste generated as a result of future operations and research to WIPP and 100,600 cubic feet (2,850 cubic meters) of LLMW in environmental restoration soils for off-site solidification and disposal.

Waste Storage. As under the No Action Alternative, prior to shipment to off-site treatment, storage, and disposal facilities, LANL would store chemical and mixed wastes. LANL would also store: legacy TRU waste until WIPP is opened for disposal; LLMW until treatment facilities are available; and LLW uranium chips until sufficient quantities were accumulated for stabilization campaigns.

Waste Retrieval. LANL would retrieve 166,000 cubic feet (4,700 cubic meters) of TRU waste from Pads 1, 2, and 4 by 2004 (same level as the No Action Alternative).

Other Waste Processing. LANL would demonstrate treatment (e.g., electrochemical) of LLMW liquids, land farm oil-contaminated soils at Area J, stabilize 14,500 cubic feet (410 cubic meters) of uranium chips, and provide special case treatment for 23,650 cubic feet (670 cubic meters) of TRU waste. These activities would be the same as under the No Action Alternative.

Disposal. LANL would dispose of 3,530 cubic feet (100 cubic meters) of LLW in shafts at Area G, 98,800 cubic feet (2,800 cubic meters) of LLW and small quantities of radioactively contaminated PCBs in disposal cells at Area G (this is the LANL LLW for which LANL has a unique disposal capability, or for which there is no approved transportation configuration), approximately 3,530 cubic feet (100 cubic meters) of administratively controlled industrial solid wastes in cells at Area J annually, and nonradiological classified wastes in shafts at Area J.

In addition, under all alternatives, LANL would construct storage domes for TRU wastes recovered from Pads 1, 2, and 4. This is described under the No Action Alternative, section 3.1.15.

3.4 GREENER ALTERNATIVE

The name and general description for this alternative were provided by interested citizens as a result of the scoping process. The Greener Alternative uses existing LANL capabilities with an emphasis on basic science, waste minimization and treatment, dismantlement of nuclear weapons, nonproliferation, and other areas of national and international importance. Thus, while similar activities may occur under both the Expanded Operations and Greener Alternatives, the purpose for which the activities would be conducted under the Greener Alternative would focus on science, waste management, and nuclear weapons dismantlement.

This alternative does not change any LANL missions, nor add or eliminate LANL programs or projects. This alternative includes increased activities and operations in areas of emphasis including: neutron science, health and nuclear medicines research, basic science research (e.g., the fundamental nature of matter), waste minimization technologies, environmental restoration technologies, nuclear weapons dismantlement, international nuclear safety, and nonproliferation. These increased activities are combined with the Reduced Operations or No Action levels of defense mission activities at LANL to make up the Greener Alternative.

Construction projects required for LANL support operations are included in the Greener Alternative. Construction also may be necessary to support consolidation of various operations to a reduced "footprint," to optimize some facilities for increased levels of operations, and/or to increase LANL capabilities and capacities as required to accomplish assigned programs, projects, and activities. These construction or upgrade activities are identified insofar as they are associated with key facilities, as described below.

3.4.1 Plutonium Facility Complex

The Plutonium Facility Complex (TA–55) is described in chapter 2 (section 2.2.2.1). Under the Greener Alternative, the following activities would occur at this complex.

Plutonium Stabilization. LANL would recover, process, and store its existing plutonium residue inventory in 8 years.

Manufacturing Plutonium Components. As with the Reduced Operations Alternative, LANL would produce up to 12 plutonium pits per year in order to maintain the technical capability to understand pit characteristics and behavior. In addition, it would fabricate other parts and samples for research and development at the same levels as under the No Action Alternative.

Surveillance and Disassembly of Weapons Components. LANL would disassemble up to 65 pits per year (up to 40 pits would be destructively examined). Up to 20 pits would be nondestructively examined.

Actinide Materials Science and Processing Research and Development. As under the No Action Alternative, LANL would continue to conduct research on plutonium (and other actinide) materials. The types and levels of these activities are the same under this alternative as under the No Action Alternative. LANL would demonstrate the disassembly/ conversion of 1 to 2 pits per day (up to 40 pits total) using hydride-dehydride processes. LANL would expand research in the material disposition technologies to support weapon disassembly. Up to 5,000 curies of neutron sources (plutonium-239/beryllium and americium-241/beryllium) and neutron sources other than sealed sources would be processed. LANL would not process actinides and would not use tritium separation, but would retain these capabilities. LANL would perform decontamination of 10 to 15 uranium components per month.

Research in support of DOE's actinide clean-up activities and on actinide processing and waste activities at DOE sites would be conducted at the same level as the Expanded Operations Alternative. In addition, as under the Expanded Operations Alternative, LANL would stabilize larger quantities of specialty items and residues from other DOE sites. As under the No Action Alternative, LANL would fabricate and study small amounts of nuclear fuels used in terrestrial and space reactors; fabricate and study prototype fuel for lead test assemblies; and analyze samples. As under the Expanded Operations Alternative, LANL would develop safeguards instrumentation for plutonium assay at a level increased from that of the No Action Alternative.

Fabrication of Ceramic-Based Reactor Fuels. LANL would make prototype MOX fuel and would continue research and development on other fuels.

Plutonium-238 Research, Development, and Applications. LANL would process, evaluate, and test up to 55 pounds (25 kilograms) of plutonium-238 per year in production of materials and parts to support space and terrestrial uses. In addition, LANL would recover, recycle, and blend up to 40 pounds (18 kilograms) per year of plutonium-238.

Storage, Shipping, and Receiving. The NMSF is to be renovated to perform as originally intended: to serve as a vault for the interim storage of up to 7.3 tons (6.6 metric tons) of the LANL SNM inventory, mainly plutonium. The NMSF renovation is included in all alternatives.

Under all alternatives, the Plutonium Facility would be renovated to ensure the continued availability of existing capabilities, as described under the No Action Alternative, section 3.1.1.

It is recognized that projects plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.4.2 Tritium Facilities

The Tritium Facilities are described in chapter 2 (section 2.2.2.2). Under the Greener Alternative, the following activities would occur at these facilities.

High-Pressure Gas Fills and Processing. LANL would handle and process tritium gas in quantities of up to 3.53 ounces (100 grams) at the WETF approximately 20 times per year.

Gas Boost System Testing and Development. Approximately 15 times per year, LANL would conduct gas boost system research, development, and testing and gas processing operations at WETF involving quantities of up to to 3.53 ounces (100 grams) of tritium.

Cyrogenic Separation. At TSTA, LANL would purify and process tritium gas in quantities of up to 7.06 ounces (200 grams) in five to six operations per year using cryogenic separation for the purpose of alternative energy development.

Diffusion and Membrane Purification. LANL would conduct research on tritium movement and penetration through materials in including major experimental efforts approximately six to eight experiments per month and continuous use for effluent treatment, with a focus on waste reduction.

Metallurgical and Material Research. LANL also would conduct metallurgical and materials research involving tritium, including research and application studies regarding tritium storage.

Thin Film Loading. In addition, LANL would use its thin film loading capability (involving chemically bonding tritium to a metallic surface) for tritium loading of neutron tube targets, processing approximately 800 units per year using small quantities of tritium (same as the No Action Alternative).

Gas Analysis. LANL's activities to measure the composition and quantities of gases used would increase from the No Action Alternative level in support of tritium operations under this alternative.

Calorimetry. LANL's calorimetry measurements (a nondestructive method of measuring the amount of tritium in a container) would increase (as compared to the No Action Alternative) under this alternative in support of tritium operations.

Solid Material and Container Storage. Tritium would continue to be stored on site in WETF, TSTA, and TSFF.

Under all alternatives, LANL would remodel Building 16–450 and connect it to WETF in support of neutron tube target loading.

3.4.3 Chemistry and Metallurgy Research Building

The CMR Building is described in chapter 2 (section 2.2.2.3). Under the Greener Alternative, the following activities would occur at this facility.

Analytical Chemistry. LANL would provide sample analysis in support of actinide research and processing activities, processing approximately 5,200 samples per year (same as the No Action Alternative).

Uranium Processing. LANL would conduct activities to recover, process, and store LANL's highly enriched uranium inventory over the next 8 years (same as the No Action Alternative).

Destructive and Nondestructive Analysis. Up to a total of 10 secondary assemblies (1 per year) would be evaluated through destructive and nondestructive analysis and disassembly (same as the No Action Alternative).

Nonproliferation Training. LANL would also conduct more nonproliferation training using quantities of SNM than under the No Action Alternative and would possibly use different types of SNM in that training.

Actinide Research and Processing. LANL would process up to 5,000 curies of neutron sources (both plutonium-238/beryllium and americium-241/beryllium sources) per year and would process neutron sources other than sealed sources. In addition, up to a total of 1,000 plutonium-238/beryllium and americium-241/beryllium neutron sources would be staged in CMR Building Wing 9 floor holes. LANL would begin a research and development effort on spent nuclear fuels related to long-term storage and would analyze components in spent and partially spent fuels, including research and development into monitoring of spent reactor fuels. Further, LANL would characterize approximately 50 samples per year using metallurgical microstructural/chemical analysis and would conduct compatibility testing of actinides and other metals in order to study long-term aging and other material effects. LANL would also conduct analysis of TRU waste disposal related to the validation of WIPP performance assessment models, characterize TRU waste, and analyze gas generation such as that which could occur during transportation to WIPP. Further, LANL would demonstrate decontamination technologies for actinide-contaminated soils and materials and develop an actinide precipitation method to reduce mixed wastes in LANL effluents.

Fabrication and Metallography. LANL would produce 1,080 targets per year for production of molybdenum-99, with each target containing approximately 0.71 ounces (20 grams) of uranium-235. In addition, LANL would support highly enriched uranium processing research and development pilot operations and casting and fabricate metal shapes using from 2.2 to 22 pounds (1 to 10 kilograms) of highly enriched uranium in each operation, with an annual throughput of approximately 2,200 pounds (1,000 kilograms) (which would be retained in the LANL material inventory). (These activities are at the same levels as under the No Action Alternative.)

In addition, four projects currently in development or implementation at the CMR Building are included in all alternatives, as described under the No Action Alternative, section 3.1.3.

3.4.4 Pajarito Site (Los Alamos Critical Experiments Facility)

The Pajarito Site is described in chapter 2 (section 2.2.2.4). Under the Greener

Alternative, the following activities would occur at this facility.

LANL would continue to conduct experiments and tests in all of the areas described in section 2.2.2.4. The level of dosimeter assessment and calibration, skyshine, and vaporization experiments would be the same as the No Action Alternative; other experiments would increase by about 25 percent over the No Action Alternative level (the same as the Expanded Operations Alternative). In those areas where nuclear criticality experiments would increase, the nuclear materials inventory would increase by about 20 percent over the No Action Alternative level. As under the No Action Alternative, LANL would also develop safeguards instrumentation and perform research and development activities for SNM, light detection and ranging experiments, materials processing, interrogation techniques, and field systems.

3.4.5 Sigma Complex

The Sigma Complex is described in section 2.2.2.5. Under the Greener Alternative, the following activities would occur at this complex.

Research and Development on Materials Fabrication, Coating, Joining, and Processing. Under the Greener Alternative, as under the No Action Alternative, LANL would continue to fabricate items from metals, ceramics, salts, beryllium, enriched uranium, depleted uranium, and other uranium isotope mixtures. Activities include casting, forming, machining, polishing, coating, and joining.

Characterization of Materials. LANL would also continue research and development activities on properties of ceramics, oxides, slicides, composites, and high-temperature materials; analyze up to 24 tritium reservoirs per year; and develop a library of aged non-SNM materials from stockpiled weapons and develop techniques to test and predict changes. As under the Expanded Operations Alternative, up to 2,500 non-SNM samples, including uranium, would be stored and characterized.

Fabrication of Metallic and Ceramic Items. LANL would (as under the No Action Alternative), on an annual basis, fabricate stainless steel and beryllium components for approximately 50 plutonium pits, 50 to 100 reservoirs for tritium, components for up to 50 secondary assemblies (of depleted uranium, depleted uranium alloy, enriched uranium, deuterium, and lithium), nonnuclear components for research and development (30 major hydrotests and 20 to 40 joint test assemblies, beryllium targets, targets and other components for accelerator production of tritium research, test storage containers for nuclear materials stabilization, and nonnuclear (stainless steel and beryllium) components for up to 20 plutonium pit rebuilds.

In addition, all of the alternatives include construction, renovation, and modification projects that are underway and planned in the near term for the purpose of maintaining the availability and viability of the Sigma Complex, as described under the No Action Alternative, section 3.1.5.

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.4.6 Materials Science Laboratory

The MSL is described in chapter 2 (section 2.2.2.6). Under the Greener Alternative, the following activities would occur at this facility.

Materials Processing. LANL would continue research at current levels for six of its eight materials processing activities at the MSL; these capabilities are: thermomechanical processing, microwave processing, heavy equipment materials, single crystal growth, amorphous alloys, and powder processing. The materials synthesis/processing activities would be expanded for nonweapons applications and to develop environmental and waste management technologies; wet chemistry would be expanded to develop a remediation chemistry capability.

Mechanical Behavior in Extreme Environments. LANL would continue dynamic testing and fabrication and assembly research at current levels. Mechanical testing would be expanded for nonweapons applications.

Advanced Materials Development. LANL would continue activities in materials, synthesis and characterization, and ceramics capabilities at current levels of research; the research effort for high-temperature superconductors would be increased from the No Action Alternative level.

Materials Characterization. LANL would also expand activities in the six materials characterization areas: surface science chemistry, corrosion characterization, electron microscopy, x-ray, optical metallography, and spectroscopy. Research into environmental corrosives would also be conducted.

3.4.7 Target Fabrication Facility

The Target Fabrication Facility is described in section 2.2.2.7. Under the Greener Alternative, the following activities would occur at this facility. (These are the same as the No Action Alternative levels.)

Precision Machining and Target Fabrication. LANL would provide targets and specialized components for approximately 1,200 laser and physics tests per year, including a 10 percent annual growth in operations for the next 10 years.

Polymer Synthesis. LANL would produce polymers for targets and specialized components for approximately 1,200 laser and physics tests per year, including a 10 percent annual growth in operations for the next 10 years. Other activities at this facility would be redirected to advanced materials research and manufacturing, waste treatment, energy technologies, and environmental restoration technology, with the potential for a moderate increase in operations.

Chemical and Physical Vapor Deposition. LANL would coat targets and specialized components for approximately 1,200 laser and physics tests per year, including a 10 percent annual growth in operations for the next 10 years. Other activities at this facility would be redirected to advanced materials research and manufacturing, waste treatment, energy technologies, and environmental restoration technology, with the potential for a moderate increase in operations. Support for pit manufacturing operations would be the same as under the No Action Alternative.

3.4.8 Machine Shops

The Machine Shops are described in chapter 2 (section 2.2.2.8). Under the Greener Alternative, the following activities would occur at this facility. (These are at the same levels as under the No Action Alternative.)

The Machine Shops would provide fabrication support for the dynamic experiments program and explosive research studies, support up to 30 hydrodynamic tests annually, manufacture 20 to 40 joint test assembly sets annually, and provide general laboratory fabrication support as requested. LANL would also continue its fabrication activities using unique and unusual materials and provide appropriate dimensional inspection of these activities.

3.4.9 High Explosives Processing Facilities

The High Explosives Processing Facilities are described in section 2.2.2.9. Under this alternative, 19,400 pounds (8,800 kilograms) of explosives and 1,150 pounds (520 kilograms) of mock explosives would be used annually (as an indicator of overall activity levels in this key facility). Under the Greener Alternative, the following activities would occur at these facilities.

High Explosives Synthesis and Production. Under the Greener Alternative, as under the Reduced Operations Alternative, LANL would reduce its current level of high explosives synthesis and production research and development, production of new materials and formulation of plastic-bonded explosives by approximately 60 percent. Process development would decrease over current levels and materials and components for directed stockpile production would be produced at a reduced level (approximately 60 percent of the No Action Alternative).

High Explosives and Plastics Development and Characterization. LANL would evaluate stockpile returns and decrease efforts in development and characterization of new plastics and high explosives for stockpile improvement. LANL would also conduct research into high explosives waste treatment methods, with the overall level of effort reduced to about 60 percent of the No Action Alternative.

High Explosives and Plastics Fabrication. LANL would reduce its traditional stockpile surveillance and process development over No Action Alternative levels by approximately 60 percent. Stockpile surveillance fabrication for hydrodynamic and environmental testing would be reduced to approximately 75 percent of the No Action Alternative.

Test Device Assembly. Operations would be increased over current levels to support stockpile related hydrodynamic tests, joint test assemblies, environmental and safety tests, and slightly increased research and development activities. Approximately 30 major hydrodynamic test devices would be assembled annually.

Safety and Mechanical Testing. As under the Reduced Operations Alternative, safety and environmental testing related to stockpile assurance would be reduced to approximately 80 percent of No Action Alternative levels and predictive models would be improved. Approximately 12 safety and mechanical tests would be conducted annually.

Research, Development, and Fabrication of High-Power Detonators. As under the No Action Alternative, LANL would increase efforts to support SSM activities, manufacture up to 20 major product lines per year, and support DOE-wide packaging and transportation of electro-explosive devices.

3.4.10 High Explosives Testing

High explosives testing is described in chapter 2 (section 2.2.2.10). The Greener Alternative for LANL's high explosives testing facilities is the same as the No Action Alternative, section 3.1.10.

3.4.11 Los Alamos Neutron Science Center

LANSCE is described in section 2.2.2.11. Under the Greener Alternative, the following activities would occur at this facility.

Accelerator Beam Delivery, Maintenance, and Development. LANSCE would deliver a linear accelerator beam to Areas A, B, and C; the WNR buildings; the Manuel Lujan Center; the dynamic test facility; and a new IPF for 10 months each year (6,400 hours). The H^+

beam current would be 1,250 microamps and the H^- beam current would be 200 microamps. The beam delivery and support equipment would be reconfigured to support new facilities, upgrades, and experiments.

A 40-million electron volt LEDA would be built and operated in an existing facility (TA–53–365) for 10 to 15 years, operating up to approximately 6,600 hours per year. This facility would be constructed and operated as described under the Expanded Operations Alternative, section 3.1.11.

Experimental Area Support. Support activities would continue, consistent with the levels of operation under this alternative. Remote handling and packaging of radioactive materials and wastes at LANSCE would increase to handle waste generation that results from the facility construction and modifications at LANSCE for LPSS and for the decontamination of Area A East under this alternative.

Neutron Research and Technology. LANL would conduct 1,000 to 2,000 different experiments annually, using neutrons from the Manuel Lujan Center, WNR, and the LPSS. LANL would construct and operate the LPSS as described under the Expanded Operations Alternative, section 3.2.11.

LANL also would continue to support contained weapons-related experiments using small to moderate quantities of high explosives. These experiments would include:

- Experiments with nonhazardous materials and small quantities of high explosives (up to approximately 100 per year)
- Experiments with up to 10 pounds (4.54 kilograms) of high explosives and/or depleted uranium (up to approximately 30 per year)
- Experiments with small quantities of actinides, high explosives, and sources (up to approximately 40 per year)
- Shockwave experiments involving small amounts, up to nominally 0.18 ounce (5 grams), of plutonium

Accelerator-Driven Transmutation Technology. LANL would conduct lead target tests for 2 years at the Area A beam stop; construct and operate the 1-megawatt, and then the 5-megawatt target/blanket experiments, as described under the Expanded Operations Alternative, section 3.2.11.

Subatomic Physics Research. LANL would conduct 5 to 10 physics experiments annually at Manuel Lujan Center, WNR, and LPSS and conduct proton radiography experiments. Proton radiography experiments would include contained experiments using small to moderate quantities of high explosives, similar to those described above under Neutron Research and Technology.

Medical Isotope Production. Up to approximately 50 targets per year would be irradiated for medical isotope production and exotic and neutron rich/deficient isotopes would be produced. LANL would also construct and operate the Exotic Isotope Production Facility as described under the Expanded Operations Alternative, section 3.2.11.

LANL would decontaminate Area A East as described under the Expanded Operations Alternative, section 3.2.11.

High-Power Microwave and Advanced Accelerators. Research and development in this area would be conducted at the same levels described under the No Action Alternative.

Under all alternatives, the following facilities (as described under the No Action Alternative, section 3.1.11 and in chapter 2, section 2.2.2.11) would be constructed and operated (based on previous NEPA reviews):

- LEDA

- Proton radiography and neutron spectroscopy facilities
- IPF relocation
- SPSS enhancement

It is recognized that project plans change over time. If this alternative is selected, the construction projects proposed under this alternative (as described above), would be reviewed prior to construction to determine whether additional NEPA analysis is required.

3.4.12 Health Research Laboratory

The HRL is described in chapter 2 (section 2.2.2.12). With one exception, activities at HRL under the Greener Alternative would be the same as those described for the Expanded Operations Alternative in section 3.2.12. LANL's neurobiology research, using magnetic fields produced in active areas of the brain to map human brain locations associated with certain sensory and cognitive functions, would be increased to twice the level of the No Action Alternative.

3.4.13 Radiochemistry Facility

The Radiochemistry Facility is described in section 2.2.2.13. As an indicator of overall activity levels, these operations would be expected to require about 250 FTEs. Under the Greener Alternative, the following activities would occur at this facility.

Radionuclide Transport. Under the Greener Alternative, as under the Expanded Operations Alternative, LANL would conduct 80 to 160 of these studies annually, but the studies would support environmental remediation.

Environmental Remediation. Environmental remediation activities would be the same as the Expanded Operations Alternative (approximately double the No Action Alternative level of operations).

Ultra-Low-Level Measurements. These activities would also be at the same levels as the Expanded Operations Alternative (about double the No Action Alternative level).

Nuclear/Radiochemistry. These operations would be approximately the same as the No Action Alternative overall levels; however, weapons work would be reduced by half, and nonweapons work would be increased by 10 percent.

Isotope Production. LANL would conduct target preparation, irradiation, and processing to recover medical and industrial application isotopes at the same level as the No Action Alternative.

Actinide/Transuranic Chemistry. LANL also would perform radiochemical separations at the No Action Alternative level of operations; however, these activities would support nonweapons programs.

Data Analysis. LANL would re-examine archive data and measure nuclear process parameters of interest to weapons radiochemists at a level slightly lower than the No Action Alternative level (same as under the Reduced Operations Alternative).

Inorganic Chemistry. LANL would conduct synthesis, catalysis, and actinide chemistry activities at a level approximately 50 percent higher than that of the No Action Alternative.

Structural Analysis. As under the Expanded Operations Alternative, LANL would perform these activities at approximately twice the No Action Alternative level of operation.

Sample Counting. LANL's sample counting activity to measure the quantity of radioactivity in samples using alpha, beta, and gamma ray counting systems would be the same as the No Action Alternative.

3.4.14 Radioactive Liquid Waste Treatment Facility

The RLWTF is described in chapter 2 (section 2.2.2.14). Under the Greener Alternative, the following activities would occur at this facility.

Waste Characterization, Packaging, and Labeling. Under the Greener Alternative, as under the No Action Alternative, LANL would support, certify, and audit generator characterization programs and maintain the WAC for the RLWTF.

Waste Transport, Receipt, and Acceptance. LANL would also collect radioactive liquid waste from generators and transport it to the RLWTF in TA–50.

Radioactive Liquid Waste Pretreatment. LANL would pretreat 185,000 gallons (700,000 liters) of RLW per year at TA–21; 6,600 gallons (25,000 liters) of RLW per year at TA–50; and solidify, characterize, and package 71 cubic feet (2 cubic meters) of TRU waste sludge per year at TA–50.

Radioactive Liquid Waste Treatment. LANL would install equipment for nitrate reduction in mid 1999, treat 6.6 million gallons (25 million liters) of RLW per year; dewater, characterize, and package 247 cubic feet (7 cubic meters) of LLW sludge per year; and solidify, characterize, and package 812 cubic feet (23 cubic meters) of TRU waste sludge per year. This would be the same level of operations as the No Action Alternative.

Decontamination Operations. The decontamination operations at RLWTF under the Greener Alternative would be the same as those under the No Action Alternative described in section 3.1.14.

Three modifications were recently completed or are planned for the RLWTF: an upgrade to the influent tank system, installation of a new process for treatment of RLW, and installation of additional treatment steps for removal of nitrates. These have all been previously reviewed under NEPA and are included in all of the SWEIS alternatives, as described under the No Action Alternative, section 3.1.14 and in section 2.2.2.14.

3.4.15 Solid Radioactive and Chemical Waste Facilities

The Solid Radioactive and Chemical Waste Facilities are described in section 2.2.2.15. Under the Greener Alternative, the following activities would occur at these facilities.

Waste Characterization, Packaging, and Labeling. Under the Greener Alternative, as under the No Action Alternative, LANL would support, certify, and audit generator characterization programs and maintain the WAC for LANL waste management facilities. At the Solid Radioactive and Chemical Waste Facilities, LANL would characterize 26,800 cubic feet (760 cubic meters) of legacy LLMW; characterize 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste; verify characterization data at the RANT Facility for unopened containers of LLW and TRU waste; maintain the WAC for off-site treatment, storage, and disposal facilities; and overpack and bulk waste containers.

As under the No Action Alternative, LANL would also perform coring and visual inspection of a percentage of TRU waste packages, ventilate 16,700 drums of TRU waste retrieved during the TWISP, and maintain the current version of the WIPP WAC and coordinate with WIPP operations.

Compaction. LANL would compact up to 706,000 cubic feet (20,000 cubic meters) of LLW.

Size Reduction. In addition, 91,800 cubic feet (2,600 cubic meters) of TRU waste would be reduced in size at the WCRR Facility in TA–50 and the Drum Preparation Facility in TA–54 (the same level as under the No Action Alternative).

Waste Transport, Receipt, and Acceptance. LANL would collect chemical and mixed wastes from LANL generators and transport them to TA–54. LANL would ship 32,000 tons (29,000 metric tons) of chemical wastes and 127,400 cubic feet (3,610 cubic meters) of LLMW for off-site treatment and disposal is accordance with EPA land disposal restrictions. In addition, LANL would ship 2,587,500 cubic feet (73,300 cubic meters) of LLW for off-site disposal. (This corresponds to shipment of LANL LLW to an off-site [e.g., regional] disposal facility to the extent practicable.) Beginning in 1999, 318,000 cubic feet (9,010 cubic meters) of legacy TRU waste would be shipped to WIPP. LANL would also ship 87,900 cubic feet (2,490 cubic meters) of TRU waste generated as a result of future operations and research to WIPP and 100,600 cubic feet (2,850 cubic meters) of LLMW in environmental restoration soils for off-site solidification and disposal.

Waste Storage. As under the No Action Alternative, prior to shipment to off-site treatment, storage, and disposal facilities, LANL would store chemical and mixed wastes. LANL would also store: legacy TRU waste until WIPP is opened for disposal; LLMW until treatment facilities are available; and LLW uranium chips until sufficient quantities were accumulated for stabilization campaigns.

Waste Retrieval. LANL would retrieve 165,900 cubic feet (4,700 cubic meters) of TRU waste from Pads 1, 2, and 4 by 2004 (same level as the No Action Alternative).

Other Waste Processing. LANL would demonstrate treatment (e.g., electrochemical) of LLMW liquids, land farm oil-contaminated soils at Area J, stabilize 14,500 cubic feet (410 cubic meters) of uranium chips, and provide special case treatment for 23,650 cubic feet (670 cubic meters) of TRU waste. These activities would be the same as under the No Action Alternative.

Disposal. LANL would dispose of 14,500 cubic feet (410 cubic meters) of LLW in shafts at Area G, 423,600 cubic feet (12,000 cubic meters) of LLW and small quantities of radioactively contaminated PCBs in disposal cells at Area G (this is the LANL LLW for which LANL has a unique disposal capability, or for which there is no approved transportation configuration), approximately 3,530 cubic feet (100 cubic meters) of administratively controlled industrial solid wastes in cells at Area J annually, and nonradiological classified wastes in shafts at Area J.

In addition, under all alternatives, LANL would construct storage domes for TRU wastes recovered from Pads 1, 2, and 4. This is described under the No Action Alternative, section 3.1.15.

3.5 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL IN THE SWEIS

Comments received during prescoping and scoping were carefully considered by DOE. Several alternatives identified during scoping were examined by DOE but determined to be unreasonable because they could not be implemented within the 10-year time frame of the SWEIS analysis, or because they would not allow DOE to meet its core mission requirements. (LANL's support for DOE missions is described in chapter 1 [section 1.1].) These alternatives include: decommissioning of LANL, conversion to nondefense activities, privatization, and operating LANL exclusively as a National Environmental Research Park.

3.5.1 Decontamination and Decommissioning LANL

Under this alternative, LANL operations would be phased out and all facilities of LANL decontaminated and decommissioned as soon as practicable. The site is a government reservation, and therefore, would be transferred by the DOE property disposition process following decommissioning.

This alternative is not considered in detail in the SWEIS because it is unreasonable in the foreseeable future under the terms of the *National Defense Authorization Act of 1994* [Public Law (PL) 103–160] and presidential policy guidance on the future of the laboratories (DOE 1995a). Under this act, as well as national security policy, the maintenance of a safe and reliable nuclear weapons stockpile will remain a cornerstone of the U.S. nuclear deterrent for the foreseeable future and the continued vitality of all three DOE weapons laboratories (LANL, Lawrence Livermore National Laboratory, and Sandia National Laboratories) is essential to ensuring national security. Core intellectual and technical competencies and the facility capabilities and capacities housed in these weapons laboratories are essential to meeting DOE's technical responsibilities for development and maintenance of the U.S. nuclear weapon stockpile.

There is a clear national security requirement for continued operation of LANL for stockpile stewardship and management based on PL 103–160 and other statutes, the DoD Nuclear Posture Review, Presidential Decision Directives, and the Nuclear Weapon Stockpile Memorandum. It is also not economically feasible for certain specific work activities conducted at LANL to be reassigned to other DOE laboratories (see PL 103-160 and DOE 1996a, Volume I, Sections 2.2 and 2.3).

Therefore, because the continued operation of LANL is essential to DOE implementation of PL 103–160 and other statutes, as well as the Presidential Decision Directives and for U.S. compliance with treaties (including the first Strategic Arms Reduction Treaty [START I], START II, Nuclear Nonproliferation Treaty, and the Proposed comprehensive Test Ban Treaty), as well as extensive congressional guidance and national security policy implementation documents, decontamination and decommissioning of LANL is not a feasible alternative and is not considered in detail in the SWEIS.

3.5.2 Elimination of All Weapons-Related Work (Including Stockpile Stewardship and Management) from Continued Operation of LANL

Under this alternative, operations at LANL would continue, but all weapons work except currently authorized pit disassembly, stabilization, and storage would cease. This alternative is unreasonable because it would not allow DOE to meet its mission requirements under the terms of the *Atomic Energy Act of 1954* (42 U.S.C. §2011). This alternative is also unreasonable because of the unique expertise, capabilities, and responsibilities of DOE assigned under the *National Defense Authorization Act of 1994* (PL 103–160) as well as other acts and the 1995 presidential decision that declares that all three weapons laboratories are essential to meeting national security requirements (DOE 1995a). In fact, because of the proposed Comprehensive Test Ban Treaty and the moratorium on nuclear testing, the importance of operations at LANL supporting weapons safety and reliability has increased. LANL is the laboratory responsible for the design of the majority of nuclear weapons that are expected to continue to comprise the U.S. stockpile under the arms control agreements and treaties. With no new design weapons being produced, the U.S. will experience an increasingly aging nuclear stockpile. The average age of a stockpile weapon is currently 13 years. By the year 2005, the average age will be 20 years, which is the design basis for these weapons. The oldest weapons will be about 35 years old at that time. LANL is responsible for the safety and reliability of a substantial number of the weapons in the enduring stockpile.

The confidence in the performance of the nuclear explosives package has traditionally been based on underground nuclear detonation test data, aboveground experiments, computer simulations, surveillance data, and technical judgment. In a future without additional underground testing, the capabilities of LANL must be increasingly employed to assess and solve stockpile problems. The ability to assess nuclear components is more difficult without underground testing and with limited “aging” data; therefore, new facilities such as the DARHT Facility are critical to stockpile assurance (DOE 1995c). Repairs and replacements that are “certified” (that is, the weapon is assured to continue to be safe and reliable) will be needed to support even the most minimal stockpile projections (DOE 1996a, Volume I, Section 2.3.4). DOE must rely on improved experimental capabilities coupled with improved computational capability to address safety and reliance questions concerning the stockpile. These techniques are also essential to the nonproliferation, recovery, and disassembly of weapons and weapons components from outside the U.S.

For the foreseeable future, it is not reasonable to pursue a course that would eliminate weapons research and development, surveillance, computational analyses, components manufacturing, and experimentation from being undertaken at LANL because it would be counter to national security policy and congressional guidance. Further, moving these capabilities elsewhere would require expenditures that are unreasonable and significantly increase the risk of continued stockpile safety and reliability during the lengthy period required for relocation. (In any case, such a relocation could not reasonably be completed in the next 10 years.) Therefore, this alternative has been eliminated from further consideration in the SWEIS.

3.5.3 Operating LANL Exclusively as a National Environmental Research Park

In August 1977, LANL was dedicated as a National Environmental Research Park (NERP), a program managed by DOE in response to congressional legislation to set aside land for ecosystem preservation and study. In addition to LANL, six other NERPs are located at DOE sites and associated with national laboratories. The ultimate goal of programs associated with LANL is to encourage environmental research that will contribute to understanding how people can best live in balance with nature while enjoying the benefits of technology. Recent research at the NERP emphasizes understanding the fundamental processes governing the interaction of ecosystems and the hydrologic cycle on the Pajarito Plateau. The NERP remains a LANL program in accordance with legislation, but it was not intended to eliminate or to add missions or operations at a site.

An alternative to operate LANL exclusively as a NERP is not analyzed in the SWEIS because it is unfeasible in the foreseeable future and is not consistent with national security policy and LANL mission element assignments (chapter 1, section 1.1). DOE solicited potential new NERP projects during the scoping for the SWEIS. No specific projects were proposed by commentors as additional NERP projects for analysis in the SWEIS. Some activities that are closely related to the use of the LANL site as a NERP address DOE responsibilities as the Natural Resources Trustee. The Natural Resources Management Plan, initiated in part as a result of the SWEIS process, is being prepared to determine existing conditions management measures at LANL within the context of the Pajarito Plateau ecosystem (chapter 4, section 4.5.1.6).

3.5.4 Privatizing the Operations of LANL

Regardless of who operates LANL, the risks and potential consequences are functions of the specific activities assigned to LANL and the facilities, equipment, and procedures used to implement them. These facilities, equipment, and procedures would not be expected to change due to actions such as privatization. Therefore, this alternative is indistinct from the alternatives presented in sections 3.1 through 3.4.

There are restrictions on DOE privatization possibilities imposed under the terms of the *Atomic Energy Act of 1954* (42 U.S.C. §2015). Section 2015 governs the transfer of property and limits what DOE can do with real properties. Four subchapters govern what can be done with respect to government responsibilities over materials; Subchapter IV: Production of Special Nuclear Material; Chapter V: Special Nuclear Material; Subchapter VI: Source Material; and Subchapter VII: By-Product Materials. Furthermore, access to restricted data remains a responsibility of DOE (Subchapter XI).

For these reasons, this alternative was considered unreasonable and not considered in detail in the SWEIS. However, the risks posed by this alternative are not distinctly different from those of the No Action Alternative; the reader is referred to the description and consequences of that alternative.

3.6 COMPARISON OF POTENTIAL CONSEQUENCES AMONG ALTERNATIVES FOR CONTINUED OPERATION OF LANL

This section consists of four parts. The first part presents a summary of the differences across the SWEIS alternatives. The second part presents a summary comparison of the potential consequences of the four alternatives for continued operations of LANL. The detailed presentation of potential consequences of the four SWEIS alternatives is included in chapter 5. The third part presents a comparison of the potential consequences (of both construction and operations) of the alternatives for two specific projects, the Expansion of the TA–54/Area G Low-Level Waste Disposal Area and the Enhancement of Plutonium Pit Manufacturing. Details on the alternatives for siting and construction for these projects may be found in volume II of this SWEIS. The construction and operations for these projects are included in the SWEIS Expanded Operations Alternative, while the SWEIS No Action Alternative includes the alternative of not undertaking the construction (and maintaining operations at the level currently planned) for each of these projects. The fourth part summarizes the ER Project impacts and benefits; environmental restoration activities do not change across the SWEIS alternatives.

3.6.1 Summary of Differences in Activities Among the SWEIS Alternatives

The SWEIS alternatives for the continued operations of LANL are described in more detail in sections 3.1 through 3.4. The differences in activities at LANL among the alternatives are within the 15 SWEIS key facilities (each of which is described in chapter 2, section 2.2.2). Tables 3.6.1–1 through 3.6.1–30 (provided at the end of this chapter) summarize these differences. These tables are of two types and are intended to be complementary: (1) the Alternatives for Continued Operations tables reflect the activities (significant "markers" are reflected in the table; more complete descriptions are provided in sections 2.2, 3.1, 3.2, 3.3, and 3.4) within each of the key facilities and how these activities change across the SWEIS alternatives (the activity names on these tables match the capabilities discussed for each key facility in sections 2.2, 3.1, 3.2, 3.3, and 3.4); and (2) the Parameter Differences Among Alternatives for Continued Operations tables reflect facility-level emissions, waste generation, and other measures that are intended to clarify what the activity-by-activity descriptions mean (in total) for each SWEIS key facility. Table 3.6.1–31 is a parameter table for the LANL activities other than those at the key facilities. (These activities do not vary by alternative.)

3.6.2 Consequences of SWEIS Alternatives

Site-wide environmental consequences are summarized in two tables. Table 3.6.2–1 (provided at the end of this chapter) summarizes the potential consequences of normal operations of LANL under the four alternatives. Table 3.6.2–2 addresses the potential consequences of a range of transportation and operational accidents possible at LANL, including beyond design basis accidents. Accidents evaluated include: natural phenomena, process accidents, and accidents resulting from external human activities (such as airplane crashes and transportation accidents).

The major contributors to environmental impacts of operating LANL are wastewater discharges and radioactive air emissions.

- Historic discharges to Mortandad Canyon from the RLWFT have resulted in above background residual radionuclide (americium, plutonium, strontium-90, and

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DOE 1995c — *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement.* U.S. Department of Energy, Albuquerque Operations Office and Los Alamos Area Office. DOE/EIS-0228. Albuquerque, New Mexico. August 1995.

DOE 1995d — *Radioactive Source Recovery Program Environmental Assessment.* U.S. Department of Energy, Los Alamos Area Office. DOE/EA-1059. Los Alamos, New Mexico. December 1995.

DOE 1996a — *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management.* U.S. Department of Energy. DOE/EIS-0236. Washington, D.C. September 1996.

DOE 1996b — *Low-Energy Demonstration Accelerator Environmental Assessment.* U.S. Department of Energy, Los Alamos Area Office. DOE/EA-1147. Los Alamos, New Mexico. April 1996.

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DOE 1997 — *Environmental Assessment for the Proposed CMR Building Upgrades at the Los Alamos National Laboratory*. U.S. Department of Energy, Los Alamos Area Office. DOE/EA-1101. Los Alamos, New Mexico. February 4, 1997.

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LANL 1995b *Automatic Chemical Inventory System.* Los Alamos National Laboratory. Los Alamos, New Mexico. January 1996.

LANL 1996 *Final Report for the Expedited Cleanup of Material Disposal Area (MDA) M, TA–9.* Appendix F, "Asbestos and RCRA Metal Air Results." Prepared by NES, Inc. for Los Alamos National Laboratory. Los Alamos, New Mexico. April 1996.

LANL 1998 *Performance Assessment and Composite Analysis for the Los Alamos National Laboratory Low-Level Waste Material Disposal Area G.* Los Alamos National Laboratory. LA-UR-97-85. Los Alamos, New Mexico. Submitted to the U.S. Department of Energy March 1997. Approved October 1998.

cesium-137) concentrations as well as nitrates in alluvial groundwater and sediments.

- Plutonium deposits have been detected along the Rio Grande between Otowi and Cochiti Lake.
- The principal contributors to radioactive air emissions have been and continue to be the Los Alamos Neutron Science Center and high explosives testing activities.

In addition, trace amounts of tritium have been detected in some samples from the main aquifer. (Isolated results have indicated the presence of other radionuclides. However, results have not been duplicated in previous or subsequent samples, making these results suspect.)

The analysis in the SWEIS indicates that there would be very little difference in the environmental impacts among the SWEIS alternatives analyzed. The major discriminators among alternatives would be collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, and electrical power demand. The lack of notable differences arises from a number of factors. First, because there were very few specific new proposals of significant size, the alternatives describe a range of minimum to maximum operations within the constraints of existing facilities. Second, the lower limit for minimum operations in the major nuclear facilities is set by previous decisions (including those based on the SSM PEIS) regarding the assignment of mission and program elements. Third, when effects are not large to start with, the changes in resource parameters that arise from projected operations under the alternatives also do not result in large effects.

Often, there are no differences between accident impacts among the alternatives, largely as a result of conservative approaches used in accident frequency and public consequence. The inventories used in the analyses are typically those of permitted or administrative limits (i.e., controls on the maximum amounts of material that can be processed at one time and/or in storage), rather than operational values (i.e., the actual amount of material needed to perform the task). The operational values would be more likely to change among the alternatives. The administrative limits or inventories are selected so that the analyses are sufficiently conservative and bounding to cover maximum possible operational values. The accident frequencies depend upon the accident initiators, such as an aircraft crash, earthquake, or wildfire. These particular initiators are independent of the operations and of inventory; therefore, the frequency or likelihood of such an event remains constant among the alternatives. In the few cases of accidents in which the frequency depends upon operations, the variation in frequency among the alternatives does not necessarily translate into a significant change in the risk of an environmental release to the public because the value of a release is very small. Likewise, the risk to workers is affected by the change in frequency of the operations; but, the consequence of a single accident remains the same. The following information highlights the similarities and differences between the consequences of alternatives.

3.6.2.1 *Land Resources*

There is little difference in the impacts to land resources between the No Action, Reduced Operations, and the Greener Alternatives. Differences among the alternatives are primarily associated with operations in existing facilities and very little new development is planned. Therefore, these impacts are essentially the same as currently experienced. The Expanded Operations Alternative has very similar land resources impacts to those of the other three alternatives, with the principal differences being attributable to the visual impacts of lighting along the proposed transportation corridor (a mitigation measure intended to reduce the number of road closures and the accident risk associated with transportation under this alternative) and the noise and vibration associated with increased frequency of high explosives testing (as compared to the other three alternatives).

3.6.2.2 *Geology, Geological Conditions, and Soils*

There is little difference in the impacts to these resources across the alternatives. Wastewater discharge volumes with associated contaminants do change across the alternatives, but not to a degree noticeable in terms of impacts (such as causing soil erosion, for example). Under all of the alternatives, small quantities (as compared to existing conditions) of contaminants would be deposited in soils due to continued LANL operations and the ER Project would continue to remove existing contaminants at sites to be remediated.

Geological mapping and fault trenching studies at LANL are currently underway or recently completed to better define the rates of fault movement, specifically for the Pajarito Fault, and the location and possible southern termination of the Rendija Canyon Fault. Appendix I (in volume III) of the SWEIS presents a detailed status of the ongoing and recently completed seismic hazard studies, as well as the implications of these studies for LANL and DOE. That report indicates that slip rates (recurrence intervals for earthquakes) are within the parameters assumed in the 1995 seismic hazards study at LANL (chapter 4, section 4.2.2.2).

3.6.2.3 *Water Resources*

Water demand under all alternatives (section 3.6.2.9, below) is within existing DOE rights to water, and would result in average drops of 10 to 15 feet (3.1 to 4.6 meters) in the water levels in DOE well fields over the next 10 years. Except for cooling water used for the TA–53 accelerator facilities, there are not predominant industrial water users at LANL. Usage, therefore, will remain within a fairly tight range among the alternatives. The related aspect of wastewater discharges is also within a narrow range for that reason. Outfall flows range from 218 to 278 million gallons (825 to 1,052 million liters) per year across the alternatives, and these flows are not expected to result in substantial changes to existing surface or groundwater quantities. Outfall flows are not expected to result in substantial surface contaminant transport under any of the alternatives. Although mechanisms for recharge to groundwater are highly uncertain, it is possible that discharges under any of the alternatives could result in contaminant transport in groundwater, particularly beneath Los Alamos Canyon and Sandia Canyon and off site. (The outfall flows associated with the Expanded Operations and Greener Alternatives would reflect the largest potential for such contaminant transport, and the flows associated with the Reduced Operations Alternative would have the least potential for such transport.)

3.6.2.4 *Air Quality*

Nonradioactive hazardous air pollutants would not be expected to degrade air quality or affect human health under any of the alternatives. The differences across the alternatives do not result in large changes in chemical usage. The activities at LANL are such that large amounts are not typically used in any industrial process (as may be found in manufacturing facilities); but research and development activities involving many users dispersed throughout the site are the norm. Air emissions are therefore not expected to change by a magnitude that would, for example, trigger more stringent regulatory requirements or warrant continuous monitoring. Radioactive air emissions change slightly, but are within a narrow range due to the controls placed on these types of emissions and the need to assure compliance with regulatory standards. The collective population radiation doses from these emissions range from about

11 person-rem per year to 33 person-rem per year across the alternatives (primarily from LANSCE and high explosives testing activities), and the radiation dose to the maximally exposed individual ranges from 1.9 millirem per year to 5.4 millirem per year across the alternatives (primarily from the operations at the LANSCE facility). These doses are considered in the human health impact analysis.

3.6.2.5 *Ecological and Biological Resources*

No significant adverse impact to these resources is projected under any of the alternatives. The separate analyses of impacts to air and water resources constitute some of the source information for analysis of impacts in this area; as can be seen from those presentations, the variation across the alternatives are not of a sufficient magnitude to cause large differences in effects. The impacts of the Expanded Operations Alternative differ from those of the other alternatives in that there is some projected loss of habitat; however, this habitat loss is small (due to limited new construction) compared to available similar habitat in the immediate vicinity, and no significant adverse effects to ecological or biological resources are expected.

3.6.2.6 *Human Health*

The total radiological doses over the next 10 years to the public under any of the SWEIS alternatives are relatively small, as compared to doses due to background radiation in the area (about 0.3 rem per year) and would not be expected to result in any excess latent cancer fatalities (LCFs) to members of the public. Additionally, exposure to chemicals due to LANL operations under any of the SWEIS alternatives are not expected to result in significant effects to either workers or the public. Exposure pathways associated with the traditional practices of communities in the LANL area (special pathways) would not be expected to result in human health effects under any of the alternatives. The annual collective radiation dose to workers at LANL ranges from 170 person-rem per year to 830 person-rem per year across the SWEIS alternatives (the difference is primarily attributable to the differences in LANSCE accelerator operations and TA–55–4 actinide processing and pit fabrication activities); these dose levels would be expected to result in from 0.07 to 0.33 excess LCFs per year of operation, respectively, among the exposed workforce. These impacts, in terms of excess LCFs per year of operation, reflect the numbers of excess fatal cancers estimated to occur among exposed members of the workforce over their lifetimes, per year of LANL operations. The reader should recognize that these estimates are intended to provide a conservative measure of the potential impacts to be used in the decision-making process and do not necessarily portray an accurate representation of actual anticipated fatalities. In other words, one could expect that the stated impacts form an upper bound, and that actual consequences could be less but probably would not be worse. Refer to appendix D, section D.1 (in volume III), for a discussion on the determination and application of risk factors for excess LCFs.

Worker exposures to physical safety hazards are expected to result in from 417 (Reduced Operations) to 507 (Expanded Operations) reportable cases each year; typically, such cases would result in minor or short-term effects to workers, but some of these incidents could result in long-term health effects or even death.

3.6.2.7 *Environmental Justice*

Executive Order 12898 (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*) requires every federal agency to analyze whether its proposed action and alternatives would have disproportionately high and adverse impacts on minority or low-income populations. Based on the analysis of other impact areas, DOE expects few high and adverse impacts from the continued operation of LANL under any of the alternatives, and, to the extent impacts may be high and adverse, DOE expects the impact to affect all populations in the area equally. DOE also analyzed human health impacts from exposure through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathways have the potential to be important to the environmental justice analysis because some of these pathways may be more important or viable for the traditional or cultural practices of minority populations in the area. However, human health impacts associated with these special pathways also would not present disproportionately high and adverse impacts to minority or low-income populations.

3.6.2.8 *Cultural Resources*

Under all of the SWEIS alternatives there is a negligible to low potential for impacts to archaeological and historic resources due to shrapnel and vibration caused by explosives testing and contamination from emissions. Logically, potential impacts would vary in intensity in accordance with the frequency of explosives tests and the operational levels that generate emissions (e.g., Reduced Operations would reflect the lowest potential, and Expanded Operations would reflect the highest potential). Recent assessments of prehistoric resources indicate a low potential compared to the effects of natural conditions (wind, rain, etc.). In addition to these potential impacts, the Expanded Operations Alternative includes the expansion of the LLW disposal site at TA–54, which contains several National Register of Historic Places (NRHP) sites; it is anticipated that a determination of no adverse effect to these resources would be achieved based on a data recovery plan.

The potential impacts to specific traditional cultural properties (TCPs) would depend on their number, characteristics, and location. Such resources could be adversely affected by changes in water quality and quantity, erosion, shrapnel from explosives testing, noise and vibration from explosives testing, and contamination from ongoing operations. Such impacts would vary in intensity in accordance with the frequency of explosives tests and the operational levels that generate emissions (e.g., Reduced Operations would reflect the lowest intensity, and Expanded Operations would reflect the highest intensity). The current practice of consultation with the four Pueblos nearest to LANL would continue to be used to provide opportunities to avoid or minimize adverse impacts to any TCPs located at LANL.

3.6.2.9 *Socioeconomics, Infrastructure, and Waste Management*

LANL employment (including employees of the University of California, Johnson Controls, Inc., and Protection Technology of Los Alamos) ranges from 9,347 (Reduced Operations) to 11,351 (Expanded Operations) FTEs across the alternatives, as compared to 9,375 LANL FTEs in 1996. These changes in employment would result in changes in the Tri-County population, employment, personal income, and other socioeconomic measures. These secondary effects would change existing conditions in the Tri-County area by less than 5 percent.

Peak electrical demand under the Reduced Operations Alternative exceeds supply during the winter months and may result in periodic brownouts. Peak electrical demand under the No Action, Expanded Operations, and Greener Alternatives exceeds the power supply in winter and summer; this may result in periodic brownouts. (Power supply to the Los Alamos area has been a concern for a number of years, and DOE continues to work with other users in the area and power suppliers to increase this supply.) Natural gas demand is not projected to change across the alternatives, and this demand is within the existing supply of natural gas to the area; however, the age and condition of the existing supply and distribution system will continue to be a reliability issue for LANL and for residents and other businesses in the area. Water demand for LANL ranges from 602 million gallons (2,279 million liters) per year to 759 million gallons (2,873 million liters) per year across the alternatives; the total water demand (including LANL and the residences and other businesses and agencies in the area) is within the existing DOE rights to water.

LANL chemical waste generation ranges from 3,173 to 3,582 tons (2,878,000 to 3,249,300 kilograms) per year across the alternatives. LANL LLW generation, including LLMW, ranges from 338,210 to 456,530 cubic feet (9,581 to 12,873 cubic meters) per year across the alternatives. LANL TRU waste generation, including mixed TRU waste, ranges from 6,710 to 19,270 cubic feet (190 to 547 cubic meters) across the alternatives. Disposal of these wastes at on-site or off-site locations is projected to constitute a relatively small portion of the existing capacity for disposal sites; disposal of all LANL LLW on site would require expansion of the LLW disposal capacity beyond the existing footprint of TA–54 Area G under all alternatives (although this is only included in the Expanded Operations Alternative).

Contaminated space in LANL facilities would increase by about 63,000 square feet (5,853 square meters) under the No Action, Reduced Operations, and Greener Alternatives (due primarily to actions previously reviewed under NEPA but not fully implemented at the time the existing contaminated space estimate was established [May 1996]). The Expanded Operations Alternative would increase contaminated space in LANL facilities by about 73,000 square feet (6,782 square meters). The creation of new contaminated space implies a cleanup burden in the future, including the generation of radioactive waste for treatment and disposal; the actual impacts of such cleanups are highly uncertain because they are dependent on the actual characteristics of the facility, the technologies available, and the applicable requirements at the time of the clean-up actions.

3.6.2.10 *Transportation*

Incident-free transportation associated with LANL activities over the next 10 years would be conservatively expected to cause radiation doses that would result in about one excess LCF to a member of the public and two excess LCFs to members of the LANL workforce over their lifetimes under each of the SWEIS alternatives. (Refer to the discussion of the limitations on quantitative estimates of excess LCF risks in volume III, appendix D.) There is little variation in impacts because effects are small, and the increased transport of radioactive materials is not enough to make a significant change in these small effects.

Transportation accidents without an associated cargo release over the next 10 years of LANL operations are conservatively projected to result in from 33 to 76 injuries and 3 to 8 fatalities (including workers and the public) across the alternatives. The bounding off-site and on-site transportation accidents over the next 10 years involving a release of cargo would not be expected to result in any injuries or fatalities to members of the public for any of the alternatives. Accidents were analyzed by type of material, and the maximum quantities were selected for analysis. These parameters do not change across the alternatives. Total risk also does not change appreciably across the alternatives, because the frequency of shipments dose not vary enough to substantially influence the result.

3.6.2.11 *Accidents (Other Than Transportation Accidents and Worker Physical Safety Incidents/Accidents)*

Accidents were analyzed by creating scenarios, ranging from probable to highly improbable, that would demonstrate the effects of abnormal circumstance on existing and proposed operations. Such scenarios were selected based on screening steps that would select for demonstration those scenarios that involved the greatest quantities of hazardous material and the most severe circumstances, or that might involve a typical operation with a hazardous material. The purpose of analyzing a variety of scenarios was to provide some perspective on risks associated with operating LANL, and not to provide a list of all the possible things that could reasonably be expected to go wrong. Variations in operations across the alternatives did not change these scenarios because there are few changes in factors that would influence this type of analysis, such as significant changes in quantities of materials involved in an operation, toxicity of material, or new physical hazard.

The operational accident analysis included four scenarios that would result in multiple source releases of hazardous materials: three due to a site-wide earthquake and one due to a wildfire. (Three different earthquake magnitudes were analyzed [labeled SITE–01, SITE–02, and SITE–03], resulting in three different degrees of damage and consequences and one wildfire scenario [labeled SITE–04].) These four scenarios dominate the radiological risk due to accidents at LANL because they involve radiological releases at multiple facilities and are considered credible (that is, they would be expected to occur more often than once in a million years), with the wildfire considered likely. Another earthquake-initiated accident, labelled RAD–12, is facility-specific (to Building TA–16–411) and is dominated by the site-wide earthquake accidents due to its very low frequency (about 1.5 x 10^{-6} per year). It is noteworthy that the consequences of such earthquakes are dependent on the frequency of the earthquake event, the facility design, and the amount of material that could be released due to the earthquake; such features do not change across the SWEIS alternatives, so the impacts of these accidents are the same for all four alternatives. Similarly, the site-wide wildfire risks do not change significantly among the alternatives because the alternatives do not affect the probability (frequency) of the wildfire. The risks were estimated conservatively in terms of both the frequency of the events and the consequences of such events. (In particular, it is noteworthy that the analysis assumes that any building that would sustain structural or systems damage in an earthquake scenario does so in a manner that creates a path for release of material outside of the building.) Similarly, the wildfire analysis assumes that any building that is vulnerable to wildfire and in the path of the wildfire will burn. The total societal risk of an accident is the product of the accident frequency and the consequences to the total population within 50 miles (80 kilometers). This risk as presented in chapter 5 and appendix G (in volume III), ranges from 0.046 (SITE–01) and 0.034 (SITE–04) excess LCF per year of operation, to extremely small numbers for most of the radiological accidents.[1] The societal risk for release of chemicals, such as chlorine, is calculated similarly as the product of the frequency and numbers of people exposed to greater than the selected guideline concentration, Emergency Response Planning

1. As an example, for SITE–01 the societal risk of 0.046 excess LCF per year was calculated by multiplying the event frequency of 0.0029 per year by the consequence to the population of 16 excess LCFs (Table 3.6.2–2). The excess LCFs resulting from public exposure are calculated by an approved model, such as the MELCOR Accident Consequences Code System (MACCS) code, or alternatively by multiplying the public exposure of 27,726 person-rem (from accident analysis) by the conversion factor of 5 x 10^{-4} excess LCFs per person-rem (ICRP 1991).

Guideline (ERPG–2)[2]. The risks for chemical releases range from 6.4 (SITE–01) people exposed per year of operation to vanishingly small numbers for some chemical releases. In general, such earthquakes would be expected to cause fatalities due to falling structures or equipment; this also would be true for LANL facilities. Thus, worker fatalities due to the direct effects of the earthquakes would be expected. Worker injuries or fatalities due to the release of radioactive or other hazardous materials would be expected to be small or modest increments to the injuries and fatalities due to the direct effects of the earthquakes.

Often, there are no differences between accident impacts among the alternatives, largely as a result of conservative approaches used in accident frequency and public consequence. The inventories used in the analyses are typically those of permitted or administrative limits (i.e., controls on the maximum amounts of material that can be processed at one time and/or in storage), rather than operational values (i.e., the actual amount of material needed to perform the task). The operational values would be more likely to change among the alternatives. The administrative limits or inventories are selected so that the analyses are sufficiently conservative and bounding to cover maximum possible operational values. The accident frequencies depend upon the accident initiators, such as an aircraft crash, earthquake, or wildfire. These particular initiators are independent of the operations and of inventory; therefore, the frequency or likelihood of such an event remains constant among the alternatives. In the few cases of accidents in which the frequency depends upon operations, the variation in frequency among the alternatives does not necessarily translate into a significant change in the risk of an environmental release to the public because the value of a release is very small. Likewise, the risk to workers is affected by the change in frequency of the operations; but, the consequence of a single accident remains the same.

Plutonium accident risks to the public (other than those associated with the site-wide earthquake scenarios) are dominated by the puncture of a “typical” TRU waste drum (typical refers to the radioactivity of the drum contents), which is the highest frequency plutonium accident analyzed, and the release of plutonium from a fire in a TRU waste container storage area, which had one of the highest population doses from a plutonium accident. These accidents, labeled as RAD–09 and RAD–07, have societal risks of 0.0008 and 0.00011 excess LCF per year, respectively, under the No Action Alternative. While other accident scenarios were considered and analyzed (including process risks in TA–55 and the CMR Building), their risks to the public are at least an order of magnitude lower because either they are associated with relatively infrequent initiating events (e.g., aircraft crashes), or because the event occurs within facilities that are designed with multiple features (referred to as defense in depth) that prevent or minimize releases to the public. The risks associated with plutonium accidents change slightly (less than an order of magnitude) across the SWEIS alternatives. (Frequency or consequence increases [up to double that of No Action] for some accidents under the Expanded Operations Alternative, and frequency decreases [by up to 25 percent] from some accidents under the Reduced Operations Alternative.) RAD–07 and RAD–09 remain the dominant plutonium accidents under all alternatives.

Worker risk due to plutonium accidents is highly dependent on the number of workers present at the time of the event, on the type of protective measures taken at the time of the accident, on the speed with which these measures are taken, and on the effectiveness of

2. ERPG–2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without irreversible or serious health effects or symptoms that could impair their abilities to take protective action.

medical treatment after exposure; as such, worker risks cannot be predicted quantitatively or reliably. In general, worker risks due to plutonium released in an accident would be limited to those workers in the immediate vicinity of the accident, and the consequences would be an increased risk of excess LCFs due to inhalation of plutonium; any acute fatalities would only be expected due to the initiating event (e.g., an aircraft crash), not due to the plutonium release. Worker risks change across alternatives only to the extent that frequencies of the events change (as discussed above for public risk from plutonium accidents).

An overview of the 1969 plutonium pit fire at the Rocky Flats site and a comparison of the design and operational differences between Rocky Flats and TA–55–4 are presented in appendix G, section G.4.1.2. Substantial differences exist between the nuclear facility and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

The risks to the public associated with highly enriched uranium (labeled as RAD–03) and tritium (RAD–05) releases due to accidents, other than the site-wide earthquakes, are several orders of magnitude lower than those for the earthquake or for the plutonium accidents. Similarly, worker risks in such accidents are also substantially lower for these types of accidents (as compared to the worker risks for site-wide earthquake or plutonium accident events). The risks to the public and to the workers associated with highly enriched uranium and tritium releases do not change across the alternatives because the frequencies of the initiating events and the amounts of material involved in the accident do not change across the alternatives.

The risk to the public from accidents that result in chemical releases (due to events other than the site-wide earthquakes and wildfire) at LANL dominate all other accident risks. In particular, the release of chlorine gas from TA–55 (labeled as CHEM–06) has a relatively high frequency and substantial consequences. The societal risk for this accident is about six people per year who would be exposed to greater than ERPG–2 concentrations of chlorine. The site-wide wildfire also can release some chemicals that would be released by earthquakes. Because the frequency of the wildfire is much greater than that of earthquakes, SITE–04 has a societal risk of 1.1 people per year exposed to greater than ERPG–2 concentrations of formaldehyde. Three other accidents that result in chemical releases (CHEM–01, CHEM–02, and CHEM–03) have societal risks that are very similar to the risks associated with hazardous chemical releases from the site-wide earthquakes (up to 0.066 people per year exposed to greater than ERPG–2 concentrations of chlorine gas for CHEM–01). It is noteworthy that the scenario for CHEM–01 is associated with potable water treatment activities; such activities are typical of municipal water supply operations throughout the U.S. It is also noteworthy that the LANL potable water treatment process is being changed to a process that does not require that quantities of chlorine gas be stored for use. The risk associated with CHEM–06 would not be expected to change across the SWEIS alternatives; CHEM–01 and CHEM–02 have slight changes in risk across the alternatives (up to a 14 percent increase and an 8 percent decrease for CHEM–02) due to the operational changes (which change the frequencies of these accidents) associated with the Expanded Operations Alternative and the Reduced Operations Alternative.

As with other worker accidents discussed above, the risk of worker injury or fatality due to these chemical release accidents is highly dependent on whether workers are present at the time of the accident, the protective measures taken, how quickly protective measures are taken, and the effectiveness of medical treatment after the event. For CHEM–01, CHEM–03, and CHEM–06, it is unlikely that workers would be in the area at the time of the event (if workers were present, there is potential for worker injury or fatality). For CHEM–02, the fire and the chlorine release would be visible, and escape is likely for any workers present; if workers present do not escape, injury or fatality is possible. For CHEM–04 and CHEM–05, four or five workers are typically in the area during working hours; workers present could be injured or killed by missiles from the cylinder rupture or from exposure to the toxic gas. Workers risks change across alternatives only to the extent that frequencies of the events change (as discussed above for public risk from chemical release accidents).

In addition to the discussions of worker risks for the accidents discussed above, four other accidents were analyzed specifically for potential risk to workers (these would not be expected to result in substantial risks to the public). Of the worker accidents analyzed (recalling that transportation and physical safety hazards are discussed separately in sections 3.6.2.10 and 3.6.2.6, respectively), the highest frequency worker accidents would be associated with a biohazard contamination (WORK–02) or with an inadvertent exposure to nonionizing radiation (WORK–04); these would be expected to result in injury or fatality to one worker. Multiple worker injuries or fatalities are possible from either an inadvertent high-explosives detonation (WORK–01) or from an inadvertent nuclear criticality event (WORK–03). Risks to workers under any of these scenarios would not be expected to change across the SWEIS alternatives.

3.6.3 Project-Specific Consequences

This section summarizes the impacts of the proposed expansion of LLW disposal in Area G (included in both the Preferred Alternative and the Expanded Operations Alternative) and the proposed enhancement of plutonium pit manufacturing operations (included only in the Expanded Operations Alternative), including siting and construction, as well as operational impacts, once construction is completed. The impacts reflected here are a portion of the impacts associated with the Expanded Operations Alternative (DOE's Preferred Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year).

3.6.3.1 *Expansion of TA–54/Area G Low-Level Radioactive Waste Disposal Area*

The disposal of LLW in excavated disposal cells at LANL has been ongoing at Area G for a number of years. At this time, it appears that the disposal space remaining in the existing footprint at Area G will be exhausted within the next 10 years. The SWEIS examines the potential solutions to disposal of LLW through shipment off the site to the extent possible, use of the existing space to maximum capacity and shipment of the remaining waste to off-site locations, and expansion of LLW disposal space at LANL to accommodate on-site disposal for the foreseeable future.

As discussed in volume II, part I, expansion could be achieved by expansion of the existing disposal site at TA–54 (different TA–54 expansion options are considered), or by expansion into a new disposal site (TA–67 is examined as representative of such sites because it is the best characterized "new" site for such purposes). Expansion into Zones 4 and 6 at TA–54 is DOE's PSSC Preferred Alternative.

Land Resources

Alternatives for the development of additional disposal capacity on site involve from approximately 40 to 72 acres (16 to 29 hectares) depending on location. Locations on Mesita del Buey involve areas that have historically been designated for waste management activities, while use of the TA–67 site would be a new land use designation. All sites present physical constraints on development of some type, such as required set backs from canyon rims and location of power lines, although the sites closest to existing disposal areas must also avoid monitoring exclusion zones established for investigations under the ER Project. Sites in the Zones 4 and 6 locations are closest to existing waste disposal activities. There would be no changes in visibility of any new site from current operations for any location other than TA–67. In that case, there would be increased visibility from Pajarito Road. As is currently the case, disposal cell excavation activities could slightly exceed background noise levels at the nearest residential area (White Rock) for all sites except the one at TA–67.

Geology and Soils

All new sites involve the same types of surface soils and the same underlying Bandelier Tuff as the current disposal site. There is evidence that TA–67 may have a geologic fault. Disposal activities would not be expected to cause seismic activity or change soil erosion or geology in the area; this is due in part to the practice of revegetating the land after a disposal cell is filled and closed. These activities are not expected to contribute substantially to soil contamination in the area; this is due in part to the geology in the area and disposal and closure practices intended to isolate the buried waste from interacting with the environment.

Water Resources

There are no differences among on-site disposal alternatives in this resource area. Activities are not expected to use large quantities of water. Additionally, current and planned disposal practices (e.g., isolation of the closed disposal cells) minimize the potential for water to run across the site and to transport contaminants. The geology in the area is also expected to contribute to the minimal transport of contaminants to either the surface or groundwater bodies in the area.

Air Quality

Short duration dust from excavation and diffuse emissions (mostly from open disposal cells) will be similar to recent historical experiences (which have not had any substantive effect on air quality), although road development for the TA–67 site would cause additional short-term dust and vehicle exhaust emissions. Additionally, if cleared trees are burned, the smoke would have a temporary effect on air quality. Finally, it is possible that excavation in Zone 4 could disturb a volatile organic compound plume from Area L, resulting in low concentration releases; it is expected that this plume would be avoided during excavation.

Ecological Resources

Total acreage disturbed is greatest for the TA–67 alternative because of the need for new road and infrastructure development, while the Zone 4 and 6 alternatives involve the least disturbance. Because the habitat is similar for all the on-site development alternatives, the extent of habitat loss is also greatest at the TA–67 site, and least at the Zone 4 and 6 locations. The habitat change is expected to be relatively small under any of the PSSC alternatives, and similar habitat is available in the immediate area at both TA–54 and TA–67. This loss of habitat is not likely to affect species in the area. Loss of foraging habitat for peregrine falcons is less than 0.1 percent of the area's potential for all alternatives, except for the TA–67 alternative (where it would be about 1.3 percent). Loss of roosting area for the Mexican spotted owl is also identified for the TA–67 alternative.

Human Health

There are no significant differences in this area among the PSSC alternatives, but effects on human health do potentially arise from operating the expanded waste disposal area. Worker health risks associated with LLW disposal range from radiation exposure (much less for individuals than the DOE radiation exposure standard) to occupational safety and health incidents and accidents related to excavation of disposal cells and equipment operations. These are similar in nature to existing worker health risks; however, the projected waste generation across LANL is higher under the Expanded Operations Alternative, so these worker impacts are slightly greater than have been experienced in recent history and greater than would be expected under the SWEIS No Action Alternative.

In general, public health impacts in the near term would be similar to those experienced in recent years due to effects on soil, water, and air quality; as discussed above, these are minimal (LANL 1998). The Area G Performance Assessment indicates that over the next 1,000 years the maximum health impacts to the public would be minimal (e.g., exposure from all pathways in White Rock and Pajarito Canyon is less than 0.1 millirem per year; exposure from all pathways in Cañada del Buey is less than 6 millirem per year).

Environmental Justice

Expansion of LLW disposal is not likely to result in disproportionately high nor adverse impacts to minority and low-income populations.

Cultural Resources

Up to 15 known archeological sites could be affected by excavation activities at the Zone 4 and 6 locations, with the fewest known sites (4) potentially affected at the North Site location. Data recovery plans and consultations would be needed under all PSSC alternatives. (These have been completed for Zone 4.) It is expected that existing policies and procedures at LANL would minimize impacts by avoiding these sites, where possible. Where sites cannot be avoided, existing procedures call for data recovery in consultation with the New Mexico State Historic Resources Office(r) and others, where appropriate. If TCPs are present in areas of excavation, they would either be destroyed by construction or diminished in value.

Socioeconomics, Infrastructure, and Waste Management

All alternatives for developing additional waste disposal areas require minimal additional workers (30 more, or about a 15 percent increase above the No Action Alternative levels for solid waste management operations). Additionally, these activities do not demand substantial amounts of water, electricity, or gas. Finally, the generation of secondary waste is attributed primarily to treatment, storage, and repackaging operations, not to waste disposal; thus, secondary waste generation would not be expected to change substantially.

Transportation

The SWEIS Expanded Operations Alternative (with on-site disposal) would increase on-site shipments substantially—to almost double the approximately 1,300 shipments per year under the No Action Alternative (due to greater waste generation under the Expanded Operations Alternative and the shipment of LLW off the site under the No Action Alternative). However, due to the low radionuclide concentrations in LLW, the relatively short distances travelled on site, and the low rate of accidents experienced for on site shipments, this large difference in shipments does not equate to large differences in on-site transportation impacts (on-site transportation impacts under either the Expanded Operations or No Action Alternatives result in far less than one fatality or injury over the next 10 years due to traffic accidents and radiation doses related to such shipments), and waste shipments do not influence the bounding cargo accident risks.

In contrast, development and use of additional disposal capacity on site would reduce the off-site shipments of waste, as compared to the No Action Alternative (410 off-site LLW shipments per year under No Action Alternative, as compared to 33 under Expanded Operations). Again, the low concentrations of radionuclides in LLW would mean that these shipments contribute very little to incident-free radiation doses, and they do not bound the off-site cargo accident risk. While the longer off-site transportation mileage results in greater risks of vehicle accidents, injuries, and deaths, these are similar to the risks of increasing any vehicular traffic and are not unique to the fact that these are radioactive waste shipments. The off-site LLW shipments are a relatively small percentage of the total off-site shipment mileage under either the SWEIS No Action Alternative or the Expanded Operations Alternative.

Accidents

Accident risk associated with waste disposal operations for all alternatives are essentially the same. This is because the accident frequencies are relatively insensitive to the differences in waste volumes across the alternatives and because the consequences of an accident are dependent on the amount of material involved in the accident (which changes very little across the alternatives), not the total amount of generated or disposed waste. An additional factor is that waste disposal requires comparable packaging, handling, and certification in accordance with WAC whether it is disposed of on or off the site.

3.6.3.2 *Enhancement of Plutonium Pit Manufacturing*

The implementation of the plutonium pit production mission is examined in the SWEIS at varying levels. The No Action Alternative for operations includes the manufacturing of pits at a maximum rate of about 14 pits per year under the Expanded Operations Alternative, and as discussed in volume II, part II, DOE is considering the enhancement of the existing capability to optimize processes and remove process “choke” points to allow for production of up to 50 pits per year under single shift operations (80 pits per year under multiple-shift operations). However, the DOE does not propose to implement pit manufacturing capability beyond a level of 20 pits per year in the time frame of analyses for the SWEIS. The Preferred Alternative would only implement pit manufacturing at the 20 pits per year level in the near term. This postponement does not modify the long-term goal announced in the ROD for the SSM PEIS (up to 80 pits per year using multiple shifts). Nevertheless, the impacts of full implementation of the enhancement of plutonium pit manufacturing PSSC is included in the Expanded Operations Alternative. The DOE used the “CMR Building Use” Alternative to bound the impact analysis. Because other activities in TA–55 cannot be discontinued to make space available for the enhancement and operation, TA–55 does not have enough plutonium laboratory space available to undertake this and all other TA–55 activities described under the Expanded Operations Alternative. Options (alternatives) for providing the additional space required to accommodate Expanded Operations, including pit production, are discussed in detail in volume II, part II. Under the PSSC “CMR Building Use” Alternative for providing this additional space, some existing activities at TA–55–4 would be moved over to available space in the CMR Building, thus freeing space in TA–55–4 to accommodate pit production. This would take place in a phased manner.

First, the existing capability would be increased to capacity of 20 pits per year; after that, the additional modifications would be made to achieve the 80 pits per year capacity (using multiple shifts).

The increased pit production will require additional transportation of materials between TA–55 and the CMR Building (at least an increase in transportation of samples, but potentially, the additional transportation of plutonium for CMR activities transferred from TA–55–4); DOE is proposing to construct a dedicated road to minimize impacts (road closures and accidents) to the public. Under the Preferred Alternative, these processes would not be moved to the CMR Building nor would the transportation corridor be built.

Land Resources

All project alternatives other than the No Action Alternative require the use of additional land, including land that would be used for an optional dedicated transportation corridor between TA–55 and TA–3. While the land disturbed under the "CMR Building Use" Alternative would be limited to that associated with the transportation corridor, the Brownfield and TA–55–4 Add-On Alternatives would each require about one additional acre, both of which are in developed areas of TA–55. The 7 acres (2.8 hectares) required for the optional transportation corridor have been disturbed previously but not developed. Fencing and security lighting along the road could result in visual impacts. There would be some short-duration increase in noise during construction of the road; once the road is constructed, traffic noise would not be substantially different from the existing traffic noise in the area. (Under the Preferred Alternative, the road would not be constructed to establish the 20 pits per year capability, and the impacts associated with construction of that road would not be incurred.) Increased noise levels due to construction activity at TA–55 would occur under any of the PSSC alternatives. In addition, the "CMR Building Use" Alternative would result in increased construction noise at TA–3.

Geology and Soils

No changes in geology or soils are anticipated for either construction or operations under any PSSC alternative.

Water Resources

Minimal increase in water use is anticipated for either construction or operations under any of the PSSC alternatives. Some increases in RLW generation (associated with all activities under this alternative; pit production activities are not substantial contributors to this waste stream) would also be anticipated (a maximum increase of 2.6 million gallons [10 million liters] per year above the No Action Alternative level of about 6.6 million gallons [25 million liters] per year) under any of the PSSC alternatives. The location for wastewater discharge does not change from that under the SWEIS No Action Alternative.

Air Quality

The only potential construction air quality impacts are related to the emissions from construction equipment; these emissions would not exceed regulatory standards for criteria pollutants and would not be expected to affect air quality beyond the immediate vicinity of the construction work.

Operations under the "CMR Building Use" PSSC alternative in TA–55–4 and the CMR Building directly related to the implementation of pit production at LANL would result in minor increases in radioactive air emissions. For the CMR Building, an increase of 38 microcuries per year is attributable to pit production activities. (The total difference between the No Action and Expanded Operations radioactive air emissions at the CMR Building is about 340 microcuries per year.) For TA–55, a net increase (considering pit manufacturing increases and decreases due to activities moved to the CMR Building) of about 9 microcuries per year is attributable to pit production activities. (The total difference between the No Action and Expanded Operations radioactive air emissions at TA–55 is about 11 microcuries per year.) Under the other PSSC alternatives, the radioactive air emissions would not increase as much at the CMR Building, but most of the total 47 microcuries in increased annual air emissions attributed to pit production in both facilities would occur at TA–55. At the 20 pits per year production rate (Preferred Alternative), radioactive air emissions for TA–55 and the CMR Building together would result in about a 20 microcuries per year increase due to pit production activities; the radioactive air emissions impacts under the Expanded Operations Alternative at this rate would be essentially the same as those presented under the "CMR Building Use" Alternative. No substantive changes in nonradioactive air emissions are expected due to these activities under any of the PSSC alternatives.

Ecological Resources

Construction of the dedicated access road under any of the PSSC alternatives would disturb about 7 acres (2.8 hectares) and would reduce peregrine falcon foraging and meadow jumping mouse habitats by this amount. Other potential effects include:

- Large mammals (bear, elk, deer, mountain lion, coyotes) could be restricted from accessing the land in the transportation corridor and transversing to lands beyond the corridor; this access restriction could also alter predator-prey associations, food use, and habitat use in the project area.
- Potential for increases in automobile/animal collisions could result from elk and deer movement into areas these animals do not usually inhabit.

Only minimal changes in potential habitat would be associated with alternatives requiring construction at TA–55 or TA–3. The total loss of 7 (for the "CMR Building Use" Alternative) to 8 (for the other two alternatives) acres (2.8 to 3.2 hectares) of habitat is small compared to that available on the entire LANL site. (Under the Preferred Alternative, at the 20 pits per year rate, these impacts would not be incurred because the road would not be constructed.) No other ecological impacts from operations are anticipated.

Human Health

Occupational exposure to radioactive material during the construction and modification of existing nuclear facility space for the "CMR Building Use" PSSC alternative is expected to result in up to 45 person-rem (0.018 excess LCF) to the involved workers. The other alternatives would have lower doses due to the reduced need for modification of existing nuclear facility spaces to accomplish the construction. Radiation doses to workers during operations that are directly related to pit production would constitute an increase of about 150 person-rem per year. (The total difference in collective dose associated with all activities at LANL between No Action and Expanded Operations is about 387 person-rem per year.) These occupational doses would not be expected to vary between the PSSC alternatives because the total work load would be the same, and the design criteria of the facilities would be the same regardless of implementation. This change in collective worker dose constitutes an incremental increase of about 0.06 excess LCF per year to the worker population involved in these activities. At the 20 pits per year rate (Preferred Alternative), worker exposures associated with pit production would be lower (about 130 person-rem per year lower than presented at the 80 pits per year rate). Thus, the worker population exposure and the estimated LCF risk associated with that exposure would be about 15 percent less than reflected for the Expanded Operations Alternative at the 80 pits per year rate.

Impacts to public health would not be expected to change substantially due to routine pit manufacturing operations. Except for transportation impacts (discussed below) and the contribution to public health impacts due to radiological air emissions, the remaining contributors to public health impacts do not change across the alternatives. As reflected in appendix B in volume III, (Table B.1.2.3–1), the radiological air emissions from TA–55 and CMR Building operations together contribute 1.005 person-rem per year and 1.853 person-rem per year under the No Action and Expanded Operations Alteratives, respectively. (The total collective public doses under these alteratives are about 14 and about 33 person-rem per year, respectively.) Of the total TA–55 and CMR Building air emissions, which lead to these collective public doses, about 1 percent of the curies emitted (under either the No Action or Expanded Operations Alternatives) are attributable to pit manufacturing, analytical chemistry support for pit manufacturing, actinide processing, and pit surveillance and disassembly activities (the activities that would be involved in the implementation of pit production at LANL under the Expanded Operations Alternative). Any variation to public health impacts between the PSSC alternatives would only be due to the differences in physical location of the air emission release points with relation to the publicly occupied areas, as discussed above in the air quality section.

Environmental Justice

Expansion of pit manufacturing is not likely to result in disproportionately high or adverse impacts to minority and low-income populations.

Cultural Resources

No impacts are anticipated under any of the PSSC alternatives due to construction or operations (prehistoric and historic sites are avoidable, and there are no known TCPs in the area).

Socioeconomics, Infrastructure, and Waste Management

Building modifications under the "CMR Building Use" PSSC alternative would employ about 221 construction workers over about a 3- or 4-year period (with peak employment for construction at 140 workers). The number of construction workers and project duration would be somewhat greater, but not substantially different for the other PSSC alternatives. Operations would increase employment by about 170 workers. (The total difference between employment under No Action and Expanded Operations is about 1,374 workers.) At the 20 pits per year rate (Preferred Alternative), construction and operations employment would be somewhat lower than reflected for the "CMR Building Use" Alternative. The employment differences are small compared to the total employment changes under the Expanded Operations Alternative. Thus, the impacts presented for the Expanded Operations Alternative are relatively insensitive to the PSSC alternatives and to the 20 pits per year phasing of pit production at LANL.

Utility use and contaminated space would not change substantially under the "CMR Building Use" PSSC alternative. The other two PSSC alternatives would require slightly more electrical power and would create about 15,000 square feet (1,400 square meters) of nuclear facility space that would be presumed as contaminated space.

Construction for the "CMR Building Use" PSSC alternative would generate about 15,100 cubic feet (426 cubic meters) of TRU waste, 10,200 cubic feet (288 cubic meters) of TRU mixed waste, 46,200 cubic feet (1,306 cubic meters) of LLW, and 1,100 cubic feet (31 cubic meters) of LLMW. The other PSSC alternatives would be expected to generate little, if any, radioactive waste (it could only be generated in equipment transfer to the new space). Pit manufacturing operations under the SWEIS Expanded Operations Alternative are not expected to generate substantial quantities of waste (as presented in the final SSM PEIS, this activity is expected to result in waste generation increases of less than 5 percent over current levels), except for TRU waste generation, which will increase from this activity by about 3,535 cubic feet (100 cubic meters) per year. (The total difference between No Action and Expanded Operations TRU waste generation is about 10,600 cubic feet [300 cubic meters] per year.) At the 20 pits per year level (Preferred Alternative), TRU waste generation would be about 530 cubic feet (15 cubic meters) per year.

Transportation

The Expanded Operations Alternative activities related to pit production would be expected to increase on-site shipments between TA–55 and the CMR Building by about 500 shipments per year (of plutonium sample solutions and plutonium metal, including components). Additionally, off-site shipments to and from Oak Ridge and Pantex are expected to increase by a total of about 50 shipments per year due to implementation of pit manufacturing at LANL. Even though the total risk is small (see Tables 3.6.2–1 and 3.6.2–2, Transportation Risks), these types of plutonium shipments are among those that bound both on-site and off-site transportation risk; additionally, such shipments are the main contributors to driver and public incident-free radiation doses. Because the portion of these shipments attributable to pit production operations is a small percentage of the total on-site (about 5 percent) and off-site (about 1 percent) shipments, transportation risks from pit production operations under the Expanded Operations Alternative are very small. Differences in shipment quantities are important contributors to the differences in transportation risk between the No Action and Expanded Operations Alternatives, although the absolute risk presented by these shipments is small. The construction of a dedicated transportation corridor between TA–55 and the CMR Building at TA–3 would further reduce risk associated with on-site shipments. At the 20 pits per year rate (Preferred Alternative), there would be somewhat fewer on- and off-site shipments in support of pit production; thus, the transportation impacts at that production rate would be slightly lower than presented for the Expanded Operations Alternative at 80 pits per year. Under the Preferred Alternative, the dedicated transportation route would not be constructed for implementation of the 20 pits per year rate.

Accidents

Accident risk associated with pit manufacturing operations (and those operations moved to the CMR Building to make space in TA–55 for pit production) are essentially the same under the No Action and Expanded Operations Alternatives. The reasons that there are such minor differences, given the differences in the number of pits manufactured, are that: accidents involving pit manufacturing activities themselves do not bound the risks associated with plutonium operations (section 3.6.2.11), although some of the support operations (e.g., waste handling and plutonium processing and recovery) are included in the set of bounding accidents analyzed; the frequencies of the bounding accidents are relatively insensitive to the number of pits manufactured (pit manufacturing activities are relatively small contributors to support operations throughputs); and, the consequences of accidents are dependent on the amount of material involved in the accident, which is relatively insensitive to the quantities of pits manufactured over a year. (That is, the difference in the number of pits produced over a year is dependent on process or room and does not change limits for the amount of material allowed to be in process at one time.) Any variation to accident risk between the PSSC alternatives would only be due to the differences in physical location of the release points with relation to the publicly occupied areas, similar to the discussion above in the air quality section.

3.6.4 Consequences of Environmental Restoration Activities

Environmental restoration activities, which include decontamination and decommissioning activities, are undertaken with the intent of reducing the long-term public and worker health and safety risks associated with contaminated sites or with surplus facilities and to reduce risk posed to ecosystems. Decisions regarding whether and how to undertake an environmental restoration action are made after a detailed assessment of the short-term and long-term risks and benefits for options specific to the site in question, and, at LANL, they are made primarily within the framework of the RCRA.

Because there are no individual or specific environmental restoration actions proposed within the scope of the SWEIS (such actions are proposed and undertaken on a time scale that is not compatible with the preparation of this SWEIS), the impact analyses regarding such actions are presented in general terms based on the experiences of the program, to date. As noted in the ecological resources and human health impact analyses in chapter 5, LANL's influence on ecological and human health risk arises primarily from the legacy of past operations in the form of contaminants that were historically deposited on land and in water. An improvement in the risk posed by the LANL site is therefore expected from the removal of some of this legacy contamination. A principal impact from restoration actions is related to the generation of waste during the cleanup or decontamination and decommissioning. The waste generated must be stored, treated, or disposed. Waste generation from the totality of future environmental restoration actions is estimated in the SWEIS, and the risks associated with the transport, treatment, storage, and disposal of this waste are included in the analyses (in particular, refer to sections 3.1.14, 3.1.15, 3.2.14, 3.2.15, 3.3.14, 3.3.15, 3.4.14, 3.4.15, 5.2.9, 5.3.9, 5.4.9, 5.5.9, and the discussion regarding the expansion of Area G in section 3.6.3.1).

The short-term risks and controls associated with the environmental restoration activities include:

- *Fugitive Dust*. This is the suspension of soil, including contaminated soil, in the air, resulting in the potential for exposure or dispersal of this material. At LANL, this potential risk is typically controlled by frequently wetting the ground at the clean-up site; this reduces the amounts of material suspended in air, and thus, the risk to human health and the environment (LANL 1996).
- *Surface Runoff*. This is the transport of contaminants from the clean-up site by surface water flow across the site. At LANL, surface runoff is controlled by flow barriers, collection of surface water, or contouring the ground such that flow off the site is precluded (LANL 1995a).
- *Soil and Sediment Erosion*. This is the transport of soil and sediment due to the force of wind and the intensity and frequency of precipitation. This potential risk is mitigated by covering clean-up sites with tarps during storm events to minimize the infiltration of water (LANL 1995a).
- *Worker Health and Safety Risks.* Environmental restoration actions have similar risks to those discussed in the human health impact analyses in chapter 5. Activities can involve heavy equipment, uneven ground (e.g., trenches), solvents and other chemicals, and other hazards of this nature. Worker health and safety risks are mitigated with work plans, safety programs, protective equipment, and similar administrative, education, and physical protection measures.

TABLE 3.6.1–1.—*Alternatives for Continued Operation of TA–55 Plutonium Facility Complex*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Plutonium Stabilization	Recover, process, and store the existing plutonium inventory in 8 years.	Same as No Action Alternative.	Decrease processing rate of residue and place metal and plutonium oxide in interim storage without further processing. Material inventory will be processed in 10 to 15 years.	Same as No Action Alternative.
Manufacturing Plutonium Components	Production of up to 14 pits/yr.	Produce 50 to 80 pits/yr (long-term goal requires major facility modifications). Produce 20 pits/yr in initial phase (requires minor facility modifications).	Maintain technical capability to understand pit characteristics and behavior. 6 to 12 pits produced per year.	Same as Reduced Operations Alternative.
Surveillance and Disassembly of Weapons Components	Pit surveillance: Up to 20 pits/yr destructively examined and 20 pits/yr nondestructively examined.	This activity moves to the CMR Building, with up to 65 pits/yr disassembled, including up to 40 pits/yr destructively examined. 20 pits/yr would be nondestructively examined.	Same as No Action Alternative.	Disassemble up to 65 pits/yr including 40 pits/yr destructively examined; 20 pits/yr nondestructively examined.
Actinide Materials and Science Processing, Research, and Development	Demonstrate disassembly/conversion of 1 to 2 pits/day for up to 40 pits total.	Develop production disassembly capacity. Process up to 200 pits/yr, including a total of 250 pits (over 4 years) as part of disposition demonstration activities.	Same as No Action Alternative.	Expand some areas of technology development for weapon dismantlement support. Otherwise, this alternative is the same as the No Action Alternative.
	Process up to 1,000 Ci/yr plutonium-239/beryllium and americium/beryllium neutron sources.	Process neutron sources up to 5,000 curies (Ci)/yr. Process neutron sources other than sealed sources.	Process up to 500 Ci/yr neutron source materials. Maintain capabilities for neutron source processing.	Same as Expanded Operations Alternative, including processing a greater variety of sources.
	Process up to 220 pounds (100 kilograms)/yr of actinides. Process 1 to 2 pits/month (up to 12 pits/yr) through tritium separation.	Process up to 880 pounds (400 kilograms)/yr of actinides[a]. Support for hydrodynamic testing and tritium separation activities move to the CMR Building[b] at the same level of activity as the No Action Alternative.	Maintain activity in standby mode; no processing of actinides; no use of routine tritium separation.	Same as Reduced Operations Alternative.

TABLE 3.6.1–1.—*Alternatives for Continued Operation of TA–55 Plutonium Facility Complex*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Actinide Materials and Science Processing, Research, and Development (continued)	Perform decontamination of 15 to 20 uranium components per month.	Perform decontamination of 28 to 48 uranium components per month.	Perform decontamination of 10 to 15 uranium components per month.	Same as Reduced Operations Alternative.
	Research in support of DOE actinide clean-up activities. Stabilize minor quantities of specialty items. Research and development on actinide processing and waste activities at DOE sites.	Increase research efforts, stabilize larger quantities of specialty materials, and increase technical support to other sites, including processing up to 310 pounds (140 kilograms) of plutonium as chloride salts from the Rocky Flats Environmental Technology Site (RFETS).	Maintain shelf-life efforts; decrease support to other sites.	Same as Expanded Operations Alternative.
	Prepare, measure, and characterize samples for fundamental research and development in areas such as aging, welding and bonding, coatings, and fire resistance.	Conduct plutonium research and development and support.	Same as No Action Alternative.	Same as No Action Alternative.
	Fabricate and study small amounts of nuclear fuels used in terrestrial and space reactors. Fabricate and study prototype fuel for lead test assemblies.	Fabricate and study more types and larger quantities of fuels.	Same as No Action Alternative.	Same as No Action Alternative.
	Develop safeguards instrumentation for plutonium assay.	Increase the level of safeguard instrumentation development.	Maintain safeguards instrumentation.	Same as Expanded Operations Alternative.
	Analyze samples in support of actinide reprocessing, research, and development activities.	Analyze half as many samples at TA–55. Remaining analyses move to the CMR Building.[b]	Analyze samples in support of actinide reprocessing, research, and development activities.	Analyze samples in support of actinide reprocessing, research, and development activities.
Fabrication of Ceramic-Based Reactor Fuels	Make prototype MOX fuel. Research and development on fuels.	Build MOX test reactor fuel assemblies and continue research and development on fuels.	Conduct fuel research and development.	Same as No Action Alternative.
Plutonium-238 Research, Development, and Applications	Process, evaluate, and test up to 25 kg/yr plutonium-238 to support space and terrestrial uses. Process up to 10 kg plutonium-238 from heat source and milliwatt recovery, research and development, and safety testing.	Process, evaluate, and test up to 25 kg/yr plutonium-238. Recycle residues and blend up to 18 kg/yr plutonium-238.	Process, evaluate, and test up to 7 kg/yr plutonium-238. Process up to 0.5 kg of plutonium-238 from heat source recovery.	Same as Expanded Operations Alternative.

TABLE 3.6.1–1.—*Alternatives for Continued Operation of TA–55 Plutonium Facility Complex*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
SNM Storage, Shipping and Receiving	Store up to 7.3 tons (6.6 metric tons) SNM in NMSF; continue to store working inventory in the PF–4 vault; ship and receive as needed to support LANL activities.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
	Conduct nondestructive assay on SNM at NMSF to verify identify and content of stored containers.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.

Note: All alternatives include refurbishment of TA–55 and renovation of the NMSF, as discussed in chapter 2 (section 2.2.2.1).

[a] The actinide activities at the CMR Building and at TA–55 are expected to total 880 pounds (400 kilograms)/yr. The future split between these two facilities is not known, so the facility-specific impacts at each facility are conservatively analyzed at this maximum amount. Waste projections that are not specific to the facility (but are related directly to the activities themselves) are only projected for the total of 880 pounds (400 kilograms)/yr.

[b] Activities assumed to transfer to the CMR Building in Expanded Operations (as discussed in volume II, part II) include:

- Pit disassembly (noted in Table 3.6.1–5 under Surveillance and Disassembly of Weapons Components)
- Pit surveillance (noted in Table 3.6.1–5 under Surveillance and Disassembly of Weapons Components)
- Actinide research and development and processing activities (noted in Table 3.6.1–5 under Actinide Research and Processing)
- Hydrodynamic testing support and tritium separations (noted in Table 3.6.1–5 under Actinide Research and Processing)

TABLE 3.6.1–2.—*Parameter Differences Among Alternatives for Continued Operation of the Plutonium Facility Complex (TA–55)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions						
Plutonium-239[b]	Ci/yr	1.7×10^{-5} [c]	1.7×10^{-5}	2.7×10^{-5}	9.2×10^{-6}	1.7×10^{-5}
Tritium in Water Vapor[n]	Ci/yr	8.2×10^{2} [d]	7.5×10^{2}	7.5×10^{1}	7.5×10^{1}	7.5×10^{1}
Tritium as a Gas[n]	Ci/yr	2.7×10^{2} [d]	2.5×10^{2}	2.5×10^{1}	2.5×10^{1}	2.5×10^{1}
NPDES Discharge[e] 03A–181	MGY (MLY)	14 (53)	14 (53)	14 (53)	14 (53)	14 (53)
Chemical Waste	lb\yr (kg/yr)	9,260[f] (4,200)	11,580 (5,250)	18,390 (8,340)	11,580 (5,250)	11,580 (5,250)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	20,800[g] (590)	24,300 (688)	26,200[h] (741)	24,300 (688)	24,300 (688)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	388[i] (11)	424 (12)	459 (13)	424 (12)	424 (12)
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	3,850[j] (109)	5,650 (160)	14,500[h] (411)	3,810 (108)	5,720 (162)
Contaminated Space[k]	ft^2 (m^2)	59,600[m] (5,540)	+ 17,500 (NMSF) (1,630)	+ 17,500 (NMSF) (1,630)	+ 17,500 (NMSF) (1,630)	+ 17,500 (NMSF) (1,630)
Number of Workers	FTEs	640[l]	735	1,111	552	712

[a] Index was used as a point of reference for projecting data for the alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.

[b] Index emissions data are based upon process knowledge and gross alpha counting; analysis of emissions for specific radionuclides was not determined. Projections for the alternatives were reported as plutonium or plutonium-239, the primary material at TA–55.

[c] Index for plutonium-239 is from 1988 to 1989.

[d] Index for tritiated water and tritium gas is from 1986.

[e] Outfall contains one process source and no storm water sources. Index is 1990 to 1995.

[f] Index is 1990 to 1991 average.

[g] Index is 1990, 1994, and 1995 average.

[h] Includes estimates of waste generated by the facility upgrades associated with Pit Fabrication.

[i] Index is average of 1990, 1994, and 1995.

[j] Index is average of 1988 to 1990.

[k] Index is Fiscal Year 1995. Data represent increments or decrements to the index.

[l] Index is Fiscal Year 1995.

[m] In addition, there are approximately 1,100 cubic feet (31 cubic meters) of contaminated ducts (see chapter 4, Table 4.9.10–1).

[n] As stated in Table 3.6.1–1 under the No Action Alternative, tritium separation activities will be carried out in TA–55; but under the Expanded Operations, Reduced Operations, and Greener Alternatives, the tritium separation activities will be moved to the CMR Building, and the operations parameters will be reduced from the No Action Alternative and remain constant in the Expanded Operations, Reduced Operations, and Greener Alternatives.

MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–3.—*Alternatives for Continued Operation of Tritium Facilities*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
High-Pressure Gas Fills and Processing: WETF	Handling and processing of tritium gas in quantities of up to 3.53 oz (100 g) at WETF with no limit on number of operations per year. Capability is used approximately 25 times/yr.	Capability used approximately 65 times/yr.	Capability used approximately 20 times/yr.	Same as Reduced Operations Alternative.
Gas Boost System Testing and Development: WETF	System testing and gas processing operations involving quantities of up to 3.53 oz (100 g) at WETF. Capability is used 20 times/yr.	Capability used approximately 35 times/yr.	Capability used approximately 15 times/yr.	Same as Reduced Operations Alternative.
Cryogenic Separation: TSTA	Tritium gas purification and processing in quantities up to 7.06 oz (200 g) at TSTA. Capability used approximately 3 times/yr.	Capability used 5 to 6 times/yr.	Capability used 1 time/yr.	Same as Expanded Operations Alternative if focused on alternative energy development.
Diffusion and Membrane Purification: TSTA, TSFF, WETF	Research on tritium movement and penetration through materials. Used 2 to 3 times/ month.	Capability use increases significantly, accompanied by continuous use for effluent treatment and 6 to 8 experiments/ month.	Same as No Action Alternative.	Same as Expanded Operations Alternative, focused on waste reduction.
Metallurgical and Material Research: TSTA, TSFF, WETF	Capability involves materials research including metal getter research and application studies. Small quantities of tritium supports tritium effects and properties research and development. Contributes < 2% of LANL's tritium emissions to the environment.	This capability could be expanded, but the use of tritium would remain < 2% of LANL's tritium emissions to the environment.	Same as No Action Alternative.	Same as No Action Alternative

TABLE 3.6.1–3.—*Alternatives for Continued Operation of Tritium Facilities*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Thin Film Loading: TSFF (WETF by 1998)	Chemical bonding of tritium to metal surfaces. Current application is for tritium loading of neutron tube targets; approximately 800 units/yr with small quantities of tritium.	Increase number of required target loading operations up to 3,000 units/yr. However, the tritium at risk quantities will not change.	Same as No Action Alternative.	Same as No Action Alternative.
Gas Analysis: TSTA, TSFF, WETF	Analytical support current capabilities. Operations estimated to contribute < 5% of LANL's tritium emissions to the environment.	Increase to support the tritium operations under this alternative. Material at risk, emissions, and other parameters are not expected to change in this measurement support activity.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Calorimetry: TSTA, TSFF, WETF	This capability provides a measurement method for tritium material accountability. Contained tritium is placed in the calorimeter for quantity measurements. This capability is used frequently, but contributes < 2% of LANL's tritium emissions to the environment.	Increase to support the tritium operations under this alternative. Material at risk, emissions, and other parameters are not expected to change in this measurement support activity.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Solid Material and Container Storage: TSTA, TSFF, WETF	Storage of tritium occurs in process systems, process samples, inventory for use and as waste.	On-site storage could increase by about a factor of 10, with most of increase occurring at WETF.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.1–4.—*Parameter Differences Among Alternatives for Continued Operation of the Tritium Facilities (TA–16 and TA–21)*

PARAMETER	UNITS	INDEX[1]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions						
TA–16/WETF, Tritium Gas (HT/T2)	Ci/yr	1.73×10^{1} [b]	1.00×10^{2}	3.00×10^{2}	1.00×10^{2}	1.00×10^{2}
TA–16/WETF, Tritium Water (HTO)	Ci/yr	4.29×10^{1}	3.00×10^{2}	5.00×10^{2}	3.00×10^{2}	3.00×10^{2}
TA–21/TSTA, Tritium Gas (HT/T2)	Ci/yr	1.23×10^{1} [b]	1.00×10^{2}	1.00×10^{2}	1.00×10^{2}	1.00×10^{2}
TA–21/TSTA, Tritium Water (HTO)	Ci/yr	4.25×10^{1}	1.00×10^{2}	1.00×10^{2}	1.00×10^{2}	1.00×10^{2}
TA–21/TSFF, Tritium Gas (HT/T2)	Ci/yr	2.00×10^{2} [b]				
10-year average:	Ci/yr	NA	4.36×10^{2}	4.36×10^{2}	4.36×10^{2}	4.36×10^{2}
1996	Ci/yr	NA	3.00×10^{2}	3.00×10^{2}	3.00×10^{2}	3.00×10^{2}
1997 to 2000	Ci/yr	NA	6.40×10^{2}	6.40×10^{2}	6.40×10^{2}	6.40×10^{2}
2001 to 2005	Ci/yr	NA	3.00×10^{2}	3.00×10^{2}	3.00×10^{2}	3.00×10^{2}
TA–21/TSFF, Tritium Water (HTO)	Ci/yr	2.13×10^{2} [b]				
10-year average:	Ci/yr	NA	5.84×10^{2}	5.84×10^{2}	5.84×10^{2}	5.84×10^{2}
1996	Ci/yr	NA	4.00×10^{2}	4.00×10^{2}	4.00×10^{2}	4.00×10^{2}
1997 to 2000	Ci/yr	NA	8.60×10^{2}	8.60×10^{2}	8.60×10^{2}	8.60×10^{2}
2001 to 2005	Ci/yr	NA	4.00×10^{2}	4.00×10^{2}	4.00×10^{2}	4.00×10^{2}
NPDES Discharge[c]						
Total Discharges	MGY (MLY)	1.3 (4.92)	0.33 (1.25)	0.33 (1.25)	0.22 (0.83)	0.22 (0.83)
05S (Sewage Treatment Plant)	MGY (MLY)	0.77 (2.91)	0.00	0.00	0.00	0.00
02A-129	MGY (MLY)	0.11[d] (0.42)	0.11 (0.42)	0.11 (0.42)	0.11 (0.42)	0.11 (0.42)
03A-036	MGY (MLY)	0.02[e] (0.08)	0.00	0.00	0.00	0.00
03A-158	MGY (MLY)	0.22[d] (0.83)	0.22 (0.83)	0.22 (0.83)	0.11 (0.42)	0.11 (0.42)
04A-091	MGY (MLY)	0.22[d] (0.83)	0.00	0.00	0.00	0.00
Chemical Waste	lb/yr (kg/yr)	2,430[f] (1,100)	2,430 (1,100)	3,750 (1,700)	2,200 (1,000)	2,870 (1,300)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	1,410[f] (40)	15,900 (450)	16,900 (480)	15,500 (440)	15,900 (450)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	71[f] (2)	71 (2)	106 (3)	71 (2)	71 (2)
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	0	0	0	0
Contaminated Space[g]	ft^2 (m^2)	19,770 (1,840)	+ 10,000 (930)	+ 10,000 (930)	+ 10,000 (930)	+ 10,000 (930)
Number of Workers	FTEs	112[h]	112	123	90	90

TABLE 3.6.1–4.—*Parameter Differences Among Alternatives for Continued Operation of the Tritium Facilities (TA–16 and TA–21)*-Continued

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index data are either emission rates for 1996 or the average of emissions over the period 1992 to 1996, whichever is higher. For WETF and TSTA, 1996 estimates are used; for TSFF, the 5-year average is used.
[c] Outfalls consist of process sources only. Index is 1990 to 1995.
[d] Index is from ESH–18 measurements for NPDES permit application and from estimates based on facility operations. No specific dates for these data were provided.
[e] Index provided as representative data by facility operations personnel. No specific dates were available.
[f] Index is 1990 to 1995 average.
[g] Index Fiscal Year 1995. Data are increments or decrements to the index.
[h] Index is from Fiscal Year 1994.
NA = Not applicable; MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–5.—*Alternatives for Continued Operation of the Chemistry and Metallurgy Research Building (TA–3)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Analytical Chemistry	Sample analysis in support of a wide range of actinide research and processing activities. Approximately 5,200 samples/yr.	Provide expanded general sample analysis. Approximately 11,000 samples/yr. Includes actinide sample analysis relocated from TA–55.[a]	Same as No Action Alternative.	Same as No Action Alternative.
Uranium Processing	Activities to recover, process, and store LANL highly enriched uranium inventory by 2005.	Same as No Action Alternative, except for possible recovery of materials resulting from manufacturing operations.	Residue processing rate will decrease and highly enriched uranium will be placed in interim storage. Material inventory will be processed in 10 to 15 years.	Same as No Action Alternative.
Destructive and Nondestructive Analysis	Evaluate up to a total of 10 secondaries (an average of 1/yr) through destructive/ nondestructive analysis and disassembly.	Evaluate 6 to 10 secondaries/yr.	Same as No Action Alternative.	Same as No Action Alternative.
Nonproliferation Training	Nonproliferation training involving SNM.	Increased training, but no additional quantities of SNM. May work with more types of SNM.	Decreased training, but capability and inventory still remain.	Same as Expanded Operations Alternative.
Actinide Research and Processing	Process plutonium-238/beryllium neutron source at up to approximately 3,600 Ci/yr. Process americium-241/beryllium neutron source at up to approximately 500 Ci/yr. Stage up to 1,000 plutonium-238/ beryllium and americium-241/ beryllium sources in Wing 9 floor holes.	Process plutonium-238/beryllium and americium-241/beryllium neutron sources up to 5,000 Ci/yr at the CMR Building. Process neutron sources other than sealed sources. Stage up to 1,000 plutonium-238/beryllium and americium-241/beryllium sources in Wing 9 floor holes.	Maintain capabilities for americium-241/beryllium and plutonium-238/beryllium neutron source processing. Throughput would not exceed 2,000 Ci/yr. Stage up to 1,000 plutonium-238/ beryllium and americium-241/ beryllium sources in Wing 9 floor holes.	Same as Expanded Operations Alternative.
	Retain technical capability for research and development activities of spent nuclear reactor fuels.	Introduce research and development effort on spent nuclear fuel related to long-term storage and analyze components in spent and partially spent fuels.	Same as No Action Alternative.	Same as Expanded Operations Alternative.

TABLE 3.6.1–5.—*Alternatives for Continued Operation of the Chemistry and Metallurgy Research Building (TA–3)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Actinide Research and Processing (continued)	Metallurgical microstructural/ chemical analysis and compatibility testing of actinides and other metals. Primary mission to study long-term aging and other material effects. Characterize about 50 samples/yr.	Increased number of samples, with no changes in type of analyses performed. Characterize about 100 samples/yr. Conduct research and development in hot cells on pits exposed to high temperatures.	Maintain capability, characterize 25 samples/yr.	Same as No Action Alternative.
	Analysis of TRU disposal related to validation of WIPP performance assessment models. TRU waste characterization. Analysis of gas generation such as could occur in TRU waste during transportation to WIPP. Performance Demonstration Program to test nondestructive analysis/nondestructive examination equipment.	In addition to No Action activities: • Demonstrate actinide decontamination technology for soils and materials. • Develop actinide precipitation method to reduce mixed wastes in LANL effluents.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Actinide Activities Relocated from TA–55 (Expanded Operations Alternative only)		Process up to 880 lb (400 kg)/yr actinides.[a] Support to hydrodynamic testing and tritium separation activities move to the CMR Building[b] (requires facility modifications to make standby wings operational).		

TABLE 3.6.1–5.—*Alternatives for Continued Operation of the Chemistry and Metallurgy Research Building (TA–3)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Fabrication and Metallography	Produce 1,080 targets/yr containing approximately 0.71 oz (20 g) uranium-235 target for molybdenum-99.	Produce 1,080 targets/yr plus additional 20 targets/wk for 12 wks. Separate fission products from irradiated targets to provide molybdenum-99. Ability to produce 3,000 6-day curies of molybdenum-99/wk.	Produce 50 targets/yr and store them.	Same as No Action Alternative.
	Support complete highly enriched uranium processing research and development pilot operations and casting. Fabricate metal shapes, including up to 50 sets of highly enriched uranium components, using 2.2 to 22 lb (1 to 10 kg) highly enriched uranium/ operation. Material recovered and retained in inventory. Up to 2,200 lb (1,000 kg) annual throughput.	Same as No Action Alternative	Same as No Action Alternative.	Same as No Action Alternative.
Disassembly of Weapons Components (Relocated from TA–55, Expanded Operations Alternative only)		Disassemble approximately 65 pits/yr, including 40 pits/yr destructively examined for surveillance. More testing on the 20 pits/yr nondestructively examined[b] (requires facility modifications to make standby wings operational).		

Note: All alternatives include completion of Phase I and II Upgrades, as discussed in chapter 2 (section 2.2.2.3).

[a] The actinide activities at the CMR Building and at TA–55 are expected to total 880 lb (400 kg)/yr. The future split between these two facilities is not known, so the facility-specific impacts at each facility are conservatively analyzed at this maximum amount. Waste projections, which are not specific to the facility (but are related directly to the activities themselves), are only projected for the total of 880 lb (400 kg)/yr.

[b] Activities to be moved to the CMR Building from TA–55 in Expanded Operations Alternative include:

- Pit disassembly (noted in Table 3.6.1–1 under Surveillance and Disassembly of Weapons Components).
- Pit surveillance, which is also a disassembly operation (noted in Table 3.6.1–1 under Surveillance and Disassembly of Weapons Components).
- Actinide research and development and processing activities (noted in Table 3.6.1–1 under Actinide Reprocessing, Research, and Development).
- Hydrodynamic testing support and tritium separation activities (noted in Table 3.6.1–1 under Actinide Reprocessing, Research, and Development).

TABLE 3.6.1–6.—*Parameter Differences Among Alternatives for Continued Operation of the Chemistry and Metallurgy Research Building (TA–3)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions						
Total Actinides	Ci/yr	2.0×10^{-4} [b]	4.20×10^{-4}	7.60×10^{-4}	3.80×10^{-4}	4.20×10^{-4}
Krypton-85[c]	Ci/yr	None	None	1.00×10^{2}	None	None
Xenon-131m	Ci/yr	None	None	4.50×10^{1}	None	None
Xenon-133	Ci/yr	None	None	1.50×10^{3}	None	None
Tritium Water (HTO)[d]	Ci/yr	Negligible	Negligible	7.50×10^{2}	Negligible	Negligible
Tritium Gas (HT)[d]	Ci/yr	Negligible	Negligible	2.50×10^{2}	Negligible	Negligible
NPDES Discharge 03A–021[e]	MGY (MLY)	0.53 (2.01)	0.53 (2.01)	0.53 (2.01)	0.53 (2.01)	0.53 (2.01)
Chemical Waste	lb/yr (kg/yr)	10,500[f] (4,760)	17,600 (7,970)	24,700 (11,200)	13,000 (5,890)	18,200 (8,270)
Low-Level Radioactive Waste[g]	ft^3/yr (m^3/yr)	27,600[f] (781)	48,700 (1,380)	65,700 (1,860)	45,200 (1,280)	49,800 (1,410)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	180[f] (5.1)	580 (16.4)	690 (19.6)	570 (16.2)	580 (16.5)
TRU/Mixed TRU Waste[g]	ft^3/yr (m^3/yr)	760[f] (21.4)	950 (26.8)	2,370 (67.0)	800 (22.8)	1,000 (28.2)
Contaminated Space[h]	ft^2 (m^2)	40,320[j] (3,750)	No change	No change	No change	No change
Number of Workers	FTEs	221[i]	329	527	299	324

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index for the actinides is 1990 to 1994 average.
c Mixed fission products are only applicable for the Expanded Operations Alternative for medical isotope production.
[d] Tritium phase calculation of 75% water and 25% gas based upon 1997 data for TA–55 process to move to the CMR Building under the Expanded Operations Alternative. See Table 3.5.2.1–1.
[e] Outfall 03A–021 consists of one process source and five storm drain sources. Index is 1990 to 1995.
[f] Index is 1990 to 1995 average.
[g] Waste from the Phase II CMR Upgrades are included (e.g. 141,000 ft^3 [4,000 m^3]) in all alternatives during 1997 to 2000 (DOE 1997). Estimates in the tables are annual averages; the 141,000 ft^3 (4,000 m^3) is a total included in these averages.
[h] Index Fiscal Year 1995. Data are increments or decrements to the index.
[i] Provided as representative data by the facility subject matter expert. No specific index date available.
[j] In addition, there are approximately 760 ft^3 (21.5 m^3) of contaminated ducts (see chapter 4, Table 4.9.10–1).
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–7.—*Alternatives for Continued Operations of Pajarito Site (TA–18)*

ACTIVITIES	NO ACTION[a]	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Dosimeter Assessment and Calibration	Perform criticality experiments.	Criticality experiments increase 25% above No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Detector Development	Develop safeguards instrumentation and perform research and development for nuclear materials, LIDAR[b] experiments, and materials processing.	Same activities as under No Action, with increased alternative nuclear materials inventory by 20% and replace portable linear accelerator.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Materials Testing	Perform criticality experiments. Develop safeguards instrumentation and perform research and development for nuclear materials, LIDAR[b] experiments, and materials processing.	Criticality experiments increase 25% above No Action Alternative.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Subcritical Measurements	Perform criticality experiments. Develop safeguards instrumentation and perform research and development for nuclear materials, LIDAR[b] experiments, and materials processing.	Criticality experiments increase 25% above No Action Alternative. Increase alternative nuclear materials inventory by 20%.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Fast-Neutron Spectrum	Perform criticality experiments. Develop safeguards instrumentation and perform research and development for nuclear materials, LIDAR[b] experiments, and materials processing.	Criticality experiments increase 25% above No Action Alternative. Increase alternative nuclear materials inventory by 20%. Increase nuclear weapons components and materials.	Same as No Action Alternative.	Same as Expanded Operations Alternative.

TABLE 3.6.1–7.—*Alternatives for Continued Operations of Pajarito Site (TA–18)*-Continued

ACTIVITIES	NO ACTION[a]	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Dynamic Measurements	Perform criticality experiments. Develop safeguards instrumentation and perform research and development for nuclear materials, LIDAR[b] experiments, and materials processing.	Criticality experiments increase 25% above No Action Alternative. Increase alternative nuclear materials inventory by 20%.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Skyshine Measurements	Perform criticality experiments.	Criticality experiments increase 25% above No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Vaporization	Perform criticality experiments.	Criticality experiments increase 25% above No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Irradiation	Perform criticality experiments. Develop safeguards instrumentation and perform research and development for nuclear materials, interrogation techniques, and field systems.	Criticality experiments increase 25% above No Action Alternative. Increase alternative nuclear materials inventory by 20%.	Same as No Action Alternative.	Same as Expanded Operations Alternative.

[a] The total number of experiments under the No Action Alternative were 570 in 1997 and projected to have an annual growth of about 5% for the next 10 years.
[b] Light detection and ranging.

TABLE 3.6.1–8.—*Parameter Differences Among Alternatives for Continued Operation of the Pajarito Site, (TA–18)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions Argon-41[b]	Ci/yr	1.16×10[c]	8.17×10^1	1.02×10^2	8.17×10^1	8.17×10^1
NPDES Discharge	MGY	No outfalls	No outfalls	No outfalls	No outfalls	No outfalls
Chemical Waste	lb/yr (kg/yr)	4,400[d] (2,000)	8,800 (4,000)	8,800 (4,000)	8,800 (4,000)	8,800 (4,000)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	2,470[d] (70)	5,120 (145)	5,120 (145)	5,120 (145)	5,120 (145)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	25[d] (0.7)	53 (1.5)	53 (1.5)	53 (1.5)	53 (1.5)
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	0	0	0	0
Contaminated Space[e]	ft^2 (m^2)	< 500 (46)	No change	No change	No change	No change
Number of Workers	FTEs	68[f]	95	95	95	113

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] These values are not stack emissions. They are projections from Gaussian plume dispersion modeling. Values are from the first 394-foot (120-meter) radius. Other isotopes (nitrogen-13 and oxygen-15) are not shown due to very short half-lives.
[c] Index data for Argon-41 is from 1995
[d] Index is 1990 to 1995 average.
[e] Index is Fiscal Year 1995. Data are increments or decrements to the existing conditions.
[f] Index is Fiscal Year 1994.

TABLE 3.6.1–9.—*Alternatives for Continued Operation of Sigma Complex*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Research and Development on Materials Fabrication, Coating, Joining, and Processing	Maintain and enhance capability to fabricate items from metals, ceramics, salts, beryllium, enriched uranium, depleted uranium, and other uranium isotope mixtures including casting, forming, machining, polishing, coating, and joining.	Same as the No Action Alternative.	Same as the No Action Alternative.	Same as the No Action Alternative.
Characterization of Materials	Maintain and enhance research and development activities on properties of ceramics, oxides, silicides, composites, and high-temperature materials	Modest increase over No Action Alternative, characterize accelerator production of tritium components	Same as the No Action Alternative.	Same as the No Action Alternative.
	Analyze up to 24 tritium reservoirs/yr.	Analyze up to 36 tritium reservoirs/yr.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Develop library of aged non-SNM materials from stockpiled weapons and develop techniques to test and predict changes. Store and characterize up to 250 samples including uranium.	Store and characterize up to 2,500 non-SNM component samples, including uranium.	Same as the No Action Alternative.	Same as Expanded Operations Alternative.

TABLE 3.6.1–9.—*Alternatives for Continued Operation of Sigma Complex*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Fabrication of Metallic and Ceramic Items	Fabricate stainless steel and beryllium components for about 50 pits/yr.	Fabricate stainless steel and beryllium components for about 80 pits/yr.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate 50 to 100 reservoirs for tritium/yr.	Fabricate up to 200 reservoirs for tritium/yr.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate components for up to 50 secondaries (of depleted uranium, depleted uranium alloy, enriched uranium, lithium hydride, and lithium deuteride) /yr.	Same as No Action Alternative.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate nonnuclear components for research and development: 30 major hydrotests and 20 to 40 joint test assemblies/yr.	Fabricate nonnuclear components for research and development: 100 major hydrotests and 50 joint test assemblies/yr.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate beryllium targets.	Modest increase over the No Action Alternative.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate targets and other components for accelerator production of tritium research.	Same as the No Action Alternative.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate test storage containers for nuclear materials stabilization.	Same as the No Action Alternative.	Same as the No Action Alternative.	Same as the No Action Alternative.
	Fabricate nonnuclear (stainless steel and beryllium) components for up to 20 pit rebuilds/yr.	Same as the No Action Alternative.	Same as the No Action Alternative.	Same as the No Action Alternative.

Note: All alternatives include Sigma Building renovation and facility modifications for pit support and beryllium technology support, as discussed in chapter 2 (section 2.2.2.5).

TABLE 3.6.1–10.—*Parameter Differences Among Alternatives for Continued Operation of the Sigma Complex (TA–3)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions	Ci/yr					
Uranium-234		2.20×10^{-6} [b]	2.20×10^{-5}	6.6×10^{-5}	2.20×10^{-5}	2.20×10^{-5}
Uranium-238		6.10×10^{-5}	6.10×10^{-4}	1.8×10^{-3}	6.10×10^{-4}	6.10×10^{-4}
NPDES Discharge						
Total Discharges	MGY (MLY)	7.3 (27.6)	7.3 (27.6)	7.3 (27.6)	7.3 (27.6)	7.3 (27.6)
03A–022[c]	MGY (MLY)	4.4[e] (16.7)	4.4 (16.7)	4.4 (16.7)	4.4 (16.7)	4.4 (16.7)
03A–024[d]	MGY (MLY)	2.9[f] (11.0)	2.9 (11.0)	2.9 (11.0)	2.9 (11.0)	2.9 (11.0)
Chemical Waste	lb/yr (kg/yr)	6,170[g] (2,800)	12,100 (5,500)	22,050 (10,000)	12,100 (5,500)	12,100 (5,500)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	7,770[h] (220)	14,830 (420)	33,890 (960)	14,830 (420)	14,830 (420)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	35[i] (1)	71 (2)	141 (4)	71 (2)	71 (2)
TRU/Mixed TRU Waste	m^3/yr	0	0	0	0	0
Contaminated Space[j]	ft^2	Not estimated	No change	No change	No change	No change
Number of Workers	FTEs	142[k]	178	284	178	178

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index data for uranium isotopes is from 1990 to 1994.
[c] Outfall 03A–022 consists of one process source and some storm water drain sources.
[d] Outfall 03A–024 consists of process source only.
[e] Index is representative data provided by facility operations based on approximate water usage. No specific dates available.
[f] Index is representative data provided by Engineering Department based on frequency of blowdown. No specific dates available.
[g] Index is 1993 to 1995.
[h] Index is 1994 to 1995.
[i] Index is 1991 to 1995.
[j] This facility is expected (based on process knowledge) to have little or no contaminated space from past operations, so no estimate of the index was made (assumed to be none). Data are increments or decrements from the index.
[k] Index is Fiscal Year 1995.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–11.—*Alternatives for Continued Operation of the Materials Science Laboratory (TA–3–1698)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Materials Processing	Maintain eight capabilities at current levels of operation: • Synthesis/processing • Wet chemistry • Thermomechanical processing • Microwave processing • Heavy equipment materials • Single crystal growth • Amorphous alloys • Powder processing	No change to seven capabilities. Expand materials synthesis/ processing to develop cold mock-up of weapons assembly and processing. Expand materials synthesis/ processing to develop environmental and waste technologies.	Maintain capabilities and personnel. Significant decrease in the number of experiments for the eight research capabilities. Expand materials synthesis/processing to develop environmental and waste technologies.	No change to six capabilities. Expand wet chemistry to develop remediation chemistry capability. Expand materials synthesis/ processing research for nonweapons applications. Expand materials synthesis/ processing to develop environmental and waste technologies.
Mechanical Behavior in Extreme Environment	Maintain three capabilities at current levels of operation: • Mechanical testing • Dynamic testing • Fabrication and assembly	No change to two capabilities. Expand dynamic testing to include research and development for the aging of weapons materials. Develop a new research capability (machining technology).	Maintain capabilities and personnel. Significant decrease in the number of experiments for the three research capabilities.	No change to two capabilities. Expand mechanical testing research for nonweapons applications.
Advanced Materials Development	Maintain four capabilities at current levels of operation: • New materials • Synthesis and characterization • Ceramics • Superconductors	Same as No Action Alternative.	Maintain capabilities and personnel. Significant decrease in the number of experiments for three research capabilities. Reduce research effort for high-temperature superconductors.	No change to three capabilities. Increase research effort for high-temperature superconductors.
Materials Characterization	Maintain six capabilities at current levels of operation: • Surface science chemistry • Corrosion characterization • Electron microscopy • X-ray • Optical metallography • Spectroscopy	No change to four capabilities. Expand corrosion characterization to develop surface modification technology. Expand electron microscopy to develop plasma source ion implantation.	Significant decrease in the number of experiments for surface science chemistry and corrosion characterization. Eliminate capabilities for electron microscopy, x-ray, optical metallography, and spectroscopy.	Expand research in all six areas. Perform research into environmental corrosives.

TABLE 3.6.1–12.—*Parameter Differences Among Alternatives for Continued Operation of the Material Science Laboratory (TA–3)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions	Ci/yr	negligible	negligible	negligible	negligible	negligible
NPDES Discharge Volume	MGY	no outfalls	no outfalls	no outfalls	no outfalls	no outfalls
Chemical Waste	lb\yr (kg/yr)	660[b] (300)	1,320 (600)	1,320 (600)	1,320 (600)	1,320 (600)
Low-Level Radioactive Waste	m^3/yr	negligible	0	0	0	0
Low-Level Radioactive Mixed Waste	m^3/yr	0	0	0	0	0
TRU/Mixed TRU Waste	m^3/yr	0	0	0	0	0
Contaminated Space[c]	ft^2	Not estimated	No change	No change	No change	No change
Number of Workers	FTEs	82[d]	82	82	82	82

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index value is the average of 1994 and 1995 data.
[c] This facility is expected (based on process knowledge) to have little or no contaminated space from past operations, so no estimate of the index was made (assumed to be none). Data are increments or decrements from the index.
[d] Index is Fiscal Year 1995.

TABLE 3.6.1–13.—*Alternatives for Continued Operation of the Target Fabrication Facility (TA–35)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Precision Machining and Target Fabrication	Provide targets and specialized components for about 1,200 tests/yr. Expect 10% growth in these operations/yr for the next 10 yrs.	Operations at about twice No Action Alternative including 20% increase in high explosives pulsed-power and increase for 100 high-energy density physics /yr.	Operations reduced to about one-third of No Action Alternative levels.	Same as No Action Alternative.
Polymer Synthesis	Produce polymers for targets and specialized components for about 1,200 tests/yr. Expect 10% growth in these operations/yr for the next 10 yrs.	Operations supporting laser and physics tests increase to twice No Action Alternative level, with 10 to 20% growth in DoD and high explosives pulsed-power target operations. Increased operations to support 100 high-energy density physics tests/yr.	Laser and physics test operations reduced to about one-third of No Action Alternative levels.	Laser and physics test operations remain at No Action Alternative level. Other operations redirected to advanced materials research and manufacturing, waste treatment, energy technologies, and environmental restoration technology.
Chemical and Physical Vapor Deposition	Coat targets and specialized components for about 1,200 tests/yr. Expect 10% growth in these operations/yr for the next 10 yrs.	Operations supporting laser and physics tests increase to twice No Action Alternative level, with 10 to 20% growth in DoD and high explosives pulsed-power target operations. Increase operations to support 100 high-energy density physics tests/yr. Support for pit rebuild operations double over 10-yr period. Other operations have low increase over No Action Alterative levels.	Laser and physics test operations reduced to about one-third of No Action Alternative levels.	Laser and physics test operations remain at No Action Alternative level. Other operations redirected to advanced materials research and manufacturing, waste treatment, energy technologies, and environmental restoration technologies with potential for moderate increase in operations.

TABLE 3.6.1–14.—*Parameter Differences Among Alteratives for Continued Operation of the Target Fabrication Facility (TA–35)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radiological Air Emissions	Ci/yr	negligible	negligible	negligible	negligible	negligible
NPDES Discharge 04A–127[b]	MGY (MLY)	2.0[c] (7.6)	0	0	0	0
Chemical Waste	lb/yr (kg/yr)	4,170[d] (1,890)	8,380 (3,800)	8,380 (3,800)	8,380 (3,800)	8,380 (3,800)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	180[e] (5)	350 (10)	350 (10)	350 (10)	350 (10)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	7[f] (0.2)	14 (0.4)	14 (0.4)	14 (0.4)	14 (0.4)
TRU/Mixed TRU Waste	m^3/yr	0	0	0	0	0
Contaminated Space[g]	ft^2	Not estimated	No change	No change	No change	No change
Number of Workers	FTEs	71[h]	71	98	38	71

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Outfall 04A–127 consists of three process sources and four storm drains. Index is 1990 to 1995.
[c] Index is representative data; no specific index date available.
[d] Index is 1990 to 1995 average.
[e] Index is 1990 to 1993 average.
[f] Index is 1990 to 1991 average.
[g] This facility is expected (based on process knowledge) to have little or no contaminated space from past operations, so no estimate of the index was made (assumed to be none). Data are increments or decrements from the index.
[h] Index is representative data; no specific index date available.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–15.—*Alternatives for Continued Operation of the Machine Shops, TA–3*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Fabrication of Specialty Components	Provide fabrication support for the dynamic experiments program and explosives research studies, support up to 30 hydrodynamic tests/yr, manufacture 20 to 40 joint test assemblies sets per yr and provide general laboratory fabrication support as requested.	Increase operations to support up to 100 hydrodynamic tests/yr., manufacture up to 50 joint test assemblies sets per yr, and provide general laboratory fabrication support as requested.	Same as No Action Alternative.	Same as No Action Alternative.
Fabrication Utilizing Unique Materials	Continue fabrication utilizing unique and unusual materials.	Up to three times No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Dimensional Inspection of Fabricated Components	Provide appropriate dimensional inspection of above fabrication activities.	Provide appropriate dimensional inspection of above fabrication activities, and undertake additional types of measurements/inspections.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.1–16.—*Parameter Differences Among Alteratives for Continued Operation of the Machine Shops (TA–3)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions Uranium-238	Ci/yr	5.00×10^{-6} [b]	5.00×10^{-5}	1.50×10^{-4}	5.00×10^{-5}	5.00×10^{-5}
NPDES Discharge	MGY	No outfalls	No outfalls	No outfalls	No outfalls	No outfalls
Chemical Waste	lb/yr (kg/yr)	52,300[c] (23,700)	313,000 (142,000)	1,045,000 (474,000)	313,000 (142,000)	313,000 (142,000)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	710[c] (20)	9,880 (280)	21,390 (606)	9,880 (280)	9,880 (280)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	120[c] (3.3)	0	0	0	0
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	0	0	0	0
Contaminated Space[d]	ft^2 (m^2)	Not estimated	+ 5,000 (460)	+ 10,000 (930)	+ 5,000 (460)	+ 5,000 (460)
Number of Workers	FTEs	60[e]	123	289	123	123

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index data for uranium-238 is from 1993.
[c] Index is 1993 to 1995 average. Nonnuclear workload will increase substantially from the index.
[d] This facility is expected (based on process knowledge) to have little or no contaminated space from past operations, so no estimate of the index was made (assumed to be none). Data are increments or decrements from the index.
[e] Index is Fiscal Year 1996 as adjusted by the facility subject matter expert.

TABLE 3.6.1–17.—*Alternatives for the Continued Operation of the High Explosives Processing Facilities (TA–8, TA–9, TA–11, TA–16, TA–22, TA–29, and TA–37)*[a]

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
High Explosives Synthesis and Production	Continue low-level synthesis research and development, produce new materials and formulate explosives as needed. Increase process development. Produce material and components for directed stockpile production.	50% increase in synthesis research and development and formulation of explosives. Increase production of materials for evaluation and process development.	Activities reduced to approximately 60% of No Action Alternative.	Same as Reduced Operations Alternative.
High Explosives and Plastics Development and Characterization	Evaluate stockpile returns. Increase efforts in development and characterization of new plastics and high explosives for stockpile improvement. Improve predictive capabilities. Research high explosives waste treatment methods.	40% increase in developing and characterizing substitute materials for stockpile application. More efforts in predictive models, process development, and high explosives waste treatment.	Overall level of effort reduced to less than 60% of No Action Alternative.	Same as Reduced Operations Alternative.
High Explosives and Plastics Fabrication	Continue traditional stockpile surveillance and process development. Supply parts to Pantex for surveillance, stockpile rebuilds, and joint test assemblies. Increase fabrication for hydrodynamic and environmental testing.	Fabrication support increased: surveillance rebuild, + 40%; stockpile rebuilds, + 100%; surety and above ground test, + 50%.	Reduced efforts in fabrication as compared to No Action Alternative; War reserve refurbishment and weapons research and development, approximately 60% of No Action Alternative. Stockpile surveillance and above ground tests reduced to approximately 75% of No Action Alternative.	Same as Reduced Operations Alternative.
Test Device Assembly	Increase test device assembly to support stockpile related hydrodynamic tests, joint test assemblies, environmental and safety tests, and somewhat increased research and development. Approximately 30 major assembles/yr.	Increase operation to support approximately 100 major assemblies/yr.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.1–17.—*Alternatives for the Continued Operation of the High Explosives Processing Facilities (TA–8, TA–9, TA–11, TA–16, TA–22, TA–29, and TA–37)*[a]-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Safety and Mechanical Testing	Increase safety and environmental test related to stockpile assurance. Improve predictive models, approximately 12 safety and mechanical tests/yr.	50% increase in safety and environmental tests to support stockpile needs. Approximately 15 safety and mechanical tests/yr.	Testing activities reduced to approximately 80% of No Action Alternative.	Same as Reduced Operations Alternative.
Research, Development, and Fabrication of High-Power Detonators	Increase efforts to support assigned SSM activities; manufacture up to 20 major product lines per year. Support DOE complex for packaging and transportation of electro-explosive devices.	Increase operations to support 40 major product lines per year.	Same as No Action Alternative.	Same as No Action Alternative.

[a] The total amount of explosives and mock explosives used across all activities is an indicator of overall activity levels for this key facility. These amounts under each alternative are:

- No Action: 46,750 pounds (21,200 kilograms) of explosives and 1,590 pounds (720 kilograms) of mock explosives.
- Expanded Operations: 82,700 pounds (37,500 kilograms) of explosives and 2,910 pounds (1,320 kilograms) of mock explosives.
- Reduced Operations: 19,400 pounds (8,800 kilograms) of explosives and 1,150 pounds (520 kilograms) of mock explosives.
- Greener: 19,400 pounds (8,800 kilograms) of explosives and 1,150 pounds (520 kilograms) of mock explosives.

TABLE 3.6.1–18.—*Parameter Differences Among Alternatives for Continued Operation of High Explosives Processing (TA–8, TA–9, TA–11, TA–16, TA–22, TA–28, and TA–37)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions						
(TA–11)	Ci/yr	1.53×10^{-7} [b]	3.98×10^{-7}	9.96×10^{-7}	2.32×10^{-7}	2.32×10^{-7}
Uranium-238	Ci/yr	2.90×10^{-9}	7.56×10^{-9}	1.89×10^{-8}	4.41×10^{-9}	4.41×10^{-9}
Uranium-235	Ci/yr	5.69×10^{-8}	1.49×10^{-7}	3.71×10^{-7}	8.67×10^{-8}	8.67×10^{-8}
Uranium-234						
NPDES Discharge						
Total Discharges	MGY (MLY)	34 (129)	12.4 (47.0)	12.4 (47.0)	12.3 (46.6)	12.3 (46.6)
02A–007[c]	MGY (MLY)	10.5[d] (40)	7.4 (28.0)	7.4 (28.0)	7.4 (28.0)	7.4 (28.0)
03A–130	MGY (MLY)	0.037[e] (0.14)	0.037 (0.14)	0.037 (0.14)	0.037 (0.14)	0.037 (0.14)
04A–070	MGY (MLY)	0.22[f] (0.83)	0.0	0.0	0.0	0.0
04A–083[c]	MGY (MLY)	0.20[g] (0.76)	0.0	0.0	0.0	0.0
04A–092[c]	MGY (MLY)	1.57[f] (5.94)	0.0	0.0	0.0	0.0
04A–115[c]	MGY (MLY)	0.53[g] (2.01)	0.0	0.0	0.0	0.0
04A–157	MGY (MLY)	7.31[g] (27.7)	0.0	0.0	0.0	0.0
05A–053[c]	MGY (MLY)	0.124[d] (0.47)	0.0	0.0	0.0	0.0
05A–054	MGY (MLY)	3.57[d] (13.5)	3.6 (13.6)	3.6 (13.6)	3.6 (13.6)	3.6 (13.6)
05A–055	MGY (MLY)	0.036[d] (0.14)	0.13 (0.49)	0.13 (0.65)	0.10 (0.38)	0.10 (0.38)
05A–056	MGY (MLY)	2.53[d] (9.58)	0.0	0.0	0.0	0.0
05A–066[c]	MGY (MLY)	4.36[d] (16.5)	0.74 (2.80)	0.74 (2.80)	0.74 (2.80)	0.74 (2.80)
05A–067[c]	MGY (MLY)	0.33[d] (1.25)	0.33 (1.25)	0.33 (1.25)	0.33 (1.25)	0.33 (1.25)
05A–068[c]	MGY (MLY)	1.16[d] (4.39)	0.06 (0.23)	0.06 (0.23)	0.06 (0.23)	0.06 (0.23)
05A–069	MGY (MLY)	0.007[d] (0.03)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)
05A–071	MGY (MLY)	0.036[d] (0.14)	0.04 (0.15)	0.04 (0.15)	0.04 (0.15)	0.04 (0.15)
05A–072[c]	MGY (MLY)	0.0219[f] (0.08)	0.0	0.0	0.0	0.0
05A–096	MGY (MLY)	0.007[d] (0.03)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)
05A–097	MGY (MLY)	0.007[d] (0.03)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)	0.01 (0.04)
06A–073	MGY (MLY)	0.084[f] (0.32)	0.0	0.0	0.0	0.0
06A–074	MGY (MLY)	0.25[g] (0.95)	0.0	0.0	0.0	0.0
06A–075	MGY (MLY)	1.0[f] (3.79)	0.0	0.0	0.0	0.0
Chemical Waste	lb/yr (kg/yr)	20,300[h] (9,200)	24,300 (11,000)	28,700 (13,000)	15,400 (7,000)	15,400 (7,000)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	210[i] (6)	390 (11)	560 (16)	280 (8)	280 (8)

TABLE 3.6.1–18.—*Parameter Differences Among Alternatives for Continued Operation of High Explosives Processing (TA–8, TA–9, TA–11, TA–16, TA–22, TA–28, and TA–37)*-Continued

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	7[j] (0.2)	7 (0.2)	7 (0.2)	7 (0.2)	7 (0.2)
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	0	0	0	0
Contaminated Space[k]	ft^2 (m^2)	Not estimated	No change	No change	No change	No change
Number of Workers	FTEs	148[l]	242	335	170	170

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index is Fiscal Year 1995.
[c] Footnoted outfalls contain both process sources and storm water sources; otherwise, outfalls contain only process sources.
[d] Index is 1990 to 1995.
[e] Index is representative data; no specific index date available.
[f] Index data from ESH–18 measurements for NPDES permit application and from estimates based on facility operations. No specific dates available.
[g] Index estimated by facility operations based on approximate water usage. No specific index date available.
[h] Index is 1990 to 1995 average.
[i] Index is 1993 to 1995 average.
[j] Index is 1994 to 1995 average.
[k] This facility is expected (based on process knowledge) to have little or no contaminated space from past operations, so no estimate of the index was made (assumed to be none). Data are increments or decrements from the index.
[l] Provided as representative data by the facility subject matter expert. Index date not available.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–19.—*Alternatives for the Continued Operation of High Explosives Testing: TA–14 (Q-Site), TA–15 (R-Site), TA–36 (Kappa-Site), TA–39 (Ancho Canyon Site), and TA–40 (DF-Site)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Hydrodynamic Tests	Conduct up to 30 hydrodynamic tests/yr. Develop containment technology. Conduct baseline and code development tests of weapons configuration. Depleted uranium use of 2,900 lb/yr (over all activities).	Increase number of hydrodynamic tests to up to 100/yr. Depleted uranium use of about 6,900 lb/yr (over all activities).	Same as No Action Alternative.	Same as No Action Alternative.
Dynamic Experiments	Conduct dynamic experiments to study properties and enhance understanding of the basic physics of state and motion for materials used in nuclear weapons including some experiments with SNM.	Increase number of dynamic experiments by about 50%.	Same as No Action Alternative.	Same as No Action Alternative.
Explosives Research and Testing	Conduct high explosives tests to characterize explosive materials.	Up to twice No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Munitions Experiments	Continued support of DoD in conventional munitions. Conduct experiments with projectiles and study other effects on munitions.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
High Explosives Pulsed-Power (HEPP) Experiments	Conduct HEPP experiments and development tests.	Up to twice the number of HEPP experiments and development tests.	Same as No Action Alternative.	Same as No Action Alternative.
Calibration, Development, and Maintenance Testing	Conduct tests to provide calibration data, instrumentation development, and maintenance of image processing capability, etc.	Up to twice the number of tests.	Same as No Action Alternative.	Same as No Action Alternative.
Other Explosives Testing	Develop advanced high explosives or weapons evaluation techniques.	Increase the number of explosives studies by 50%.	Same as No Action Alternative.	Same as No Action Alternative.

Note: All alternatives include completion of construction for the DARHT Facility and its operation, as discussed in chapter 2 (section 2.2.2.10).

TABLE 3.6.1–20.—*Parameter Differences Among Alternatives for Continued Operation of High Explosives Testing, TA–14 (Q-Site) TA–15 (R-Site) TA–36 (Kappa Site), and TA–40 (DF-Site)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions[b]						
Depleted Uranium	Ci/yr	Not Available	5.0×10^{-2}	1.5×10^{-1}	5.0×10^{-2}	5.0×10^{-2}
Chemical Usage[c]						
TA–14						
Depleted Uranium	lb/yr (kg/yr)	6.6 (3)	22 (10)	66 (30)	22 (10)	22 (10)
Lead	lb/yr (kg/yr)	22 (10)	22 (10)	66 (30)	22 (10)	22 (10)
TA–15[d]						
Depleted Uranium	lb/yr (kg/yr)	730 (330)	1,980 (900)	5,950[e] (2,700)	1,980 (900)	1,980 (900)
Lead	lb/yr (kg/yr)	44 (20)	110 (50)	330 (150)	110 (50)	110 (50)
Beryllium	lb/yr (kg/yr)	22 (< 10)	22 (10)	66 (30)	22 (10)	22 (10)
Aluminum	lb/yr (kg/yr)	150 (70)	330 (150)	990 (450)	330 (150)	330 (150)
Copper	lb/yr (kg/yr)	44 (20)	220 (100)	660 (300)	220 (100)	220 (100)
Tantalum	lb/yr (kg/yr)	22 (< 10)	220 (100)	660 (300)	220 (100)	220 (100)
Tungsten	lb/yr (kg/yr)	22 (10)	220 (100)	660 (300)	220 (100)	220 (100)
TA–36						
Depleted Uranium	lb/yr (kg/yr)	330 (150)	880 (400)	2,650 (1,200)	880 (400)	880 (400)
Lead	lb/yr (kg/yr)	22 (< 10)	22 (10)	66 (30)	22 (10)	22 (10)
Beryllium	lb/yr (kg/yr)	0	22 (10)	66 (30)	22 (10)	22 (10)
Copper	lb/yr (kg/yr)	22 (10)	22 (10)	66 (30)	22 (10)	22 (10)
TA–39						
Lead	lb/yr (kg/yr)	0	22 (10)	66 (30)	22 (10)	22 (10)
Beryllium	lb/yr (kg/yr)	0	22 (10)	66 (30)	22 (10)	22 (10)
Aluminum[n]	lb/yr (kg/yr)	1,410 (640)	33,100 (15,000)	99,200 (45,000)	33,100 (15,000)	33,100 (15,000)
Copper[n]	lb/yr (kg/yr)	2,510 (1,140)	33,100 (15,000)	99,200 (45,000)	33,100 (15,000)	33,100 (15,000)
TA–40						
Copper	lb/yr (kg/yr)	44 (20)	220 (100)	660 (300)	220 (100)	220 (100)

TABLE 3.6.1–20.—*Parameter Differences Among Alternatives for Continued Operation of High Explosives Testing, TA–14 (Q-Site) TA–15 (R-Site) TA–36 (Kappa Site), and TA–40 (DF-Site)*-Continued

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
NPDES Discharge						
Total Discharges	MGY (MLY)	3.95 (15.0)	3.6 (13.6)	3.6 (13.6)	3.6 (13.6)	3.6 (13.6)
03A–028	MGY (MLY)	2.2[g] (8.33)	2.2 (8.33)	2.2 (8.33)	2.2 (8.33)	2.2 (8.33)
03A–185	MGY (MLY)	0.73[h] (2.76)	0.73 (2.76)	0.73 (2.76)	0.73 (2.76)	0.73 (2.76)
04A–101[f]	MGY (MLY)	< 0.05[i] (0.19)	0	0	0	0
04A–139	MGY (MLY)	None	None	None	None	None
04A–141	MGY (MLY)	0.031[h] (0.12)	0.0	0.0	0.0	0.0
04A–143	MGY (MLY)	0.018[h] (0.07)	0.018 (0.07)	0.018 (0.07)	0.018 (0.07)	0.018 (0.07)
04A–156	MGY (MLY)	0.091[h] (0.34)	0.0	0.0	0.0	0.0
06A–079	MGY (MLY)	0.54 (2.04)	0.54 (2.04)	0.54 (2.04)	0.54 (2.04)	0.54 (2.04)
06A–080	MGY (MLY)	0.027[h] (0.10)	0.03 (0.11)	0.03 (0.11)	0.03 (0.11)	0.03 (0.11)
06A–081	MGY (MLY)	0.027[h] (0.10)	0.03 (0.11)	0.03 (0.11)	0.03 (0.11)	0.03 (0.11)
06A–082	MGY (MLY)	0.027[h] (0.10)	0.0	0.0	0.0	0.0
06A–099[f]	MGY (MLY)	0.027[h] (0.10)	0.0	0.0	0.0	0.0
06A–100	MGY (MLY)	0.037[h] (0.14)	0.04 (0.15)	0.04 (0.15)	0.04 (0.15)	0.04 (0.15)
06A–123	MGY (MLY)	0.13[g] (0.49)	0.0	0.0	0.0	0.0
Chemical Waste	lb/yr (kg/yr)	52,700[j] (23,900)	55,600 (25,200)	77,800 (35,300)	55,600 (25,200)	55,600 (25,200)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	2,800[j] (80)	10,600 (300)	33,200 (940)	10,600 (300)	10,600 (300)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	3.5[j] (0.1)	10.6 (0.3)	31.8 (0.9)	10.6 (0.3)	10.6 (0.3)
TRU/Mixed TRU Waste[k]	ft^3/yr (m^3/yr)	0	7.1 (0.2)	7.1 (0.2)	7.1 (0.2)	7.1 (0.2)
Contaminated Space[l]	ft^2 (m^2)	Not estimated	No change	No change	No change	No change
Number of Workers	FTEs	341[m]	411	619	411	411

TABLE 3.6.1–20.—*Parameter Differences Among Alternatives for Continued Operation of High Explosives Testing, TA–14 (Q-Site) TA–15 (R-Site) TA–36 (Kappa Site), and TA–40 (DF-Site)*-Continued

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] The isotopic composition of depleted uranium is approximately 99.7% uranium-238, approximately 0.3% uranium-235, and approximately 0.002% uranium-234. Because there are no historic measurements of emissions from these sites, projections are based on estimated release fractions of the materials used in tests.
[c] Index from 1990 and 1995 chemical inventory data (LANL 1990 and LANL 1995b).
[d] Usage for TA–15 includes operations at DARHT and other TA–15 firing sites. The usage at DARHT for the No Action Alternative is the same as analyzed in the DARHT EIS (DOE 1995c). Conservatively, no credit was taken for the phased containment to be implemented at DARHT because the full benefits of phased containment would not be realized until late in the period examined in this SWEIS.
[e] Usage listed for the Expanded Operations Alternative includes projections for expanded operations at DARHT as well as the other TA–15 firing sites, consistent with the Expanded Operations Alternative description (the highest foreseeable level of such activities that could be supported by the LANL infrastructure). No proposals are currently before DOE to exceed the material expenditures at DARHT that are evaluated in the DARHT EIS (DOE 1995c).
[f] Outfall contains both process sources and storm water sources.
[g] Index provided as representative data by facility operations personnel. No specific dates available.
[h] Index data is from ESH–18 measurements for NPDES permit application and from estimates based on facility operations. No specific dates available.
[i] Index is representative data provided by facility operations based on approximate water usage. No specific dates available.
[j] Index is 1990 to 1995 average.
[k] TRU waste (steel) will be generated as a result of DARHT's Phased Containment Option (see DARHT EIS [DOE 1995c]).
[l] Most of these activities occur outdoors and, in general, such activities do not have the potential to result in contamination within facilities; thus, no estimate of the index was made. Environmental contamination from such test activities is addressed in chapter 4 (sections 4.2, 4.3, and 4.5). Data are increments or decrements from the index.
[m] Data provided as representative data by the facility subject matter expert. No specific index date available.
[n] The quantities of copper and aluminum involved in these tests are used primarily in the construction of support structures. These structures are not expended in the explosive tests, and thus, do not contribute to air emissions.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–21.—*Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS[c]	REDUCED OPERATIONS	GREENER[c]
Accelerator Beam Delivery, Maintenance, and Development	Deliver LANSCE linac beam to Areas A, B, C, WNR, Manuel Lujan Center, radiography sites, and new IPF for 8 months/yr (5,100 hrs). Positive ion current 1.00 milliampere and negative ion current of 200 microampere.	Deliver LANSCE linac beam to Areas A, B, C, WNR, Manuel Lujan Center, Dynamic Experiment Facility, and new IPF for 10 months/yr (6,400 hrs). Positive ion current 1.25 milliampere and negative ion current of 200 microampere.	Deliver LANSCE linac beam to Areas A, B, C, WNR, Manuel Lujan Center, radiography firing sites, and new IPF for 4 months/yr (2,600 hrs). Positive ion current 1.00 milliampere and negative ion current of 200 microampere.	Same as Expanded Operations Alternative.
	Reconfigure beam delivery and support equipment to support new facilities, upgrades, and experiments.[a]	Reconfigure beam delivery and support equipment to support new facilities, upgrades, and experiments.	Reconfigure beam delivery and support equipment to support new facilities, upgrades, and experiments.	
	Commission/operate/maintain LEDA for 6 yrs; operate up to approximately 6,600 hrs/yr.	Commission/operate/maintain LEDA for 10 to 15 yrs; operate up to approximately 6,600 hrs/yr.	Commission/operate/maintain 12-million electron volts LEDA for 2 yrs; operate up to approximately 1,000 hrs/yr.	
Experimental Area Support	Remote handling and radioactive waste disposal capability maintained.	Full-time remote handling and radioactive waste disposal capability required during Area A interior modifications, Area A East renovation.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
	Support of experiments, facility upgrades, and modifications.	Support of experiments, facility upgrades, and modifications.		
	Increased power demand for LEDA radiofrequency operation.	Increased power demand for LANSCE linac and LEDA radiofrequency operation.	Same as No Action Alternative.	Same as Expanded Operations Alternative.

TABLE 3.6.1–21.—*Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS[c]	REDUCED OPERATIONS	GREENER[c]
Neutron Research and Technology[b]	Conduct 500 to 1,000 experiments/yr using Manuel Lujan Center and WNR. Conduct accelerator production of tritium (APT) target neutronics experiment for 6 months. Support contained weapons-related experiments: • With small quantities of actinides, high explosives, and sources (up to approximately 40/yr) • With nonhazardous materials and small quantities of high explosives (up to approximately 100/yr) • With up to 10 lbs (4.5 kg) high explosives and/or depleted uranium (up to approximately 30/yr) • Shockwave experiments involving small amounts, up to (nominally) 0.18 oz (5 g) plutonium Provide support for static stockpile surveillance technology research and development.	Conduct 1,000 to 2,000 experiments/yr using Manuel Lujan Center, WNR, and LPSS. Establish LPSS in Area A (requires modification). Conduct APT target neutronics experiment for 6 months. Construct dynamic experiment laboratory adjacent to WNR. Support contained weapons-related experiments: • With small quantities of actinides, high explosives, and sources (up to approximately 80/yr) • With nonhazardous materials and small quantities of high explosives (up to approximately 200/yr) • With up to 10 lbs (4.5 kg) high explosives and/or depleted uranium (up to approximately 60/yr) • Shockwave experiments involving small amounts, up to (nominally) 1.8 oz (50 g) plutonium Provide support for static stockpile surveillance technology research and development.	Conduct 100 to 500 experiments/yr using Manuel Lujan Center and WNR. Support weapons-related experiments: • With small quantities of actinides, high explosives, and sources (up to approximately 20/yr) • With nonhazardous materials and small quantities of high explosives (up to approximately 50/yr) • With up to 10 lbs (4.5 kg) high explosives and/or depleted uranium (up to approximately 15/yr)	Conduct 1,000 to 2,000 experiments/yr using Manuel Lujan Center, WNR, and LPSS. Support weapons-related experiments: • With small quantities of actinides, high explosives, and sources (up to approximately 40/yr) • With nonhazardous materials and small quantities of high explosives (up to approximately 100/yr) • With up to 10 lbs (4.5 kg) high explosives and/or depleted uranium (up to approximately 30/yr) • Shockwave experiments involving small amounts, up to (nominally) 0.18 oz (5 g) plutonium

TABLE 3.6.1–21.—*Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS[c]	REDUCED OPERATIONS	GREENER[c]
Accelerator-Driven Transmutation Technology (ADTT)	Conduct lead target tests for 2 yrs at Area A beam stop. Establish 1-megawatt ADTT target/blanket experiment area in Area A. Conduct low-power experiments (< 1 megawatt) for 8 months/yr for 4 yrs.	Conduct lead target tests for 2 yrs at Area A beam stop. Implement LIFT (establish 1-megawatt, then 5-megawatt ADTT target/blanket experiment areas) adjacent to Area A. Conduct 5-megawatt experiments for 10 months/yr for 4 yrs (using about 6.6 lbs (3 kg) of actinides).	Conduct basic research using existing LANSCE facilities.	Same as Expanded Operations Alternative.
Subatomic Physics Research	Conduct 5 to 10 physics experiments/yr at Manuel Lujan Center and WNR. Continue neutrino experiment through Fiscal Year 1997. Conduct proton radiography experiments, including contained experiments with high explosives.	Conduct 5 to 10 physics experiments/yr at Manuel Lujan Center, WNR, and LPSS. Continue neutrino experiment through Fiscal Year 1997. Conduct proton radiography experiments, including contained experiments with high explosives.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Medical Isotope Production	Irradiate up to approximately 40 targets/yr for medical isotope production.	Irradiate up to approximately 50 targets/yr. Added production of exotic and neutron-rich/neutron-deficient isotopes (requires modification of an existing target area).	Irradiate up to approximately 20 targets/yr.	Same as Expanded Operations Alternative.
High-Power Microwaves and Advanced Accelerators	Conduct research and development in these areas, including microwave chemistry research for industrial and environmental applications.	Same as No Action Alternative.	Research reduced to about 50 percent of the No Action Alternative levels. No research in microwave chemistry for industrial and environmental applications.	Same as No Action Alternative.

TABLE 3.6.1–21.—*Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*-Continued

[a] **Note:** All alternatives include the completion of proton and neutron radiography facilities, the LEDA, the IPF relocation, and the SPSS enhancement, as discussed in chapter 2 (section 2.2.2.11).

[b] Numbers of neutron experiments represent plausible levels of activity for each alternative. Bounding conditions for the consequences of operations are primarily determined by: (a) length and power of beam operation and (b) maintenance and construction activities.

[c] The Expanded Operations and Greener Alternatives at TA–53 include the facility construction or modification activities and the operations associated with the LPSS, the 5-megawatt target/blanket experimental area (also referred to as LIFT), the DEL, and the Exotic Isotope Production Facility (in addition to TA–53 activities previously reviewed under NEPA). The parameters presented in Table 3.6.1–22, and the impacts presented in section 3.6 (and in chapter 5, sections 5.3 and 5.5) include the construction and the operation impacts associated with these projects. There are no meaningful siting and construction alternatives for these projects because they are dependent on the delivery of an accelerator beam that is not provided at other LANL facilities. (Construction of a new accelerator solely to provide for these activities is not considered reasonable.)

H^+ = proton (positively charged ion), H^- = negatively charged hydrogen ion

TABLE 3.6.1–22.—*Parameter Differences Among Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions[b]						
Argon-41 (10-yr average)	Ci/yr	2.4×10^{2}	4.81×10^{2}	7.68×10^{2}	2.46×10^{2}	7.68×10^{2}
1996 to 1997 average	Ci/yr		1.13×10^{3}	1.38×10^{3}	5.90×10^{2}	1.38×10^{3}
1998 to 1999 average	Ci/yr		6.01×10^{1}	7.44×10^{1}	3.12×10^{1}	7.44×10^{1}
2000 to 2001 average	Ci/yr		4.05×10^{2}	5.05×10^{2}	2.03×10^{2}	5.05×10^{2}
2002 to 2005 average	Ci/yr		4.05×10^{2}	9.37×10^{2}	2.03×10^{2}	9.37×10^{2}
Carbon-10 (10-yr average)	Ci/yr	2.08×10^{3}	1.35×10^{2}	1.53×10^{2}	1.05×10^{2}	1.53×10^{2}
1996 to 1997 average	Ci/yr		6.69×10^{2}	7.55×10^{2}	5.20×10^{2}	7.55×10^{2}
1998 to 2005 average	Ci/yr		2.12×10^{0}	2.65×10^{0}	1.06×10^{-0}	2.65×10^{0}
Carbon-11 (10-yr average)	Ci/yr	1.13×10^{4}	7.56×10^{3}	1.08×10^{4}	4.16×10^{3}	1.08×10^{4}
1996 to 1997 average	Ci/yr		1.90×10^{4}	2.30×10^{4}	1.14×10^{4}	2.30×10^{4}
1998 to 1999 average	Ci/yr		2.37×10^{3}	2.96×10^{3}	1.19×10^{3}	2.96×10^{3}
2000 to 2001 average	Ci/yr		5.47×10^{3}	6.84×10^{3}	2.74×10^{3}	6.84×10^{3}
2002 to 2005 average	Ci/yr		5.47×10^{3}	1.07×10^{4}	2.74×10^{3}	1.07×10^{4}
Nitrogen-13 (10-yr average)	Ci/yr	7.18×10^{3}	1.34×10^{3}	1.59×10^{3}	8.67×10^{2}	1.59×10^{3}
1996 to 1997 average	Ci/yr		4.98×10^{3}	5.81×10^{3}	3.48×10^{3}	5.81×10^{3}
1998 to 2005 average	Ci/yr		4.28×10^{2}	5.35×10^{2}	2.14×10^{2}	5.35×10^{2}
Nitrogen-16 (10-yr average)	Ci/yr	1.08×10^{3}	1.80×10^{2}	2.10×10^{2}	1.19×10^{2}	2.10×10^{2}
1996 to 1997 average	Ci/yr		8.98×10^{2}	1.05×10^{3}	5.95×10^{2}	1.05×10^{3}
1998 to 2005 average	Ci/yr		2.85×10^{-2}	2.85×10^{-2}	2.85×10^{-2}	2.85×10^{-2}
Oxygen-14 (10-yr average)	Ci/yr	7.5×10^{2}	7.32×10^{1}	8.33×10^{1}	5.63×10^{1}	8.33×10^{1}
1996 to 1997 average	Ci/yr		3.45×10^{2}	3.90×10^{2}	2.71×10^{2}	3.90×10^{2}
1998 to 2005 average	Ci/yr		5.29×10^{0}	6.61×10^{0}	2.65×10^{-0}	6.61×10^{0}
Oxygen-15 (10-yr average)	Ci/yr	2.84×10^{4}	2.79×10^{3}	3.18×10^{3}	2.09×10^{3}	3.18×10^{3}
1996 to 1997 average	Ci/yr		1.20×10^{4}	1.35×10^{4}	9.55×10^{3}	1.35×10^{4}
1998 to 2005 average	Ci/yr		4.84×10^{2}	6.06×10^{2}	2.32×10^{2}	6.06×10^{2}

TABLE 3.6.1–22.—*Parameter Differences Among Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*-Continued

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
LEDA Projections						
Oxygen-19 (8-yr average)	Ci/yr	Not Operating	2.16×10^{-3}	2.16×10^{-3}	2.16×10^{-3} [c]	2.16×10^{-3}
Sulfur-37 (8-yr average)	Ci/yr	Not Operating	1.81×10^{-3}	1.81×10^{-3}	1.81×10^{-3}	1.81×10^{-3}
Chlorine-39 (8-yr average)	Ci/yr	Not Operating	4.70×10^{-4}	4.70×10^{-4}	4.70×10^{-4}	4.70×10^{-4}
Chlorine-40 (8-yr average)	Ci/yr	Not Operating	2.19×10^{-3}	2.19×10^{-3}	2.19×10^{-3}	2.19×10^{-3}
Krypton-83m (8-yr average)	Ci/yr	Not Operating	2.21×10^{-3}	2.21×10^{-3}	2.21×10^{-3}	2.21×10^{-3}
Others (8-yr average)	Ci/yr	Not Operating	1.11×10^{-3}	1.11×10^{-3}	1.11×10^{-3}	1.11×10^{-3}
NPDES Discharge						
Total Discharges[d,e]	MGY (MLY)	16.8 (63.6)	67.7[f] (256)	81.8[f] (310)	26.2[f] (99.2)	81.8[f] (310)
03A–047	MGY (MLY)	2.64 (9.99)	4.7 (17.8)	7.1 (26.9)	2.3 (8.71)	7.1 (26.9)
03A–048	MGY (MLY)	8.56 (32.4)	15.6 (59.0)	23.4 (88.6)	7.7 (29.1)	23.4 (88.6)
03A–049	MGY (MLY)	4.15 (15.7)	7.5 (28.4)	11.3 (42.8)	3.7 (14.0)	11.3 (42.8)
03A–113	MGY (MLY)	0.9 (3.41)	39.7 (150)	39.8 (151)	12.3 (46.6)	39.8 (151)
03A–125	MGY (MLY)	0.18 (0.68)	0.18 (0.68)	0.18 (0.68)	0.18 (0.68)	0.18 (0.68)
03A–145	MGY (MLY)	0.37 (1.40)	0.0	0.0	0.0	0.0
Chemical Waste	lb/yr (kg/yr)	36,600[g] (16,600)	36,600 (16,600)	36,600 (16,600)	36,600 (16,600)	36,600 (16,600)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	3,530[h] (100)	5,510 (156)	38,300[i] (1,085)	5,510 (156)	38,300[i] (1,085)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	35[j] (1)	35 (1)	35 (1)	35 (1)	35 (1)
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	0	0	0	0
Electric Power	megawatts	29[k]	58	63	38	63
Electricity	gigawatt-hours	104[k]	372	437	163	437
Water	MGY (MLY)	78[l] (295)	218 (825)	265 (1,000)	108 (409)	265 (1,000)
Contaminated Space[m]	ft^3/ft^2 (m^3/m^2)	380,000 (10,750)	+19,000 (1,770)	+24,000 (2,230)	+19,000 (1,770)	+19,000 (1,770)
Number of Workers	FTEs	741[n]	856	856	731	856

TABLE 3.6.1–22.—*Parameter Differences Among Alternatives for Continued Operation of the Los Alamos Neutron Science Center (TA–53)*-Continued

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] 8-year average (1990 to 1997) is used as the basis for projected emissions for isotopes associated with the LEDA project. 5-year average (1991 to 1995) is used for the index for all other air emissions.
[c] For the Reduced Operations Alternative, power would be reduced from 40-million electron volts to 12-million electron volts. This would result in somewhat lower emissions; however, the relation is not linear. Therefore, no difference was shown in the Reduced Operations Alternative to remain conservative.
[d] Index is 1990 to 1995.
[e] All outfalls consist of process sources only.
[f] Values given across the alternatives are peak values for the 10 years. For most years, total discharges will be less.
[g] Index is 1990 to 1995.
[h] Index is 1992 to 1995.
[i] LLW volumes increase significantly in the Expanded Operations Alternative and Greener Alternative due to the LPSS project, which requires the decontamination and renovation of Experimental Area A (Building 53–03M).
[j] Assumed index value of 1. LLMW moratorium in mid 1990's caused changes in operations such that no more than 35 ft^3 (1 m^3) is expected.
[k] The index is the 6-year period 1990 to 1995.
[l] The index is 3-year average 1993 to 1995.
[m] Data are increments or decrements to the index. Index is May 1996. The index value is in ft^3 (m^3) because existing contamination is in materials in target areas that are best described in terms of volumes. The projections by alternative are in ft^2 (m^2) to recognize new areas that would have/handle irradiated or contaminated materials.
[n] Index is Fiscal Year 1995.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–23.—*Alternatives for the Continued Operation of the Health Research Laboratory (TA–43)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Genomic Studies	Conduct research utilizing molecular and biochemical techniques to analyze the genes of animals, particularly humans. Develop strategies at current levels to analyze the nucleotide sequence of individual genes, especially those associated with genetic disorders, and to identify their map genes and/or genetic diseases to locations on individual chromosomes. Part of this work is to map each nucleotide, in sequence, of each gene in all 46 chromosomes of the human genome.	Activities increased 25% above No Action Alternative.	Activities reduced to 20% of No Action Alternative.	Same as Expanded Operations Alternative.
Cell Biology	Conduct research at current levels utilizing whole cells and cellular systems, both in-vivo and in-vitro, to investigate the effects of natural and catastrophic cellular events like response to aging, harmful chemical and physical agents, and cancer.	Activities increased 40% above No Action Alternative.	Activities reduced to 30% of No Action Alternative.	Same as Expanded Operations Alternative.[a]
Cytometry	Conduct research utilizing laser imaging systems to analyze the structures and functions of subcellular systems.	Activities increased 33% above No Action Alternative.	Activities reduced to 25% of No Action Alternative.	Same as Expanded Operations Alternative.[a]
DNA Damage and Repair	Research using isolated cells to investigate DNA repair mechanisms.	Activities increased 40% above No Action Alternative.	Activities reduced to 30% of No Action Alternative.	Same as Expanded Operations Alternative.[a]

TABLE 3.6.1–23.—*Alternatives for the Continued Operation of the Health Research Laboratory (TA–43)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Environmental Effects	Research identifies specific changes that occur in DNA and proteins in certain microorganisms after events in the environment.	Activities increased 25% above No Action Alternative.	Activities reduced to 40% of No Action Alternative.	Same as Expanded Operations Alternative.[a]
Structural Cell Biology	Conduct research utilizing chemical and crystallographic techniques to isolate and characterize the three-dimensional shapes and properties of DNA and protein molecules.	Activities increased 50% above No Action Alternative.	Activities reduced to 20% of No Action Alternative.	Same as Expanded Operations Alternative.
Neurobiology	Conduct research using magnetic fields produced in active areas of the brain to map human brain locations associated with certain sensory and cognitive functions. Instrumentation is sensitive magnetic detection devices.	Activities increased to three times the level of the No Action Alternative.	Same activities as No Action Alternative.	Activities increased to two times the level of the No Action Alternative.
In-Vivo Monitoring	Continue 1,500 whole-body scans/yr as a service, a part of the LANL personnel monitoring program, which supports operations with radioactive materials conducted elsewhere at LANL.	Activities increased to 3,000 scans/yr.	Activities decreased to 500 scans/yr.	Same activities as Expanded Operations Alternative.

[a] Activity level is the same as Expanded Operations Alternative but FTE level is only slightly increased above the No Action Alternative. This is possible through use of more automated analytical apparatus.

TABLE 3.6.1–24.—*Parameter Differences in Alternatives for Continued Operation of the Health Research Laboratory (TA–43)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions	Ci/yr	Negligible	Not estimated	Not estimated	Not estimated	Not estimated
NPDES Discharge 03A–040[b]	MGY (MLY)	2.7[c] (10.2)	2.5[d] (9.46)	2.5 (9.46)	2.5 (9.46)	2.5 (9.46)
Chemical Waste	lb/yr (kg/yr)	10,800[e] (4,900)	15,400 (7,000)	28,700 (13,000)	11,000 (5,000)	28,700 (13,000)
Biomedical Waste	lb/yr (kg/yr)	290[e] (130)	110[f] (50)	620[g] (280)	110[f] (50)	620[f] (280)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	810[e] (23)	490 (14)	1,200 (34)	490 (14)	1,200 (34)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	14[e] (0.4)	95 (2.7)	120 (3.4)	88 (2.5)	120 (3.4)
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	0	0	0	0
Electric Power[j]	MW	0.445[i]	0.5	0.7	0.2	0.5
Water[j]	MGY (MLY)	10.5[j] (39.7)	12 (45.4)	15 (56.8)	4 (15.1)	12 (45.4)
Contaminated Space[k] Total Radiation Wing Irradiator Suite	 ft^2 (m^2) ft^2 (m^2) ft^2 (m^2)	 93,000 (8,640) 1,730 (160) 840 (80)	No change	No change	No change	No change
Number of Workers	FTEs	180[l]	190	250	70	200

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Outfall 03A–040 consists of one process outfall and nine storm drains. The process outfall is scheduled for elimination.
[c] Index is data from ESH–18 measurements for NPDES permit application and from estimates based on facility operations. No specific dates available.
[d] Storm water only. Estimated as the difference between total volume and process cooling water volume. An expected roof area increase of 10% is factored in as well.
[e] Index is 1994 to 1995 average.
[f] Waste comes from the animal colony. The animal colony was downsized substantially in the 1996 to 1997 period; waste in 1997 (calendar) was 165 lbs (75 kg). A future change in animal colony size is projected only for the Expanded Operations Alternative.
[g] Animal colony and the associated waste are projected to double.
[h] Facility-specific data are available for HRL, which is metered.
[i] The index is the average of 1994 (0.44 megawatts) and 1995 (0.45 megawatts) usage.
[j] The index is the average of 1993 (10 MGY [38 MLY]) and 1994 (11 MGY [42 MLY]) usage.
[k] Data are increments or decrements to the index. Index is May 1996.
[l] Index is Fiscal Year 1994, as adjusted by the facility subject matter expert.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–25.—*Alternatives for Continued Operation of the Radiochemistry Facility (TA–48)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radionuclide Transport Studies	Actinide transport, sorption, and bacterial interaction studies. Development of models for evolution of groundwater. Assessment of performance or risk of release for radionuclide sources at proposed waste disposal sites. 45 to 80 studies/yr.	Increased level of operations, approximately twice No Action Alternative. 80 to 160 studies/yr.	Reduced level of operations, approximately half No Action Alternative. 18 to 36 studies/yr.	Same level of activities as Expanded Operations Alternative, but activities are in support of environmental remediation.
Environmental Remediation Support	Background contamination characterization pilot studies. Performance assessments, soil remediation research and development, and field support at current levels.	Increased level of operations, approximately twice No Action Alternative.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Ultra-Low-Level Measurements	Isotope separation and mass spectrometry at current levels.	Increased level of operations, more than twice No Action Alternative.	Level of operations slightly reduced from No Action Alternative.	Same as Expanded Operations Alternative.
Nuclear/ Radiochemistry	Radiochemical operations involving quantities of alpha-, beta-, and gamma-emitting radionuclides at current levels for nonweapons and weapons work.	Slightly increased level of operations.	Reduced level of operations, approximately half of No Action Alternative.	About same activity level as No Action Alternative, but weapons work reduced by half, and nonweapons work increased by 10%.
Isotope Production	Target preparation. High-level beta/ gamma chemistry and target processing to recover isotopes for medical and industrial application.	Increased level of operations, approximately twice No Action Alternative.	Reduced level of operations, approximately half of No Action Alternative.	Same as No Action Alternative.
Actinide/ Transuranic Chemistry	Radiochemical operations involving significant quantities of alpha-emitting radionuclides at current level.	Increased level of operations, approximately twice No Action Alternative.	Reduced level of operations, approximately half of No Action Alternative.	Same level of activity as No Action Alternative, but activities are in support of nonweapons programs.

TABLE 3.6.1–25.—*Alternatives for Continued Operation of the Radiochemistry Facility (TA–48)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Data Analysis	Re-examination of archive data and measurement of nuclear process parameters of interest to weapons radiochemists at current levels.	Increased level of operations, approximately twice No Action Alternative.	Slightly reduced level of operations from No Action Alternative.	Same as Reduced Operations Alternative.
Inorganic Chemistry	Synthesis, catalysis, actinide chemistry (all activities at current level): • Chemical synthesis of new organo-metallic complexes • Structural and reactivity analysis, organic product analysis, and reactivity and mechanistic studies • Synthesis of new ligands for radiopharmaceuticals Environmental technology development (all activities at current level): • Ligand design and synthesis for selective extraction of metals • Soil washing • Membrane separator development • Ultra-filtration	Increased level of operations by 50% from No Action Alternative.	Same No Action Alternative.	Same as Expanded Operations Alternative.
Structural Analysis	Synthesis and structural analysis of actinide complexes at current levels. X-ray diffraction analysis of powders and single crystals at current levels.	Increased level of operations, almost twice No Action Alternative.	Same as No Action Alternative.	Same as Expanded Operations Alternative.
Sample Counting	Measurement of the quantity of radioactivity in samples using alpha-, beta-, and gamma-ray counting systems at current levels.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.1–26.—*Parameter Differences Among Alternatives for Continued Operation of the Radiochemistry Site (TA–48)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions						
Mixed Fission Products	Ci/yr	2.95×10^{-5}	1.1×10^{-4}	1.4×10^{-4}	6.9×10^{-5}	1.3×10^{-4}
Plutonium-239	Ci/yr	5.15×10^{-6}	5.5×10^{-6}	1.1×10^{-5}	5.2×10^{-6}	1.1×10^{-5}
Uranium-235[4]	Ci/yr	3.97×10^{-7}	4.0×10^{-7}	4.4×10^{-7}	2.0×10^{-7}	4.0×10^{-7}
Mixed Activation Products	Ci/yr	2.81×10^{-4}	1.6×10^{-6}	3.1×10^{-6}	7.8×10^{-7}	1.6×10^{-6}
Arsenic-72	Ci/yr	1.11×10^{-2}	5.6×10^{-5}	1.1×10^{-4}	2.8×10^{-5}	5.6×10^{-5}
Arsenic-73	Ci/yr	1.90×10^{-2}	9.5×10^{-5}	1.9×10^{-4}	4.8×10^{-5}	9.5×10^{-5}
Arsenic-74	Ci/yr	3.75×10^{-3}	2.0×10^{-5}	4.0×10^{-5}	9.8×10^{-6}	2.0×10^{-5}
Beryllium-7	Ci/yr	1.94×10^{-5}	7.4×10^{-6}	1.5×10^{-5}	3.6×10^{-6}	7.4×10^{-6}
Bromine-77	Ci/yr	2.37×10^{-2}	4.3×10^{-4}	8.5×10^{-4}	2.2×10^{-4}	4.3×10^{-4}
Germanium-68	Ci/yr	1.70×10^{-3}	8.5×10^{-6}	1.7×10^{-5}	4.3×10^{-6}	8.5×10^{-6}
Gallium-68	Ci/yr	1.70×10^{-3}	8.5×10^{-6}	1.7×10^{-5}	4.3×10^{-6}	8.5×10^{-6}
Rubidium-86	Ci/yr	2.76×10^{-5}	1.4×10^{-7}	2.8×10^{-7}	6.9×10^{-8}	1.4×10^{-7}
Selenium-75	Ci/yr	2.45×10^{-2}	1.6×10^{-4}	3.4×10^{-4}	8.3×10^{-5}	1.6×10^{-4}
NPDES Discharge						
Total Discharges	MGY (MLY)	15.6 (59.0)	4.1 (15.5)	4.1 (15.5)	4.1 (15.5)	4.1 (15.5)
03A–045[d]	MGY (MLY)	1.1[f] (4.16)	0.87[g] (3.29)	0.87 (3.29)	0.87 (3.29)	0.87 (3.29)
04A–016[e]	MGY (MLY)	6.3[f] (23.8)	No outfall[h]	No outfall	No outfall	No outfall
04A–131[e]	MGY (MLY)	0.95[f] (3.60)	No outfall[h]	No outfall	No outfall	No outfall
04A–152[e]	MGY (MLY)	4.0[f] (15.1)	No outfall[h]	No outfall	No outfall	No outfall
04A–153[d]	MGY (MLY)	3.2[f] (12.1)	3.2[g] (12.1)	3.2 (12.1)	3.2 (12.1)	3.2 (12.1)
Chemical Waste	lb/yr (kg/yr)	4,400 (2,000[i])	4,400 (2,000)	7,300 (3,300)	3,500 (1,600)	6,400 (2,900)
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	5,300 (150[i])	6,000 (170)	9,500 (270)	4,200 (120)	8,500 (240)
Low-Level Radioactive Mixed Waste	ft^3/yr (m^3/yr)	71 (2.0[i])	71 (2.0)	130 (3.8)	46 (1.3)	120 (3.4)
TRU/Mixed TRU Waste[j]	ft^3/yr (m^3/yr)	0	0	0	0	0
Contaminated Space[k]	ft^2 (m^2)	39,300 (3,600)	No change	No change	No change	No change
Number of Workers	FTEs	141[l]	171	248	132	248

TABLE 3.6.1–26.—*Parameter Differences Among Alternatives for Continued Operation of the Radiochemistry Site (TA–48)*-Continued

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Index data is the higher of stack emissions for 1994 or 1995.
[c] Uranium-235 index value is for 1994.
[d] Outfall consists of one process source and several storm water sources (roof drains).
[e] Outfall consists of one process source only.
[f] Index values from ESH–18 measurements for NPDES permit application and from estimates based on facility operations. No specific dates available.
[g] Estimates across the alternatives for outfalls 03A–045 and 04A–153 represent storm water only.
[h] Outfalls 04A–016 and 04A–152 were eliminated in August 1997, and these outfalls do not exist in any of the alternatives.
[i] Index 1990 to 1995 average.
[j] TRU waste is returned to the generating facility.
[k] Data are increments or decrements to the index. Index is May 1996.
[l] Index is February 1997 value.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–27.—*Alternatives for Continued Operation of the Radioactive Liquid Waste Treatment Facility (TA–50)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Waste Characterization, Packaging, Labeling	Support, certify, and audit generator characterization programs. Maintain waste acceptance criteria for RLW treatment facilities.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Waste Transport, Receipt, and Acceptance	Collect RLW from generators and transport to TA–50.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Radioactive Liquid Waste Pretreatment	Pretreat 185,000 gal/yr (700,000 l/yr) of RLW at TA–21. Pretreat 7,900 gal/yr (30,000 l/yr) of RLW from TA–55 in Room 60. Solidify, characterize, and package 71 ft^3/yr (2 m^3/yr) of TRU waste sludge in Room 60.	Pretreat 238,000 gal/yr (900,000 l/yr) of RLW at TA–21. Pretreat 21,100 gal/yr (80,000 l/yr) of RLW from TA–55 in Room 60. Solidify, characterize, and package 106 ft^3/yr (3 m^3/yr) of TRU waste sludge in Room 60.	Pretreat 158,000 gal/yr (600,000 l/yr) of RLW at TA–21. Pretreat 5,300 gal/yr (20,000 l/yr) of RLW from TA–55 in Room 60. Solidify, characterize, and package 71 ft^3/yr (2 m^3/yr) of TRU waste sludge in Room 60.	Pretreat 185,000 gal/yr (700,000 l/yr) of RLW at TA–21. Pretreat 6,600 gal/yr (25,000 l/yr) of RLW from TA–55 in Room 60. Solidify, characterize, and package 71 ft^3/yr (2 m^3/yr) of TRU waste sludge in Room 60.
Radioactive Liquid Waste Treatment	Install ultrafiltration and reverse osmosis equipment in 1997. Install equipment for nitrate reduction in 1999. Treat 6.6 MGY (25 MLY) of RLW. Dewater, characterize, and package 247 ft^3/yr (7 m^3/yr) of LLW sludge. Solidify, characterize, and package 812 ft^3/yr (23 m^3/yr) of TRU waste sludge.	Same as No Action Alternative except: • Treat 9.2 MGY (35 MLY) of RLW. • Dewater, characterize, and package 353 ft^3/yr (10 m^3/yr) of LLW sludge. • Solidify, characterize, and package 1,130 ft^3/yr (32 m^3/yr) of TRU waste sludge.	Same as No Action Alternative except: • Treat 5.3 MGY (20 MLY) of RLW. • Solidify, characterize, and package 671 ft^3/yr (19 m^3/yr) of TRU waste sludge.	Same as No Action Alternative.

TABLE 3.6.1–27.—*Alternatives for Continued Operation of the Radioactive Liquid Waste Treatment Facility (TA–50)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Decontamination Operations	Decontaminate personnel respirators for reuse (approximately 500/month). Decontaminate air-proportional probes for reuse (approximately 200/month). Decontaminate vehicles and portable instruments for reuse (as required). Decontaminate precious metals for resale (acid bath). Decontaminate scrap metals for resale (sand blast). Decontaminate 6,700 ft^3 (190 m^3) of lead for reuse (grit blast).	Same as No Action Alternative except: • Decontaminate LANL personnel respirators for reuse (approximately 700/month). • Decontaminate air-proportional probes for reuse (approximately 300/month). • Decontaminate 7,100 ft^3 (200 m^3) of lead for reuse (grit blast).	Same as No Action Alternative except: • Decontaminate LANL personnel respirators for reuse (approximately 300/month).	Same as No Action Alternative.

Note: Under all alternatives, influent storage tank upgrade, installation of a new process for treatment of radioactive liquid waste (RLW), and installation of additional treatment steps for removal of nitrates are all completed, as discussed in chapter 2 (section 2.2.2.14).

TABLE 3.6.1–28.—*Parameter Differences Among Alternatives for Continued Operations of the Radioactive Liquid Waste Treatment Facility (TA–50)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions[b]	Ci/yr	Negligible	Negligible	Negligible	Negligible	Negligible
Radioactive Liquid Waste Influent[c]	MGY (MLY)	5.3 (20.0)	6.6 (25.0)	9.3 (35.0)	5.3 (20.0)	6.6 (35.0)
NPDES Discharge Process[c]	MGY (MLY)	5.5[d] (20.8)	6.6 (25.0)	9.3 (35.0)	5.3 (20.0)	6.6 (25.0)
Radioactive Liquid Waste[d,e]	gal/yr (l/yr)	1,100 (4,000)	2,500 (9,500)	2,600 (10,000)	2,500 (9,500)	2,500 (9,500)
Chemical Waste[f]	lb/yr (kg/yr)	4,900 (2,200)	4,900 (2,200)	4,900 (2,200)	4,900 (2,200)	4,900 (2,200)
Low-Level Radioactive Waste[f]	ft^3/yr (m^3/yr)	5,300 (150)	5,300 (150)	5,600 (160)	5,300 (150)	5,300 (150)
Low-Level Radioactive Mixed Waste[g]	ft^3/yr (m^3/yr)	1,300 (38)	0	0	0	0
TRU/Mixed TRU Waste[f]	ft^3/yr (m^3/yr)	110 (3)	740 (21)	1,060 (30)	740 (21)	740 (21)
Contaminated Space[h]	ft^2 (m^2)	37,000 (3,400)	No change	No change	No change	No change
Number of Workers	FTEs	90[8]	98	110	96	98

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Radiological air emissions from this facility are minimal and would not vary across the alternatives.
[c] Outfall consists of process sources only.
[d] Index is 1994.
[e] Secondary wastes are generated during the treatment of RLW and as a result of decontamination operations. Examples include decontamination acid bath solutions and rinse waters, HEPA filters, personnel protective clothing and equipment, and sludges from the pretreatment and main RLW treatment processes.
[f] RCRA-listed hazardous chemicals are not used in RLWTF, and secondary mixed wastes are therefore not generated.
[g] Data are increments or decrements to the index. Index is May 1996. The index is the footprint of the facility; even though the entire facility is not contaminated, no other method of estimating contaminated space was devised.
[h] Index is Fiscal Year 1995.
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.1–29.—*Alternatives for Continued Operation of the Solid Radioactive and Chemical Waste Facilities (TA–54 and TA–50)*

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Waste Characterization, Packaging, and Labeling	Support, certify, and audit generator characterization programs. Maintain WAC for LANL waste management facilities. Characterize 26,800 ft^3 (760 m^3) of legacy LLMW. Characterize 318,000 ft^3 (9,010 m^3) of legacy TRU waste. Verify characterization data at the Radioactive Assay and Nondestructive Test Facility for unopened containers of LLW and TRU waste. Maintain WAC for off-site treatment, storage, and disposal facilities. Overpack and bulk waste as required. Perform coring and visual inspection of a percentage of TRU waste packages. Ventilate 16,700 drums of TRU waste retrieved during TWISP. Maintain current version of WIPP WAC and liaison with WIPP operations.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Compaction	Compact up to 614,000 ft^3 (17,400 m^3) of LLW.	Compact up to 897,000 ft^3 (25,400 m^3) of LLW.	Compact up to 590,000 ft^3 (16,700 m^3) of LLW.	Compact up to 706,000 ft^3 (20,000 m^3) of LLW.

TABLE 3.6.1–29.—*Alternatives for Continued Operation of the Solid Radioactive and Chemical Waste Facilities (TA–54 and TA–50)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Size Reduction	Size reduce 91,800 ft^3 (2,600 m^3) of TRU waste at WCRR Facility and the Drum Preparation Facility.	Size reduce 102,000 ft^3 (2,900 m^3) of TRU waste at WCRR Facility and the Drum Preparation Facility.	Same as No Action Alternative.	Same as No Action Alternative.
Waste Transport, Receipt, and Acceptance	Collect chemical and mixed wastes from LANL generators, and transport to TA–54. Begin shipments to WIPP in 1999. Over the next 10 years: • Ship 32,000 tons (29,000 metric tons) of chemical wastes and 127,000 ft^3 (3,590 m^3) of LLMW, for off-site land disposal restrictions (LDR) treatment and disposal. • Ship 1,437,000 ft^3 (40,700 m^3) of LLW for off-site disposal. • Ship 318,000 ft^3 (9,010 m^3) of legacy TRU waste to WIPP. • Ship 86,800 ft^3 (2,460 m^3) of operational and environmental restoration TRU waste to WIPP. • Ship 101,000 ft^3 (2,850 m^3) of LLMW (environmental restoration soils) for off-site solidification and disposal. Annually receive, on average, 177 ft^3 (5 m^3) of LLW and TRU waste from off-site locations in 5 to 10 shipments.	Same as No Action Alternative, except over next 10 years: • Ship 35,300 tons (32,000 metric tons) of chemical wastes and 128,000 ft^3 (3,640 m^3) of LLMW, for off-site LDR treatment and disposal. • Ship no LLW or environmental restoration soils for off-site disposal. • Ship 193,000 ft^3 (5,460 m^3) of operational and environmental restoration TRU waste to WIPP.	Same as No Action Alternative, except over next 10 years: • Ship 32,000 tons (29,000 metric tons) of chemical wastes and 126,000 ft^3 (3,570 m^3) of LLMW for off-site LDR treatment and disposal. • Ship 2,578,000 ft^3 (73,030 m^3) of LLW for off- site disposal. • Ship 67,100 ft^3 (1,900 m^3) of operational and environmental restoration TRU waste to WIPP.	Same as No Action Alternative, except over next 10 years: • Ship 32,000 tons (29,000 metric tons) of chemical wastes and 127,000 ft^3 (3,610 m^3) of LLMW, for off-site LDR treatment and disposal. • Ship 2,587,000 ft^3 (73,300 m^3) of LLW for off-site disposal. • Ship 88,000 ft^3 (2,490 m^3) of operational and environmental restoration TRU waste to WIPP.

TABLE 3.6.1–29.—*Alternatives for Continued Operation of the Solid Radioactive and Chemical Waste Facilities (TA–54 and TA–50)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Waste Storage	Stage chemical and mixed wastes prior to shipment for off-site treatment, storage, and disposal. Store legacy TRU waste and LLMW. Store LLW uranium chips until sufficient quantities have accumulated for stabilization.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Waste Retrieval	Begin retrieval operations in 1997. Retrieve 166,000 ft^3 (4,700 m^3) of TRU waste from Pads 1, 2, 4 by 2004.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Other Waste Processing	Demonstrate treatment (e.g., electrochemical) of LLMW liquids. Land farm oil-contaminated soils at Area J. Stabilize 14,500 ft^3 (410 m^3) of uranium chips. Provide special-case treatment for 23,700 ft^3 (670 m^3) of TRU waste.	Same as No Action Alternative except: Stabilize 30,700 ft^3 (870 m^3) of uranium chips. Provide special-case treatment for 36,400 ft^3 (1,030 m^3) of TRU waste. Solidify 101,000 ft^3 (2,850 m^3) of LLMW (environmental restoration soils) for disposal at Area G.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.1–29.—*Alternatives for Continued Operation of the Solid Radioactive and Chemical Waste Facilities (TA–54 and TA–50)*-Continued

ACTIVITY	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Disposal	Over next 10 years: Dispose 3,530 ft^3 (100 m^3) of LLW in shafts at Area G. Dispose 1,271,000 ft^3 (36,000 m^3) of LLW in disposal cells at Area G. Dispose 3,530 ft^3/yr (100 m^3/yr) of administratively controlled industrial solid wastes in pits at Area J. Dispose nonradioactive classified wastes in shafts at Area J.	Same as No Action Alternative, except over next 10 years: • Dispose 14,800 ft^3 (420 m^3) of LLW in shafts at Area G. • Dispose 4,060,000 ft^3 (115,000 m^3) of LLW in disposal cells at Area G. • Expand on-site LLW disposal operations beyond existing Area G footprint.	Same as No Action Alternative, except over next 10 years: • Dispose 98,800 ft^3 (2,800 m^3) of LLW in disposal cells at Area G.	Same as No Action Alternative, except over next 10 years: • Dispose 14,500 ft^3 (410 m^3) of LLW in shafts at Area G. • Dispose 424,000 ft^3 (12,000 m^3) of LLW in disposal cells at Area G.

Note: Under all alternatives, the TRU waste Inspectable Storage Project storage domes for TRU wastes would be constructed, as discussed in chapter 2 (section 2.2.2.15).

TABLE 3.6.1–30.—*Parameter Differences Among Alternatives for Continued Operation of the Solid Radioactive and Chemical Waste Facilities (TA–54 and TA–50)*

PARAMETER	UNITS	INDEX[a]	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Radioactive Air Emissions[b]						
Tritium	Ci/yr	2.10×10^{1} [c]	4.83×10^{1}	6.09×10^{1}	4.83×10^{1}	5.46×10^{1}
Americium-241	Ci/yr	6.60×10^{-7}	6.60×10^{-7}	6.60×10^{-7}	6.60×10^{-7}	6.60×10^{-7}
Plutonium-238	Ci/yr	4.80×10^{-6}	4.80×10^{-6}	4.80×10^{-6}	4.80×10^{-6}	4.80×10^{-6}
Plutonium-239	Ci/yr	6.80×10^{-7}	6.80×10^{-7}	6.80×10^{-7}	6.80×10^{-7}	6.80×10^{-7}
Uranium-234	Ci/yr	8.00×10^{-6}	8.00×10^{-6}	8.00×10^{-6}	8.00×10^{-6}	8.00×10^{-6}
Uranium-235	Ci/yr	4.10×10^{-7}	4.10×10^{-7}	4.10×10^{-7}	4.10×10^{-7}	4.10×10^{-7}
Uranium-238	Ci/yr	4.00×10^{-6}	4.00×10^{-6}	4.00×10^{-6}	4.00×10^{-6}	4.00×10^{-6}
NPDES Discharge	MGY	No outfalls	No outfalls	No outfalls	No outfalls	No outfalls
Chemical Waste[d]	lb/yr (kg/yr)	243,000[e] (110,000)	2,030 (920)	2,030 (920)	2,030 (920)	2,030 (920)
Radioactive Liquid Waste	gal/yr (l/yr)	2,100[e] (8,000)	2,600 (10,000)	2,600 (10,000)	2,600 (10,000)	2,600 (10,000)
Low-Level Radioactive Waste[d]	ft^3/yr (m^3/yr)	3,100[e] (88)	6,100 (174)	6,100 (174)	6,100 (174)	6,100 (174)
Low-Level Mixed Waste[d]	ft^3/yr (m^3/yr)	110[e] (3)	140 (4)	140 (4)	140 (4)	140 (4)
TRU/Mixed TRU Waste[d]	ft^3/yr (m^3/yr)	950[e] (27)	950 (27)	950 (27)	950 (27)	950 (27)
Contaminated Space[f]	ft^2 (m^2)	Not estimated	+ 11,500 (1,100)	+ 11,500 (1,100)	+ 11,500 (1,100)	+ 11,500 (1,100)
Number of Workers	FTEs	144[g]	195	225	192	198

[a] Index was used as a point of reference for projecting data for alternatives (as discussed on page 3–3). Index is NOT a consistent time period across parameters or facilities. Each parameter is footnoted with the index used.
[b] Values for tritium were determined from the emission estimates for the index and the differences in waste volumes by alternative.
[c] Index for the emissions is 1990 to 1994.
[d] Secondary wastes are generated during the treatment, storage, and disposal of chemical and radioactive wastes. Examples include repackaging wastes from the visual inspection of TRU waste, HEPA filters, personnel protective clothing and equipment, and process wastes from size reduction and compaction. The large difference between the index and projections for chemical waste generation are due to a change in operations. The generation of barium-contaminated sands, formerly treated at Area L and disposed at Area J, was ended in 1995.
[e] Index is 1990 to 1995.
[f] This facility is expected (based on process knowledge) to have little or no contaminated space from past operations, so no estimate of the index was made (assumed to be none.) Data are increments or decrements from the index. The contaminated space projections are for activities in TA–50 (RAMROD and WCRR) that were previously reviewed under NEPA.
[g] Index is Fiscal Year 1995.
MGY = million gallons per year.

TABLE 3.6.1–31.—*Parameters for LANL Activities Other Than Those at the Key Facilities*

PARAMETER	UNITS	ONGOING	INDEX YEAR
Radioactive Air Emissions[a]			
Tritium	Ci/y	9.1×10^{2}	1994
Plutonium	Ci/y	3.3×10^{-6}	1994
Uranium	Ci/y	1.8×10^{-4}	1994
NPDES Discharge	MGY (MLY)	142 (537)	1996
Chemical Waste	lb/yr (kg/yr)	1,435,000 (651,000)	1990 to 1994
Low-Level Radioactive Waste	ft^3/yr (m^3/yr)	18,400 (520)	1990 to 1994
Low-Level Mixed Radioactive Waste	ft^3/yr (m^3/yr)	1,060 (30)	1990 to 1994
TRU/Mixed TRU Waste	ft^3/yr (m^3/yr)	0	
Contaminated Space[b]	ft^2 (m^2)	222,930 (20,700)	1996
	ft^3 (m^3)	224,060 (6,300)	
	tons (metric tons)	350 (320)	
Number of Workers	FTEs	6579	1996

[a] Stack emissions from previously active facilities (TA–33, TA–21, and TA–41); these are not projected as continuing emissions in the future. Does not include nonpoint sources.
[b] As discussed further in chapter 4, section 4.9.4, contaminated space is estimated by square footage where feasible. However, ductwork in some facilities, rubble from cleanup actions, and activated materials from accelerator target areas are better estimated on the basis of cubic footage (or in the case of lead shielding, in tonnage).
MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
LAND RESOURCES				
Land Use	No changes projected, except where specific environmental restoration actions change use from waste disposal back to research and development or explosives land uses (none specifically known at this time).	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Visual Resources	Temporary and minor changes due to equipment associated with construction and environmental restoration activities.	Same as No Action Alternative, plus effects of lighting for the transportation corridor constructed under this alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Noise	Continued ambient noise at existing levels, temporary and minor noise associated with construction, and explosives noise and vibration at increased frequencies and at the same amplitudes as compared to recent experience.	Individual activities similar to those under No Action Alternative. Additional construction would result in additional temporary and minor noise. Noise and vibration associated with explosives testing is more frequent under this alternative, but the amplitude is the same as compared to No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
GEOLOGY AND SOILS				
Geology	LANL activities are not expected to change geology in the area, trigger seismic events, or substantively change slope stability.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Soils	Minimal deposition of contaminants to soils and continued removal of existing contaminants under the Environmental Restoration Project.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
WATER RESOURCES				
Water Use	Effect of water use over the next 10 years (extracted from main aquifer) is an average drop in DOE well fields of up to 13 feet (4.0 meters).	Effect of water use over the next 10 years (extracted from main aquifer) is an average drop in DOE well fields of up to 15 feet (4.6 meters).	Effect of water use over the next 10 years (extracted from main aquifer) is an average drop in DOE well fields of up to 10 feet (3.1 meters).	Effect of water use over the next 10 years (extracted from main aquifer) is an average drop in DOE well fields of up to 14 feet (4.3 meters).
NPDES Outfall Volumes	261 MGY (988 MLY) discharged from outfalls (an increase of about 28 MGY (106 MLY) from recent discharges).	278 MGY (1,052 MLY) discharged from outfalls (an increase of about 45 MGY (170 MLY) from recent discharges).	218 MGY (825 MLY) discharged from outfalls (a decrease of about 15 MGY (57 MLY) from recent discharges).	275 MGY (1,041 MLY) discharged from outfalls (an increase of about 42 MGY (160 MLY) from recent discharges).
Effect of Outfall Flows on Groundwater Quantities	No substantial changes to groundwater quantities are expected, as compared to recent experience, due to outfall flows.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Surface Water Quality	Outfall water quality should be similar to or better than in recent experience, so surface water quality on the site is not expected to change substantially as compared to existing quality.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Surface Contaminant Transport	Continued outfall flows are not expected to result in substantial contaminant transport off the site.	Similar to No Action Alternative; the small increase in outfall flows (as compared to No Action) are not expected to result in substantial contaminant transport off site.	Same as No Action Alternative.	Same as Expanded Operations Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Groundwater Quality	Mechanisms for recharge to groundwater are highly uncertain; thus, the potential for LANL operations to contaminate groundwater is highly uncertain. It is possible that increased discharges could increase contaminant transport beneath Los Alamos Canyon and Sandia Canyon and off site due to increased recharge to intermediate perched groundwater. No other effects can be projected based on existing information.	Same as No Action Alternative.	Although NPDES outfall flows are lower than in the other alternatives, it is still possible that the flows under this alternative could transport contaminants beneath Los Alamos Canyon and Sandia Canyon and off site.	Same as No Action Alternative.
AIR QUALITY				
Criteria Pollutants	Criteria pollutant emissions are not expected to exceed ambient air quality standards and are not expected to approach levels that could affect human health.	Same as No Action Alternative. Construction activities associated with the expansion of Area G and the enhancement of pit manufacturing would be transitory and would not be expected to degrade air quality substantially.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Toxic Pollutants	Toxic air pollutants, including carcinogenic pollutants, are not expected to approach levels that could affect human health.	Firing site toxic emissions and the total of carcinogenic pollutant emissions exceeded screening values; but, more detailed analysis does not indicate that these emissions would have a significant effect on ecological resources or human health (see comments under those resource areas). Construction activities associated with the expansion of Area G and the enhancement of pit manufacturing would be transitory and would not be expected to degrade air quality substantially.	Same as No Action Alternative.	Same as No Action Alternative.
Radioactive Emissions Dose to the Public Maximally Exposed Individual (MEI)	3.1 millirem (mrem)/year to the LANL MEI (see human health effects below).	5.4 mrem/year to the LANL MEI (see human health effects below).	1.9 mrem/year to the LANL MEI (see human health effects below).	4.5 mrem/year to the LANL MEI (see human health effects below).
Radioactive Emissions Population Dose	About 14 person-rem/year to the population within 50 miles (80 kilometers) of LANL (see human health effects below).	About 33 person-rem/year to the population within 50 miles (80 kilometers) of LANL (see human health effects below).	About 11 person-rem/year to the population within 50 miles (80 kilometers) of LANL (see human health effects below).	About 14 person-rem/year to the population within 50 miles (80 kilometers) of LANL (see human health effects below).
ECOLOGICAL AND BIOLOGICAL RESOURCES				
Biological Resources, Ecological Processes, and Biodiversity	No significant adverse impacts projected for biological resources, ecological processes, or biodiversity, including threatened and endangered species.	Same as the No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Habitat Reduction	No reduction in habitat projected.	Removal of about 7 acres (2.8 hectares) of habitat for small mammals and birds, plus fencing that could alter large mammal movement, are associated with the proposed dedicated road between TA–55 and TA–3. Gradual removal of up to approximately 41 acres (17 hectares) of pinyon-juniper woodland associated with the Area G expansion; corresponds to small wildlife habitat loss and disturbance.	Same as No Action Alternative.	Same as No Action Alternative.
Ecological Risk	No significant risk to biotic communities due to LANL legacy contamination or contamination due to ongoing operations.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
HUMAN HEALTH				
Public Health —Radiological (inhalation, ingestion, and external radiation pathways)[a]	Average total ingestion dose to: • Los Alamos County resident: 3.9 mrem/year of operation (2.0×10^{-6} excess LCFs/year of operation). • Non-Los Alamos County resident: 7.5 mrem/year of operation (3.8×10^{-6} excess LCFs/year of operation). • Nonresident recreational user: 0.2 mrem/year of operation (1.0×10^{-7} excess LCFs/year of operation). • Resident recreational user: 0.6 mrem/year of operation (2.8×10^{-7} excess LCFs/year of operation). Air pathway dose to: • LANL MEI: 3.11 mrem/year of operation (1.6×10^{-6} excess LCFs/year of operation). • Total population: 14 person-rem/year of operation (0.007 excess LCF/year of operation).	Average total ingestion doses are the same as under the No Action Alternative. Air pathway dose to: • LANL MEI: 5.44 mrem/year of operation (2.7×10^{-6} excess LCFs/year of operation). • Total population: 33 person-rem/year of operation (0.017 excess LCF/year of operation).	Average total ingestion doses are the same as under the No Action Alternative. Air pathway dose to: • LANL MEI: 1.88 mrem/year of operation (9.4×10^{-7} excess LCFs/year of operation). • Total population: 11 person-rem/year of operation (0.005 excess LCF/year of operation).	Average total ingestion doses are the same as under the No Action Alternative. Air pathway dose to: • LANL MEI: 4.52 mrem/year of operation (2.3×10^{-6} excess LCFs/year of operation). • Total population: 14 person-rem/year of operation (0.007 excess LCF/year of operation).
Public Health —Chemical	No significant effect to off-site residents or to the recreational user.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Special Pathways	No significant effect through special pathways (< 1×10^{-6} excess LCFs/year of operation).	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Worker Health—Radiological[a]	• Collective worker dose: 446 person-rem/year of operation (0.18 excess LCF/year of operation). • Average (non-zero) worker dose: 0.14 rem/year of operation (0.00005 excess LCF/year of operation).	• Collective worker dose: 833 person-rem/year of operation (0.33 excess LCF/year of operation). • Average (non-zero) worker dose: 0.24 rem/year of operation (0.000096 excess LCF/year of operation).	• Collective worker dose: 170 person-rem/year of operation (0.07 excess LCF/year of operation). • Average (non-zero) worker dose: 0.08 rem/year of operation (0.00003 excess LCF/year of operation).	• Collective worker dose: 472 person-rem/year of operation (0.19 excess LCF/year of operation). • Average (non-zero) worker dose: 0.14 rem/year of operation (0.00005 excess LCF/year of operation).
Worker Health—Chemical	1 to 3 reportable chemical exposures per year (none expected to result in serious injury or in fatalities).	2 to 5 reportable chemical exposures per year (none expected to result in serious injury or in fatalities).	Same as No Action Alternative.	Same as No Action Alternative.
Worker Health—Physical Safety Hazards	About 445 reportable cases per year.	About 507 reportable cases per year.	About 417 reportable cases per year.	Same as No Action Alternative.
		ENVIRONMENTAL JUSTICE		
Environmental Justice Impacts	No disproportionately high or adverse impacts to minority or low-income populations identified.	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
		CULTURAL RESOURCES		
Prehistoric Resources	Negligible to minor potential for effects to some prehistoric resources due to shrapnel or vibrations from explosives testing. However, inspection of resources does not indicate that past operations have caused such effects. Other effects of ongoing operations are negligible or small compared to legacy contamination and natural effects.	Similar to the impacts under No Action, except that Expanded Operations would mean increased frequency of explosives testing (potentially accelerating any damage due to shrapnel and ground vibration). In addition, the expansion of Area G could affect 15 NRHP sites; it is anticipated that a determination of no adverse effect would be achieved based on a data recovery plan.	Same as No Action Alternative.	Same as No Action Alternative.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Historic Resources	Negligible potential for future operations to add contaminants that may limit preservation options. Other effects of ongoing operations are negligible or small compared to legacy contamination and natural effects.	Similar to the impacts under No Action, except that Expanded Operations would mean increased frequency of explosives testing (potentially accelerating damage due to shrapnel and ground vibration).	Same as No Action Alternative.	Same as No Action Alternative.
Traditional Cultural Properties	Unknown due to a lack of information on specific TCPs. Potential for effects to all types of TCPs due to changes in water quality and quantity, erosion, explosives testing shrapnel, noise and vibrations from explosives testing, and contamination from ongoing operations. Security at LANL can prevent access by traditional communities to some TCPs.	Highly uncertain due to a lack of information on specific TCPs. Similar to the impacts under No Action, except that Expanded Operations would mean increased frequency of explosives testing (potentially accelerating damage due to shrapnel, ground vibration, and noise). Additionally, TCPs could be affected by the expansion of Area G; coordination with the four Accord Pueblos would be pursued to identify and mitigate any potential adverse effects.	Same as No Action Alternative.	Same as No Action Alternative.
SOCIOECONOMICS, INFRASTRUCTURE, AND WASTE MANAGEMENT				
LANL Employment	9,977 full-time equivalents	11,351 full-time equivalents	9,347 full-time equivalents	9,968 full-time equivalents
Tri-County Employment	Increase of 691 full-time equivalents, as compared to the 1995 regional employment, about 85,720.	Increase of 2,186 full-time equivalents, as compared to 1995 regional employment.	Decrease of 33 full-time equivalents, as compared to 1995 regional employment.	Increase of 680 full-time equivalents, as compared to 1995 regional employment.
Tri-County Population	Increase of 1,337 people, as compared to the estimated 1996 Tri-County population of 165,938.	Increase of 4,230 people, as compared to the 1996 estimated population.	Decrease of 64 people, as compared to the 1996 estimated population.	Increase of 1,316 people, as compared to the 1996 estimated population.

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Tri-County Personal Income	Increase of about $53 million, as compared to the 1994 estimate of $3.5 billion.	Increase of $172 million, as compared to the 1994 estimate.	Decrease of $6 million, as compared to the 1994 estimate.	Increase of $55 million, as compared to the 1994 estimate.
Maximum Annual Electrical Demand	717 gigawatt-hours	782 gigawatt-hours	508 gigawatt-hours	782 gigawatt-hours
Peak Electrical Demand	108 megawatts (exceeds supply during winter and summer months). May result in brownouts.	113 megawatts (exceeds supply during winter and summer months). May result in brownouts.	88 megawatts (exceeds supply during winter and within the existing supply throughout the rest of the year). May result in brownouts.	113 megawatts (exceeds supply during winter and summer months). May result in brownouts.
Maximum Annual Natural Gas Demand	1,840,000 decatherms (well within existing supply capacity).	Same as No Action Alternative.	Same as No Action Alternative.	Same as No Action Alternative.
Maximum Annual Water Demand	712 MGY (2,700 MLY) (DOE rights to water from main aquifer are adequate to meet this demand and other demands that draw from this right to water).	759 MGY (2,900 MLY) (DOE rights to water from main aquifer are adequate to meet this demand and other demands that draw from this right to water).	602 MGY (2,300 MLY) (DOE rights to water from main aquifer are adequate to meet this demand and other demands that draw from this right to water).	759 MGY (2,900 MLY) (DOE rights to water from main aquifer are adequate to meet this demand and other demands that draw from this right to water).
Annual Chemical Waste Generation	6,364,000 pounds (2,886,000 kilograms)	7,164,000 pounds (3,249,000 kilograms)	6,346,000 pounds (2,878,000 kilograms)	6,372,000 pounds (2,890,000 kilograms)
Annual LLW Generation (includes LLMW)	344,000 cubic feet (9,752 cubic meters)	454,000 cubic feet (12,873 cubic meters)	338,000 cubic feet (9,581 cubic meters)	382,000 cubic feet (10,825 cubic meters)
Annual TRU Waste Generation (includes Mixed TRU)	19,000 cubic feet (537 cubic meters)	19,300 cubic feet (546 cubic meters)	6,700 cubic feet (190 cubic meters)	8,800 cubic feet (250 cubic meters)

TABLE 3.6.2–1.—*Comparison of Potential Consequences of Continued Operations of LANL: Normal Operations*-Continued

RESOURCE AREA	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
Increase in Contaminated Space	Increase of 63,000 square feet (5,900 square meter), as compared to the index.	Increase of 73,000 square feet (6,800 square meter), as compared to the index.	Same as No Action Alternative.	Same as No Action Alternative.
TRANSPORTATION (INCIDENT FREE)				
Public Radiation Exposure (Off-Site Shipments)[a]	• Along route: 3.3 person-rem/year of operation (0.0017 excess LCF/year of operation). • Sharing route: 30 person-rem/year of operation (0.015 excess LCF/year of operation). • At rest stops: 210 person-rem/year of operation (0.11 excess LCF/year of operation). • MEI: 0.0003 rem/year of operation (1.5×10^{-7} excess LCFs/year of operation).	• Along route: 4.2 person-rem/year of operation (0.0021 excess LCF/year of operation). • Sharing route: 37 person-rem/year of operation (0.019 excess LCF/year of operation). • At rest stops: 270 person-rem/year of operation (0.14 excess LCF/year of operation). • MEI: 0.0004 rem/year of operation (1.9×10^{-7} excess LCFs/year of operation).	• Along route: 3.5 person-rem/year of operation (0.0017 excess LCF/year of operation). • Sharing route: 31 person-rem/year of operation (0.015 excess LCF/year of operation). • At rest stops: 230 person-rem/year of operation (0.12 excess LCF/year of operation). • MEI: 0.0003 rem/year of operation (1.6×10^{-7} excess LCFs/year of operation).	• Along route: 3.6 person-rem/year of operation (0.0018 excess LCF/year of operation). • Sharing route: 33 person-rem/year of operation (0.015 excess LCF/year of operation). • At rest stops: 250 person-rem/year of operation (0.12 excess LCF/year of operation). • MEI: 0.0003 rem/year of operation (1.7×10^{-7} excess LCFs/year of operation).
Worker (Drivers) Radiation Exposure[a]	• Off-site: 470 person-rem/year of operation (0.19 excess LCF/year of operation). • On-site: 4.2 person-rem/year of operation (0.0018 excess LCF/year of operation).	• Off-site: 580 person-rem/year of operation (0.23 excess LCF/year of operation). • On-site: 10.3 person-rem/year of operation (0.0041 excess LCF/year of operation).	• Off-site: 510 person-rem/year of operation (0.21 excess LCF/year of operation). • On-site: 4.3 person-rem/year of operation (0.0017 excess LCF/year of operation).	• Off-site: 530 person-rem/year of operation (0.21 excess LCF/year of operation). • On-site: 4.5 person-rem/year of operation (0.0018 excess LCF/year of operation).

[a] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., a maximally exposed individual [MEI]), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

Note: The impacts of implementing the proposed actions in the Surplus Plutonium Disposition EIS; Lead Test Assembly (chapter 1, section 1.5.8); Siting and Construction, and Operation of the Spallation Neutron Source (chapter 1, section 1.5.9); and Conveyance and Transfer of Certain Land Tracts Located Within Los Alamos County and Los Alamos National Laboratory EIS (chapter 1, section 1.5.10) are summarized in chapter 5, section 5.6.

MGY = million gallons per year; MLY = million liters per year.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
TRANSPORTATION ACCIDENTS[c,f]					
Vehicle Accidents (No Cargo Release)	Accidents per year	4.5	9.0	4.9	5.2
	Resulting injuries per year	3.8	7.6	3.3	3.8
	Resulting fatalities per year	0.38	0.78	0.33	0.44
Release of Radioactive Cargo (Bounding Off-Site Accidents)	Radiation dose (person-rem/year)	2.8	3.0	2.8	3.0
	Resulting excess LCF per year of operation (total along entire route)	0.0014	0.0016	0.0014	0.0016
Release of Radioactive Cargo (Bounding On-Site Accidents)	Plutonium-238: Accidents per year MEI dose (rem) Resulting MEI risk	8.8×10^{-8} 8.7 7.7×10^{-7} rem/yr (3.1×10^{-10} excess LCFs/yr)	1.7×10^{-7} 8.7 1.4×10^{-6} rem/yr (5.8×10^{-10} excess LCFs/yr)	8.8×10^{-8} 8.7 7.7×10^{-7} rem/yr (3.1×10^{-10} excess LCFs/yr)	8.8×10^{-8} 8.7 7.7×10^{-7} rem/yr (3.1×10^{-10} excess LCFs/yr)
	Irradiated targets: Accident frequency MEI consequence Resulting MEI risk	3.1×10^{-6} Acute fatality 3.1×10^{-6} fatalities/yr	3.2×10^{-6} Acute fatality 3.2×10^{-6} fatalities/yr	2.9×10^{-6} Acute fatality 2.9×10^{-6} fatalities/yr	3.2×10^{-6} Acute fatality 3.2×10^{-6} fatalities/yr
Release of Chemical Cargo	Chlorine: Injuries per year (total)	0.006	0.013	0.0056	0.006
	Chlorine: Fatalities per year (total)	0.0016	0.0036	0.0015	0.0016
	Propane: Injuries per year (total)	0.0014	0.0031	0.0014	0.0014
	Propane: Fatalities per year (total)	0.00035	0.00076	0.00032	0.00035
ACCIDENTS (OTHER THAN TRANSPORTATION ACCIDENTS AND WORKER PHYSICAL SAFETY INCIDENTS/ACCIDENTS)[c]					
SITE–01: Site-Wide Earthquake with Severe Damage to Multiple Low-Capacity Facilities[a]	Event frequency (per year)	0.0029	0.0029	0.0029	0.0029
	MEI dose (rem)	20	20	20	20
	Public exposure (person-rem) excess LCF	27,726 16	27,726 16	27,726 16	27,726 16

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
SITE–02: Site-Wide Earthquake with Severe Damage to Multiple Moderate-Capacity Facilities[a]	Event frequency (per year)	0.00044	0.00044	0.00044	0.00044
	MEI dose (rem)	34	34	34	34
	Public exposure (person-rem) excess LCF	41,340 24	41,340 24	41,340 24	41,340 24
SITE–03: Site-Wide Earthquake with Severe Damage to Essentially All Facilities[a,d]	Event frequency (per year)	0.000071	0.000071	0.000071	0.000071
	MEI dose (rem)	247	247	247	247
	Public exposure (person-rem) excess LCF	210,758 134	210,758 134	210,758 134	210,758 134
SITE–04: Site-Wide Wildfire Consuming Combustible Structures and Vegetation	Event frequency (per year)	0.1	0.1	0.1	0.1
	MEI dose (rem)	< 25	< 25	< 25	< 25
	Public exposure (person-rem) excess LCF	675 0.34	675 0.34	669 0.33	675 0.34
RAD–12: Plutonium Release from a Seismically Initiated Event	Event frequency (per year)	approximately 1.5×10^{-6}	approximately 1.5×10^{-6}	approximately 1.5×10^{-6}	approximately 1.5×10^{-6}
	MEI dose (rem)	138	138	138	138
	Public exposure (person-rem) excess LCF	approximately 35,800 18	approximately 35,800 18	approximately 35,800 18	approximately 35,800 18
	Worker Consequences	Any in the facility would be killed by explosion or falling debris	Any in the facility would be killed by explosion or falling debris	Any in the facility would be killed by explosion or falling debris	Any in the facility would be killed by explosion or falling debris

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
CHEM–01: Single Cylinder Chlorine Release from Potable Water Treatment Station (TA–0)	Event frequency (per year)	0.0012	0.0013	0.0011	0.0012
	MEI	NA	NA	NA	NA
	Public exposed to: > ERPG–3 > ERPG–2[b]	 12 43	 12 43	 12 43	 12 43
	Worker consequences	If workers are present, there is potential for worker injury or fatality.	If workers are present, there is potential for worker injury or fatality.	If workers are present, there is potential for worker injury or fatality.	If workers are present, there is potential for worker injury or fatality.
CHEM–02: Multiple Cylinder Chlorine Release from Toxic Gas Storage Facility (TA–3)	Event frequency (per year)	0.00013	0.00015	0.00012	0.00013
	MEI	NA	NA	NA	NA
	Public exposed to > ERPG–3 or > ERPG–2	292	292	292	292
	Worker consequences	Possible injuries or fatalities to workers present at time of accident or responding to accident.	Possible injuries or fatalities to workers present at time of accident or responding to accident.	Possible injuries or fatalities to workers present at time of accident or responding to accident.	Possible injuries or fatalities to workers present at time of accident or responding to accident.
CHEM–03: Single Cylinder Chlorine Release from Toxic Gas Storage Facility (TA–3)	Event frequency (per year)	0.00012	0.00012	0.00012	0.00012
	MEI	NA	NA	NA	NA
	Public exposed to: > ERPG–3 > ERPG–2	 239 263	 239 263	 239 263	 239 263
	Worker consequences	Unlikely that workers are present; but if present, there is potential for worker injury or fatality.	Unlikely that workers are present; but if present, there is potential for worker injury or fatality.	Unlikely that workers are present; but if present, there is potential for worker injury or fatality.	Unlikely that workers are present; but if present, there is potential for worker injury or fatality.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
CHEM–04: Bounding Single Container Release of Toxic Gas (Selenium Hexaflouride) from Toxic Gas Cylinder Storage (TA–54)	Event frequency (per year)	0.004	0.004	0.004	0.004
	MEI	NA	NA	NA	NA
	Public exposed to: > ERPG–3 > ERPG–2	 0 0	 0 0	 0 0	 0 0
	Worker consequences	Possible injuries or fatalities to up to 5 workers present at time of accident.	Possible injuries or fatalities to up to 5 workers present at time of accident.	Possible injuries or fatalities to up to 5 workers present at time of accident.	Possible injuries or fatalities to up to 5 workers present at time of accident.
CHEM–05: Bounding Multiple Cylinder Release of Toxic Gas (Sulfur Dioxide) from Toxic Gas Cylinder Storage (TA–54)	Event frequency (per year)	0.00051	0.00051	0.00051	0.00051
	MEI	NA	NA	NA	NA
	Public exposed to: > ERPG–3 > ERPG–2	 0 0	 0 0	 0 0	 0 0
	Worker consequences	Possible injuries or fatalities to up to 5 workers present at time of accident.	Possible injuries or fatalities to up to 5 workers present at time of accident.	Possible injuries or fatalities to up to 5 workers present at time of accident.	Possible injuries or fatalities to up to 5 workers present at time of accident.
CHEM–06: Chlorine Gas Release from Plutonium Facility (TA–55) Process Line	Event frequency (per year)	0.063	0.063	0.063	0.063
	MEI	NA	NA	NA	NA
	Public exposed to: > ERPG–3 > ERPG–2	 7 102	 7 102	 7 102	 7 102
	Worker consequences	Unlikely that workers are present; but if present, there is potential for worker injury.	Unlikely that workers are present; but if present, there is potential for worker injury.	Unlikely that workers are present; but if present, there is potential for worker injury.	Unlikely that workers are present; but if present, there is potential for worker injury.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
RAD–01: Plutonium Release from Container Storage Area Fire Involving TRU Waste Drums (TA–54)	Event frequency (per year)	0.0016	0.0016	0.0016	0.0016
	MEI dose (rem)	46	46	46	46
	Public exposure (person-rem) excess LCF	72 0.04	72 0.04	72 0.04	72 0.04
	Worker consequences	Potential for plutonium inhalation, but no fatalities would be expected.	Potential for plutonium inhalation, but no fatalities would be expected.	Potential for plutonium inhalation, but no fatalities would be expected.	Potential for plutonium inhalation, but no fatalities would be expected.
RAD–03: Reactivity Excursion at Pajarito Site (TA–18) Kiva #3, Vaporizing Some Enriched Uranium Fuel and Melting the Remainder	Event frequency (per year)	3.4×10^{-6}	3.4×10^{-6}	3.4×10^{-6}	3.4×10^{-6}
	MEI dose rem[e]	150	150	150	150
	Public exposure (person-rem) excess LCF	110 0.06	110 0.06	110 0.06	110 0.06
	Worker consequences	No acute fatalities would be expected.	No acute fatalities would be expected.	No acute fatalities would be expected.	No acute fatalities would be expected.
RAD–05: Aircraft Crash with Explosion and/or Fire at TA–21 Resulting in Tritium Oxide Release	Event frequency (per year)	5.3×10^{-6}	5.3×10^{-6}	5.3×10^{-6}	5.3×10^{-6}
	MEI dose (rem)	0.01	0.01	0.01	0.01
	Public exposure (person-rem) excess LCF	24 0.01	24 0.01	24 0.01	24 0.01
	Worker consequences	Aircraft crash could cause injuries and accidents to workers present; workers not affected by crash could be exposed to tritium oxide released by crash.	Aircraft crash could cause injuries and accidents to workers present; workers not affected by crash could be exposed to tritium oxide released by crash.	Aircraft crash could cause injuries and accidents to workers present; workers not affected by crash could be exposed to tritium oxide released by crash.	Aircraft crash could cause injuries and accidents to workers present; workers not affected by crash could be exposed to tritium oxide released by crash.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
RAD–07: Plutonium Release due to Container Storage Area Fire Involving TRU Waste Drums (TA–50)	Event frequency (per year)	0.00015	0.0003	0.00011	0.00015
	MEI dose (rem)	74	74	74	74
	Public exposure (person-rem) excess LCF	1,300 0.69	1,300 0.69	1,300 0.69	1,300 0.69
	Worker consequences	No acute fatalities would be expected.	No acute fatalities would be expected.	No acute fatalities would be expected.	No acute fatalities would be expected.
RAD–08: Aircraft Crash with Explosion and/or Fire at the TRU Waste Area at TA–54	Event frequency (per year)	4.3×10^{-6}	4.3×10^{-6}	4.3×10^{-6}	4.3×10^{-6}
	MEI dose (rem)	22	22	22	22
	Public exposure (person-rem) excess LCF	400 0.2	400 0.2	400 0.2	400 0.2
	Worker consequences	Aircraft crash could cause injuries and fatalities to workers present; workers not affected by crash could be exposed to plutonium released by crash.	Aircraft crash could cause injuries and fatalities to workers present; workers not affected by crash could be exposed to plutonium released by crash.	Aircraft crash could cause injuries and fatalities to workers present; workers not affected by crash could be exposed to plutonium released by crash.	Aircraft crash could cause injuries and fatalities to workers present; workers not affected by crash could be exposed to plutonium released by crash.
RAD–09: Transuranic Waste Drum Failure or Puncture at TA–54, Area G (results are for typical drum)	Event frequency (per year)	0.4	0.49	0.4	0.4
	MEI dose (rem)	0.41	0.41	0.41	0.41
	Public exposure (person-rem) excess LCF	4.3 0.002	4.3 0.002	4.3 0.002	4.3 0.002
	Worker consequences	Some workers could inhale plutonium (dose would depend on protective measures taken), but no acute fatalities would be expected.	Some workers could inhale plutonium (dose would depend on protective measures taken), but no acute fatalities would be expected.	Some workers could inhale plutonium (dose would depend on protective measures taken), but no acute fatalities would be expected.	Some workers could inhale plutonium (dose would depend on protective measures taken), but no acute fatalities would be expected.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
RAD–13: Plutonium Melting and Release Accident at Pajarito Site (TA–18) Kiva #3	Event frequency (per year)	0.000016	0.000016	0.000016	0.000016
	MEI dose (rem)	120	120	120	120
	Public exposure (person-rem) excess LCF	160 0.08	160 0.08	160 0.08	160 0.08
	Worker consequences	No acute fatalities would be expected.	No acute fatalities would be expected.	No acute fatalities would be expected.	No acute fatalities would be expected.
RAD–15: Plutonium Release from a Wing Fire at the CMR Building (in TA–3)	Event frequency (per year)	0.000032	0.000032	0.000032	0.000032
	MEI dose (rem)	40	91	40	40
	Public exposure (person-rem) excess LCF	1,700 0.85	3,400 1.7	1,700 0.85	1,700 0.85
	Worker consequences	1 to 3 workers present in accident location could be injured or killed due to fire; if not killed, could inhale plutonium. Other workers in the area could be affected by smoke inhalation.	1 to 3 workers present in accident location could be injured or killed due to fire; if not killed, could inhale plutonium. Other workers in the area could be affected by smoke inhalation.	1 to 3 workers present in accident location could be injured or killed due to fire; if not killed, could inhale plutonium. Other workers in the area could be affected by smoke inhalation.	1 to 3 workers present in accident location could be injured or killed due to fire; if not killed, could inhale plutonium. Other workers in the area could be affected by smoke inhalation.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
RAD–16: Aircraft Crash with Explosion and/or Fire at the CMR Building (in TA–3) Resulting in a Plutonium Release	Event frequency (per year)	3.5×10^{-6}	3.5×10^{-6}	3.5×10^{-6}	3.5×10^{-6}
	MEI dose (rem)	3	3	3	3
	Public exposure (person-rem) excess LCF	56 0.03	56 0.03	56 0.03	56 0.03
	Worker consequences	Aircraft crash could cause injuries and accidents to nearly all workers in the building; workers not affected by crash could be exposed to plutonium released by crash.	Aircraft crash could cause injuries and accidents to nearly all workers in the building; workers not affected by crash could be exposed to plutonium released by crash.	Aircraft crash could cause injuries and accidents to nearly all workers in the building; workers not affected by crash could be exposed to plutonium released by crash.	Aircraft crash could cause injuries and accidents to nearly all workers in the building; workers not affected by crash could be exposed to plutonium released by crash.
WORK–01: Worker Fatality Due to Inadvertent High Explosives Detonation	Event frequency (per year)	0.001 to 0.01	0.0015 to 0.015	0.0008 to 0.008	0.0006 to 0.006
	Worker injuries or fatalities	1 to 10 injuries or fatalities.	1 to 10 injuries or fatalities.	1 to 10 injuries or fatalities.	1 to 10 injuries or fatalities.
WORK–02: Worker Illness or Fatality Due to Inadvertent Biohazard Contamination	Event frequency (per year)	0.01 to 0.1	0.01 to 0.1	0.01 to 0.1	0.01 to 0.1
	Worker injuries or fatalities	1 injury or fatality.	1 injury or fatality.	1 injury or fatality.	1 injury or fatality.
WORK–03: Multiple Worker Fatality Due to Inadvertent Nuclear Criticality Event	Event frequency (per year)	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Worker exposures or fatalities	Substantial doses and possible fatalities.	Substantial doses and possible fatalities.	Substantial doses and possible fatalities.	Substantial doses and possible fatalities.
WORK–04: Worker Injury or Fatality Due to Inadvertent Nonionizing Radiation Exposure	Event frequency (per year)	0.01 to 0.1	0.01 to 0.1	0.01 to 0.1	0.01 to 0.1
	Worker injuries or fatalities	Typically 1, rarely several, injuries or fatalities.	Typically 1, rarely several, injuries or fatalities.	Typically 1, rarely several, injuries or fatalities.	Typically 1, rarely several, injuries or fatalities.

TABLE 3.6.2–2.—*Comparison of Potential Consequences of Continued Operations of LANL: Accidents*-Continued

ACCIDENT	MEASURE	NO ACTION	EXPANDED OPERATIONS	REDUCED OPERATIONS	GREENER
WORK–05: Worker Exposure to Plutonium Released from a Degraded Storage Container at TA–55	Event frequency (per year)	0.23	0.23	0.23	0.23
	Worker injuries or fatalities	1 or 2 workers potentially exposed to plutonium inhalation.	1 or 2 workers potentially exposed to plutonium inhalation.	1 or 2 workers potentially exposed to plutonium inhalation.	1 or 2 workers potentially exposed to plutonium inhalation.

[a] Workers in buildings that are structurally damaged or collapse could be injured or killed, but the number of workers injured or killed cannot be predicted a priori. Worker excess latent cancer fatalities due to radiological releases in an earthquake and worker injuries or fatalities due to chemical releases in an earthquake are expected to be small or modest increments to the impacts directly attributable to the earthquake (e.g., the collapse of structures). The estimates of event frequencies and impacts are conservative.

[b] ERPG–2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without irreversible or serious health effects or symptoms that could impair their abilities to take protective action. ERPG–3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without life-threatening health effects.

[c] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., a maximally exposed individual [MEI]), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

[d] There is a potential for fault rupturing to occur at the CMR Building (TA–3–29) at a somewhat lower frequency than the SITE–03 earthquake (estimated at 1 to 3 x 10^{-5} per year). Should this occur in association with the SITE–03 earthquake, a conservative estimate results in an additional 133,833 person-rem population exposure (increasing LCFs by 99), and an increase to the MEI of 134 rem.

[e] The MEI dose is provided, under this accident scenario, for an individual located on Pajarito Road at a distance of 50 meters from the facility, even though Pajarito Road would be closed to the public during outdoor operations.

[f] Transportation accidents are typically calculated using computer codes, considering varying accident rates for route types, varying populations along the routes, and other factors. The calculated risks are presented as the product of the accident frequency and the accident consequence; for such calculations, the frequency and consequence terms are not readily accessible from the calculational results. As such, this table reflects the risks associated with transportation accidents, but generally does not separately present the consequence and frequency terms. The on-site radioactive transportation analyses were done by hand calculations, and for these accidents, frequency, consequence, and risk are all presented separately in the table.

Note: Often, there are no differences between accident impacts among the alternatives, largely as a result of conservative approaches used in accident frequency and public consequence. The inventories used in the analyses are typically those of permitted or administrative limits (i.e., controls on the maximum amounts of material that can be processed at one time and/or in storage), rather than operational values (i.e., the actual amount of material needed to perform the task). The operational values would be more likely to change among the alternatives. The administrative limits or inventories are selected so that the analyses are sufficiently conservative and bounding to cover maximum possible operational values. The accident frequencies depend upon the accident initiators, such as an aircraft crash, earthquake, or wildfire. These particular initiators are independent of the operations and of inventory; therefore, the frequency or likelihood of such an event remains constant among the alternatives. In the few cases of accidents in which the frequency depends upon operations, the variation in frequency among the alternatives does not necessarily translate into a significant change in the risk of an environmental release to the public because the value of a release is very small. Likewise, the risk to workers is affected by the change in frequency of the operations; but, the consequence of a single accident remains the same.

CHAPTER 4.0
AFFECTED ENVIRONMENT

LANL is located in north-central New Mexico, 60 miles (97 kilometers) north-northeast of Albuquerque, 25 miles (40 kilometers) northwest of Santa Fe, and 20 miles (32 kilometers) southwest of Española in Los Alamos and Santa Fe Counties (Figure 4.0–1). LANL and the surrounding region are characterized by forested areas with mountains, canyons, and valleys, as well as diverse cultures and ecosystems.

The area is dominated by the Jemez Mountains to the west and the Sangre de Cristo Mountains to the east. These two mountain ranges and the State of New Mexico are divided north to south by the Rio Grande. LANL is located on the Pajarito Plateau, a volcanic shelf on the eastern slope of the Jemez Mountains at an approximate elevation of 7,000 feet (2,135 meters). The Pajarito Plateau is cut by 13 steeply sloped and deeply eroded canyons that have formed isolated finger-like mesas running west to east. The Santa Fe National Forest, which includes the Dome Wilderness Area, lies to the north, west, and south of LANL. The American Indian Pueblo of San Ildefonso and the Rio Grande border the site on the east, and the Bandelier National Monument (BNM) and Bandelier Wilderness Area lie directly south.

A large variety of natural, cultural, and scientific resources lie within the LANL region. The Pajarito Plateau is one of the longest continually occupied areas in the U.S. The archaeological and historical resources of the LANL site reflect the length of temporal occupation as well as the diversity in the cultures of its occupants. American Indian and Hispanic communities—where traditional ceremonies and customs are still honored—and the ruins of prehistoric cultures surround LANL. The County of Los Alamos has developed a unique science-support community culture of its own since the creation of Los Alamos townsite as a LANL "company town." LANL has played a leading role in scientific research in this country since 1943, including the design and development of nuclear weapons, and continues to offer support to the world's scientific community.

The ecosystems in the region are diverse due to the 5,000-foot (1,525-meter) gradient that extends between the Rio Grande Valley on the eastern edge of LANL and the top of Pajarito Mountain on its western border. Variations in precipitation and temperature and differences in the amount of sunlight that reach the north-facing and south-facing canyon slopes have resulted in a diversity of plant life, wildlife, and soils. The mosaic of mesa tops, mountains, canyon bottoms, cliffs, and steep slopes within this region support the habitats of several threatened and endangered species including the Mexican spotted owl, peregrine falcon, and bald eagle.

This chapter describes the environmental setting and existing conditions associated with LANL and DOE's operations at LANL. The information presented in this chapter forms a baseline description for use in evaluating the environmental impacts of the four identified SWEIS alternatives. Much of the information presented in this chapter is drawn from LANL's Environmental Surveillance and Compliance Program, which is described below.

Environmental Surveillance and Compliance at LANL

DOE requires monitoring of LANL and the surrounding region for radiation, radioactive materials, and hazardous chemicals. The LANL Environmental Surveillance and Compliance Program (in previous years, this program was referred to as the Environmental Surveillance Program) is intended to meet this requirement,

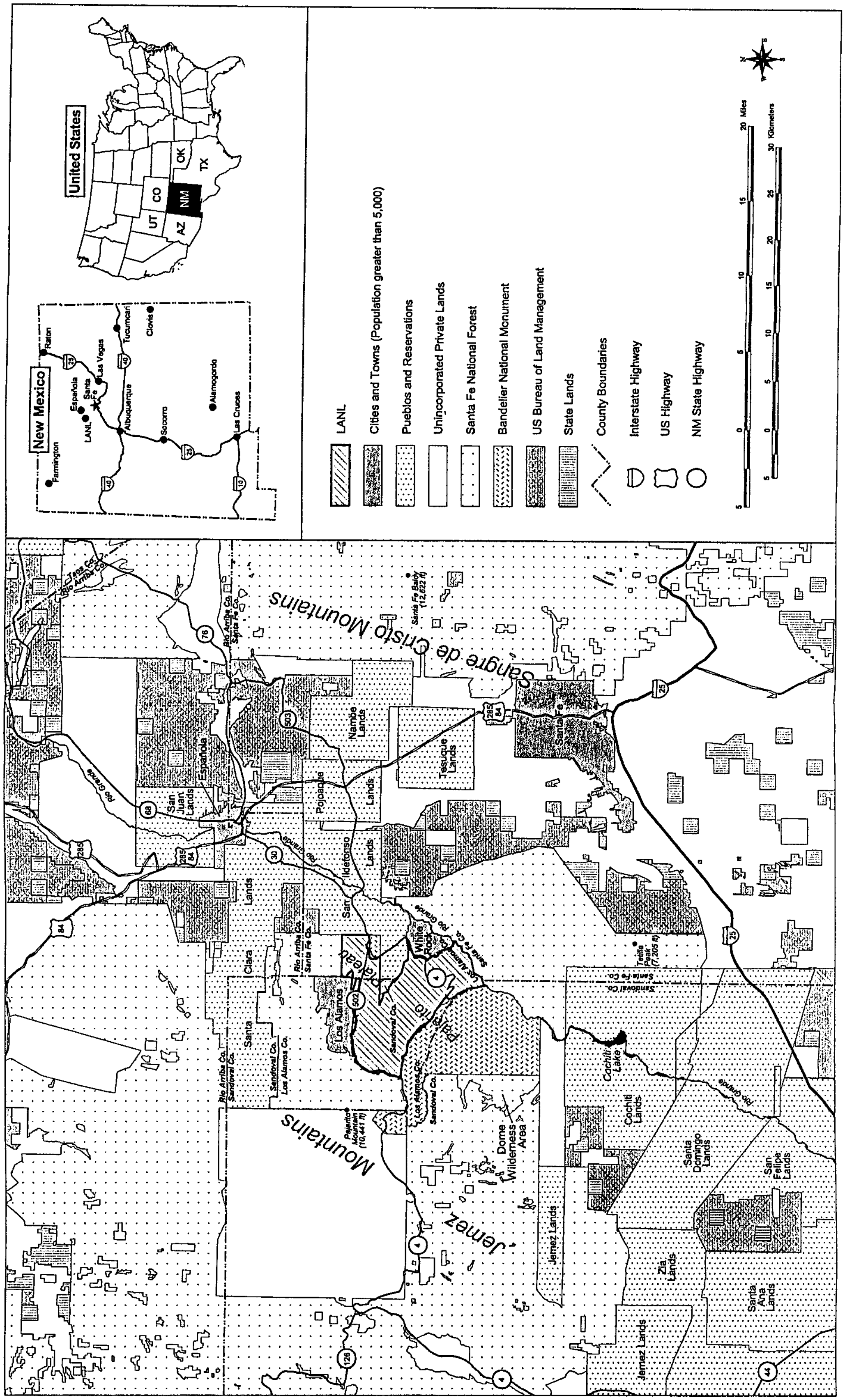


FIGURE 4.0–1.—*Location of LANL.*

> ***A Look Back in Time—***
> ***U.S. Army Corps of Engineers' Criteria for a Secret Laboratory***
>
> 1. *Adequate housing for 30 scientists.*
> 2. *Must be owned by the government or easily acquired in secrecy.*
> 3. *Large enough and uninhabited enough so as to permit safe separation of sites for experiments.*
> 4. *Easy control of access for security and safety reasons.*
> 5. *Enough cleared land free of timber to locate the main buildings at once.*
>
> *Source: LAHS nd*

as well as to determine compliance with appropriate standards and to identify undesirable trends. Data collected and analyzed under this program include: external penetrating radiation; airborne radioactive materials; the radioactive and hazardous chemical content of soils, sediments, and water; and radioactive and hazardous chemicals in foodstuffs and biological resources. Biological studies also are conducted on all major levels of the food chain.

This program provides more than 11,000 environmental samples each year from more than 450 sampling stations in and around LANL. These samples are subjected to more than 200,000 analyses to identify the chemical constituents in the samples collected. The sampling and analysis results are made publicly available annually, once analyses are complete (e.g., *Environmental Surveillance at Los Alamos During 1995* [LANL 1996i] was published in October 1996, and *Environmental Surveillance and Compliance at Los Alamos During 1996* [LANL 1997c] was published in 1997).

4.1 LAND RESOURCES

The relative isolation of north-central New Mexico was considered ideal for a secret nuclear weapons research laboratory when the site was selected during World War II. Today the area surrounding LANL, Los Alamos County, and much of Sandoval, Santa Fe, and Rio Arriba Counties is still undeveloped (LANL 1996d). This predominantly undeveloped area supports a wide variety of land uses that range from the protected wilderness areas in BNM and the Santa Fe National Forest to research and development activities.

4.1.1 Land Use

Land use in this region is linked to the economy of northern New Mexico, which depends heavily on tourism, recreation (e.g., skiing, fishing), agriculture, and the state and federal governments for its economic base. Area communities are generally small, such as Los Alamos townsite with under 12,000 residents, and primarily support urban uses including residential, commercial, light industrial, and recreational facilities. The region also includes American Indian communities; lands of the Pueblo of San Ildefonso share LANL's eastern border, and six other pueblos are clustered nearby.

LANL occupies an area of approximately 27,832 acres (11,272 hectares), or approximately 43 square miles (111 square kilometers), of the DOE land, of which 86 percent (23,951 acres [9,700 hectares]) lies within Los Alamos County.

The remaining 14 percent of LANL acreage lies within Santa Fe County, which also borders portions of LANL boundaries along the east and southeast. In this western portion of Santa Fe County, development is very limited, occurring primarily on American Indian lands within the Rio Grande Valley. A small isolated portion of

Sandoval County borders LANL on the east and is composed entirely of undeveloped lands belonging to the Pueblo of San Ildefonso. Additionally, a small portion of Sandoval County borders LANL on its southwest boundary, with the remainder of the county being located (noncontiguously) to the south, west, and north. In the LANL area, Sandoval County is generally undeveloped, being primarily U.S. Forest Service (USFS) and U.S. National Park Service (NPS) lands.

The Fenton Hill site (TA–57) occupies 15 acres (6 hectares) in Sandoval County, on land leased from the USFS. The use of this land is governed by a Memorandum of Understanding with the USFS.

Rio Arriba County is located approximately 2.5 miles (4.0 kilometers) north of LANL. The southern part of Rio Arriba County includes the town of Española and large areas of undeveloped American Indian land (see Figure 4.1.1–1), together with portions of the Santa Fe National Forest.

4.1.1.1 *Stewardship and Land Use Authority*

Los Alamos County (LAC), New Mexico's smallest county in size (approximately 110 square miles [285 square kilometers]), was created in 1963 from Sandoval and Santa Fe Counties (PC 1997a). Four major governmental bodies serve as land stewards and determine land uses within Los Alamos County (Figure 4.1.1–1).

- *DOE*—primarily the land that LANL occupies.
- *Los Alamos County*—all county and privately held land within the communities of Los Alamos and White Rock (LAC 1987). (There are no incorporated cities in Los Alamos County.)
- *U.S. Forest Service*—the Santa Fe National Forest.
- *National Park Service*—the BNM and Wilderness Area and Tsankawi Ruins.

Land area ratios distributed among these land stewards are presented in Table 4.1.1.1–1.

Land stewards and land use authorities in the western portion of Santa Fe County include the USFS, the State of New Mexico, the U.S. Bureau of Land Management (BLM), and American Indian Pueblos. Land use decisions for the BLM lands are made in agreement with the adjacent American Indian Pueblos.

All Sandoval County lands adjacent to or near LANL are controlled by one of three stewards: the NPS (BNM), the USFS (Santa Fe National Forest, including the Dome Wilderness), and the Pueblo of San Ildefonso (the small isolated parcel east of LANL). The nearest Rio Arriba

TABLE 4.1.1.1–1.—*Land Stewards Within Los Alamos County*

STEWARD	PERCENT OF LAND	AREA IN SQUARE MILES	AREA IN SQUARE KILOMETERS	AREA IN ACRES	AREA IN HECTARES
DOE (LANL)	35	37[a]	96	23,951	9,700
Private or Los Alamos County	12	13	34	8,613	3,488
U.S. Forest Service	43	46	119	29,593	11,985
National Park Service	10	10	26	6,482	2,625

Source: LAC 1987
[a] 6 square miles (16 square kilometers) of LANL lie within Santa Fe County.

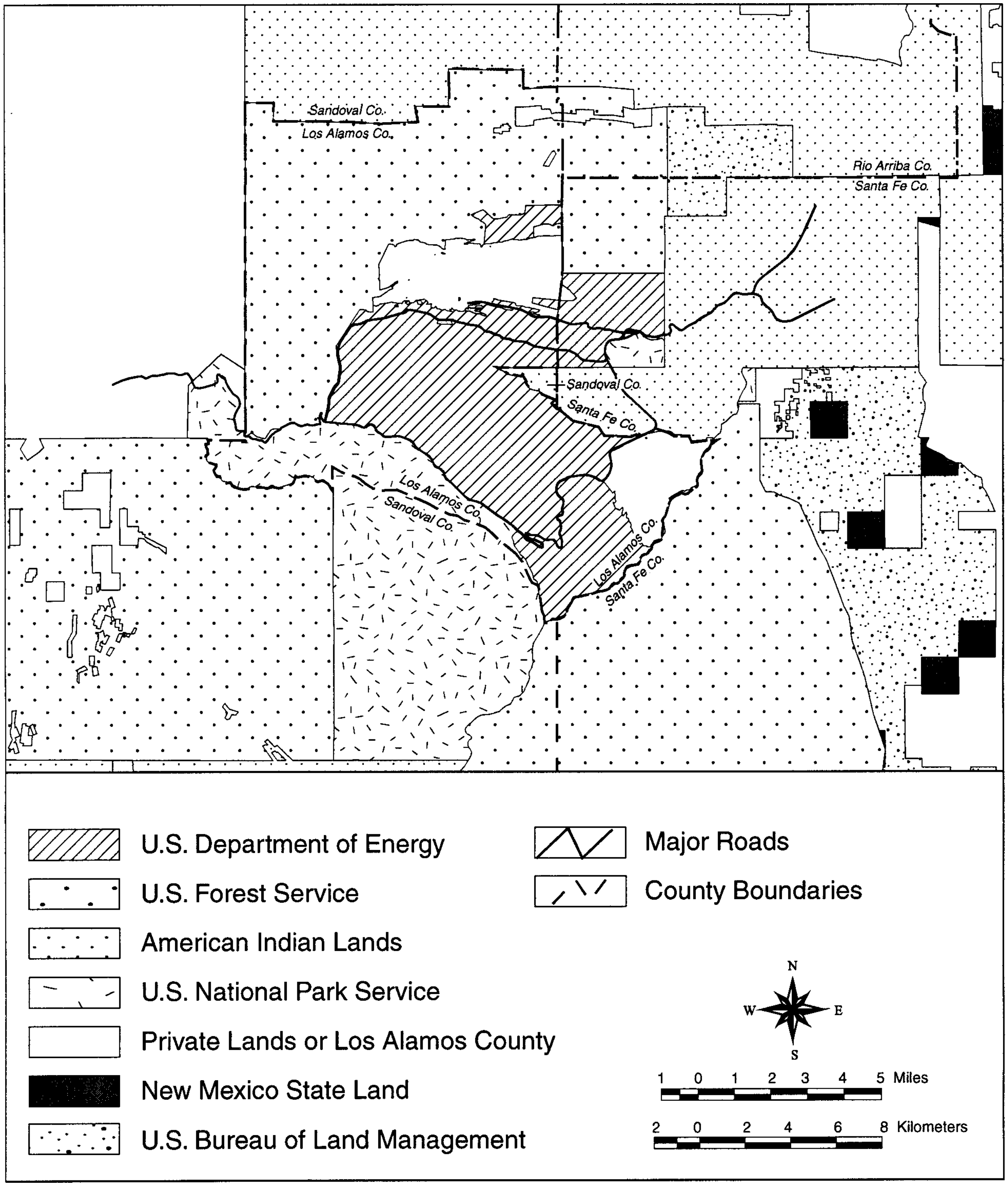


FIGURE 4.1.1–1.—*Land Stewardship in the LANL Area.*

County land is either USFS property or American Indian land.

Resource management involving land use planning, especially that incorporating an integrated approach that is implemented across land management boundaries, has only recently begun to be considered and employed by land stewards within Los Alamos County and surrounding areas.

4.1.1.2 *LANL Land Use*

LANL is divided into 49 separate technical areas (TAs) with location and spacing that reflect the site's historical development patterns, regional topography, and functional relationships. While the number of structures changes slightly with time (in particular, there is frequent addition or removal of temporary structures and miscellaneous buildings), a recent publication reflected the following breakdown of structures at LANL: there are approximately 944 permanent structures (including 93 plant and utility structures); 512 temporary structures (e.g., trailers, transportable buildings); and 806 miscellaneous buildings (e.g., sheds) with approximately 5,000,000 square feet (465,000 square meters) that could be occupied. However, only 1,316,000 square feet (122,400 square meters) of space, in 599 buildings, is designed to house personnel in an office environment. In addition to on-site office space, 213,262 square feet (19,833 square meters) of space is leased within the Los Alamos townsite and White Rock community to provide work space for an additional 806 people (LANL 1995d). These rented or leased spaces are considered part of TA–0.

Overall, 30 percent of the LANL structures (not including leased or rented space) are more than 40 years old, and 50 percent are more than 30 years old. A recent DOE assessment survey reflected the condition of LANL facilities as follows: 1 percent are in excellent condition; 8 percent are in good condition; 37 percent are adequate; 44 percent are fair; 9 percent are poor; and 1 percent fail condition review requirements (LANL 1995e). Condition review requirements cover a wide range of criteria and standards (e.g., safety, severity, seismic, etc.).

In addition to the buildings at LANL, there are over 80 miles (130 kilometers) of asphalt roads and parking areas at LANL. Unpaved roads and remote high explosives testing or firing sites are estimated to include up to an additional 200 acres (81 hectares). The majority of the land associated with the high explosives firing sites is open to most wildlife. Less than 5 percent (approximately 1,375 acres [557 hectares]) of the LANL total area is estimated to be unavailable to most wildlife because of security fencing.

Over the years, land on LANL has been developed in response to the specific needs of a variety of users. Many of the structures have changed uses. New programs have often been placed in existing facilities. New facilities have been constructed in the few areas of readily developable land (relatively flat land supported by the appropriate infrastructure, without other physical or environmental constraints). This has led to a pattern of mixed land uses throughout the property. For example, a support use such as an administrative office may be located near, or even in the same building with, a research and development use requiring a high level of security. This makes "absolute" classification of land use on LANL difficult.

In the following discussions, land use characterization is based on the most hazardous activities in each TA. For the purposes of the SWEIS, land use within LANL boundaries is organized into six categories:

- *Support*—includes TAs with support facilities only, without research and development activities, that are generally free from chemical, radiological, or explosive hazards; also includes undeveloped TAs (other than those that serve as buffers).

- *Research and Development*—includes TAs where research and development occur, with associated chemical and radiological hazards, but that are generally free of explosives hazards; does not include waste disposal sites.
- *Research and Development/Waste Disposal*—the remaining research and development areas (that is, those areas generally free of explosives hazards and that have existing waste disposal sites).
- *Explosives*—includes TAs where explosives are tested or stored, but does not include waste disposal sites.
- *Explosives/Waste Disposal*—the remaining sites where explosives are tested or stored (that is, those with existing waste disposal sites).
- *Buffer*—land identified in each of the usage types described above also may serve as buffers. This last land use category, therefore, includes areas that only serve as buffers for the safety or security of other TAs, usually explosives areas.

Figure 4.1.1.2–1 shows LANL land sorted into these categories (while Fenton Hill is not reflected in this figure, it is designated for research and development). Table 4.1.1.2–1 presents the number of acres associated with each of these six categories of LANL land use.

Any actual future consideration of changing land use within a particular LANL land use category location would be subject to DOE's Land Use and Facility Use Planning Process (DOE 1996b). The planning process allows for the holistic management of DOE's land and facilities through an integration of missions, ecology, economics, and regional cultural and social factors. LANL's 1990 Site Development Plan, which was last updated in 1995, guides land use decision-making at LANL (LANL et al. 1990 and LANL 1995e). The Site Development Plan contains policies, specific recommendations, and mapping of land use, as well as other information. This plan is periodically updated.

4.1.1.3 *Los Alamos County Land Use*

The Los Alamos County Comprehensive Plan, which established land planning issues and objectives, addresses private and county lands comprising 8,613 acres (3,488 hectares) (LAC 1987). Twenty-nine percent of this land is located within the Los Alamos townsite and 26 percent is located in the community of White Rock (LAC 1987). The remaining 45 percent of the land is undeveloped and is used for recreational activities and open space. Table 4.1.1.3–1 presents the amount of land used for the various land uses as defined by Los Alamos County.

Although it may appear that there is sufficient land within Los Alamos County for future expansion by private citizens, business owners, and the county, the majority of this land is very difficult to develop due to the many severe physical constraints of the topography and excessive associated development costs. Fifty-four percent of county land consists of slopes that exceed 20 percent and cannot be reasonably built upon. Therefore, the county's comprehensive plan establishes direction for urban development to occur in compact and contiguous areas where public services can be most efficiently provided and adverse environmental impacts can be minimized. By necessity, much of this development would occur by building in between existing structures or reuse of land. Outlying development areas are designated along West Jemez Road (northwest of LANL); on the northern edge of the townsite on DOE land, which is designated for transfer; and north of the White Rock community, which is the Pueblo of San Ildefonso's land. Recommendations in the Los Alamos County Comprehensive Plan are for the county to work with the Pueblo of San Ildefonso

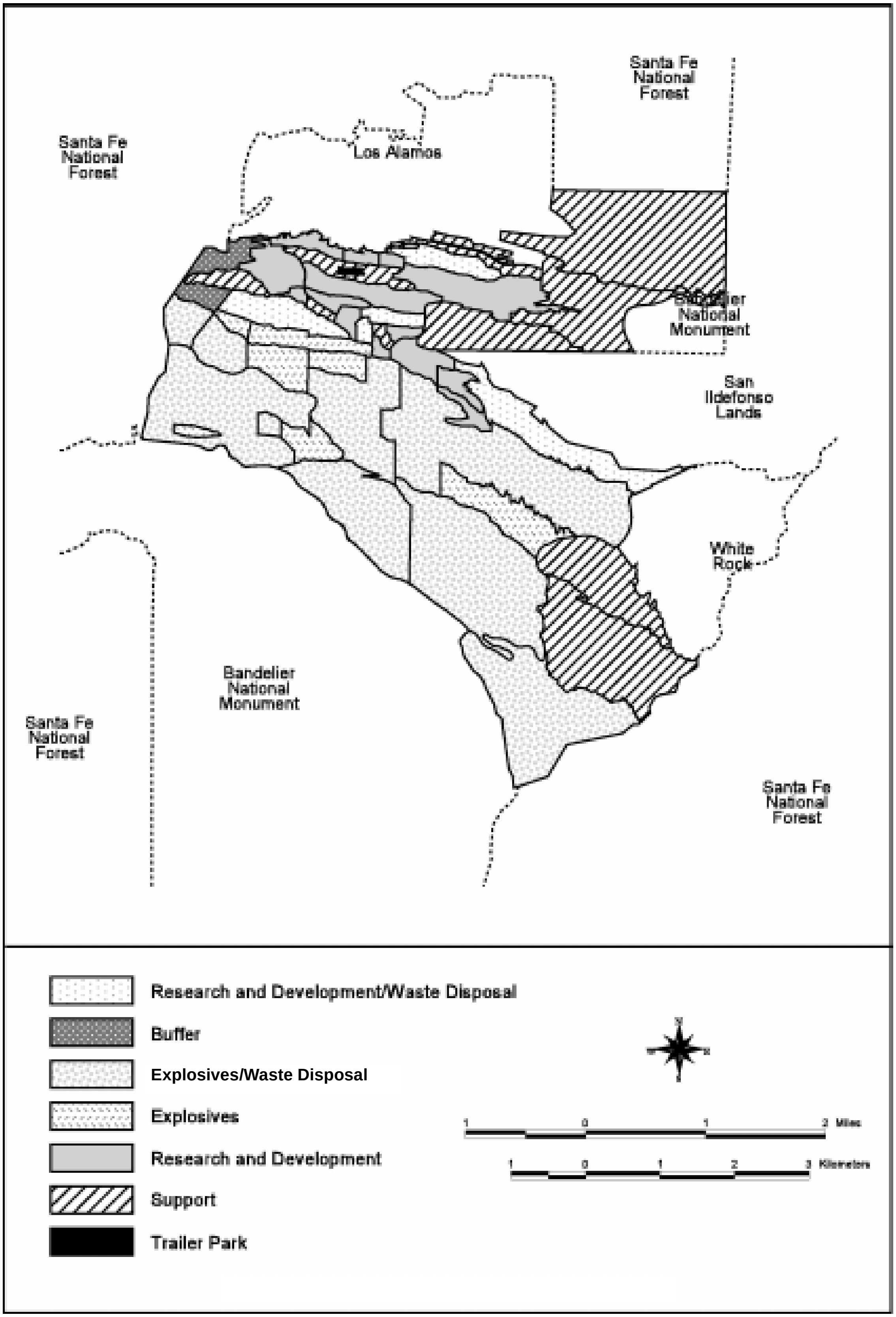


FIGURE 4.1.1.2–1.—*Land Use Within LANL Boundaries.*

TABLE 4.1.1.2–1.—*LANL General Land Use*

LAND USE	ACREAGE	HECTARES	PERCENT[a]
Support	8,457	3,422	30
Research and Development	2,745	1,111	10
Research and Development/Waste Disposal	1,966	796	7
Explosives	1,947	788	7
Explosives/Waste Disposal	12,285	4,972	44
Buffer	404	163	2

[a] Percentages may not total 100 due to rounding.
Source: LANL 1998a

TABLE 4.1.1.3–1.—*Los Alamos County (Excluding LANL) Land Use Definitions*

LAND USE	ACREAGE	HECTARES	PERCENT[a]
Residential	2,919	1,182	34
Commercial	157	64	2
Public (Governmental)	1,699	688	20
Streets/Undeveloped Land	3,838	1,554	45
Total	8,613	3,488	100

[a] Percentages may not total 100 due to rounding.
Source: LAC 1987

to encourage growth in this area (LAC 1987). Los Alamos townsite borders LANL's TA–2, TA–21, TA–41, TA–43, TA–62, TA–72, TA–73, and TA–74. The community of White Rock borders TA–36, TA–54, TA–70, and TA–71.

4.1.1.4 *Potential Land Transfers and Related Land Use Issues*

DOE has entered into discussions with several entities, including Los Alamos County, regarding the potential transfer or lease of DOE-managed land that is part of LANL. DOE has recently examined the proposal to lease a tract of land containing about 60 acres (24 hectares) to the County of Los Alamos for their development and use as a research park. An environmental assessment (EA) was prepared, entitled *Environmental Assessment for Lease of Land for the Development of a Research Park at Los Alamos National Laboratory* (DOE 1997a), that resulted in a Finding of No Significant Impact (FONSI), signed on October 8, 1997. This research park would be located within TA–3 of LANL and would be consistent in use with the current land use designation for TA–3. A lease for this land is expected to be negotiated in 1998. It would not result in a change in the LANL boundary. Another recent proposal considered by DOE to transfer a 28-acre (11-hectare) tract of land along DP Road within TA–21 to the county, would, however, result in a change of land use designation and in the redefinition of LANL's boundary. An EA, entitled *Environmental Assessment for the Transfer of the DP Road Tract to the County of Los Alamos* (DOE 1997b) was prepared that supported a FONSI, signed on January 23, 1997. This transfer of land would change the land use designation of research and development/waste disposal to the county's land use designation of light commercial and professional (C–1), civic center business and professional (C–2), heavy commercial (C–3), or light industrial (M–1), in keeping with the current zoning of the land use in the nearby Los Alamos townsite area. It is likely that the transfer of this tract could occur in 1998.

The *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act for Fiscal Year 1998*, passed by Congress in the fall of 1997 and signed into law by the President, directs the Secretary of Energy to convey parcels of land that are identified by DOE as being suitable for conveyance or transfer. These parcels would be those that are not now required to meet the national security mission of DOE or would not be required for that purpose before the end of the next 10-year period, and which are suitable for use for the purposes of historic, cultural, or environmental preservation, economic diversification, or community self-sufficiency. The act further directs the Secretary of Energy to "carry out any review of the environmental impact of the conveyance or transfer of each such parcel that is required under the provisions of NEPA." The disbursement of this land by lease or transfer will be to the Incorporated County of Los Alamos and the Secretary of the Interior, in trust for the Pueblo of San Ildefonso. A DOE decision on this matter is expected by late 1999. Complex-wide DOE initiatives affecting present and future land use are interwoven with this issue. This SWEIS does not include analysis of these potential land transfer(s). While any land transfer(s) could result in changes to land use, the total potential land transfer of this potentially large amount of acreage and the potential changes in land use were not well enough defined to include in the SWEIS to allow for meaningful analysis. On May 6, 1998, DOE published a Notice of Intent to prepare an EIS for the Proposed Conveyance and Transfer of Certain Land Tracts in the *Federal Register* (63 FR 25022). A draft EIS is expected to be released for public review and comment in early 1999.

4.1.1.5 *Santa Fe National Forest Land Use*

The Santa Fe National Forest encompasses 1,567,181 acres (634,708 hectares) and is separated into two divisions: the Pecos Division in the Sangre de Cristo Mountains to the east of LANL and the Jemez Mountains Division to the west. Both divisions of the Santa Fe National Forest support tourism; logging; cattle grazing; and recreational activities such as hiking, fishing, hunting, camping, and skiing. The Jemez Division also contains the Dome Wilderness Area and is a designated habitat for federal and state protected species, including the Mexican spotted owl (section 4.5, Biodiversity and Ecological Resources) (USFS 1987).

The USFS has classified land use on its property surrounding LANL into forest management areas (Figure 4.1.1.5–1) (USFS 1987). These management areas are described in Table 4.1.1.5–1. The 1987 Santa Fe National Forest Plan (USFS 1987) presents the most current land management directions for forest lands within the Jemez Division. Eight forest management policies have been adopted by the USFS for the Santa Fe National Forest. Each of these forest management areas emphasizes activities for the enhancement, development, or preservation of a natural resource. The portions of land within the Santa Fe National Forest that border LANL are within designated management Area C (TA–8, TA–16, TA–62, and TA–69), Area L (TA–33, TA–70, and TA–71), and Area N (TA–74).

4.1.1.6 *Bandelier National Monument Land Use*

BNM consists of two units: the primary unit is located immediately south of LANL, and the Tsankawi unit (secondary unit) is located to the northeast of LANL. It has been a popular tourist attraction since 1916, when a Presidential Proclamation established it as a National Monument offering natural beauty, American

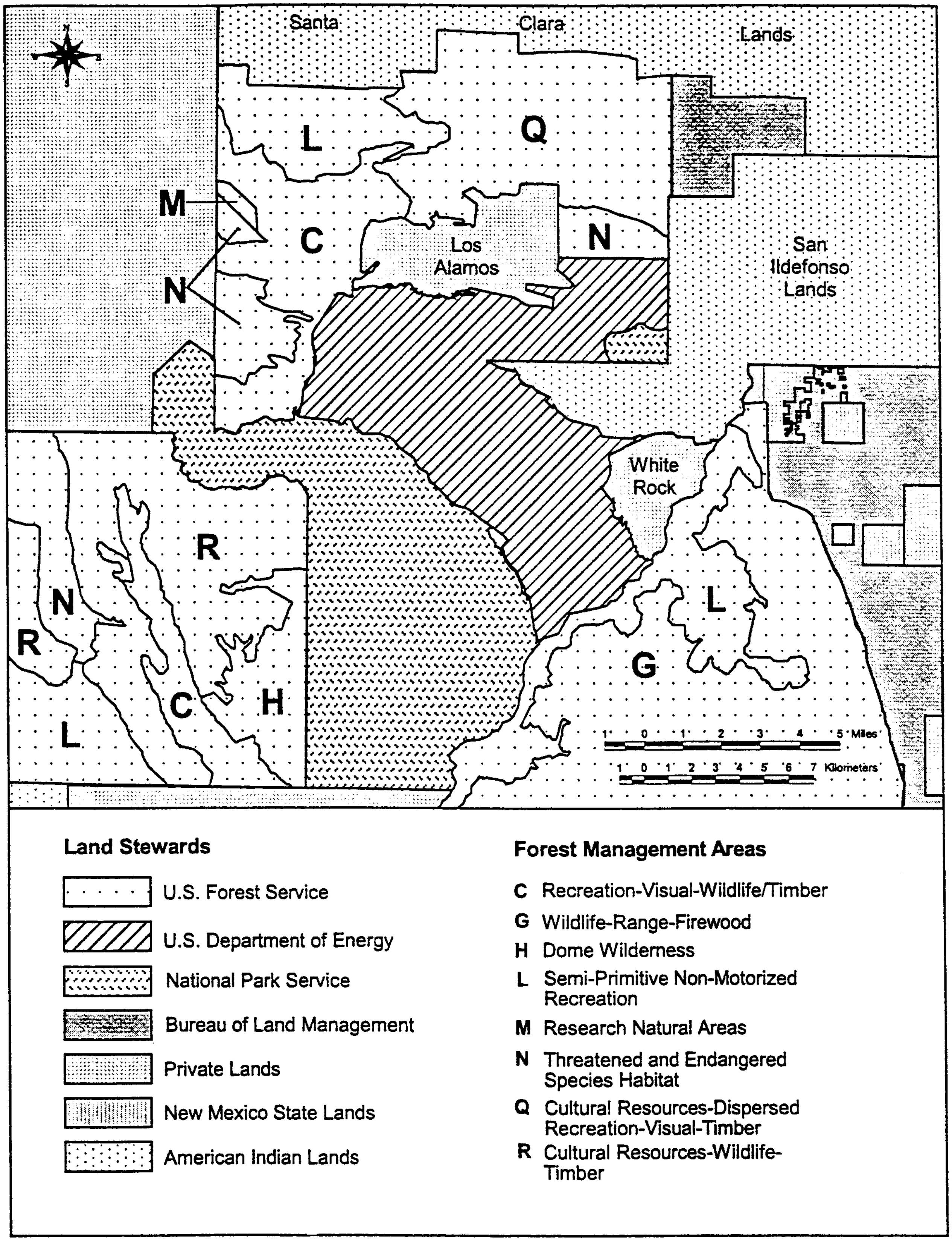


FIGURE 4.1.1.5–1.—*Santa Fe National Forest Management Areas.*

TABLE 4.1.1.5–1.—*Santa Fe National Forest Management Areas*

MANAGEMENT AREA	GENERAL USES	LAND USE MANAGEMENT EMPHASIS
C	Recreation—Visual—Wildlife—Timber	Emphasis is on enhancing visual quality and developing recreation opportunities while protecting essential wildlife habitat and riparian zones. Grazing and timber activities occur where compatible with primary emphasis.
G	Wildlife—Range—Firewood	Emphasis is on key wildlife habitat protection, habitat improvement, and forage and firewood protection. Recreational opportunities are dispersed and consist of firewood and pinyon nut gathering, hunting, and recreational driving.
H	Wilderness	Emphasis is on preserving wilderness character and values. Managed to retain the primeval, wild character and influence without permanent improvements or habitation and to preserve the natural conditions. Primitive recreation opportunities, wildlife habitat management, grazing, and fire management will occur only when consistent with these values and where historically established.
L	Semi-Primitive Nonmotorized Recreation	Emphasis is on providing semi-primitive nonmotorized recreation opportunities. Wildlife, range, and fuels management may occur where consistent with this emphasis. Timber harvest and road building are not consistent with this emphasis.
M	Research—Nature Areas	Emphasis is on providing opportunities for nondisruptive research and education. This allows natural processes to occur and the protection of natural features. Use restrictions are imposed as necessary to keep areas in their natural and unmodified condition. There is no harvest of timber or firewood nor any grazing.
N	Threatened and Endangered Species Habitat	Emphasis is on management that protects and enhances essential wildlife habitat. Not included in the suitable timber base. Certain timber management activities, grazing, firewood harvesting, and fire management may occur when compatible with protection emphasis.
Q	Cultural Resources—Dispersed Recreation—Visual—Timber	Emphasis is on cultural resource site location, inventory, nomination, and protection; also on providing dispersed recreation opportunities while maintaining visual quality, timber, and firewood production. Grazing activities vary. Emphasis is also on maintenance or enhancement of wildlife habitat diversity.
R	Cultural Resources—Wildlife—Timber	Emphasis is on cultural resource site location, inventory, nomination, and protection; also on wildlife habitat improvement and essential habitat protection and enhancement. Grazing and timber harvest activities occur where compatible with the primary emphasis. Firewood provided as a byproduct of timber harvest.

Source: USFS 1987

Indian ruins, abundant wildlife, and structures of historical importance (DOI 1995). The two monument units border along LANL TA–16, TA–18, TA–33, TA–39, TA–49, and TA–72.

The primary unit of BNM contains the ruins of nearby American Indian communities. Only a small portion of this unit has been developed for visitors: the area in and around Frijoles Canyon, just south of LANL. This developed area contains a visitors' center, concession facilities, administrative facilities, maintenance facilities, housing facilities, picnic areas, campgrounds, parking areas, trails, and roadways. The remainder of BNM has been left relatively undisturbed within the Historic era, with only a few trails and unpaved roads crossing the property. The majority of this unit of BNM has been designated as a Wilderness Area, where protection of the environment is the highest priority (DOI 1995).

Nearby Tsankawi ruins are ancestral to several nearby Pueblos. The 826-acre (335-hectare) Tsankawi unit, located adjacent to LANL to the northeast, is a large, unexcavated ruin with many small caves in the canyon walls. Few visitor facilities are available. There is a 1.5-mile (2.4-kilometer) trail providing access to the ruin (DOI 1995).

The number of visitors arriving at BNM is increasing annually. The attendance for 1997 was 410,143, which represents an increase of 42,665 over the 1993 attendance of 367,478. Approximately 586,860 visitors are projected to visit BNM annually by 2003 (DOI 1995).

The NPS has developed numerous plans and public documents that address the management of BNM. The *Final Master Plan* for the monument was approved in 1977, identifying broad objectives for the area (DOI 1977). However, this plan is now out of date and is no longer a reasonable guide. *The Bandelier National Monument Draft Development Concept Plans: Frijoles Canyon and Tsankawi* (DOI 1995) is a development concept plan to manage visitor use and facilities in the main headquarters area of the park and in a small portion of Tsankawi. These plans focus on reducing the impacts of visitors on the limited resources within BNM and preserving the natural and cultural setting to the greatest extent possible. The NPS has never developed a general management plan for BNM.

4.1.1.7 American Indian Pueblo Land Use

The lands of the Pueblo of San Ildefonso are located immediately east of LANL (Figure 4.1.1.2–1), bordering LANL's TA–5, TA–46, TA–54, and TA–72. The Pueblo traces its origins north of Colorado's Mesa Verde area. The Pueblo of San Ildefonso's traditional history holds that the Pueblo people migrated south to the Pajarito Plateau. The villages of Otowi (located in the northeast portion of LANL) and Tsankawi (now part of BNM) were established there around the year 1300 A.D.

The Pueblo of San Ildefonso owns or has use of 28,136 acres (11,395 hectares) of land. The Pueblo of San Ildefonso is bounded by LANL to the west, the Santa Fe National Forest to the south, the Tsankawi ruins of BNM to the west, the Pueblo of Santa Clara to the north, and the community of White Rock to the south. Most of the Pueblo land is within the boundaries of Santa Fe County, although a small portion lies in an isolated section of Sandoval County as mentioned earlier (Figure 4.1.1.2–1).

The U.S. Bureau of Indian Affairs (BIA) reports the current population of the Pueblo of San Ildefonso at 580 (BIA 1996). Most of the inhabitants of San Ildefonso live in the developed area located along New Mexico State Road 30 (NM 30) in Santa Fe County, approximately 2.75 miles (4.43 kilometers) northeast of LANL. The remainder of the Pueblo lands are largely undeveloped. Land use by the Pueblo is a mixture of residential use, gardening and farming, cattle grazing, hunting, fishing, food and medicinal plant gathering, and firewood production along with general cultural and resource preservation. The Pueblo of San Ildefonso has not adopted a formal land use plan yet.

Other American Indian lands are located in Santa Fe, Sandoval, and Rio Arriba Counties with similar land uses, together with the addition of some commercial and light industrial land use. However, the land uses on these other lands are not directly affected by activities on LANL. (Section 4.8, Cultural Resources; Section 4.9, Socioeconomics; Section 4.7, Environmental Justice; and in volume III, appendix E, Cultural Resources, provide additional information on American Indian pueblos and reservations.)

4.1.2 Visual Environment

The natural setting of the Los Alamos area is very panoramic and scenic. The mountain landscape, unusual geology, varied plant communities, and archeological heritage of the area create a diverse visual environment.

4.1.2.1 *Physical Characteristics Within the Visual Environment*

Modern inhabitants of the Los Alamos region have altered the natural physical environment to a greater extent over the past 100 years than the early inhabitants due to larger populations and enhanced use of machinery. For the most part, this alteration of the environment takes three forms: terrain alteration (cutting and filling), land cover changes (e.g., forestry, farming, fire suppression), and development. Terrain alteration has been relatively limited in the region. For the most part, disturbance has occurred on the level areas. The most obvious terrain alterations in this area are the side-hill cuts sometimes necessary for roadways. However, these steep cuts are not as out of character with the surrounding sharply angled terrain as they would be in more gentle topography.

The topography in this part of northern New Mexico is rugged, especially in the vicinity of Los Alamos. Mesa tops are cut by deep canyons, creating sharp angles in the land forms. In some cases, slopes are nearly vertical. Often little vegetation grows on these steep slopes, exposing the geology, which is equally striking with contrasting horizontal planes varying from fairly bright orange-red to almost white in color.

A variety of vegetation occurs in the region (section 4.5.1.1). The density of vegetation and height of vegetation may change over time, both of which can affect the visibility of an area within the LANL viewshed (the area from which an observer can potentially view LANL). In some areas the only vegetation is low-lying meadows (grasslands and recent burn areas). At the other end of the scale, portions of LANL are covered with mixed conifer evergreen forests, which have increased in density over the past decades due to the suppression of natural fires. The height and density of mature trees in this forest type may obscure many views and partially screen others. Mixed grass, shrub and savannah lands, which have varying densities of trees, are between these extremes. Over the years, the clearing of vegetation within the LANL viewshed has occurred through timber harvests or to make room for farming or development. It is sometimes difficult, if not impossible, to recognize these cleared areas, due to the high variability in vegetation type. The opposite has also occurred. Very generally, portions of LANL located along mesa tops at the lower elevations of the facility toward the eastern site boundary are covered with grasslands, mixed shrubs or short trees with sparsely distributed taller trees, allowing greater visibility from within the viewshed. In contrast, the portions of LANL located at the upper elevations toward the western boundary are

> ***A Look Back In Time***
>
> *[Prior to the development of LANL], an incident occurred that had great portent for the future. A visitor rode over the mesas on a pack trip. His summer home was across the valley, in the high mountains at the headwaters of the Pecos River, east of Santa Fe. His name was J. Robert Oppenheimer.*
>
> *He admired the setting, and thereafter often visited the [Los Alamos Ranch] school. He remembered the place upon being confronted with a momentous decision a few years later, when he was asked to advise the Corps of Engineers on the selection of a secret laboratory site.*
>
> *Source: LAHS nd*

more densely covered by tall mixed conifer forests that lessen the visibility of these areas.

The most obvious modern alteration of the natural environment is development. Within LANL and Los Alamos townsite, much of this development is austere and utilitarian in appearance, contrasting greatly with nature (LANL et al. 1990). Because both LANL and the townsite were established in response to a national emergency, many buildings were built as temporary structures. Overcrowded conditions, due to the limited amount of developable land, have often resulted in an unplanned, visually discordant assembly of structures and functions, equipment, parking, and outside storage. More recent development, however, includes many facilities with designs and materials that are more visually appropriate and compatible with the natural environment. Many LANL planning documents, such as the *Capital Assets Management Process, Fiscal Year 1997* (LANL 1995d), target improving the quality of building design at LANL, creating more attractive work environments, and providing clear signage and an easy-to-navigate road system.

For security reasons, much of the development within LANL has occurred out of the public's view. Passing motorists or nearby residents can only see a small fraction of what is actually there. The view of most of LANL property from many stretches of the area roadways is that of woodlands and brushy areas. The most visible developments are a limited number of very tall structures; facilities at relatively high, exposed locations; or those beside well-traveled, publicly accessible roads within the core part of LANL, the TA–3 area. Designed structures that blend in with other features include the Los Alamos Canyon Bridge, the Otowi Building, the Oppenheimer Study Center, and the entry sign on East Jemez Road.

However, there are examples of existing facilities that cause adverse visual impacts:

- The National Radio Astronomy Observatory Very Long Baseline Array telescope, which is a large, white, dish-type antenna located at a high elevation, clearly visible from surrounding sensitive land use areas such as BNM.
- The extremely dense and mixed development in areas such as TA–3, combined with the parking lots and little room for screening elements such as landscaping.
- Very tall structures such as the radio towers or the Rack Assembly and Alignment Complex.

At the lower elevations, at a distance of several miles away from LANL, the facility is primarily distinguishable among the trees in the daytime by views of its water storage towers, emission stacks, and occasional glimpses of older buildings that are very austere and industrial in appearance. Similarly, the Los Alamos townsite appears mostly residential in character with the water storage towers being very visible against the forested backdrop of the Jemez Mountains. The most readily visible LANL and Los Alamos townsite landmarks at very distant vantage points are the water storage towers that are painted white. These show up against the evergreen forests and cause the developed areas to appear to be spread over a broad distance along the Pajarito Plateau. At elevations above LANL, along the upper reaches of the Pajarito Plateau rim, the view of LANL is primarily of scattered austere-appearing buildings among heavily forested areas and the nested several-storied buildings of the TA–3 area. Similarly, the residential character of the Los Alamos townsite is predominately visible from higher elevation viewpoints.

4.1.2.2 *Air Quality and Light Pollution Within the Visual Environment*

Visibility related to air quality is an important facet of the visual environment within the Los Alamos viewshed. (Section 4.4.3, Air Quality Visibility, includes additional discussion on this subject.) In addition to smoke produced by wood burning in nearby residential areas, smoke is produced within the viewshed area both at LANL, where there is periodic burning of high explosives waste material, and at the neighboring Santa Fe National Forest, where there is periodic, controlled forest burning as a wildfire management tool. Permitted waste fires at LANL can last for hours at a time, while under certain weather conditions, forest burning can last for several days. As is true throughout the region, fugitive dust can also be generated within the viewshed on windy days if soil moisture levels are inadequate to prevent this from occurring. These types of temporary air pollutions by particulate suspension can be easily noticed in the relatively clear air in northern New Mexico and can negatively affect visibility.

Similarly, light pollution from various sources within the Los Alamos viewshed is an important facet of the nighttime visual environment with regards to the visibility of LANL and the visibility of celestial features within the natural environment, such as the planets and the stars. Two types of light impacts typically occur around development: direct impacts related to views of the light source itself and indirect impacts related to the cumulative and reflected light that creates an unnatural glow in the sky and reduces the visibility of stars. The lights of LANL, Los Alamos townsite, and White Rock are directly visible from various locations across the viewshed as far away as the towns of Española and Santa Fe. Because there is little nighttime activity at LANL, light sources are generally security lighting rather than personnel safety lighting. The sodium vapor lights used for this purpose can be distinguished from the lights of the nearby communities at White Rock and the Los Alamos townsite by their slightly yellow color. At a distance across the viewshed, however, the color variation in light sources become unrecognizable and any nighttime distinction between LANL and the two communities is lost to the casual observer. There are relatively few of the LANL security light sources compared to the greater number of safety light sources coming from the nearby communities. Indirect (reflected) light impacts from LANL sources are very limited for three reasons: first, there are relatively few sources, compared to the nearby communities; second, the designs of these light sources direct light downward only; third, most of these sources are located at the perimeter of security areas, in areas that are not paved. Because of this, very little light is reflected upward. By contrast, lights in parking lots in the surrounding communities are more likely to be reflected off asphalt and concrete.

4.1.3 Noise, Air Blasts, and Vibration Environment

Noise (considered to be unpleasant, loud, annoying or confusing sounds to humans), air blasts (also known as air pressure waves or over pressures) and ground vibrations are intermittent aspects of the LANL area environment. Although the receptor most often considered for these environmental conditions is human, sound and vibrations may also be perceived by animals and birds in the LANL vicinity. Little is known about how different wildlife species may process these sensations, or how certain species may react to them. The vigor and well being of area wildlife and sensitive, federally protected bird populations suggests that these environmental conditions are present at levels within an acceptable tolerance range for most wildlife species and sensitive nesting birds found along the Pajarito Plateau. (Biological resources are discussed in more detail in section 4.5.)

"Public noise" is the noise present outside the LANL site boundaries. It is from the combined effect of the existing LANL traffic and site activities and the noise generated by activities around the Los Alamos and White Rock communities. "Worker noise" is the noise generated by LANL activities within LANL boundaries. Air blasts consist of a higher frequency portion of air pressure waves that are audible and that accompany an explosives detonation. This noise can be heard by both workers and the area public. The lower frequency portion of air pressure waves is not audible but may cause a secondary and audible noise within a testing structure that may be heard by workers. Air blasts and most LANL-generated ground vibrations result from testing activities involving above-ground explosives research.

The forested condition of much of LANL (especially where explosives testing areas are located), the prevailing area atmospheric conditions, and the regional topography that consists of widely varied elevations and rock formations all influence how noise and vibrations can be both attenuated (lessened) and channeled away from receptors. These regional features are jointly responsible for there being little environmental noise pollution or ground vibration concerns to the area resulting from LANL operations. Sudden loud "booming" noises associated with explosives testing are similar to the sound of thunder and may occasionally startle members of the public and LANL workers alike. The human startle response is usually related to the total amounts of explosives used in the test, the prevailing atmospheric conditions, and the receptor's relative location to the source location and to channeling valleys. Although these noises are sporadic or episodic in nature, they contribute to the perception of noise pollution in the area.

Concerns for damage that may be caused by ground vibrations as a result of explosives testing are primarily related to sensitive architectural receptors, such as the many archeological sites and historic building near the LANL firing ranges. The low masonry adobe or rock walls at prehistoric sites, and the nonrobust walls of what were expected to be temporary or short-term use buildings when originally constructed, may be speculated to suffer from subtle structural deterioration (fatigue damage) over time. However, field observations of eight prehistoric archeological sites in the vicinity of the firing ranges determined that none of the sites exhibited deterioration other than natural weathering.

Limited data currently exist on the levels of routine background ambient noise levels, air blasts, or ground vibrations produced by LANL operations that include explosives detonations. The following discussions of noise level limitations are provided to identify applicable regulatory limits or administrative controls regarding LANL's noise, air blast, and vibration environment; there are no regulatory, worker health protective, or maximum permissible level limitations for air blasts or ground vibrations. Available LANL noise and vibration information from specific activities is also summarized and presented.

4.1.3.1 *Noise Level Regulatory Limits and LANL Administrative Requirements*

Noise generated by LANL operations, together with the audible portions of explosives air blasts, is regulated by county ordinance and worker protection standards. The standard unit used to report sound pressure levels is the decibel (dB); the A-weighted frequency scale (db[A] or dBA) is an expression of adjusted pressure levels by frequency that accounts for human perception of loudness. Los Alamos County has promulgated a local noise ordinance that establishes noise level limits for residential land uses. Noise levels that affect residential receptors are limited to a maximum of 65 dBA during daytime hours and 53 dBA during nighttime hours between 9 p.m. and 7 a.m. Between 7 a.m. and 9 p.m., the permissible noise level can be increased to 75 dBA in residential areas, provided the noise is limited to 10 minutes in any 1 hour. Activities that do not meet the noise ordinance limits require a permit (LANL 1994a).

Noise standards related to protecting worker hearing are contained in LANL's Administrative Requirements, *Hearing Conservation*, which is part of the electronic Environmental, Safety, and Health Manual (LANL 1993c). LANL hearing conservation policy and noise level limits are based on:

- U.S. Air Force Regulation 161-35, *Hazardous Noise Exposure*
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*
- 29 Code of Federal Regulations (CFR) 1910.95, *Occupational Noise Exposure*
- American Conference of Governmental Industrial Hygienists' (ACGIH) publication (ACGIH 1993) entitled, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (1992–1993)*

The occupational exposure limit for steady-state noise, defined in terms of accumulated daily (8-hour) noise exposure dose that allows for both exposure level and duration, is 84 dBA (29 CFR 1910.95). When a worker is exposed for a shorter duration, the permitted noise level is increased (Table 4.1.3.1–1). LANL Administrative Requirements also limit worker impulse/impact noise exposures that consist of a sharp rise in sound pressure level (high peak) followed by a rapid decay less than 1 second in duration and greater than 1 second apart. These limits are based on noise level and number of impacts allowed per day (Table 4.1.3.1–2).

To meet the limits presented above, managers at LANL are required to minimize excessive worker noise exposure through measures such as worker hearing protection, control of noise using alternative operating conditions, and engineering designs or modifications to reduce operating noise levels.

There are no regulatory, worker health protective LANL administrative controls or other maximum permissible levels regarding

TABLE 4.1.3.1–1.—*Limiting Values for Average Daily Noise Exposure*

DURATION OF TOTAL DAILY EXPOSURES HOURS	OCCUPATIONAL EXPOSURE LIMITS NOISE LEVEL dBA
16	80
8	84
6	86
4	88
2	92
1	96
0.5	100
0.033 (2 minutes)	115[a]

[a] Exposure above 115 dBA is not permitted.
Source: LANL 1993c

TABLE 4.1.3.1–2.—*Occupational Exposure Limits for Impulse/Impact Noise*

SOUND LEVEL dBA	NUMBER OF IMPULSES OR IMPACTS PERMITTED DAILY
140[a]	100
130	1,000
120	10,000

[a] Exposure above 140 dBA is not permitted.
Source: LANL 1993c

property damage resulting from vibrations such as those generated through LANL operations.

Vibration criteria for ancient monuments have been recommended as low as 2 millimeters per second amplitude; a few European countries have established standards for ground vibrations levels allowed at their historic monuments of 2 millimeters per second. The vibration limit recommended at Mesa Verde and Chaco Canyon for one-of-a-kind, irreplaceable structures was not to exceed 2 millimeters per second in the 2 to 20 hertz frequency bandwidth. Given the lack of vibration damage attributable to vibrations from 50 years of explosives testing (as discussed in section 4.1.3.2), and given the environmental setting of the firing site areas (additional information regarding these sites is presented in section 4.8), it appears unnecessary to adopt such a limit for the types of resources present at LANL.

4.1.3.2 *Existing LANL Noise Air Blast and Vibration Environment*

Existing LANL-related publicly detectable noise levels are generated by a variety of sources, including truck and automobile movements to and from the LANL TAs, high explosives testing, and security guards' firearms practice activities. Noise levels within Los Alamos County unrelated to LANL are generated predominately by traffic movements and, to a much lesser degree, other residential-, commercial-, and industrial-related activities within the county communities and the surrounding areas.

Traffic noise from truck and automobile movements around the LANL TAs is excepted under Los Alamos County noise regulations, as is the traffic noise generated along public thoroughfares within the county. This type of noise contributes heavily to the background noise heard by humans over most of the county. Although some measurements of sound specifically targeting traffic-generated noise have been made at various county locations in recent studies, these sound levels are found to be highly dependent upon the exact measuring location, time of day, and meteorological conditions. There is, therefore, no single representative measurement of ambient traffic noise for the LANL site. Noise generated by traffic has been computer modeled to estimate the impact of incremental traffic for various studies, including recent NEPA analyses, without demonstrating meaningful change from current levels due to any new activities. While very few measurements of nonspecific background ambient noise in the LANL area have been made, two such measurements have been taken at a couple of locations near the LANL boundaries next to public roadways. Background noise levels were found to range from 31 to 35 dBA at the vicinity of the entrance to BNM and NM 4. At White Rock, background noise levels range from 38 to 51 dBA; this is slightly higher than was found near BNM, probably due to higher levels of traffic and the presence of a residential neighborhood (DOE 1995b) as well as the different physical setting.

The detonation of high explosives represents the peak noise levels generated by LANL operations. The results of these detonations are air blasts and ground vibrations. LANL has instituted stringent administrative controls to protect site workers from potential physical damages that could result from these detonations. These protective measures include the employment of TA perimeter fencing, badge exchange programs at manned access points, and gated personnel exclusion zones located at varying distances from the firing site detonation points determined by site safety requirements. Personal protective hearing devices are also made available for use by personnel as necessary as part of the standard operating procedures established for these sites. Exclusion zones are provided both for hearing protection and to keep workers from potentially being struck with high speed detonation debris or being adversely affected by air blasts. The perimeter fencing is also provided both for the protection of co-located workers and for members of the public. The primary source of these activities is the high explosives experiments conducted at the LANL Pulsed High-Energy Radiation Machine Emitting X-Rays (PHERMEX) Facility and surrounding TAs with active firing sites. Within the foreseeable future, the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility will begin operation (followed by a corresponding reduction of PHERMEX operations) and will become a source of high explosives testing. Explosives detonations were performed in March 1995 for the DARHT EIS analysis and measurements of air blasts and ground vibrations were obtained for representative PHERMEX explosives tests. The sound measurements recorded the following:

- *70 dBA* at a distance from the source of 4 miles (6 kilometers) using 150 pounds (68 kilograms) of TNT
- *71 dBA* at a distance from the source of 1 mile (2 kilometers) using 150 pounds (68 kilograms) of TNT (the closest public access point next to TA–49 at NM 4)
- *60 dBA to 63 dBA* at a distance from the source of 3 miles (5 kilometers) using 150 pounds (68 kilograms) of TNT (BNM entrance near NM 4) (DOE 1995b)

Based on such findings, the Los Alamos County Community Development Department has determined that LANL does not need a special permit under the Los Alamos County Code because noise related to explosives testing is not prolonged, nor is it considered unusual to the Los Alamos community (Los Alamos County Code, August 8, 1996).

The DARHT EIS analysis performed to determine vibratory ground motion from detonation of high explosives indicated that the peak ground motion for the energy transmitted through the ground was less than the ground motion caused by the air wave pulse when it arrived at a measurement point. This is understandable because of the above ground placement of the explosives used in testing activities. Ground motion (particle velocity) amplitudes slightly above 2 millimeters per second were estimated by derivative calculations to occur within 1 mile (1.61 kilometers) of a 500-pound (227-kilogram) TNT explosives test (GRAM 1997). In general, structures within 2,000 feet (610 meters) are estimated to be exposed to ground vibration in excess of 5 millimeters per second. For explosive tests in the range of 10 pounds (4.5 kilograms) to 150 pounds (68 kilograms), ground vibrations in excess of 5 millimeters per second are not expected to be exceeded at locations of 1,000 feet (305 meters) or more from the firing site (GRAM 1997). For architectural sites near the firing site, but separated from them by an intervening canyon(s), the effects would be greatly lessened to absent from ground transmitted vibrations. Detonations of up to 500 pounds (227 kilograms) of TNT or its equivalent are not expected to generate vibrations sufficient to result in any damage to either sensitive historical or prehistoric structures at BNM or to residences in the White Rock or Los Alamos communities. Measurement of the air blast associated with a 150-pound (68-kilogram) detonation of TNT indicated that the maximum air blast over pressure was 5.05 millibar (0.073 pounds per square inch [psi] or 143 dB at 1,200 feet [366 meters]) to the blast site. The effect of a 500-pound (227-kilogram) detonation of TNT is estimated to be in excess of the 7 millibar (0.1 psi or 150 dB) that would be required to occur at that distance from the blast site before cracking of building windows and walls would be expected to occur. Given the distance of buildings from existing LANL blast site locations, it is unlikely that any cracks to building walls or windows would result due to air blasts from explosives testing.

Field observations were made in 1997 to determine the existing condition of eight sensitive prehistoric resource sites within an 800-foot (244-meter) radius of 13 active explosives firing sites at LANL. The survey did not identify any significant structural deterioration to these sites that could conclusively be associated with ground vibrations. Rather, they appeared to be deteriorating due to natural weathering processes (LANL 1997e).

4.2 Geology and Soils

This section describes the geology, geologic conditions, soils, and mineral and geothermal resources present at LANL and the surrounding area. As presented in Figure 4.2–1, the area includes LANL, extends to the northernmost point of the Jemez Mountains and Española Valley in the north, to the Cerros del Rio Volcanic Field in the east, to Cochiti Lake in the south, and to the Valles Caldera in the west.

Information on the Fenton Hill site is provided in section 4.3.

A Look Back In Time

Early map makers, looking at the rectangular block of the Jemez Mountain range in northern New Mexico, apparently noted with only a passing interest the circular shape formed by a series of peaks near the center.

It was not until sometime in the 1920's that the idea that this unusual geographic feature might actually be the rim of an ancient and extinct volcano began to gain acceptance. There never was any question of the volcanic origin of the Jemez range. Even to the untrained eye thick layers of volcanic ash, heaps of burned rock, cone-shaped hills and fumeroles, and bubbling hot sulfur springs, all give unmistakable evidence of an open passage to the underworld in the not-too-distant past.

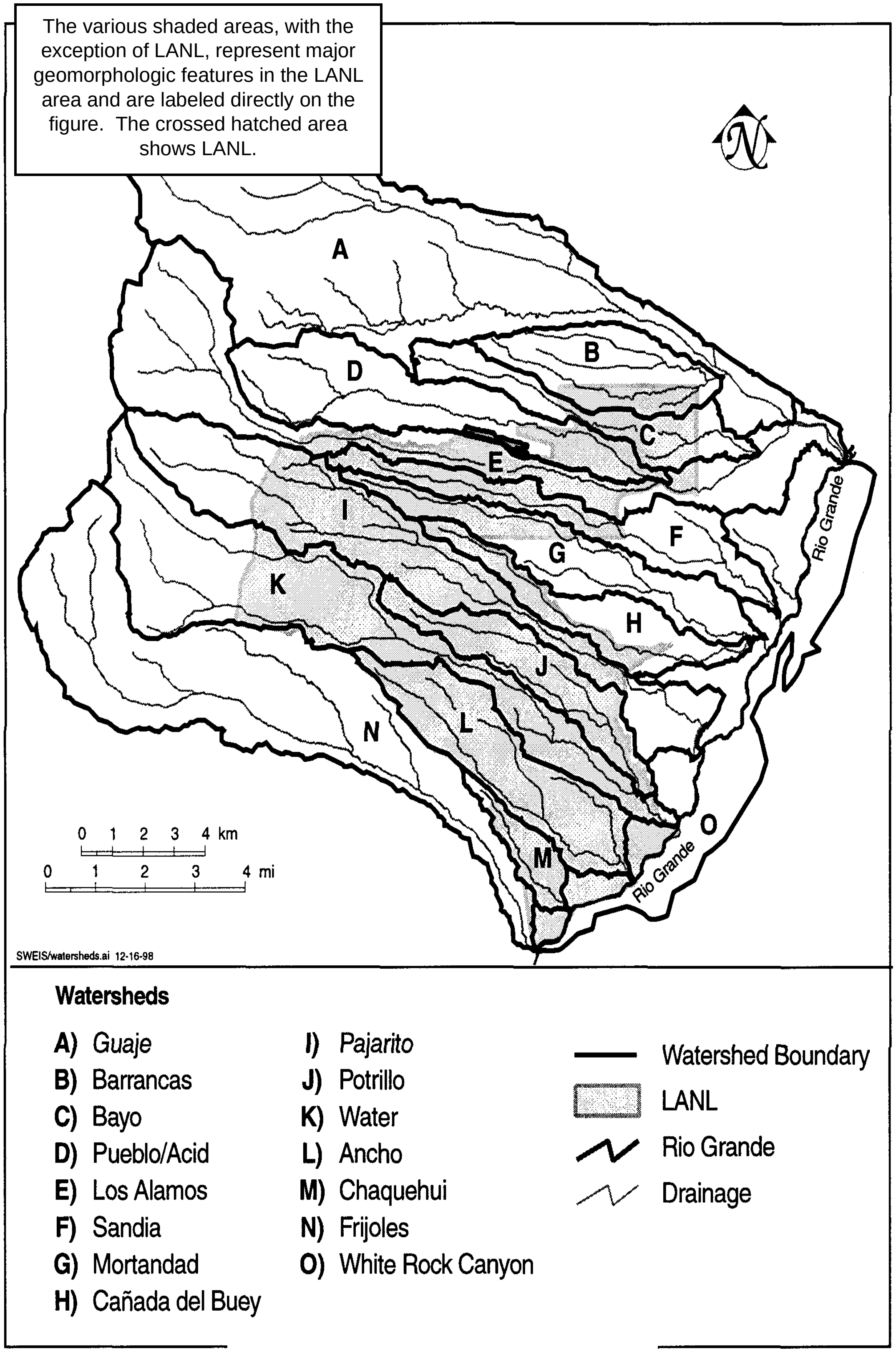
Source: LAHS nd

4.2.1 Geology

LANL and the communities of Los Alamos and White Rock are located on the Pajarito Plateau (Figure 4.2–1). The Pajarito Plateau is 8 to 16 miles (13 to 26 kilometers) wide and 30 to 40 miles (48 to 64 kilometers) long, lying between the Sierra de los Valles to the west and the Rio Grande to the east (Purtymun et al. 1995). The Sierra de los Valles lies between the Jemez Mountains and the Pajarito Plateau. The crest of this north-south range of peaks and ridges forms a surface water divide. The surface of the Pajarito Plateau is divided into numerous narrow, finger-like mesas separated by deep east-to-west oriented canyons that drain toward the Rio Grande.

A primary geologic feature in the region is the Rio Grande Rift, which begins in northern Mexico, trends northward across central New Mexico, and ends in central Colorado (Figure 4.2–1). The rift is a complex system of north-trending basins that have formed by downfaulting of large blocks of the Earth's crust (Dransfield and Gardner 1985). Faults are breaks in the Earth's crust involving horizontal or vertical movement, or both, along a zone of weakness called a fault plane. In the Los Alamos area, the Rio Grande Rift is about 35 miles (56 kilometers) wide and encompasses the Española Basin. The Sangre de Cristo Mountains border the Rio Grande Rift on the east, and the Jemez Mountains lie over the western fault margin of the rift. The north-trending Pajarito Fault system is part of the Rio Grande Rift and consists of a group of interconnecting faults that are nearly parallel. Information regarding these faults is presented in section 4.2.2.2.

The rocks present in the LANL region were predominantly produced by volcanic and sedimentary processes. Geologists classify rock types by the processes or events that formed them and the approximate time when the rocks were formed. The classification of rocks by type and geologic history is referred to as stratigraphy. The broadest classification of different rocks is referred to as a group, formations may be subdivisions of a group or a major category alone without an associated group, and members are subdivisions of a formation. The characteristics of the major stratigraphic units in the LANL region are summarized in Table 4.2.1–1. A generalized



SOURCE: DOE 1979

FIGURE 4.2–1.—*Geology of the LANL Region.*

TABLE 4.2.1–1.—*Characteristics of the Major Stratigraphic Units in the LANL Region*

GROUP	FORMATION	AGE OF DEPOSITION[a]	ROCK TYPES	THICKNESS IN LANL REGION[b]	COMMENTS
Tewa[c]					
	Bandelier Tuff	1.61 to 1.22	Rhyolitic tuff and pumice	0 to 700 feet (0 to 213 meters)	Ash-flow deposits formed by catastrophic eruption of the Valles and Toledo calderas west of LANL. Formation is composed of Otowi and Tshirege members.
	Cerro Toledo “Interval”	1.61 to 1.22	Volcaniclastic sediments	10 to 130 feet (3 to 40 meters)	Informal name. Not considered part of the Bandelier Tuff because of unique petrologic features and different eruptive style.
Polvadera[d]					
	Puye	4 to 1.7	Clays, gravel, volcanic debris	0 to 600 feet (0 to 183 meters)	Shed from eastern Jemez Mountains. Interwoven with Cerro del Rio basalts in some locations. Top of the main aquifer is usually within this formation. The basal Totavi Lentil consists of channel deposits of the ancestral Rio Grande and is sometimes given its own formation by some authors.
	Tschicoma[e]	7 to 3	Andesite, rhyolite, and dacite	0 to 5,000 feet (0 to 1,524 meters)	Originated from volcanic vents in the central to northeastern Jemez Mountains.
Basalt Fields[d]					
	Cerros del Rio	4.6 to 2.0	Basalts, breccia, and scoria	0 to 600 feet (0 to 183 meters)	Many source vents beneath the plateau and to the east. The top of the main aquifer is in this formation in some locations.
Keres[d]					
	Paliza Canyon	13 to 6	Volcanic andesite and basalt	0 to ?	Erupted from St. Peter’s Dome area 3 miles (5 kilometers) south of LANL. Possibly found in southern part of LANL (e.g., TA–49 wells).
	Cochiti	13 to 6	Vent breccias and gravels of dacite and andesite	0 to ?	Laterally equivalent to some rocks in the Santa Fe Group. Transition between Cochiti, Santa Fe, and Puye formations probably occurs beneath Los Alamos County but is poorly defined.

TABLE 4.2.1–1.—*Characteristics of the Major Stratigraphic Units in the LANL Region*-Continued

GROUP	FORMATION	AGE OF DEPOSITION[a]	ROCK TYPES	THICKNESS IN LANL REGION[b]	COMMENTS
Santa Fe[f]		18 to 4.5			Most extensive rock units filling the Rio Grande Rift and most productive in terms of water.
	Chamita		Terrestrial conglomerates, sandstones, mudstones, minor limestones, evaporites, tuff and intercalated basalts	0 to 30 feet (0 to 9 meters)	Localized deposits only. Shallow stream or deltaic deposits.
	Tesuque		Same as Chamita	> 1,300 feet (> 396 meters)	Shallow stream or deltaic deposits. Underlain by Precambrian crystalline rock. Contact between the two rock types can be at depths up to 7,500 feet (2,300 meters) below ground surface.

[a] Million Years
[b] Where question marks appear, the thickness of the formation is unknown.
[c] Broxton and Reneau 1995
[d] Gardner et al. 1986
[e] Tschicoma—The spelling of the word “Tschicoma” may be a derivative of the Native American spelling “Tsichomo,” which refers to a lake and a mountain peak within the Santa Clara Pueblo Indian Reservation. The U.S. Geological Survey (USGS) reference to “Chicoma Peak” may also be a derivative of the Native American spelling.
[f] LANL 1996a

cross-section of the geology in the region is illustrated in Figure 4.2.1–1.

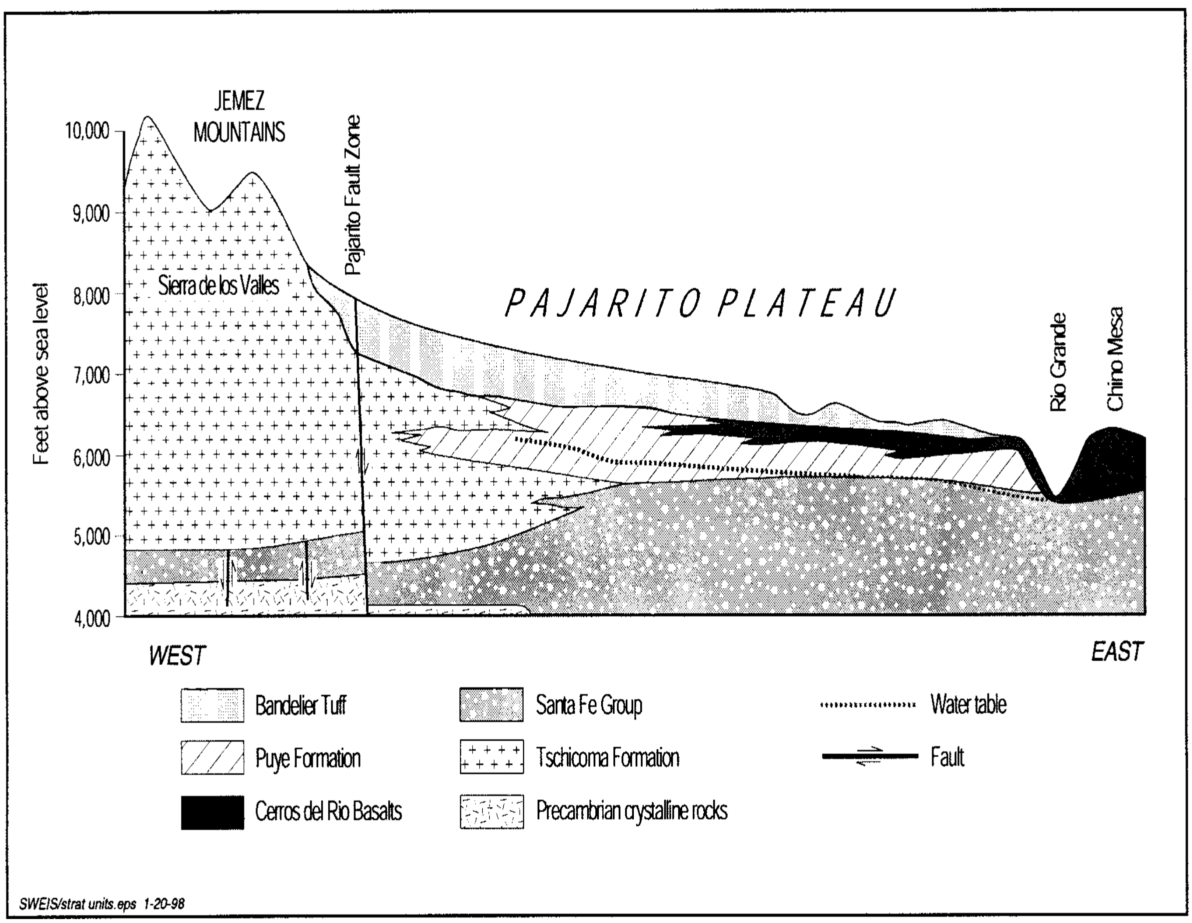
4.2.2 Geologic Conditions

This subsection describes the geologic conditions that could affect the stability of buildings and infrastructure at LANL and includes volcanic activity, seismic activity (earthquakes), slope stability, surface subsidence, and soil liquefaction.

4.2.2.1 *Volcanism*

Volcanism in the Jemez Mountains volcanic field, west of LANL, has a 13-million-year history. An understanding of the area's volcanic history is important when evaluating the potential volcanic hazards that may occur at LANL. Seismic activity and volcanic activity are being tracked and studied by LANL.

The first 11 million years of activity in the Jemez Mountains volcanic field resulted in the formation of a large volcanic ridge on the western margin of the Rio Grande Rift. This activity was followed by the formation of the Valles Caldera. The volcanic history of the Valles Caldera includes two major eruptive episodes (Izett and Obradovich 1994). The first major episode of caldera formation occurred 1.6 million years ago and produced the Otowi member of the Bandelier Tuff. Subsequent activity produced domes within the caldera and associated tuffs. The eruption that occurred 1.22 million years ago produced the Tshirege member of the Bandelier Tuff (Self et al. 1986). The Bandelier Tuff is the material upon which most LANL facilities are constructed



SOURCE: Modified from LANL 1996f

FIGURE 4.2.1–1.—*Stratigraphic Units and Structure of the LANL Area.*

(Purtymun 1995 and Broxton and Reneau 1995). The Bandelier Tuff is generally thickest to the west of LANL near its source, and thins eastward across the Pajarito Plateau, due to increasing distance from the source and erosion.

Volcanic eruptions continued from 1.22 million to 520,000 years ago, followed by a 460,000-year period of dormancy. Following this period of dormancy, the most recent volcanic activity produced several rock units including the El Cajete pumice, a member of the Valles Rhyolite Formation of the Tewa Group. Although present in the LANL area, the El Cajete does not constitute a major stratigraphic unit. The El Cajete pumice is a widespread stratigraphic marker (used for denoting rocks of similar age) in areas east, southeast, and south of the caldera. Therefore, determining the age of the El Cajete pumice is important to understanding potential for volcanic activity in the region (Wolff and Gardner 1995). Recent analysis of the El Cajete dates the pumice at 50,000 to 60,000 years old (Reneau et al. 1996). Additionally, the chemical composition of the rocks resulting from the most recent volcanic activity is dissimilar to the earlier caldera-related units.

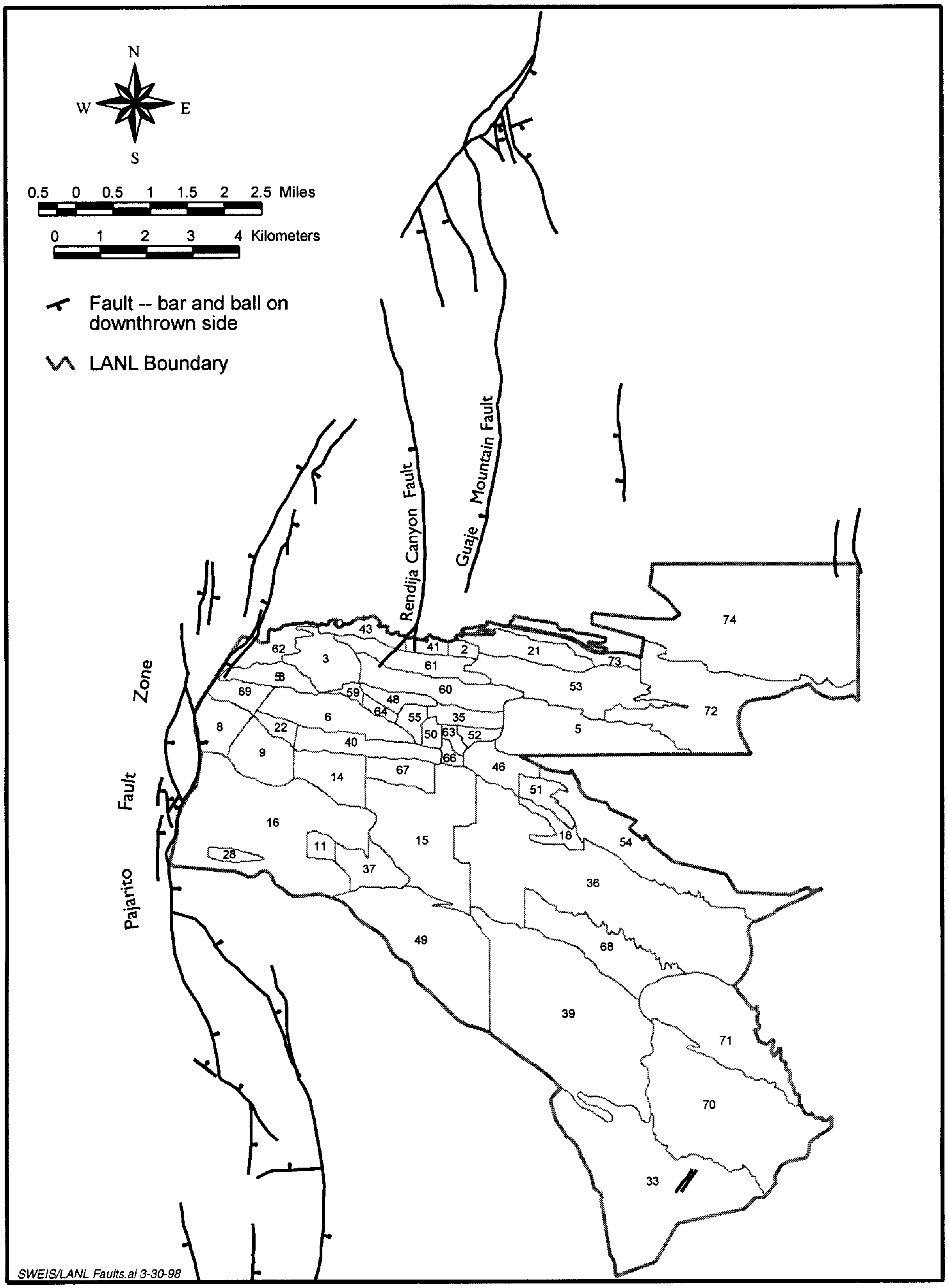
Volcanic activity is difficult to predict, and the accuracy of a prediction may depend on the type of eruption. Increasing seismic activity deep below the Earth's surface is often an indication that magma is migrating toward the surface. The Jemez Mountains show an unusually low amount of seismic activity, which suggests that no magma migration is occurring. However, it is also possible that seismic signals are partially absorbed deep in the subsurface due to elevated temperatures and high heat flow. Such masking of seismic signals would add to the difficulty of predicting volcanism in the LANL area. However, a large Bandelier Tuff-type eruption would give years of warning as regional uplift and doming occurred. A smaller, El Cajete-type eruption may only be detectable by the existing LANL seismographic network within weeks or days of the eruption, and may result in ashfall at LANL depending on the location of the eruption and prevailing wind direction. There are plans to install additional seismograph stations in the vicinity of the Valles Caldera to improve predictive capabilities (Wolff and Gardner 1995 and PC 1996i).

4.2.2.2 *Seismic Activity*

A comprehensive seismic hazards study was completed in 1995 at LANL (Wong et al. 1995). This study provided estimates of the ground shaking hazards by considering the location and rates of movement of earthquakes on a variety of seismic sources and the resulting ground motions that may be caused by these earthquake sources. This study included a detailed assessment of uncertainties, including those associated with the rates of movement for earthquake faults near LANL. The earthquake faults included in the study included all faults within 10 miles (16 kilometers) that met the definition of the term capable fault used by the U.S. Nuclear Regulatory Commission to assess the seismic safety of nuclear power reactors (10 CFR 100, Appendix A).

The nearby north-trending Pajarito Fault system dominates the geologic structure of the LANL area (Figure 4.2.2.2–1). The Pajarito Fault system forms the structural boundary along the western edge of the Española Basin, which is a part of the Rio Grande Rift and the eastern edge of the Valles volcanic province (Wong et al. 1995).

The Pajarito Fault system consists of three major faults and numerous secondary faults. The major faults in Los Alamos County are the Pajarito, Rendija Canyon, and Guaje Mountain. A summary of the characteristics of these faults is presented in Table 4.2.2.2–1. Estimates of the most recent movements along the faults are based on trench studies where the faults are not buried. Therefore, it is possible that the most recent movements along the faults are younger than those presented in Table 4.2.2.2–1 (Wong et al. 1995). As discussed above, these



SOURCE: Gardner and House 1987

FIGURE 4.2.2.2–1.—*Major Surface Faults at LANL.*

TABLE 4.2.2.2–1.—*Summary of Major Faults*

NAME	APPROXIMATE LENGTH miles (kilometers)	TYPE	MOST RECENT MOVEMENT	MAXIMUM POTENTIAL EARTHQUAKE[a]
Pajarito	26 miles (42 kilometers)	Normal, down-to-the-east[b]	Approximately 45,000 to 55,000 years ago	7
Rendija Canyon	6 miles (10 kilometers)	Normal, down-to-the-west	8,000 to 9,000 or 23,000 years ago	6.5
Guaje Mountain	8 miles (14 kilometers)	Normal, down-to-the-west	4,000 to 6,000 years ago	6.5

[a] Richter magnitude
[b] The crustal block on the east side of the fault slips downward toward the east when fault movement occurs. This results in a fault plane for the Pajarito Fault, for example, which runs under LANL toward the east. A normal west fault involves the crustal block on the west side of the fault slipping downward toward the west.
Source: Wong et al. 1995

uncertainties were factored into the seismic hazards study (Wong et al. 1995).

Geologic mapping and fault trenching studies at LANL are currently underway or were recently completed to better define the rates of fault movement, specifically for the Pajarito Fault, and the location and possible southern termination of the Rendija Canyon Fault. A summary of these studies is provided in Table 4.2.2.2–2, including the date or expected date of publication for each study's final report. Results of these studies have been and will continue to be reviewed to determine if the seismic hazards study (Wong et al. 1995) needs to be updated. To account for the results and potential results of this work, selection of earthquake scenarios for evaluation of risk-dominant accidents has considered the uncertainties that exist related to the frequency and location of earthquakes, including the possibility that Rendija Canyon Fault intersects TA–3 (see volume III, appendix G, section G.4.1.1). Locations of active faults, such as the Rendija Canyon Fault, may also need to be addressed as part of any new facility siting decisions.

In volume III, appendix I presents a detailed status of the ongoing and recently completed seismic hazard studies as well as the implications of these studies for LANL and DOE. The Status and Implications of Seismic Hazard Studies at LANL Report (this report, appendix I, has been reviewed and accepted by DOE) indicates that TA–3 does have faults with vertical displacements in the range of 1 to 10 feet (0.3 to 30 meters). The faults found include one under the Chemistry and Metallurgy Research (CMR) Building in TA–3 with a vertical offset of approximately 8 feet (2.4 meters). While surface rupture can cause significant structural damage, surface rupturing earthquakes are low probability events. As discussed in the report, the probability of an earthquake causing significant surface displacement at this site in the future is small. From the probabilistic assessment of surface rupture, earthquakes that might result in permanent ground displacements capable of causing structures to collapse are estimated to be 33,000 to 100,000 year events. The displacement threshold for collapse was taken as about 20 inches (50 centimeters). For the CMR Building, a nuclear facility, the probability of damaging ground displacement is at or beyond the performance goal for the facility (10,000 year recurrence interval). In its current condition, the probability of damaging ground motion is at least 20 times greater than the probability of damage caused by surface

TABLE 4.2.2.2–2.—*Summary of Ongoing Geologic Field Studies*

GEOLOGIC FIELD TASK	SUMMARY AND PURPOSE OF FIELD WORK	SCHEDULE FOR COMPLETION
Stratigraphic Survey for TA–55[a]	High precision geologic mapping effort in the vicinity of TA–55 to identify and locate faults with the potential for seismic surface rupture. The technique used identifies faults with as little as 0.5 meters of offset in 1.2-million-year-old Bandelier Tuff.	6/98 Final Report
Probabilistic Surface Rupture Assessment for TA–3[b]	Provide bounding estimates on the probability of surface rupture and expected displacement at TA–3. Upper bound will assume the Rendija Canyon Fault runs adjacent to TA–3.	7/98 Final Report
Core Holes (Facility-Specific) Study: SCC/NISC Site and CMR Site[c,d]	To investigate individual sites for evidence of primary faults with the potential for seismic surface rupture. The location at which a stratigraphic marker is found in a series of holes cored across an individual site would indicate the presence/absence of primary faulting.	Final Reports 9/98 SCC/NISC Site 10/98 CMR Site
Fiscal Year 1997 Pajarito Trench Study[e]	Complete data analysis and report writing of investigation started in fiscal year 1997 to help establish the recurrence interval and latest event of the major fault affecting the LANL seismic hazard. This effort focuses on seven trenches cut immediately to the south of Los Alamos Canyon to the west and north of the LANL site.	8/98 Final Report
Stratigraphic Survey for TA–3	High precision geologic mapping effort in the vicinity of TA–3 to identify and locate faults with the potential for seismic surface rupture. The technique used identifies faults with as little as 0.5 meters of offset in 1.2-million-year-old Bandelier Tuff.	12/98 Field Work 3/99 Final Report
Fiscal Year 1998 Pajarito Trench Study	Initiate seven new trenches on the Pajarito Fault to continue the investigation into the recurrence interval and latest event on the major fault affecting the LANL seismic hazard. These trenches are located roughly 1 mile (1.6 kilometer) or greater to the south of those in the fiscal year 1997 effort and are near the western boundary of the LANL site.	8/98 Field Work 3/99 Final Report

SCC = Strategic Computing Complex, NISC = Nonproliferation and International Security Center

Sources:

[a] Gardner and WoldeGabriel 1998
[b] Olig et al. 1998
[c] Krier et al. 1998a
[d] Krier et al. 1998b
[e] McCalpin 1998

rupture. Therefore, the discovery of the fault under the CMR Building does not increase the seismic risk. However, the discovery of a fault under the CMR Building has an impact on decisions concerning upgrades and future uses for the facility.

The report, presented as appendix I (in volume III), indicates that slip rates (recurrence intervals for earthquakes) are within the parameters assumed in the 1995 seismic hazards study at LANL (Wong et al. 1995). The 1995 study (Wong et al. 1995) was used for the LANL facility design basis for ground motion. The report also indicates that TA–55 has no evidence of existing faults and is not susceptible to surface rupture from earthquakes.

A historical catalog has been compiled of earthquakes that have occurred in the LANL area from 1873 to 1991 (Wong et al. 1995). A review of these earthquakes indicates that only six, having an estimated magnitude of 5 or greater on the Richter scale, have occurred in the LANL region. The most significant seismic event in this period was the 1918 Cerrillos earthquake. This earthquake had an estimated Richter magnitude of 5.5 and was centered approximately 31 miles (50 kilometers) southeast of LANL. Near the epicenter, an earthquake of this magnitude may cause damage to buildings, depending on their design, and cause chimneys and factory stacks to collapse.

It is possible to relate Richter magnitudes to ground acceleration values (the change of rate in ground movement during an earthquake) and to observed effects of earthquakes. However, it is important to note that these relationships are approximate. The observed effects can vary with ground motion and Richter magnitude, depending upon the distance to the epicenter, the type of ground on which the observer is standing, the type and orientation of the fault with respect to the observer, and many other variables. Table 4.2.2.2–3 was prepared to provide the reader with a frame of reference that is important in understanding earthquakes and the impacts of earthquakes on structures. Table 4.2.2.2–3 was developed based on general correlations between observed earthquake effects and earthquake magnitudes and the correlations between earthquake magnitudes and ground acceleration from the comprehensive LANL seismic hazard study.

The seismic hazards results indicate that the Pajarito Fault system represents the greatest potential seismic risk to LANL, with an estimated maximum earthquake magnitude of about 7. Although large uncertainties exist, an earthquake with a Richter magnitude greater than or equal to 6 is estimated to occur once every 4,000 years; an earthquake with a magnitude greater than or equal to 7 is estimated to occur once every 100,000 years along the Pajarito Fault system. Earthquakes of this magnitude may cause considerable damage to structures and underground pipes.

Modern earthquake design standards for DOE are based on criteria defined in DOE Standard 1020–94 (DOE 1996c). Four levels of design earthquake ground motions are defined for structures corresponding to return periods of 500, 1,000, 2,000, and 10,000 years, depending on the off-site hazard posed by failure of the facility. These standards were promulgated in 1993 through 1995. The seismic hazards study of facilities in eight LANL TAs found that earthquakes representative of frequency of 1 in 10,000 per year would cause the horizontal peak ground acceleration ranging from 0.53 ground acceleration to 0.57 ground acceleration (Table 4.2.2.2–4) (Wong et al. 1995). Some of the maintenance and refurbishment activities at LANL (chapter 3, section 3.4) are specifically intended to upgrade the seismic performance of older structures.

TABLE 4.2.2.2–3.—*Correlations Among Observed Effects of Earthquakes, Richter Magnitudes, and Peak Ground Acceleration*

OBSERVED EFFECTS OF EARTHQUAKES	APPROXIMATE RICHTER MAGNITUDE[a]	APPROXIMATE PEAK GROUND ACCELERATION (*g*) WITHIN 0 TO 10 mi (0 TO 16 km)[b]
Usually not felt	2	
Felt by persons at rest, on upper floors, or favorably placed		
Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	
Felt noticeably by persons indoors, especially on upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak		
Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start	4	
Felt by all; persons walk unsteadily; windows and dishes break; objects fall off shelves and pictures fall off walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	5	0.05 to 0.20
Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well-built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	6	0.15 to 0.30
Automobile steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes		
Masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams, and reservoirs; underground pipes break; conspicuous ground cracks	7	0.35 to 0.70
Most masonry and frame structures destroyed; some well-built wooden structures and bridges destroyed; serious damage to dams and dikes, large landslides; rails bent		
Rails bent greatly; underground pipelines completely out of service	8	0.50 to 1.0
Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted		

Sources: [a] Richter 1958 and [b] Wong et al. 1995.

TABLE 4.2.2.2–4.—*Peak Horizontal Ground Accelerations Corresponding to Return Periods from 500 to 10,000 Years for Eight LANL Technical Areas*

SITE	GROUND ACCELERATION 500-YEAR RETURN PERIOD	GROUND ACCELERATION 1,000-YEAR RETURN PERIOD	GROUND ACCELERATION 2,000-YEAR RETURN PERIOD	GROUND ACCELERATION 10,000-YEAR RETURN PERIOD	GROUND ACCELERATION 100,000-YEAR RETURN PERIOD (EST.)
TA–2	0.14	0.22	0.31	0.57	> 1.0
TA–3	0.14	0.21	0.30	0.56	> 1.0
TA–16	0.14	0.21	0.29	0.53	1.0
TA–18	0.14	0.22	0.31	0.57	0.98
TA–21	0.15	0.22	0.31	0.55	1.0
TA–41	0.14	0.22	0.31	0.57	> 1.0
TA–46	0.15	0.22	0.30	0.55	0.99
TA–55	0.15	0.22	0.30	0.56	> 1.0

> = greater than
Source: Wong et al. 1995

4.2.2.3 *Slope Stability, Subsidence, and Soil Liquefaction*

Rockfalls and landslides are two geologic processes related to slope stability at LANL. The historic downward cutting or erosion of surface water streams in the LANL region results in steep canyon walls. The primary risk factors most likely to affect slope stability are wall steepness, canyon depth, and stratigraphy. Because of this, the LANL facilities near a cliff edge (e.g., TA–33) or in a canyon bottom (e.g., TA–2, Omega West reactor) are potentially susceptible to slope instability. The largest slope instability may be triggered by any process that might destabilize supporting rocks. These processes include, but are not limited to, excessive rainfalls, erosion, and seismic activity.

Although no LANL-wide slope stability studies have been performed, several site-specific studies have been published. Slope stability studies have been performed for Los Alamos Canyon (in the vicinity of TA–2, the Omega West reactor), TA–33, TA–21, and Pajarito Mesa (Kelley 1970, Reneau et al. 1995, Reneau 1995, and Reneau 1994). Generally, the proximity of these sites to canyon edges prompted these reports, and these may represent worst-case scenarios for LANL.

A rock catcher was installed in TA–2 in the Los Alamos Canyon in 1944 to protect the Omega West reactor (which is no longer operational) from rockfalls. Additionally, a rock catcher was installed at TA–41 in 1978, and periodic inspections are performed at both sites. Twenty-four separate rockfalls were recorded at both sites between 1944 and 1993. The rocks caught range in size from 300 to 21,000 pounds (136 to 9,525 kilograms) (McLin 1993).

Subsidence (lowering of the ground surface) and soil liquefaction are two geologic processes that are less likely to affect LANL than rockfalls or landslides. The potential for subsidence is minimal due to the firm rock beneath LANL. Soil liquefaction is a process where saturated (or nearly saturated soils) and unconsolidated sediments become fluid during an earthquake, to the extent that the ground may be unable to support structures. Bedrock, soils, and unconsolidated deposits that are unsaturated, such as those that occur beneath LANL, are unlikely to undergo liquefaction.

4.2.3 Soils

Several distinct soils have developed in Los Alamos County as a result of interactions between the bedrock, topography, and local climate. Soils that formed on mesa tops of the Pajarito Plateau include the Carjo, Frijoles, Hackroy, Nyjack, Pogna, Prieta, Seaby, and Tocal soil series (Reneau 1994). All of the soils in the aforementioned soil series are well-drained and range from very shallow (0 to 10 inches [0 to 25 centimeters]) to moderately deep (20 to 40 inches [51 to 102 centimeters]), with the greatest depth to the underlying Bandelier Tuff being 40 inches (102 centimeters) (Nyhan et al. 1978). The geochemistry, geomorphology, and formation of soils in the LANL area have been characterized (Longmire et al. 1996).

4.2.3.1 *Soil Monitoring*

Soils on and surrounding LANL are sampled annually as a part of the Environmental Surveillance and Compliance Program to determine if they have been affected by LANL operations (LANL 1992b, LANL 1993b, LANL 1994b, LANL 1995f, LANL 1996e, LANL 1996i, and LANL 1997c). Sediments, which occur along most segments of LANL canyons as narrow bands of canyon-bottom deposits that can be transported by surface water during runoff events or by LANL outfall effluent flows, are not part of the soil monitoring program and are discussed under section 4.3.1.4. A soil sampling and analysis program, as mandated by DOE Orders 5400.1

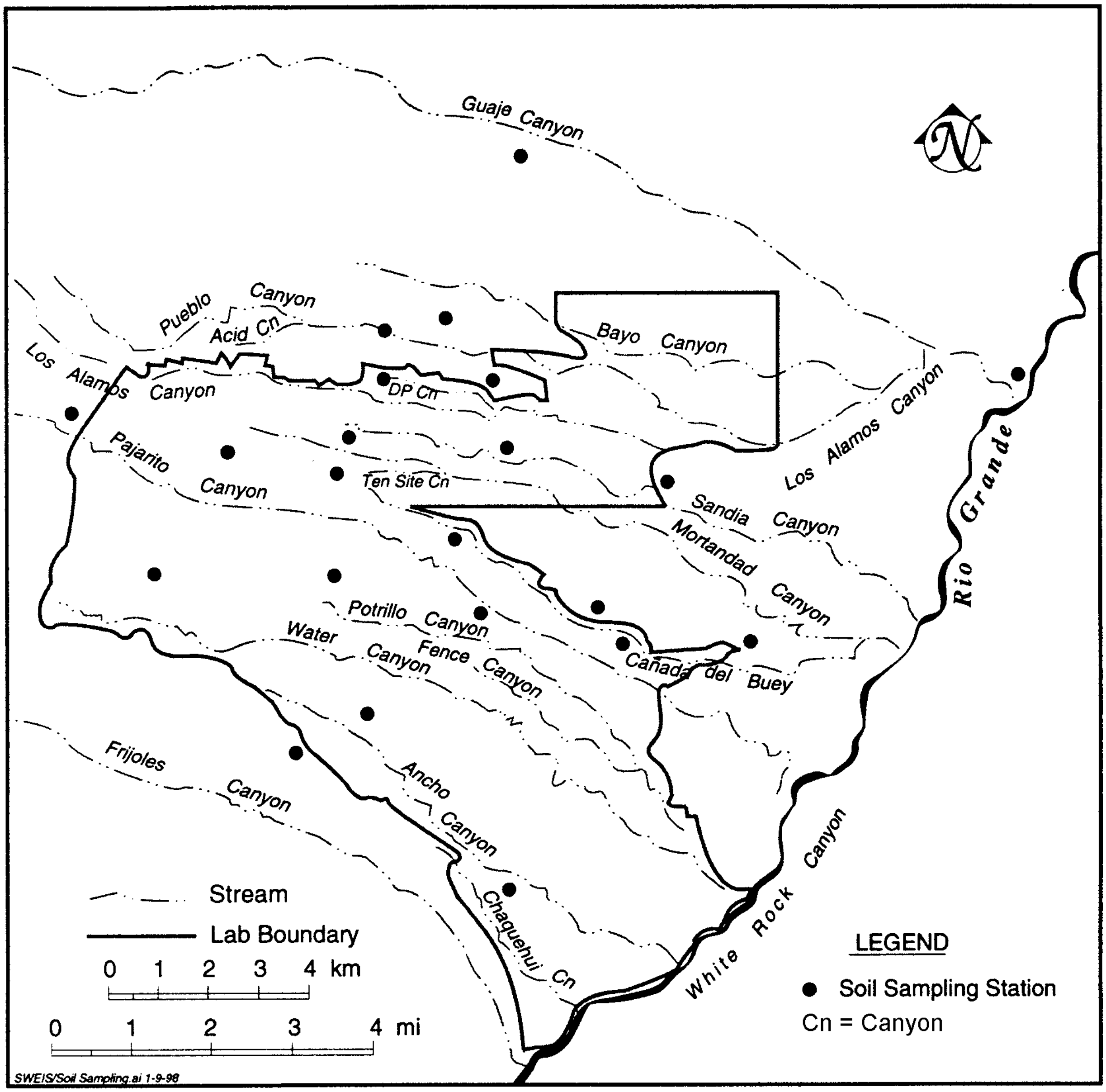
and 5400.5, provides information on the concentration and distribution of radionuclides in soils near LANL. Soil samples are collected from on-site, perimeter, and off-site locations shown in Figure 4.2.3.1–1. Additionally, background soil samples are collected from regional stations that are located in three major drainages surrounding LANL (Rio Chama and Embudo, Cochiti and Bernalillo, and Jemez) and one regional station located near Santa Cruz Lake, across the Rio Grande Valley to the northeast of LANL (Figure 4.2.3.1–2). These background stations are located over 9 miles (15 kilometers) from LANL, which is considered beyond the range of potential influence from normal LANL operations (DOE 1991).

On-site areas sampled at LANL are not from potential release sites (PRSs) or wastewater outfalls. Instead, the majority of on-site sampling stations are located close to and downwind from major facilities and/or operations at LANL in an effort to assess radionuclide, radioactivity, and heavy metals in soils that may have been contaminated as a result of air stack emissions and fugitive dust (e.g., the resuspension of dust from PRSs). A rough estimate, based on information from LANL's database, FIMAD, which has areal estimates of the PRSs, indicates that the areal extent of the PRS are less than 3 percent of LANL's approximately 43 square miles (111 square kilometers). The areal extent of this 3 percent does not include the canyons because they are not classified under the FIMAD database as PRSs.

The soil radionuclide and radioactivity samples collected from 1974 through 1995 have been analyzed for tritium; cesium-137; plutonium-238, -239, and -240; americium-241; strontium-90; total uranium; gross alpha; gross beta; and gross gamma activities.

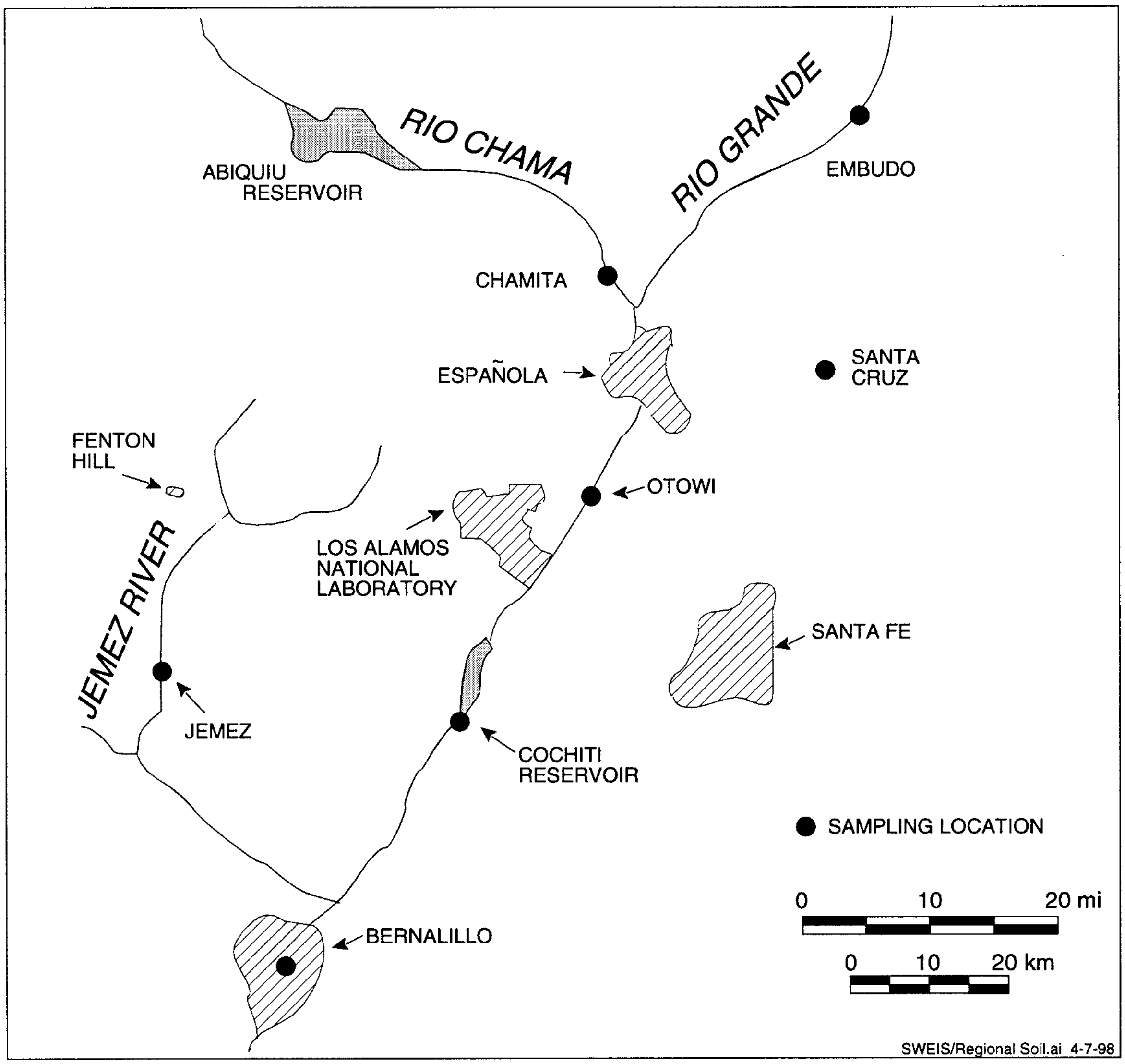
Sources of radionuclides in soil may include natural minerals, atmospheric fallout from nuclear weapons testing (Klement 1965), burn-up of nuclear-powered satellites (Perkins and Thomas 1980), and planned or unplanned releases of radioactive gases, liquids, and/or solids by LANL. Naturally occurring uranium is present in relatively high concentrations in soil and rocks due to the regional geologic setting (Purtymun et al. 1987). Sources of plutonium include LANL operations and atmospheric fallout. Metals in soil may be naturally occurring or may result from LANL releases.

LANL on-site and perimeter soil samples (Figure 4.2.3.1–1) are collected and analyzed for radiological and nonradiological constituents, and compared to the regional (background) locations (Figure 4.2.3.1–2). In general, the average concentrations of tritium, strontium-90, cesium-137, plutonium-239, plutonium-240, americium-241, and gross alpha and beta activity in soils collected from perimeter stations were not significantly different than radionuclide concentrations and activity in soil samples collected from regional background locations. In contrast, the average levels of uranium (3.12 micrograms per gram), plutonium-238 (0.015 picocurie per gram), and gross gamma activity (4.1 picocuries per gram) were significantly higher than uranium (1.84 micrograms per gram), plutonium-238 (0.004 picocurie per gram), and gross gamma (3.4 picocuries per gram) in background soils. Although the average levels of uranium and gross gamma activity in perimeter soils were significantly higher than background, they were still within the regional statistical reference level (RSRL) of 4.05 micrograms per gram and 7.3 picocuries per gram, respectively. The RSRL is the average background concentration plus twice the standard deviation of the mean from data collected over a 21-year period (Fresquez et al. 1996a). Plutonium-238 average concentrations, on the other hand, were just above the RSRL (0.008 picocurie per gram); however, these levels were far below LANL screening action levels (SALs) of 27 picocuries per gram. LANL SALs, developed by the



SOURCE: LANL 1997c

FIGURE 4.2.3.1–1.—*On-Site and Off-Site Perimeter Soil Sampling Locations.*
(**Note:** Perimeter stations are located within 2.5 miles [4 kilometers] of LANL.)



SOURCE: LANL 1997c

FIGURE 4.2.3.1–2.—*Regional Soil Sampling Locations.*

Environmental Restoration (ER) Project at LANL, are used to identify the presence of contaminants of concern and are derived from a risk assessment pathway using a 10 millirem per year dose limit. SALs are used by the ER Project at LANL to identify "hot spots" that will require additional sampling and may require remediation. Table 4.2.3.1–1 shows the RSRL and the LANL SAL values for several radionuclides. The SALs shown in Table 4.2.3.1–1 provide an indication of how far below RSRLs are to the 10 millirem per year standard.

For 1995 on-site soil samples, only plutonium-239, plutonium-240 (both 0.059 picocurie per gram) and total uranium (3.57 micrograms per gram) were detected in significantly higher concentrations as compared to off-site background soils. However, the levels were still within the RSRL and/or were far below LANL SALs. In general, the higher concentration of radionuclides, particularly uranium and plutonium isotopes, in perimeter soils as compared to background soils may be due in part to LANL operations but are mostly due to worldwide fallout and to naturally occurring radioactivity in Bandelier Tuff soils; whereas, higher radioactivity in soils from on-site areas may be due to worldwide fallout, natural radioactivity, and to LANL operations. (Fresquez et al. 1995d.)

Trend analyses show that most radionuclides and radioactivity, with the exception of plutonium-238 and gross alpha, in soils from on-site and perimeter areas have been decreasing over time (Fresquez et al. 1996a). These trends were especially apparent (i.e., significant at the 0.05 probability level

TABLE 4.2.3.1–1.—*Regional Statistical Reference Level and LANL Screening Action Levels for Radionuclides*[a]

	RSRL[b] (AVERAGE FROM 1974 TO 1994)	LANL SCREENING ACTION LEVEL (SAL)[c]
Tritium	6.34 nCi/l	1,900 nCi/l
Cesium-137	1.13 pCi/g	5.10 pCi/g
Plutonium-238	0.008 pCi/g	27 pCi/g
Plutonium-239, -240	0.028 pCi/g	24 pCi/g
Americium-241	0.208 pCi/g	22 pCi/g
Strontium 90	0.82 pCi/g	4.40 pCi/g
Total Uranium	4.05 µg/g	29 µg/g
Gross Alpha	35.24 pCi/g	Not Available
Beta	13.62 pCi/g	Not Available
Gamma	7.33 pCi/g	Not Available

nCi/l = nanocuries per liter, pCi/g = picocuries per gram, µg/g = microcuries per gram.

[a] Fresquez et al. 1996a

[b] Regional Statistical Reference Level; this is the upper limit background concentration (mean plus two standard deviations) (Fresquez et al. 1996a).

[c] SALs are a benchmark for the potential for human health risk and are derived from toxicity data using a risk assessment approach that requires information regarding the contaminant toxicity, the uptake rate of the medium in which the contaminant is found, the body weight of the receptor, and the biological availability of the contaminant after uptake. Because all of this information is rarely known, assumptions and/or extrapolations from other data usually are required. These assumptions and extrapolations result in some degree of uncertainty associated with the resultant SALs. Also, SALs may change over time as studies that result in new toxicological data or new information regarding other parameters that are used in calculating the SALs are obtained.

[probability less than 0.05]) for tritium and uranium in soils from on-site areas. Their decrease may be due in part to reductions in LANL operations, air stack emissions, and to better engineering controls employed by LANL (LANL 1996i), but is more probably due to: (1) the cessation of aboveground nuclear weapon testing in the early 1960's, (2) weathering (wind, water erosion, and leaching), and (3) radioactive decay (half-life) (Whicker and Schultz 1982). Tritium, which has a half-life of about 12 years, exhibited the greatest decrease in activity over the 21 years in almost all of the soil sites studied, including regional locations. Plutonium-238 and gross alpha activity generally increased over time in most on-site, perimeter, and even regional background sites; all sites, however, were far from being statistically significant (probability less than 0.05). The source of most plutonium-238 detected in the environment is from nuclear weapons testing in the atmosphere (Klement 1965) and from the re-entry burn-up of satellites containing a plutonium-238 power source (Perkins and Thomas 1980). Only a few gross alpha readings and a few gross beta readings showed significantly increasing trends (probability less than 0.05) over time. In these cases, however, the measurement period was both early and very short (1978 to 1981).

Soils were also analyzed for trace and heavy metals, and most metals were within RSRLs and were well below LANL SALs (LANL 1996i). Only beryllium and lead, both products of firing site activities, exhibited any kind of trend; that is, both were consistently higher in perimeter and on-site soils than in background soils. Concentrations over time show that average beryllium in perimeter soils decreased from 0.97 microgram per gram in 1992 to 0.62 microgram per gram in 1995. Lead decreased from 32 micrograms per gram in 1992 to 22.7 micrograms per gram in 1995. Similarly, beryllium in on-site soils averaged 1.17 micrograms per gram in 1992, and decreased to 0.63 microgram per gram in 1995. Lead in on-site soils, on the other hand, increased slightly in concentration from an average of 16 micrograms per gram in 1992 to 20 micrograms per gram in 1995. The RSRL for beryllium and lead is 0.90 and 21.8 micrograms per gram, respectively.

The EPA studied radionuclides and radioactivity in soils at the Pueblo of San Ildefonso in 1994 (EPA 1995). Samples were collected from 16 locations east of the Rio Grande; 9 locations west of the Rio Grande in Los Alamos Canyon, Mortandad Canyon, and Cañada del Buey; and 5 regional background locations at Embudo Station, Santa Fe, Rio Chama above and below Abiquiu Reservoir, and Albuquerque. The EPA analyzed the soil samples for tritium; cesium-137; plutonium-238, -239, and -240; americium-241; strontium-90; uranium isotopes (uranium-234, -235, and -238); thorium isotopes (thorium-227, -228, -230, and -232); and gamma-emitting radionuclides. Analyses of the various isotopes of uranium and thorium were performed to evaluate whether these radionuclides were from natural sources or a result of human activities. The EPA concluded that, with the exception of cesium-137 and cobalt-56, the radionuclides detected were of natural origin and had concentrations typical of southwestern soils. The source of cesium-137 was interpreted to be from atmospheric fallout from nuclear weapons testing. Cobalt-56 is not normally detected in the environment due to its short half-life (79 days) and was found in only one sample. The EPA concluded that the origin of this radionuclide was unknown (EPA 1995).

4.2.3.2 *Soil Erosion*

Soil erosion can have serious consequences to the maintenance of biological communities and may also be a mechanism for moving contaminants across LANL and off site. Soil erosion rates vary considerably on the mesa tops at LANL, with the highest rates occurring in drainage channels and areas of steep slopes and the lowest rates occurring on gently sloping portions of the mesa tops away from the channels (LANL 1993a). A recent study performed in BNM suggests that erosion rates are high across widespread portions of local pinyon-juniper woodlands, which are found on the eastern portion of LANL (Wilcox et al. 1996a).

Another study found that light summer rain storms in 1993 resulted in erosion of more than 12 tons per acre (26,900 kilograms per hectare) of soil (Wilcox et al. 1996b). It is estimated that the current annual rate of soil erosion in BNM is 36 tons per acre (80,700 kilograms per hectare).

Areas where runoff is concentrated by roads and other structures are especially prone to high erosion rates. High erosion rates appear to be relatively recent, most likely resulting from loss of vegetative cover, decreased precipitation, past logging practices, and past livestock grazing (Wilcox et al. 1996b).

4.2.4 Mineral Resources

There are no active mines, mills, pits, or quarries in Los Alamos County or on DOE land at LANL. Sand, gravel, and pumice are mined throughout the surrounding counties. For example, there is a pumice mine in Guaje Canyon on USFS land.

The major sand and gravel deposit in the area is located in the lower member of the Puye Conglomerate (DOE 1979). The Totavi Gravel Pit, located approximately 4 miles east (6.4 kilometers) of Los Alamos County on NM 502, is an active operation that extracts sand and gravel from this deposit. The deposit is approximately 50 feet (15 meters) thick and is overlain by 20 to 50 feet (6 to 15 meters) of overburden (Griggs and Hein 1954). Sand and gravel are used for construction purposes such as aggregate for concrete, asphalt paving, and road base.

Sand and gravel have also been taken from terrace deposits in Los Alamos Canyon, from the floors of Pajarito and Water Canyons, and from river deposits near the slopes of the Jemez Mountains (DOE 1979). The terrace and river deposits have been exhausted. However, small sand and gravel deposits may exist west of the previously worked areas in Pajarito and Water Canyons (DOE 1979).

Commercial deposits of pumice are actively mined to the northeast, east, south, and southwest of Los Alamos County (NMNRD 1994). Pumice is used in textile laundries to soften material, for building blocks and landscaping, and as an abrasive (NMNRD 1994). Although pumice deposits of potential commercial value lie within Los Alamos County, no active mines exist. The deposit of Guaje Flats has been estimated to contain 7 million cubic yards (about 5 million cubic meters) of pumice (Kelley 1948).

The moderately welded and welded units of the Bandelier Tuff are suitable as foundation rocks, structural building stone, ornamental stone, or insulating material (Purtymun and Koopman 1965). Volcanic tuff has been used successfully by the Zia Company as the aggregate in soil-cement sub-bases for roads (Pettitt 1969).

4.2.5 Paleontological Resources

No paleontological sites are reported to occur within LANL boundaries, and the near-surface stratigraphy is not conducive to preserving plant and animal remains. These near-surface materials are volcanic ash and pumice that were extremely hot when deposited. Occasionally, some charcoal is found at the base of an ashfall (DOE 1995b).

4.3 WATER RESOURCES

Only a small percentage of the world's total water supply is available to humans as fresh water, and more than 98 percent of the available fresh water is groundwater (Fetter 1988). Water is scarce in the semi-arid climate of northern New Mexico where precipitation is variable and stems primarily from summer thunderstorms and winter snowfall. During most of the year in the LANL region, surface water is present only in the Rio Grande and Rito de los Frijoles and in reservoirs. Naturally perennial surface water reaches also are located in Ancho, Pajarito, and Chaquehui Canyons.[1] The canyon-bottom streams within LANL boundaries are mostly dry and only portions of some streams contain water year-round. Flash floods can occur from the Sierra de Los Valles to the Rio Grande. Sediments moved by stormwater events from upstream, hill sides, or mesa tops occur along most of LANL canyons. Flash floods move the sediments from the canyon bottoms to downstream locations such as Cochiti Lake. Springs and the 87 National Pollutant Discharge Elimination System (NPDES)-permitted industrial and sanitary wastewater outfalls from LANL operations are additional sources of water to watersheds in the region. The 87 index NPDES flows were estimated using data provided by the surface water data team reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997).

The geology of the region has set the stage for the locations of groundwater. Bodies of groundwater can occur near the surface of the earth in the canyon bottom alluvium, perched or trapped above the less-permeable rocks below, or at deeper levels, forming groundwater bodies referred to as intermediate perched groundwater (Purtymun 1995). Where these perched groundwater bodies occur or how large they are, is still under investigation and is not fully characterized.

The main aquifer is the only body of groundwater in the region that is sufficiently saturated and permeable to transmit economic quantities of water to wells for public use. All drinking water for LAC, LANL, and BNM comes from the main aquifer (Purtymun et al. 1995). Depth to water in the main aquifer from the ground surface varies from approximately 1,200 feet (366 meters) along the western boundary to approximately 600 feet (183 meters) along the eastern edge below the surface of the Pajarito Plateau. This groundwater body is relatively insulated from the alluvial and intermediate perched groundwater bodies by geologic formations. To better understand the hydrology of the Pajarito Plateau, LANL personnel have prepared a Hydrogeologic Workplan (LANL 1998b). The workplan proposes the installation of new wells that will further investigate the recharge and cross-connection mechanisms to the main aquifer (sections 4.3.2.1 and 4.3.2.3). The main

A Look Back in Time

The autumn colours of America are famous and some of the mountain-sides, where aspens grew, turned an unbelievable butter-cup yellow in the autumn, such as I have never seen anywhere else, in brilliant contrast to the dark green of the pine woods. Below us in the valley was the Rio Grande in its early course, a quiet trickle of water during much of the year (and of course frozen in winter) but a torrent of tomato soup in the spring when it was fed by the melting snow of the Rocky Mountains and carried millions of tons of red soil. The ground in the valley had been cut up by ages of erosion into table mountains, some of those mesas almost unclimbable, with steep rocky walls like the Lost World which Conan Doyle so vividly described.

Source: Frisch 1979

[1] This does not include LANL effluent supported discharges.

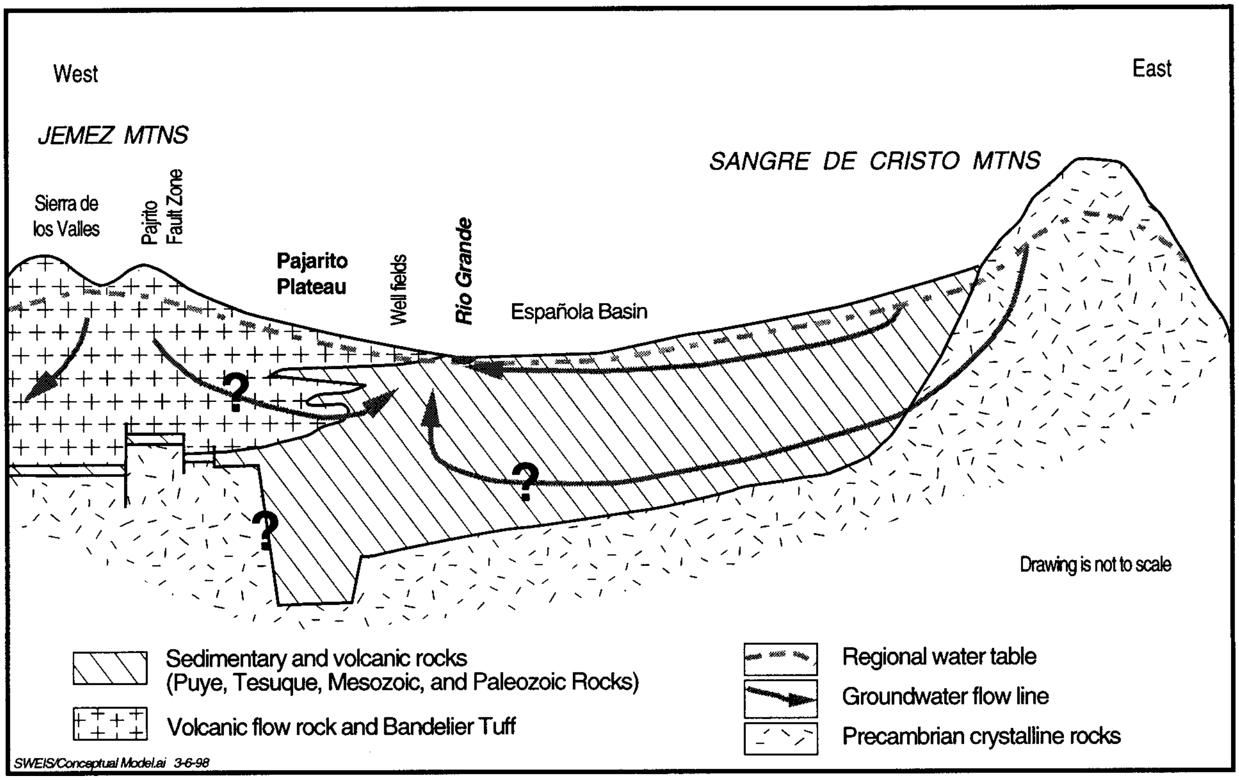
aquifer exists regionally in the sedimentary and volcanic rock of the Española Basin, which extends from the Jemez Mountains in the west to the Sangre de Cristo Mountains in the east, and from the village of Abiquiu in the north to the village of La Bajada in the south. The main aquifer takes residence in interconnected geologic units of the Puye Formation and the Tesuque Formation. The latter unit is a member of the Santa Fe Group. Data on water levels and groundwater ages suggest that the main aquifer of the Española Basin is not strongly interconnected across its extent. There are significant differences in water chemistry at various locations in the Española Basin, further indicating that the regions are not connected. These observations may result from variations in permeability and from different directions of water movement in the aquifer (LANL 1998b). For information on the hydraulic parameters for the unsaturated zone, alluvium, and intermediate and main aquifer, see volume III, appendix A.

Water in the main aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun and Johansen 1974). The source of recharge to the aquifer is presently uncertain. Early research studies concluded that major recharge to the main aquifer is probably from the Jemez Mountains to the west, because the piezometric surface slopes downward to the east, suggesting easterly groundwater flow beneath the Pajarito Plateau. The small amount of recharge available from the Jemez Mountains relative to water supply pumping quantities, along with differences in isotopic and trace element composition, appear to rule this out. Further, isotopic and chemical composition of some waters from wells near the Rio Grande suggest that the source of water underlying the eastern part of the Pajarito Plateau may be the Sangre de Cristo Mountains (Blake et al. 1995). Groundwater flow along the Rio Grande rift from the north is another possible recharge source. The main aquifer discharges into the Rio Grande through springs in White Rock Canyon (LANL 1996i).

A conceptual drawing of groundwater flow paths in the Española portion of the northern Rio Grande Basin is presented in Figure 4.3–1. The question marks indicate uncertainties in the groundwater flow.

A conceptual drawing of the surface and groundwater bodies as they occur beneath the Pajarito Plateau (the geohydrologic setting) is presented in Figure 4.3–2. A description of the types of water resources in the LANL region and where they occur is presented in Table 4.3–1. The surface and groundwater resources present in the LANL region are described further in this section. Information and data regarding surface water and groundwater quality, NPDES outfalls, sediments, and stormwater monitoring are presented by watershed. It should be noted that the grouping of groundwaters by watershed is applicable to alluvial groundwater, but may not reflect flow pathways to intermediate perched groundwater bodies. The main aquifer is present beneath all watersheds, but is generally considered to receive negligible recharge from surface water streams in the watersheds (Purtymun et al. 1995). The Hydrogeologic Workplan proposes the installation of new wells that will further investigate recharge to the main aquifer (section 4.3.2.3).

Monitoring data presented in this section are primarily from the LANL Environmental Surveillance and Compliance Program (previously called the Environmental Surveillance Program) for the period 1990 through 1996. This program is described in more detail on page 4–1. Summary water quality data tables derived from the 1991 to 1996 LANL Environmental Surveillance and Compliance reports are presented in volume III, appendix C (Tables C–1 through C–7). Additional information regarding water use projections and the groundwater model are presented in appendix A.



SOURCE: Stephens et al. 1993

FIGURE 4.3–1.—*Conceptual Sketch of Groundwater Flow Paths in the Española Portion of the Northern Rio Grande Basin.*

Fenton Hill Site

The Fenton Hill site (TA–57) is located about 20 miles (32 kilometers) west of Los Alamos on the southwestern edge of the Valles Caldera in the Jemez Mountains and was the location of LANL's now decommissioned Hot Dry Rock Geothermal Project (chapter 1, Figure 1–1). From the early 1970's until the 1990's, LANL carried out geothermal research at this facility. The main LANL site lies on the eastern side of the caldera, known as the Pajarito Plateau; whereas, the Fenton Hill site is on the western side, known as the Jemez Plateau. The drainage from the main LANL site is eastward toward the Rio Grande; whereas, the drainage from the Fenton Hill site is westward toward the Jemez River. Liquid waste discharges were governed by NPDES Permit No. NM0028576. During the time of operation there were no NPDES permit violations at the Fenton Hill site. No discharges have been made from the Fenton Hill site outfall since fiscal year 1990, and the NPDES permit was discontinued at the request of DOE and LANL on December 29, 1997. Additional information on this facility is available in the *Resource Conservation and Recovery Act* (RCRA) Facility Investigation (RFI) Work Plan for Operable Unit 1154 at the LANL (LANL 1994c).

4.3.1 Surface Water

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into the upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the LANL site before they are depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande, the major

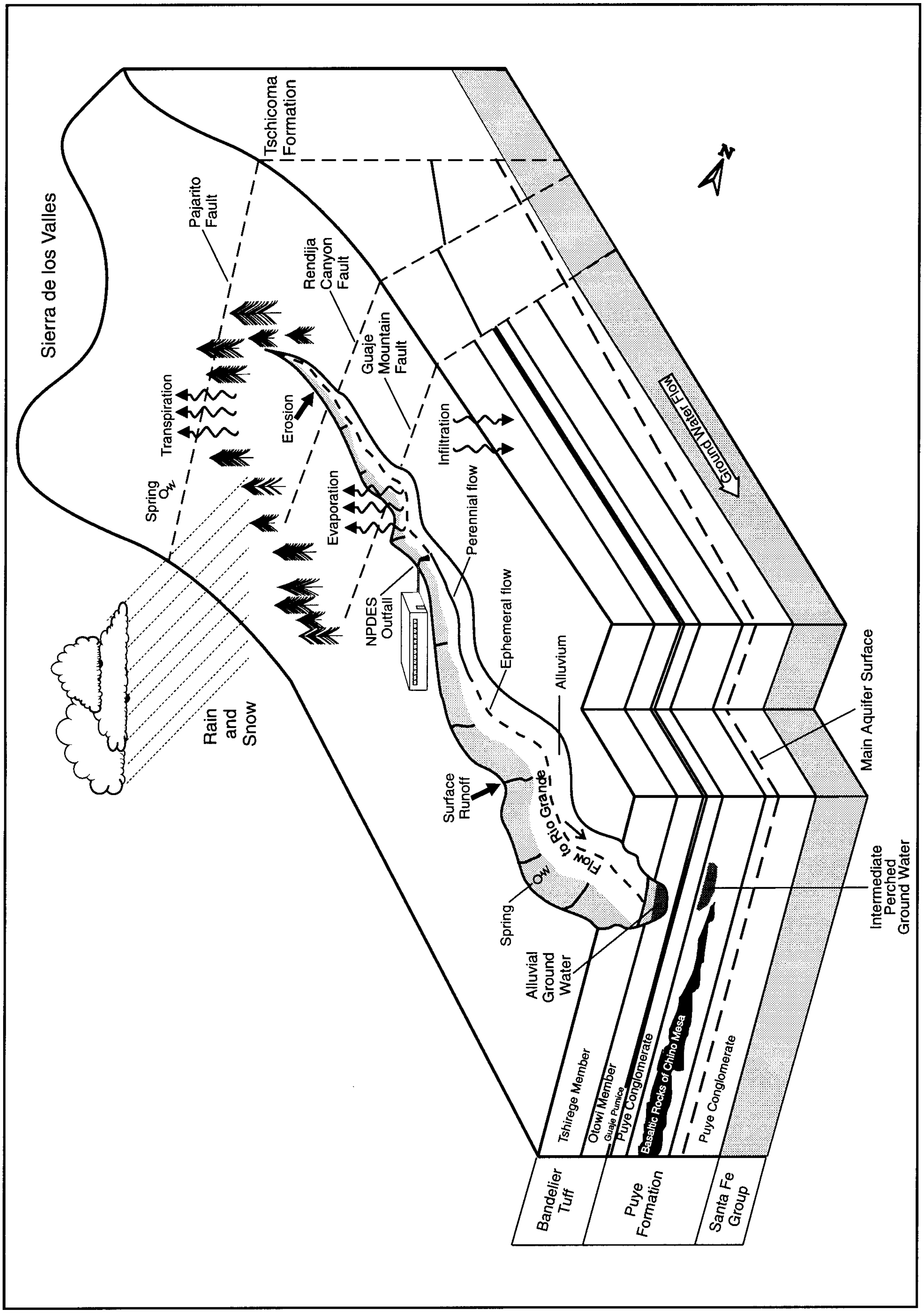


FIGURE 4.3–2.—*Conceptual Geohydrological Drawing of the Pajarito Plateau.*

TABLE 4.3–1.—*Summary of Water Resources and Sampling Locations by Watershed*

		GUAJE	BARRANCAS	BAYO	PUEBLO	LOS ALAMOS	SANDIA	MORTANDAD	CAÑADA DEL BUEY	PAJARITO	POTRILLO	WATER	ANCHO	CHAQUEHUI	FRIJOLES	WHITE ROCK CANYON[a]
LANL Technical Areas Within Watershed			74	74	72, 73, 74	2, 3, 21, 41, 43, 53, 61, 62, 72, 73, 74	3, 5, 53, 60, 61, 72	3, 5, 35, 48, 50, 52, 55, 59, 60, 63	36, 46, 51, 52, 54, 63, 66	3, 6, 8, 9, 14, 15, 18, 22, 36, 40, 46, 48, 50, 51, 54, 55, 58, 59, 62, 63, 64, 66, 67, 69	15, 36, 68, 71	8, 9, 11, 14, 15, 16, 28, 36, 37, 39, 49, 68, 70, 71	39, 49, 70, 33	33		33, 70
1) Surface Water Flow Category		P/E	E	E	P/E[g]	P/E	P/E[g]	P/E[g]	E	P/E	E	P/E	P/E	P/E	P	P
	Number of Gaging Stations	0	0	0	1	3	1	2[f]	2	3	1	4	1	0	0	0
	Days with Flow[b] (10-1-94 to 9-30-95)	NM	NM	NM	365	247	6	83	15	239	3	74	5	NM	NM	NM
	Number of Sampling Locations[c]	1	0	0	4	4	3	2[f]	1	2	0	1	1	0	2	0
	Number of NPDES Outfalls	7	0	0	1	12	11	12	3	17	0	21	2	1	0	0
2) Sediment Sampling Locations[c]		1	0	1	6	12	2	13	5	8	0	10	8	1	2	2
3) Presence of Alluvial Ground Water		unknown	unknown	unknown	yes	yes	unknown	yes	unknown	yes	unknown	unknown	unknown	unknown	unknown	yes
	Number of Wells Sampled[c]	0	0	0	1	7	2	5	6	3	1	4	0	0	0	0
	Number of Springs Sampled[c]	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
4) Presence of Intermediate Ground Water		unknown	unknown	unknown	yes	yes	yes	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
	Number of Wells Sampled[c]	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	Number of Springs Sampled[c]	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5) Presence of Main Aquifer		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	Number of Wells Sampled[c, d]	6[e]	0	0	4	5	2	1	2	1	0	2	1	0	0	0
	Number of Springs Sampled[c]	1	0	0	0	0	1	0	0	2	0	1	1	2	0	20

E = Ephemeral (flow is not continuous throughout the year for the entire reach of the canyon); P = Perennial (flow is continuous throughout the year for the entire reach of the canyon); P/E = Drainage contains both ephemeral and perennial reaches; NM = Not measured
[a] Sampling points located at the confluence of a specific watershed and White Rock Canyon (e.g., Los Alamos and the Rio Grande) are included as part of the specific watershed.
[b] Represents local flow at the stream gage only. Does not represent entire canyon.
[c] Number of samples collected by LANL's Environmental Surveillance and Compliance Program. Other Samples collected by LANL's Environmental Restoration Project are not included here.
[d] The number of main aquifer wells is grouped by watershed for consistency. However, the main aquifer is relatively isolated from recharge from the watersheds. Thus, water quality in the main aquifer wells does not necessarily correlate to surface water quality in watersheds.
[e] Only six of the seven wells in Guaje Canyon are sampled. Well G–3 is off-line and has not been sampled during the evaluation period of the SWEIS.
[f] Gaging station GS–1 in Mortandad Canyon is also a surface water sampling location.
[g] Perennial flow in Pueblo, Sandia, and Mortandad Canyons is strictly the result of effluent discharge. Perennial flow in Los Alamos Canyon is partially the result of effluent discharge.
[h] Perennial flow recorded at GS–E060 in Pueblo Canyon is strictly the result of effluent discharge from the Los Alamos County Sewage Treatment Plant.

river in north-central New Mexico, several times a year in some drainages. Effluents from sanitary sewage, industrial water treatment plants, and cooling-tower blowdown enter some canyons at rates sufficient to maintain surface flows for varying distances. Fifteen watersheds in the LANL region are shown in Figure 4.3.1–1 (watersheds A through O). Only 12 of these watersheds (watersheds B through M in Figure 4.3.1–1), with a total area of 82 square miles (212 square kilometers), pass through the boundary of LANL. All of these watersheds are tributaries to an 11-mile (18-kilometer) segment of the Rio Grande between Otowi Bridge and Frijoles Canyon. The Rio Grande passes through Cochiti Lake, approximately 11 miles (18 kilometers) below Frijoles Canyon. The Los Alamos Reservoir, in upper Los Alamos Canyon, has a capacity of 41 acre-feet (51,000 cubic meters). The reservoir water is used for recreation, swimming, fishing, and landscape irrigation in the Los Alamos townsite (LANL 1996i).

The Pajarito Plateau canyons, which serve as collection points for the regional watersheds, originate either along the eastern rim of the Sierra de Los Valles or on the Pajarito Plateau. Within LANL boundaries, only Los Alamos, Pajarito, Water, Ancho, Sandia, Pueblo, and Chaquehui Canyons contain reaches or streams with sections that have continuous flow. Surface water within LANL boundaries is not a source of municipal, industrial, or irrigation water, but is used by wildlife that live within, or migrate through, the region.

To better understand LANL's influence to surface water in the Los Alamos area, the following surface water sections will first present information on surface water monitoring (section 4.3.1.1) and surface water quality standards (section 4.3.1.2). The text will then focus on the two primary potential sources of contamination to surface water quality: the NPDES-permitted outfalls at LANL (section 4.3.1.3.) and the sediments in the LANL area (section 4.3.1.4). Surface water quality is discussed in section 4.3.1.5, and floodplain information is discussed in section 4.3.1.6.

4.3.1.1 *Surface Water Monitoring*

Surface waters in the region are monitored by LANL and the New Mexico Environment Department (NMED) to survey the environmental effects of LANL operations. LANL's Environmental Surveillance and Compliance Program is one of the ways LANL determines whether its operations are adversely affecting the public health or the environment, and that LANL conforms with applicable regulatory requirements. This program is described in more detail on page 4–1. As a part of this program, surface water samples from off-site and on-site locations are collected (Figures 4.3.1.1–1 and 4.3.1.1–2, respectively) (LANL 1996i); the monitoring results are published annually in Environmental Surveillance and Compliance Reports. There are several locations at which surface water samples are taken; however, which locations are selected for sampling may vary from year to year. Figures 4.3.1.1–1 and 4.3.1.1–2 reflect the locations where surface water samples were collected in 1995 (LANL 1996i). Beginning 1996, some environmental surveillance runoff samples were collected using automated samplers. The samplers are activated when a significant precipitation event causes flow in a drainage crossing LANL's eastern or western boundaries. The 1996 analysis results for the surface water program were consistent with past findings (LANL 1997c). Surface water samples are not collected from Barrancas and Bayo Canyons due to the lack of surface water in these drainages. Surface water samples are analyzed annually for surface water chemistry, radionuclides, and metals. Samples from one-third of the surface water sampling locations are analyzed annually for organics, with the samples from all of the surface water locations being analyzed for organics at least once every three years. Surface water at the Pueblo of San

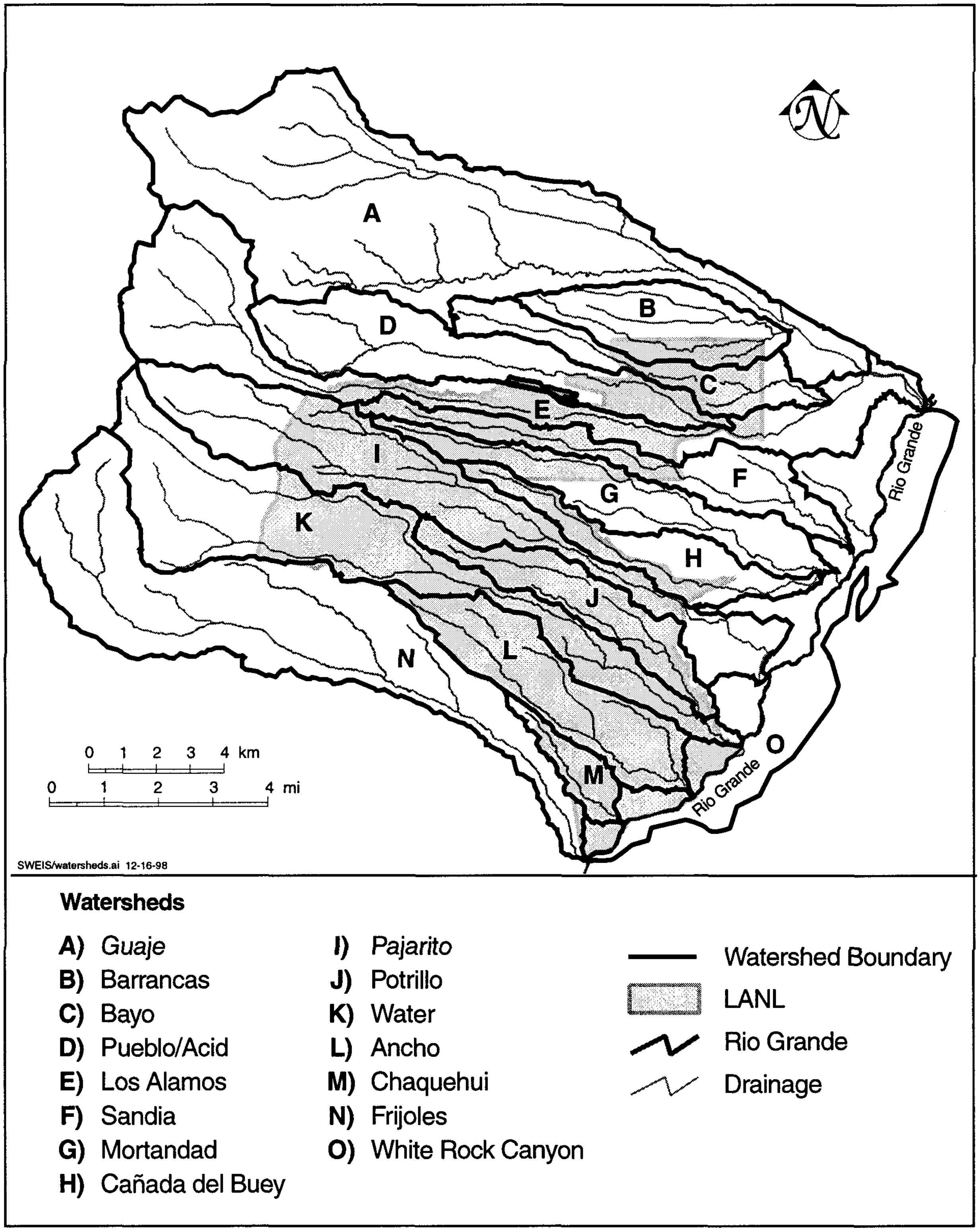


FIGURE 4.3.1–1.—*Watersheds in the LANL Region.*

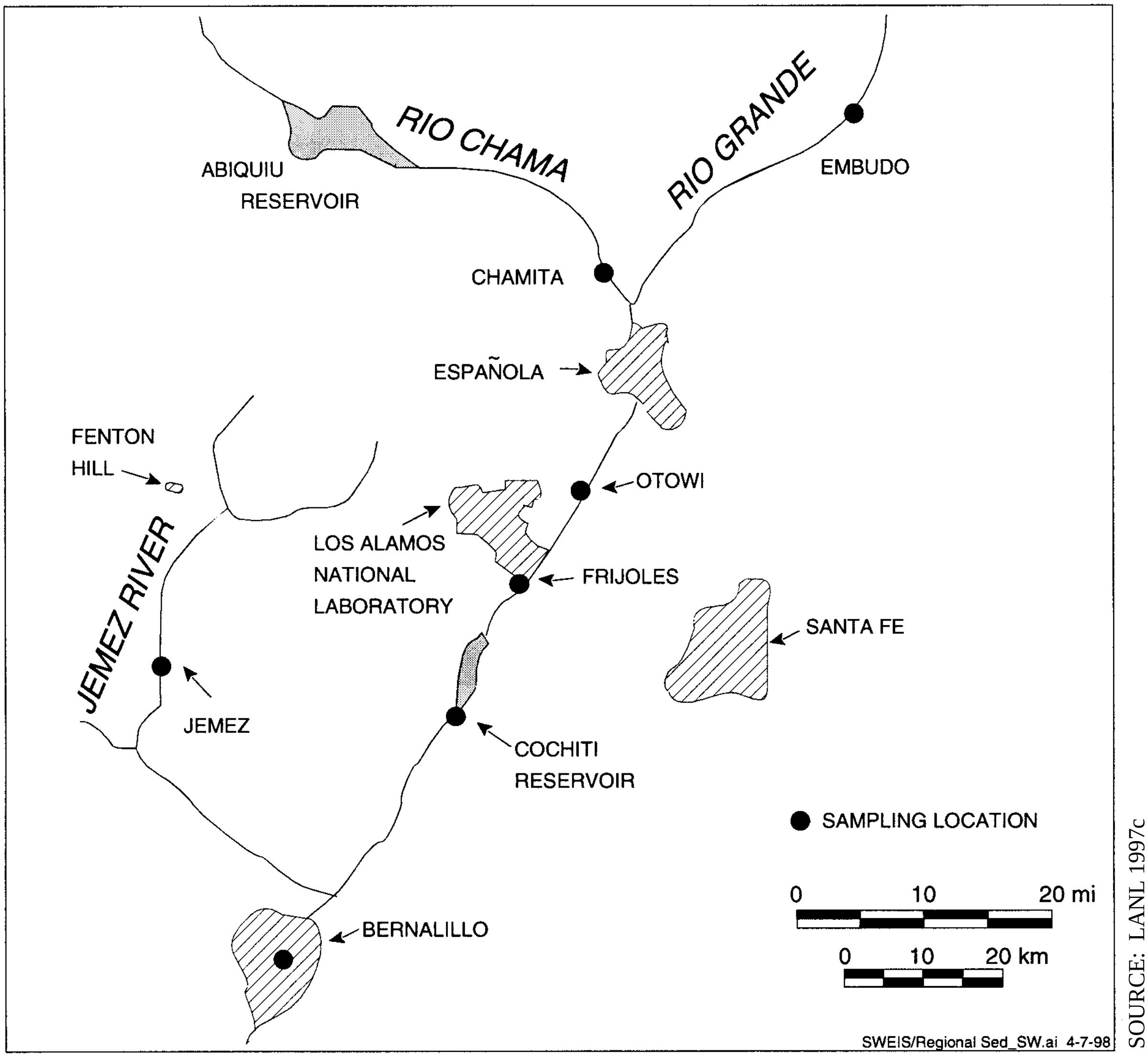
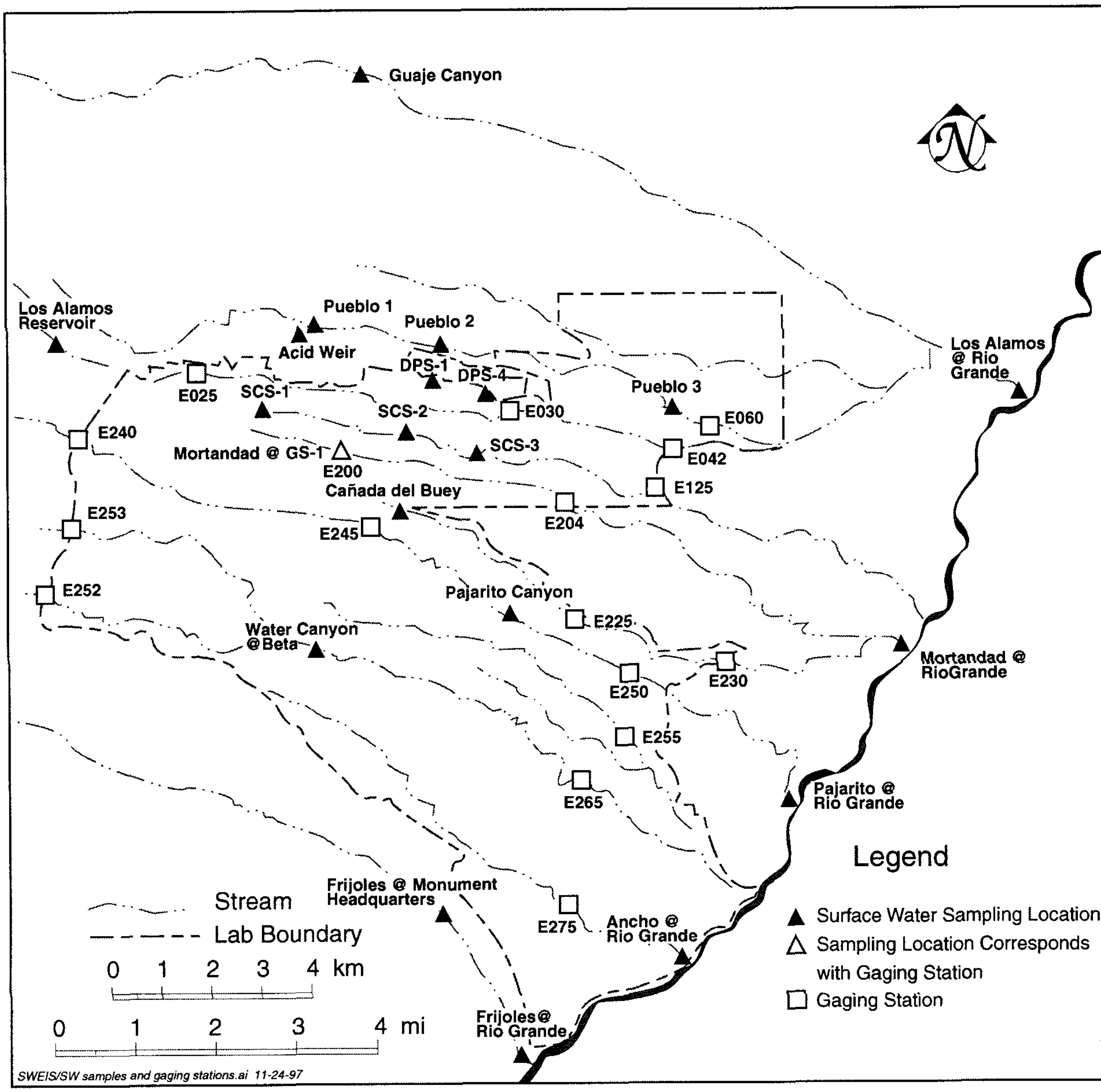


FIGURE 4.3.1.1–1.—*Regional Surface Water and Sediment Sampling Locations.*



SOURCE: LANL 1997c

FIGURE 4.3.1.1–2.—*On-Site and Perimeter Surface Water Sampling Locations.*

Ildefonso is also sampled in accordance with a Memorandum of Understanding (MOU) among the Pueblo, U.S. Bureau of Indian Affairs (BIA), and DOE (BIA 1987). Pueblo of San Ildefonso or U.S. Bureau of Indian Affairs representatives may observe sampling and collect samples from the same surface water locations.

The NMED also collects surface water within the LANL region in accordance with the Agreement in Principle between DOE and the State of New Mexico (DOE 1995e). When LANL collects surface water samples, NMED will often (though not always) take split samples to verify the sampling data. NMED recently performed a comparison of LANL and NMED split-sampling data. The statistical analyses for general water chemistry parameters compared favorably, and for the majority of the samples there was no statistically significant difference between LANL and NMED analytical data (PC 1996f). Only LANL analytical data are presented in this SWEIS. Information is also collected from stream monitoring stations. Table 4.3.1.1–1 provides information (days with flow, volume of water, etc.) for various canyon reaches monitored in 1995. These canyon site locations (gaging stations) are further identified in Figure 4.3.1.1–2.

TABLE 4.3.1.1–1.—*Summary of Discharges from Stream Monitoring Stations at LANL, Water Year 1995 (October 1, 1994 Through September 30, 1995)*

CANYON SITES	DAYS W/ FLOW	TOTAL VOLUME OF WATER		INSTANTANEOUS MAX		COMMENTS
		acre-feet	gallons	ft^3/s	gpm	
E025 Upper Los Alamos	247	465	151,520,715	10	4,488	
E030 Middle Los Alamos	169	492	160,318,692	12	5,386	
E042 Lower Los Alamos[a]	110	328	106,879,128	54	24,235	USGS Operated
E060 Pueblo[a]	365	874	284,810,380	5.8	2,621	USGS Operated
E125 Sandia[a]	6	5	1,629,255	13	5,834	
E204 Lower Mortandad[a]	0	--	--	--	--	
E200 Middle Mortandad	83	18	5,865,318	9.7	4,353	Record began 5/10/95
E225 Upper Cañada del Buey	1	0.4	130,340	17	7,630	
E230 Lower Cañada del Buey[a]	15	14	4,561,914	75	33,660	
E240 Upper Pajarito	239	106	34,540,206	1.9	853	
E245 Middle Pajarito	211	250	81,462,750	24	10,771	
E250 Lower Pajarito[a]	210	30	9,775,530	4.6	2,064	
E255 Potrillo[a]	3	3.5	1,140,479	63	28,274	
E252 Upper Water	74	9.5	3,095,585	0.21	94	
E253 Canyon de Valle	0	--	--	--	--	
E265 Lower Water[a,b]	2	--	--	21	9,425	Gage rating to be established
E275 Ancho[a,b]	5	--	--	--	--	Gage rating to be established

ft^3/s = cubic feet per second, USGS = U.S. Geological Survey
[a] Station at downstream LANL boundary
[b] Daily values table not published this year
gpm = gallons per minute

4.3.1.2 *Surface Water Quality Standards*

Streams within LANL property are nonclassified, and therefore, according to 20 NMAC 6.1, 1105.A, are protected for the uses of livestock watering and wildlife habitat. Most of LANL effluent is discharged into normally dry arroyos (Table 4.3–1), and LANL is required to meet effluent limitations under the NPDES permit program (as discussed in section 4.3.1.3). As discussed in section 4.3.1.1, surface waters from the regional and Pajarito Plateau stations are monitored to evaluate the environmental effects of LANL operations. A study is being performed at LANL to determine if uses in addition to livestock watering and wildlife habitat can be attained for selected reaches on streams present on LANL. The U.S. Fish and Wildlife Service (FWS) is performing the study and will present the results to a Use Selection Committee consisting of NMED, DOE, and University of California members. The results should be available by early 1999.

Concentrations of radionuclides in surface water samples may be compared to either the DOE-Derived Concentration Guide (DCG) for estimation of potential exposure to members of the public from ingested water[2] or the New Mexico Water Quality Control Commission (NMWQCC) stream standards, which reference the New Mexico Health and Environment Department Environmental Improvement Division's New Mexico Radiation Protection Regulations (part 4, appendix A). New Mexico radiation standards are in general two orders of magnitude greater than DOE's DCG for the public (i.e., DCGs are more restrictive than New Mexico standards). Accordingly, only the DCGs will be discussed here. The concentrations of nonradioactive constituents may be compared with NMWQCC Standards for Interstate and Intrastate Streams, Livestock Watering, and Wildlife Habitat Stream Provisions. NMWQCC groundwater standards can also be applied in cases where groundwater discharge may affect stream water quality.

LANL conducts a variety of construction, maintenance, and environmental activities that result in excavation or fill within water courses, which are waters of the U.S. under Section 404 of the *Clean Water Act*. These activities are done pursuant to 404 permits issued by the Army Corps of Engineers and certified per Section 401 by NMED. Each permit is issued pursuant to one or more specific nationwide permits. These include relevant permit conditions to protect water quality and wildlife that must be complied with by LANL and its construction contractors. The NMED also adds conditions as a part of its 401 certification that require application of "best management practices" to ensure compliance with New Mexico stream standards. The following are some examples of currently active 404/401 permits at LANL:

- *LADP3 Culvert Removal Project*— Removal of access road culvert and channel restoration in Los Alamos Canyon
- *Sandia Wetland Restoration Project*— Erosion control, contaminated sediment trapping, and wetland restoration in Sandia Canyon
- *Otowi 1 Well Erosion Control Project*— Arroyo erosion control for well discharge tributary to Pueblo Canyon (PC 1998)

4.3.1.3 *National Pollutant Discharge Elimination System Permitted Outfalls*

Planned releases from industrial and sanitary wastewater facilities within LANL boundaries are controlled by NPDES permits. These permits require routine monitoring of point

2. The DOE-DCG for water is the concentration that would deliver a 100-millirem dose to an adult who ingests 772 quarts (730 liters) of water in 1 year.

source discharges and reporting of results. In 1995, there were 10 NPDES permits: one for effluent discharges from LANL operations; one for effluent discharges at the Fenton Hill Hot Dry Rock Geothermal Facility (now decommissioned) located 20 miles (32 kilometers) west of Los Alamos; and eight for stormwater discharges (LANL 1996i).

An analysis of data was completed for the 87 currently active NPDES industrial outfalls. Index NPDES flows were estimated using data provided by the surface water data team reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Approximately 233 million gallons (882 million liters) per year of effluent are discharged from NPDES outfalls into 10 of the 15 watersheds in the LANL region. There are no LANL NPDES-permitted effluents discharging directly into Barrancas, Bayo, Potrillo, Frijoles, or White Rock Canyon watersheds. The total number of gallons that were discharged into each canyon are presented in Table 4.3.1.3–1. Of the 233 million gallons (882 million liters) per year, the key facilities contributed about 103 million gallons (390 million liters) per year. The non-key facilities contributed about 130 million gallons (492 million liters) per year. Figure 4.3.1.3–1 shows the locations of the NPDES outfalls identified by legend number as listed in Table 4.3.1.3–1 and identifies eliminated outfalls that are discussed in chapter 5. Figure 4.3.1.3–1 also shows areas in the canyons that support perennial flows, ephemeral and intermittent flows, and NPDES effluent-supported flow. The primary sources of outfall effluent and the approximate volume of effluents that are discharged are presented below.

- Treated sanitary wastewater accounts for approximately 13 percent of the discharge volume.
- Treated cooling water and noncontact cooling water account for 50 percent of the discharge volume.
- Photo waste and demineralizer and boiler discharges account for 11 percent of the discharge volume.
- Power plant outfall and high-explosives wastewater account for 26 percent of the discharge volume (Bradford 1996 and Garvey 1997).

The LAC Bayo Wastewater Treatment Plant Facility discharges treated sanitary effluent into Pueblo Canyon. In 1990, the plant increased its sanitary effluent discharge resulting in a nearly continual flow in the lower portions of Pueblo Canyon. This flow extended into the lower, off-site segments of Los Alamos Canyon and onto Pueblo of San Ildefonso land. These flows generally extend to a location between Totavi (just east of the LANL and Pueblo of San Ildefonso boundary) and the confluence of Guaje and Los Alamos Canyons. There is continual flow in this drainage except during the months of June and July (LANL 1995f). The Radioactive Liquid Waste Treatment Facility (RLWTF) discharges treated effluents into Mortandad Canyon at an average rate of 5.51 million gallons (21 million liters) per year. Surface water flow in Mortandad Canyon has not reached the LANL boundary since the RLWTF began operating in 1963 (LANL 1996e). The Los Alamos County Treatment Plant discharges into Cañada del Buey and provides nearly continual flow in the lower portions of Cañada de Buey. Table 4.3.1.3–1 does not include the Los Alamos County treatment plants that flow into Pueblo Canyon and Cañada de Buey because they are not owned and operated by LANL. Their locations, however, are shown on Figure 4.3.1.3–1. Cooling tower water from the power plant and treated effluents from the sanitary wastewater systems consolidation (SWSC) treatment plant in TA–46 are discharged into Sandia Canyon at outfall 01A-001. These effluents support a continuous flow in a short segment of upper Sandia Canyon. During summer thunderstorms, stream flow in this canyon reaches the LANL boundary

TABLE 4.3.1.3–1.—*NPDES Outfalls by Watershed*[a]

WATER-SHED	OUTFALL[b]	LEGEND[c]	FACILITY[d]	TA[e]	BUILDINGS	DESCRIPTION[h]	FLOW (MGY)[f]
Ancho	04A-141*	85	HE Testing	39	69	Light Gas Gun Fac.	0.03
	04A-156*	86	HE Testing	39	89	Gas Gun Shop	0.09
	Sum					2 Outfalls	0.1
Cañada del Buey	03A-042	44	S&T	46	01	Laboratory	5.30
	04A-118	46	S&T	54	1013	Pajarito #4 Well	1.10
	04A-166	43	S&T	05	26	Pajarito #5 Well	0.01
	Sum					3 Outfalls	6.4
Chaquehui	03A-038	87	S&T	33	114	Support Bldg.	5.80
	Sum					1 Outfall	5.8
Guaje	04A-171	07	S&T	NF	01	Guaje #1 Well	0.00
	04A-172	06	S&T	NF	01A	Guaje #1A Well	0.00
	04A-173	05	S&T	NF	02	Guaje #2 Well	0.00
	04A-174	04	S&T	NF	04	Guaje #4 Well	0.00
	04A-175	02	S&T	NF	05	Guaje #5 Well	0.00
	04A-176	01	S&T	NF	06	Guaje #6 Well	0.66
	04A-177	03	S&T	NF	B1	Guaje Booster #1 Well	0.06
	Sum					7 Outfalls	0.7
Los Alamos	02A-129*	11	Tritium	21	155N,357	Steam Plant	0.11
	03A-034	13	S&T	21	166	Equipment Bldg.	0.26
	03A-035	10	S&T	21	210	Research Bldg.	0.04
	03A-036*	12	Tritium	21	152, 155, 155N, 220	Laboratory, TSTA, C-Tower	0.02
	03A-040*	08	HRL	43	01	HRL	2.70
	03A-047*	18	LANSCE	53	60	Linac C-Tower	2.64
	03A-048*	19	LANSCE	53	62	Linac C-Tower	8.56
	03A-049*	20	LANSCE	53	64	Linac C-Tower	4.15
	03A-158*	14	Tritium	21	209	TSFF	0.22
	04A-182	09	S&T	21	1003	Backflow Preventer	0.00
	04A-186	16	S&T	21	452	Otowi #4 Well	0.18
	05S(STP)*	15	Tritium	21	227	Sewage treatment	0.77
	Sum					12 Outfalls	19.7

TABLE 4.3.1.3–1.—*NPDES Outfalls by Watershed*[a]-Continued

WATER-SHED	OUTFALL[b]	LEGEND[c]	FACILITY[d]	TA[e]	BUILDINGS	DESCRIPTION[h]	FLOW (MGY)[f]
Mortandad	03A-021*	31	CMR	03	29	CMR	0.53
	03A-022*	32	Sigma	03	66,127,141	Sigma Complex	4.40
	03A-045*	37	Radiochemistry	48	01	RC-1	1.10
	03A-160	41	S&T	35	124	Antares Target Hall	5.10
	03A-181*	38	Plutonium	55	06	Utility Bldg.	14.00
	04A-016*	34	Radiochemistry	48	01	RC-1	6.30
	04A-127*	40	TFF	35	213	TFF	2.00
	04A-131*	33	Radiochemistry	48	01	RC-1	0.95
	04A-152*	36	Radiochemistry	48	28	RC-1	4.00
	04A-153*	35	Radiochemistry	48	01	RC-1	3.20
	06A-132	42	S&T	35	87	Laboratory	5.80
	EPA051*	39	RLWTF	50	01	RLWTF	5.51
	Sum					12 Outfalls	52.9
Pajarito	03A-025	47	S&T	03	208	Equipment Bldg.	0.18
	04A-101*	58	HE Testing	40	09	Firing Site	0.05
	04A-115*	49	HE Processing	08	70	NDT Facility	0.53
	04A-143*	61	HE Testing	15	306	Hydrotest Bldg.	0.02
	04A-164	63	S&T	18	252	Pajarito #2 Well	0.01
	05A-066*	53	HE Processing	09	A,21,28	Lab., Shop	4.36
	05A-067*	51	HE Processing	09	B,41,42	Laboratory	0.33
	05A-068*	52	HE Processing	09	48	Machining Bldg.	1.16
	06A-074*	48	HE Processing	08	22	X-ray Bldg.	0.25
	06A-075*	50	HE Processing	08	21	Laboratory	1.00
	06A-079*	54	HE Testing	40	04	Firing Site	0.54
	06A-080*	55	HE Testing	40	05	Firing Site	0.03
	06A-081*	56	HE Testing	40	08	Firing Site	0.03
	06A-082*	59	HE Testing	40	12	Prep. Room	0.03
	06A-099*	57	HE Testing	40	23	Laboratory	0.03
	06A-100*	60	HE Testing	40	15	Firing Site	0.04
	06A-106	62	S&T	36	01	Laboratory	0.58
	Sum					17 Outfalls	9.2
Pueblo	04A-161	17	S&T	72	01	Otowi #1 Well	1.00
	Sum					1 Outfall	1.0

TABLE 4.3.1.3–1.—*NPDES Outfalls by Watershed*[a]-Continued

WATER-SHED	OUTFALL[b]	LEGEND[c]	FACILITY[d]	TA[e]	BUILDINGS	DESCRIPTION[h]	FLOW (MGY)[f]
Sandia	01A-001[7]	27	S&T	03	22	Power Plant	77.9
	03A-024*	30	Sigma	03	35,187	Press Bldg./ C. Tower	2.90
	03A-027	28	S&T	03	285	Cooling Tower	5.80
	03A-113*	21	LANSCE	53	293,294,1032	LEDA C-Towers	0.90
	03A-125*	23	LANSCE	53	28	Proton Storage Ring	0.18
	03A-145*	22	LANSCE	53	06	Orange Box Offices	0.37
	03A-148	26	S&T	03	1498	Data Center	6.30
	04A-094	29	S&T	03	170	Gas Facility	5.30
	04A-163	25	S&T	72	04	Pajarito #1 Well	6.20
	04A-165	24	S&T	72	07	Pajarito #3 Well	2.00
	Sum					11 Outfalls[g]	107.9
Water	02A-007*	64	HE Processing	16	540	Steam Plant	10.50
	03A-028*	72	HE Testing	15	184,185,202	Cooling Tower	2.20
	03A-130*	81	HE Processing	11	30	Laboratory	0.04
	03A-185*	70	HE Testing	15	184,202	Cooling Tower	0.73
	04A-070*	65	HE Processing	16	220	X-ray Bldg.	0.22
	04A-083*	73	HE Processing	16	202	Shops	0.20
	04A-091*	76	Tritium	16	450	Process Bldg.	0.22
	04A-092*	80	HE Processing	16	370	Metal Forming	1.57
	04A-139*	71	HE Testing	15	184	PHERMEX	0.00
	04A-157*	75	HE Processing	16	460	Laboratory	7.31
	05A-053*	79	HE Processing	16	410	Assay Bldg.	0.12
	05A-054*	68	HE Processing	16	340	HE Synthesis	3.57
	05A-055*	78	HE Processing	16	401,406	Pressure Tanks	0.04
	05A-056*	67	HE Processing	16	260	Process Bldg.	2.53
	05A-069*	82	HE Processing	11	50	Drop Tower Sump	0.01
	05A-071*	77	HE Processing	16	430	HE Pressing	0.04
	05A-072*	74	HE Processing	16	460	Laboratory	0.02
	05A-096*	83	HE Processing	11	51	Drop Tower Sump	0.01
	05A-097*	84	HE Processing	11	52	Drop Tower Sump	0.01
	06A-073*	66	HE Processing	16	222	Dark Room	0.08
	06A-123*	69	HE Testing	15	183	Laboratory	0.13
	Sum					21 Outfalls	29.5

TABLE 4.3.1.3–1.—*NPDES Outfalls by Watershed*[a]-Continued

WATER-SHED	OUTFALL[b]	LEGEND[c]	FACILITY[d]	TA[e]	BUILDINGS	DESCRIPTION[h]	FLOW (MGY)[f]
Grand Totals	10 Watersheds					87 Outfalls	233

[a] Index NPDES flows were estimated using data provided by the surface water data team reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997).
[b] * Indicates a key facility
[c] Legend numbers correspond to NPDES locations shown in Figure 4.3.1.3–1.
[d] HE = High Explosives, S&T = Science and Technology, HRL = Health Research Laboratory, LANSCE = Los Alamos Neutron Science Center, CMR = Chemistry and Metallurgy Research, TFF = Target Fabrication Facility
[e] NF = National Forest.
[f] Watershed totals have been rounded to one decimal place, and grand total to two. MGY = million gallons per year
[g] All effluent from the TA–46 Sanitary Wastewater Systems Consolidation (SWSC) Facility is pumped to a re-use tank adjacent to the TA–3 Power Plant. When the Power Plant is in operation, water is drawn from the tank as make-up for the power plant cooling towers, where it is either lost to the air through evaporation or discharged to Sandia Canyon via the power plant outfall 01A-001. Of the total 77.9 million gallons per year (MGY) flow for outfall 01A-001, approximately 29 MGY are contributed by SWSC as make-up water. Outfall 135 is located at the TA–46 SWSC facility but is not used. Outfall 13S, although not listed in table, is added to the number of outfalls, making a total of 11 outfalls in Sandia Canyon.
[h] NDT = Nondestructive Testing

SOURCE: Stoker 1993

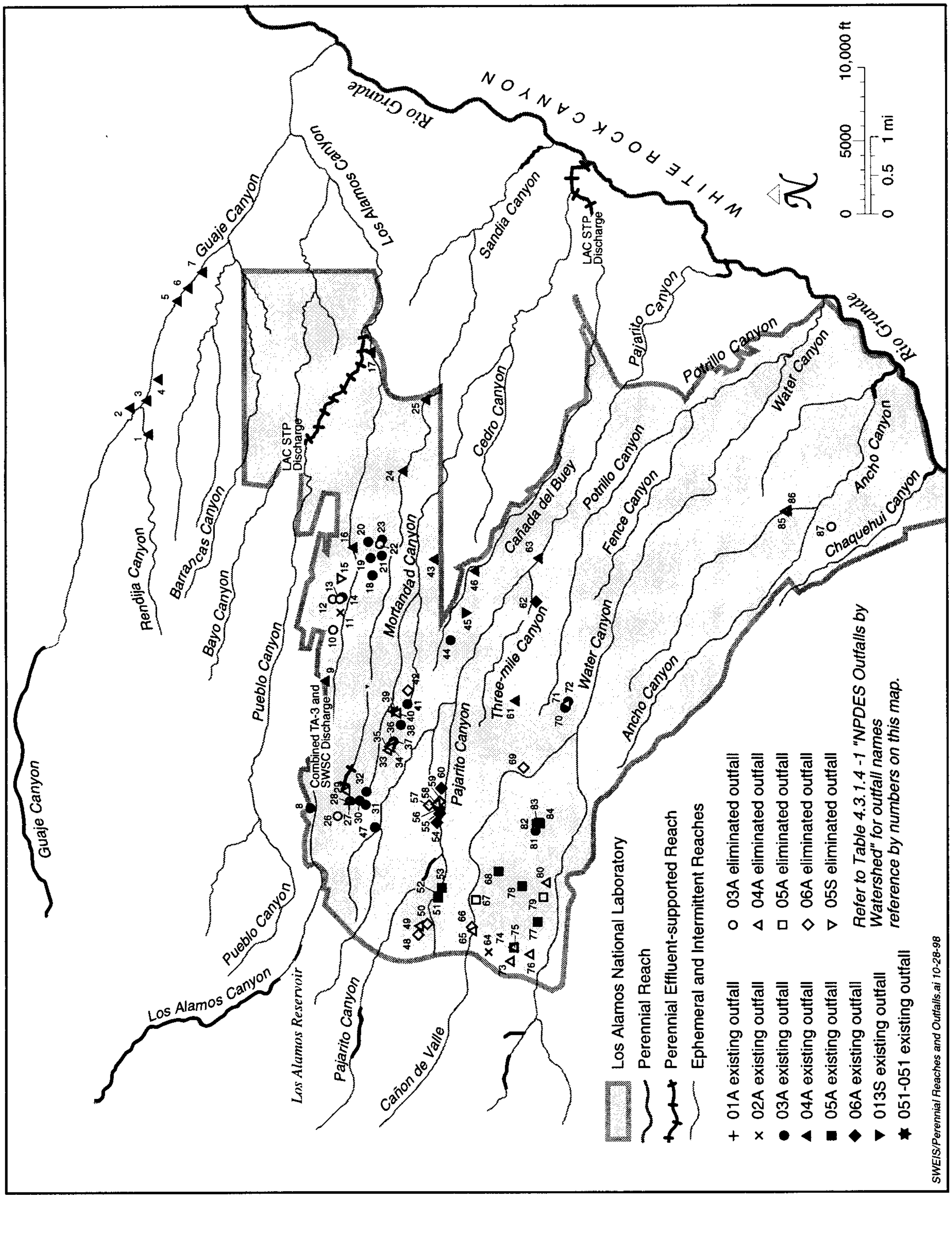


FIGURE 4.3.1.3–1.—*Stream Reaches and NPDES Outfall Locations.*

at NM 4; and during periods of heavy thunderstorms or snowmelt, the surface water flow extends beyond LANL boundaries and reaches the Rio Grande (LANL 1996e).

National Pollutant Discharge Elimination System Regulatory Compliance

The goal of the *Clean Water Act* is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The regulations specify water quality standards and effluent limitations. To comply with the *Clean Water Act*, LANL has two primary programs: the NPDES permit program and the Spill Prevention Control and Countermeasure Program. The University of California (UC) and DOE are co-operators on a site-wide NPDES permit covering the industrial and sanitary effluent discharges at Los Alamos. The permits are issued and enforced by EPA Region 6 in Dallas, Texas. However, NMED performs some compliance evaluation inspections and monitoring for EPA through a water quality grant issued under Section 106 of the act. The NPDES permits specify the parameters measured and the sampling frequency for the outfalls. The LANL NPDES industrial outfalls are identified by numbers and by types of industrial outfalls. Table 4.3.1.3–2 provides information on the industrial NPDES outfalls by number-type and NPDES permit limits. The NPDES numbers presented in Table 4.3.1.3–2 correspond to the first three numbers and/or characters identified for each outfall presented in Table 4.3.1.3–1. Concentrations limits are indicative of the overall quality of effluent discharges. Sampling frequency is dependent on the type of discharge and varies from once a week to annually. The chemical and biological constituents measured in outfall effluent samples and sampling results are presented in LANL's annual Environmental Surveillance and Compliance Reports. In 1995, effluent limits for the sanitary waste facilities were not exceeded. Analyses of 1,751 industrial outfall samples indicate that the NPDES permit limits for industrial outfalls were exceeded 21 times during 1995 (LANL 1996i). Table 4.3.1.3–3 presents information on the number of NPDES violations from 1991 through 1995. NPDES industrial discharge water quality data over the 24-month period of August 1994 (when the most recent NPDES permit and its new discharge limits became effective) through July 1996 is presented in summary NPDES water quality data tables in volume III, appendix C (Table C–1). Examples of types of exceedances are described later on in this section.

During the early 1990's, LANL was listed as a "Significant Non-Compliant Federal Facility" by EPA Region 6 for NPDES violations. DOE and LANL have had several Federal Facility Compliance Agreements and parallel administrative orders in effect to correct NPDES deficiencies. The current DOE compliance agreement (Docket No. VI-96-1237, December 12, 1996) (EPA 1996c) and the current LANL administrative order (AO Docket No. VI-96-1236, December 10, 1996) (EPA 1996b) include schedules for coming into full compliance with the *Clean Water Act* by completing the High Explosives Wastewater Treatment Facility and Waste Stream Characterization projects. These corrective actions required by compliance agreement and administrative order are continuing.

Examples of the materials that have been involved in NPDES exceedances at outfalls include arsenic, chlorine, total suspended solids, acidity, chemical oxygen demand (COD), biochemical/biological oxygen demand (BOD), cyanide, vanadium, copper, iron, oil and grease, silver, phosphorus, and radium. In 1995, most of the industrial outfall exceedances were for chlorine and arsenic; the NPDES permit for chlorine was exceeded four times, with the largest exceedance of 9.2 milligrams per liter as compared to the permit limit of 0.5 milligrams per liter for the daily maximum. The permitted levels for arsenic were exceeded nine times with the largest exceedance of 0.211 milligrams per liter as compared to the permit limit of

TABLE 4.3.1.3–2.—*LANL NPDES Discharge Limits (Daily Average/Daily Maximum)*

NPDES CHARACTERISTIC		POWER PLANT	DEMINERALIZED AND BOILER BLOWDOWN	COOLING TOWER BLOWDOWN	NONCONTACT COOLING WATER	HE WATER DISCHARGE	PHOTO WASTE	ASPHALT PLANT	RLWTF	SEWAGE	SEWAGE
NPDES NO.		**001**	**02A**	**03A**	**04A**	**05A**	**06A**	**07A**	**051**	**05S**	**13S**
PART I LIMITS											
Flow	MGD	*	*	*	*	*	*	*	*	*	*
TSS	mg/l	30/100	30/100	30/100	—	30/45	—	100/100	—	30/45	30/45
BOD	mg/l	—	—	—	—	—	—	—	—	30/45	30/45
COD	mg/l	—	—	—	—	125/125	—	125/125	125/125	125/125	—
O&G	mg/l	—	—	—	—	15/15	—	15/15	—	—	—
Fecal Coliform	(#/100 ml)	—	—	—	—	—	—	—	—	500/500	500/500
Ammonia (as N)	mg/l	—	—	—	—	—	—	—	*	—	—
Free Chlorine	mg/l	0.2/0.5	—	0.2/0.5	—	—	—	—	—	—	—
Residual Chlorine	mg/l	—	—	—	*	—	—	—	—	—	—
Iron	mg/l	—	10/40	—	—	—	—	—	—	—	—
Nickel	mg/l	—	—	—	—	—	—	—	*	—	—
Nitrate/Nitrite (as N)	mg/l	—	—	—	—	—	—	—	*	—	—
Nitrogen	mg/l	—	—	—	—	—	—	—	*	—	—
Phosphorous	mg/l	—	20/40	20/40	—	—	—	—	—	—	—
Silver	mg/l	—	—	—	—	—	0.5/1.0	—	—	—	—
Sulfite	mg/l	—	35/70	—	—	—	—	—	—	—	—
Toxic Organics	mg/l	—	—	—	—	—	—	—	1.0/1.0	—	—
PART II LIMITS											
Aluminum	mg/l	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0
Arsenic	mg/l	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04	0.04/0.04
Boron	mg/l	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0	5.0/5.0
Cadmium	mg/l	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2

TABLE 4.3.1.3–2.—*LANL NPDES Discharge Limits (Daily Average/Daily Maximum)*-Continued

NPDES CHARACTERISTIC		POWER PLANT	DEMINERALIZED AND BOILER BLOWDOWN	COOLING TOWER BLOWDOWN	NONCONTACT COOLING WATER	HE WATER DISCHARGE	PHOTO WASTE	ASPHALT PLANT	RLWTF	SEWAGE	SEWAGE
NPDES NO.		**001**	**02A**	**03A**	**04A**	**05A**	**06A**	**07A**	**051**	**05S**	**13S**
Chromium	mg/l	5.1/5.1	**1.0/1.0**	5.1/5.1	5.1/5.1	5.1/5.1	5.1/5.1	5.1/5.1	5.1/5.1	5.1/5.1	5.1/5.1
Cobalt	mg/l	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0
Copper	mg/l	1.6/1.6	**1.0/1.0**	1.6/1.6	1.6/1.6	1.6/1.6	1.6/1.6	1.6/1.6	1.6/1.6	1.6/1.6	1.6/1.6
Lead	mg/l	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4
Mercury	mg/l	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01	0.01/0.01
Selenium	mg/l	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05	0.05/0.05
Vanadium	mg/l	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1	0.1/0.1
Zinc	mg/l	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4	95.4/95.4
Radium-226, Radium-228	pCi/l	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0	30.0/30.0
Tritium	µCi/l	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3	3/3

* = Report only
— = No limit specified

001—Power plant discharge (Outfall 001)
02A—Neutralized demineralizer regeneration brine and boiler blowdown
03A—Cooling tower blowdown, evaporative coolers, chillers, condensers, and air washer blowdown
04A—Noncontact cooling water, nondestructive testing discharge, and water production facilities
05A—High explosives waste discharges
06A—Photo waste discharges
07A—Asphalt batch plants nonprocess wastewater (scrubber air wash)
051—RLWTF discharge
05S—Treated sanitary sewage effluent (Outfall 05S)
13S—Treated sanitary sewage effluent (Outfall 13S)
Other notes are as follows: TSS = total suspended solids; BOD = biological oxygen demand; COD = chemical oxygen demand; O&G = oil and grease; MGD = million gallons per day; mg/l = milligrams per liter; ml = milliliter; pCi/l = picocuries per liter; µCi/l = microcures per liter
Limits are set forth as "Daily Average/Daily Maximum."

TABLE 4.3.1.3–3.—*Number of NPDES Violations (1991 Through 1995)*[a,b]

YEAR	SANITARY OUTFALLS			INDUSTRIAL OUTFALLS		
	SAMPLES	VIOLATIONS	% VIOLATIONS	SAMPLES	VIOLATIONS	% VIOLATIONS
1991	297	3	1.0%	1,799	21	1.2%
1992	266	1	0.4%	2,028	20	1.0%
1993	147	0	0.0%	2,120	19	0.9%
1994	154	0	0.0%	2,045	28	1.4%
1995	166	0	0.0%	1,751	21	1.3%
Totals	1,030	4	0.4%	9,743	109	1.1%

[a] When summarizing LANL environmental programs, NPDES outfalls are grouped as either “domestic waste,” which is sewage, or as “industrial waste,” which is all other NPDES discharges (noncontact cooling water, power plant discharges, cooling tower blowdown, photo rinse waters, etc.). Compliance with LANL’s NPDES Permit (NM0028355) is then reported as “number of violations for a year” versus “number of NPDES samples collected.”
[b] Information as to which quality limits were exceeded can be found in the annual Los Alamos surveillance reports.

0.04 milligrams per liter for the daily maximum. Actions to improve compliance with permit conditions are continually being taken including, elimination of outfalls, improvements and corrective actions at specific outfalls, and implementation of the Waste Stream Characterization Program and Corrections Project (see also chapter 7, section 7.5).

Radioactive liquid effluent discharges are regulated by DOE Order 5400.5. One NPDES permitted outfall at TA–50, the RLWTF, began operations in 1963. This outfall had continued to discharge residual radionuclides to Mortandad Canyon in liquid effluents to the present time. DOE Order 5400.5 specifies DCGs for liquid radioactive effluents, which provide a reference for determining dose to various exposure pathways. For liquid radioactive effluents, the “as low as reasonably achievable” (ALARA) and the “best available technology” (BAT) processes are adopted to determine the appropriate level of treatment. If discharges are below DCG reference values at the point of discharge to a surface waterway, generally no further treatment is required due to cost/benefit considerations. Historic discharges to Mortandad Canyon have resulted in above background residual radionuclide concentrations in alluvial groundwater and sediments. For calendar year 1996, two DCGs were exceeded in TA–50 effluents (for americium-241 and plutonium-238). The TA–50 discharge also contains nitrates that have caused the alluvial groundwater to exceed the state groundwater standard of 10 milligrams per liter. LANL is working to continue to upgrade the treatment process at TA–50 to correct these problems. A treatment system will be operational by early 1999 that will reduce concentrations of americium-241, cesium-137, plutonium-238, plutonium-239, and strontium-90 and will result in concentrations of these radionuclides in effluent that will meet the DOE-DCG for the public. A treatment system to comply with nitrate levels within the new groundwater discharge limits established by NMED will be operational by mid 1999. Tritium concentrations, which are well below the DOE-DCG, will not be reduced by the new treatment system. There is currently no practical treatment technology for tritium for the dilute concentrations present in the RLWTF effluent. Investigation and cleanup, if required, are conducted through the ER Project, and interim controls (sediment traps) have been implemented to control movement of contaminants off the site.

Stormwater Effluents

In 1995, there were eight NPDES General Permits for LANL stormwater discharges (LANL 1996i): one permit is for LANL industrial activities; one permit is for the remediation of an environmental restoration site off of DOE property; and the other six permits are for construction activities disturbing more than 5 acres (2 hectares). As conditions of the General Permit, UC must develop and implement Stormwater Pollution Prevention Plans (SWPPs) and conduct monitoring activities (LANL 1996i). In 1993, 76 industrial facilities were identified that required SWPPs. There were 14 SWPPs developed and implemented in 1994 to cover these 76 facilities. In addition, several individual SWPPS were developed to address specific solid waste management units (SWMUs) and PRSs. LANL plans in 1999 to consolidate all the SWPPs into approximately 24 plans that will address all the 76 industrial facilities, as well as all the SWMUs.

UC monitors stormwater at TA–54, Areas G and J, and TA–50 as a requirement of the LANL NPDES general stormwater permit. Twenty-nine locations in 8 watersheds were sampled a total of 55 times between August 1991 and August 1995.

The largest amount of monitoring occurs in the Pajarito Canyon watershed where the stormwater from TA–54 drains. It is difficult to obtain stormwater samples repeatedly from the same location due to the inherently sporadic nature of stormwater. Therefore, it is difficult to identify trends in the stormwater quality or to perform confirmatory analyses. This problem should be corrected in the future by using U.S. Geological Survey (USGS) stream gage stations as consistent monitoring points and increasing the number of overall stormwater samples that are collected (PC 1997c). Also beginning 1996, environmental surveillance runoff samples were collected using automated samplers. The samplers are actuated when a significant precipitation event causes flow in a drainage crossing LANL boundaries.

4.3.1.4 *Sediments*

Sediments occur along most segments of LANL canyons as narrow bands of canyon-bottom deposits that can be transported by surface water during runoff events or by LANL outfall effluent flows. The 12 watersheds that cross LANL boundaries are watersheds B through M (Figure 4.3.1–1) and vary in their drainage area, peak flow volumes, and sediment-carrying capacity. Nearly every on-site LANL drainage has historically received LANL liquid industrial or sanitary effluents that contribute to the flow and water quality characteristics in the drainage area. As LANL effluents move downstream, some of the metals and radionuclides from LANL outfalls bind (or adsorb) to the sediments.

Sediment Monitoring

Samples of sediment are collected in the LANL region for DOE and NMED to monitor the environmental effects of LANL operations and activities on the environment. Sediment samples are analyzed for the presence of radionuclides, metals, and organics as a part of the LANL Environmental Surveillance and Compliance Program (described on page 4–1) (DOE Order 5400.1). Sediment samples are collected from off-site (regional and perimeter) and on-site locations (Figures 4.3.1.1–1 and 4.3.1.4–1). The locations at which sediment samples are collected may vary from year to year. Figure 4.3.1.4–1 shows locations where sediment samples were collected in 1995. Sediment samples are also collected at the Pueblo of San Ildefonso. Representatives of the Pueblo of San Ildefonso or U.S. Bureau of Indian Affairs may monitor or collect splits when LANL sediment samples are collected. NMED recently performed comparisons of LANL and NMED sediment and soil data. The statistical analysis of soils and sediments, which

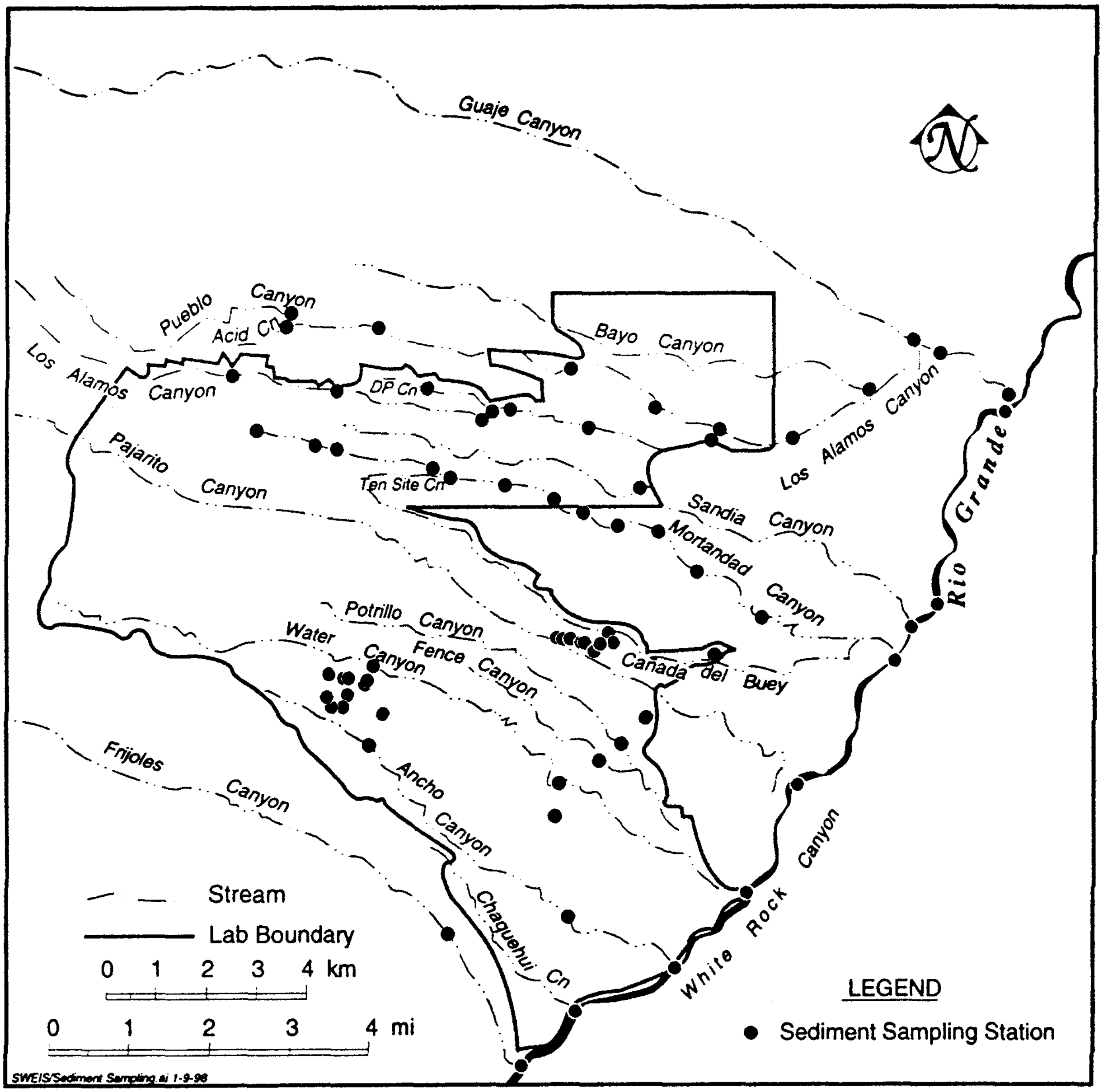


FIGURE 4.3.1.4–1.—*On-Site and Off-Site Perimeter Sediment Sampling Locations.*
(**Note:** Perimeter stations are located within 2.5 miles [4 kilometers] of LANL.)

included radionuclides (i.e., plutonium, uranium, cesium, gross alpha) and metals (i.e., lead, beryllium, arsenic), compared favorably, and for the majority of samples there was no statistically significant difference (PC 1997g).

Sediment Quality

Sediments in the LANL region naturally contain minerals and metals, and may also contain radionuclides from worldwide fallout. Nuclear weapon atmospheric testing (Klement 1965) and the re-entry and burn-up of satellites (Perkins and Thomas 1980) containing plutonium power sources have resulted in worldwide fallout of strontium-90; cesium-137; and plutonium-238, -239, and -240. Therefore, these radionuclides can be found in sediments in very small but measurable concentrations.

There are no standards for radionuclides or metals in sediments; therefore, regional comparison levels were developed for the purposes of the SWEIS. These comparison levels were established by taking the average of 1990 to 1994 existing data for the following six stations: Chamita, Embudo, Otowi, Los Alamos Reservoir, Jemez, and Bernalillo (Figure 4.3.1.1–1). These locations were selected to provide a broad overall coverage for comparison purposes in the LANL region. These values may differ from background values used in various remedial action cleanups. Background values used for remedial action cleanup are based on the local geologic formation in the area being remediated. Because the SWEIS covers a very large area, these six locations were used instead and are within the accuracy necessary for providing relative useful information for the SWEIS.

Sediment samples from individual LANL locations are analyzed every 3 years for organic contaminants (PC 1996h). It should be noted that sediment samples were not collected from the Barrancas watershed from 1990 through 1994, and there are no sediment sampling data for organics for 1991 and 1992 (LANL 1993b and LANL 1994b). In 1993 LANL's Environmental Surveillance and Compliance Program started analyzing sediments for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Starting in 1995, selected sediment samples were also analyzed for high explosives (HE) residues. In 1996, sediment samples were analyzed for VOCs, SVOCs, PCBs, and HE residues from about one-sixth of the regional and local stations (approximately 75 stations). The analytical results showed that there were no VOC, SVOC, PCBs or HE residues detected in any of the sediment samples collected during 1996 (LANL 1997c). Details on contaminants in sediments can be found in the annual LANL Environmental Surveillance and Compliance Reports. Summary sediment data tables derived from the 1991 to 1996 LANL Environmental Surveillance and Compliance Reports are presented in volume III, appendix C (Tables C–4 and C–5). To provide a general understanding of the contaminants in sediments, additional information is presented below.

- Samples from all sediment sampling locations for the period 1990 to 1994 exceeded the regional comparison value for at least one metal. Most of the metals that were above the regional comparison value occur naturally in the environment as a constituent of the sediments. The exception may be a 1994 sediment sample from Los Alamos Canyon, which contained 68 milligrams per gram selenium. The regional comparison value for selenium is 0.2 micrograms per gram. The source of this contaminant is unknown (LANL 1996e).
- The regional comparison levels for at least one radionuclide were exceeded at nearly all sediment sampling locations in the sediment monitoring network for the period 1990 to 1994. Plutonium-239 and -240 (regional comparison level of 0.003 picocuries per gram) have been

detected in sediments at 11.8 picocuries per gram in Acid Canyon, at 9.71 picocuries per gram in Pueblo Canyon, and at 0.329 picocuries per gram in Los Alamos Canyon). The source of this contamination is believed to be historic releases from LANL operations that occurred in Acid Canyon (a tributary to Pueblo Canyon) from 1945 to 1952. Natural stream processes have moved the contaminated materials out of Acid Canyon, down through Pueblo Canyon, and into lower Los Alamos Canyon to the Rio Grande (Graf 1995). This natural pathway crosses down-slope of San Ildefonso lands and meets the Rio Grande down-gradient from a nearby San Ildefonso well field.

Values of plutonium-239 and -240 at monitoring stations downstream at TA–50 and upstream of the sediment traps in Mortandad Canyon are above regional comparison levels. However, values of plutonium at monitoring stations downstream of the sediment traps and upstream of the Pueblo of San Ildefonso boundary are at or near atmospheric fallout levels. These results suggest that there has been little or no transport of plutonium from TA–50 below the sediment traps in Mortandad Canyon (LANL 1997c).

The distribution of plutonium-contaminated sediments is a result of several factors that control the ability of the stream to trap sediments. These factors include stream gradient, canyon width, the presence or lack of boulders, and vegetation. The locations, amounts, and likely sources of plutonium (in picocuries) that are found in the sediments of the Los Alamos region are illustrated in Figure 4.3.1.4–2.

Off-Site Sediment Sampling

A study that evaluated the deposition of plutonium in sediments in the northern portion of the Rio Grande estimated LANL contribution to the contamination (Graf 1993). The study found that, when averaged over several decades, 90 percent of the plutonium in the sediment moving into the northern Rio Grande system could be attributed to atmospheric fallout (Graf 1993). The remaining 10 percent of the plutonium in the sediments in the Rio Grande system can be attributed to releases from LANL operations. The sediment deposits along the Rio Grande between Otowi and Cochiti Lake are most likely to contain the plutonium that can be attributed to LANL operations (Graf 1993).

DOE continues to monitor and characterize the movement of sediments across LANL and into the Rio Grande. The LANL ER Project is currently evaluating the extent of the contamination (and the associated risks) in the canyon sediments. These sediment studies have found that off-site transport of sediments with elevated plutonium-239 and -240 levels has taken place. The study found the following:

- For sediments collected at Cochiti Lake during the period of 1982 through 1988, the mean plutonium-239 and -240 concentration was 0.189 picocuries per gram, compared to a mean plutonium-239 and -240 value of 0.0081 picocuries per gram that was found in sediments from a background monitoring station at Abiquiu Reservoir (Graf 1993).
- For sediments collected at Embudo Station during the period of 1974 to 1986, the mean plutonium-239 and -240 value was 0.0033 picocuries per gram, and at Cochiti Lake was 0.0092 picocuries per gram (Graf 1993).

Sediment samples have also been collected at the Pueblo of San Ildefonso and analyzed for radionuclides and trace metals. Tritium and plutonium-238, -239, and -240 were found at levels above regional comparison level at sampling locations. The plutonium-239 and plutonium-240 values were obtained at the boundary of Pueblo land with LANL. Strontium-90, cesium-137, total uranium, americium-241, gross alpha, gross beta, and

SOURCE: Gallaher 1997

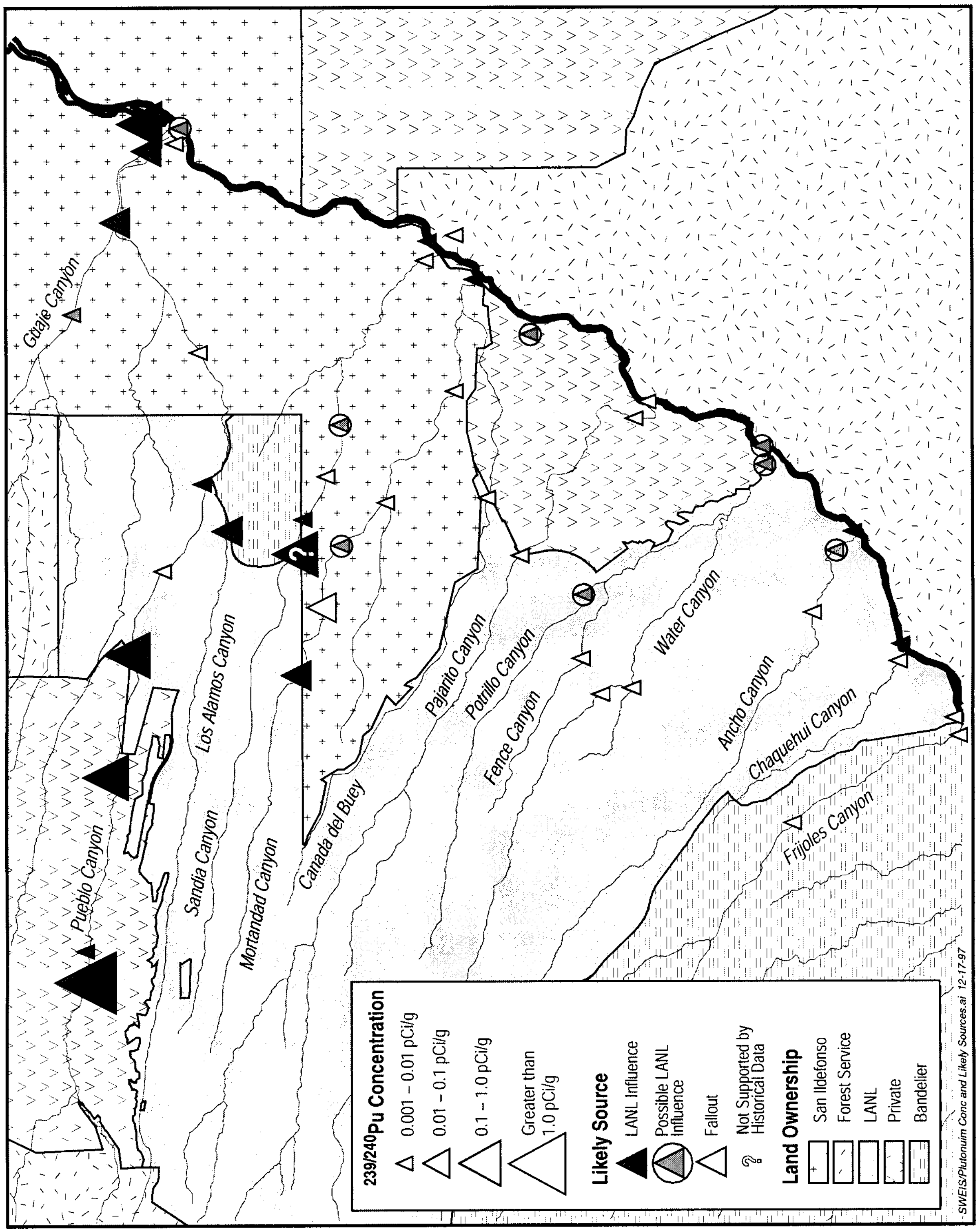


FIGURE 4.3.1.4–2.—*Plutonium Concentrations and Likely Sources.*

gross gamma were not found to be elevated above the regional comparison levels for sediment sampling stations located in Mortandad Canyon or on Pueblo land. The levels of radionuclides found in sediment samples from Bayo and Sandia Canyons on San Ildefonso Pueblo land were found to be at or below the regional comparison levels. Trace metals were all found to be within the range expected for natural background geologic materials (LANL 1996i).

4.3.1.5 *Surface Water Quality*

Analysis of LANL surface water sampling data indicates that LANL operations have affected the surface water within LANL boundaries. Data from the Environmental Surveillance and Compliance Program indicate that the greatest effects to surface water are attributable to historic LANL activities and radiological releases that occurred in Acid, Pueblo, Los Alamos, and Mortandad Canyons. Historical activities and releases that have contributed to the contamination in these canyons include:

- Nuclear materials research activities that occurred during the Manhattan Project
- An industrial liquid waste treatment plant, operated from 1952 to 1986, at TA–21
- Discharges from former TA–45 (operated from 1951 to 1964)
- Discharges from the Los Alamos Neutron Science Center (LANSCE) sanitary sewage lagoon system
- Discharges from the RLWTF
- NPDES-permitted effluent discharges (LANL 1996i)

Details on surface water quality can be found in the annual LANL Environmental Surveillance and Compliance Reports. Summary water quality data tables derived from the 1991 to 1996 LANL Environmental Surveillance and Compliance Reports are presented in volume III, appendix C (Tables C–2 and C–3). However, in order to provide a general understanding of the surface water quality at LANL, information from the 1996 Environmental Surveillance and Compliance Report is summarized in the following text. This information is, in most cases, consistent with past findings (LANL 1997c).

In 1996, the radiochemical analyses results for surface water samples were below DOE-DCGs for the public, and the majority of the results were near or below the detection limits of the analytical methods used and also were below DOE-DCGs for drinking water systems (except for samples from Mortandad Canyon). This was consistent with past findings. Long-term trends in the activity of tritium and total plutonium in surface water in Mortandad Canyon are depicted in Figure 4.3.1.5–1. These measurements were made from samples collected a short distance downstream of the TA–50 effluent discharge into Mortandad Canyon.

The measurements in waters from areas receiving effluents show the effects of these effluents; however, none of the results exceeded standards except for some pH measurements above 8.5. EPA drinking standards are only directly applicable to a public water supply. In particular, they would only apply to the supply wells in the main aquifer, which are the source of the Los Alamos water supply. EPA drinking water standards are useful for comparison purposes. Aluminum, iron, and manganese concentrations exceeded EPA secondary drinking water standards at most locations. The results reflect the presence of suspended solids in the water samples. Because the metals analyses are performed on unfiltered water samples, the results are influenced by naturally occurring metals (e.g., aluminum, iron, and manganese) that comprise the suspended solids. In 1996, barium and silver concentrations were within the NMWQCC groundwater limits. In 1996, mercury was not observed above the detection limit (0.2 microgram per liter) at any location, with the exception of a measurement

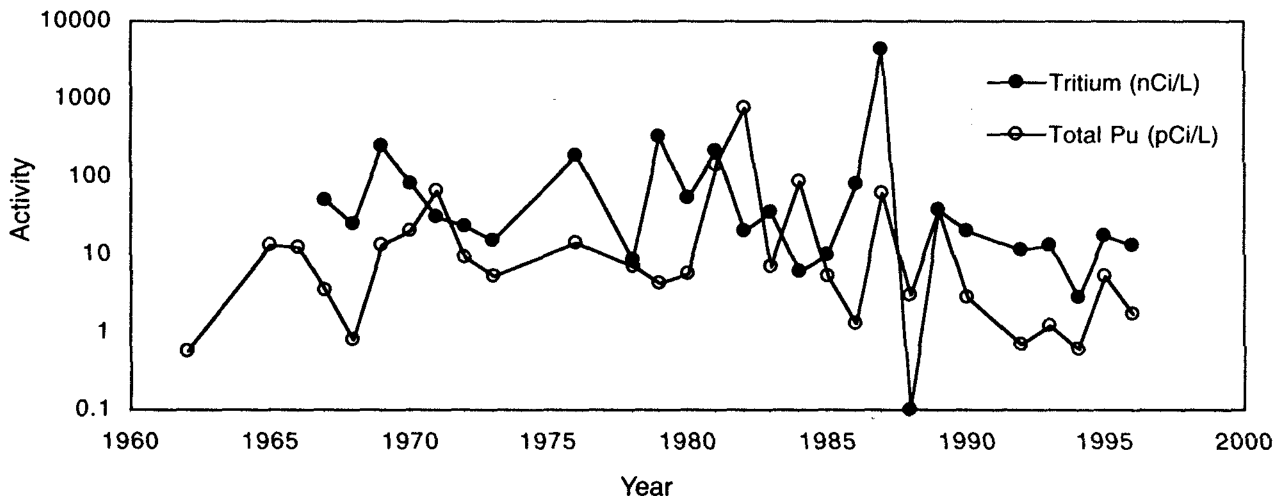


FIGURE 4.3.1.5–1.—*Tritium and Plutonium Activity at Mortandad Canyon at Gaging Station 1.[a]*

[a] This figure shows long-term trends of the activity of tritium and total plutonium in surface water in Mortandad Canyon. These measurements were made on samples collected at the station GS-1 at Mortandad, which is a short distance downstream of the TA–50 effluent discharge into Mortandad Canyon. Samples collected before 1996 were preserved in the field and filtered through a 0.45-micron filter in the laboratory. The 1996 measurements represented the total (unfiltered) activity. Plutonium values for 1962 to 1966 are for plutonium-239 and plutonium-240 only. Plutonium-238 was not recorded for those years. If more than one sample is collected in a year, the average value for the year is plotted. The DOE-DCG for the public for tritium is 2 x 10^6 picocuries per liter; for plutonium-238 it is 40 picocuries per liter, and for plutonium-239 and plutonium-240 it is 30 picocuries per liter. This figure shows the total plutonium values (LANL 1997c).

of 0.3 microgram per liter for one of two measurements in DP Canyon. The other measurement found the concentration to be below the detection limit. Selenium values exceeded the New Mexico Wildlife Habit Stream Standard (2 micrograms per liter) at numerous locations around LANL. The highest selenium value (18 micrograms per liter) was reported below the Bayo Wastewater Treatment Plant Facility discharge. Low levels of HE were detected at Water Canyon, Beta, and Frijoles Canyons near the BNM headquarters.

4.3.1.6 *Floodplains*

DOE has delineated all 100-year floodplain elevations within LANL boundaries in accordance with requirements presented in RCRA (40 CFR 270.14[b]) and Executive Order 11988—Floodplain Management (McLin 1992). There are a number of structures within the 100-year floodplain. Most may be characterized as small storage buildings, guard stations, well heads, water treatment stations, and some light laboratory buildings. There are no waste management facilities in the 100-year floodplain. Some facilities are characterized as moderate hazard due to the presence of sealed sources or x-ray equipment, but most are low hazard or with no hazard designation. The Solution High-Energy Burst Assembly (SHEBA) Building at TA–18 is within the 100-year floodplain, but the assembly is located there only during an experiment.

The 500-year flood plain has been designated only for Los Alamos Canyon. The Omega West reactor (inactive) is located with this floodplain, but was reclassified as a low hazard radiological facility. The remainder of the structures are of the type described for the 100-year floodplain. Overall, most laboratory development is on mesa tops, and development within canyons is light.

4.3.2 Groundwater Resources

The nature and extent of groundwater bodies in this region have not been fully characterized. The LANL Hydrogeologic Workplan (LANL 1998b) proposes the installation of new wells that will provide further characterization (section 4.3.2.3). Current data indicate that groundwater bodies occur near the surface of the Earth in the canyon bottom alluvium, perched at deeper levels (intermediate perched groundwater), and at deeper levels in the main aquifer (Purtymun 1995). Data about the groundwater resources, including springs and groundwater quality, will be presented in this subsection.

Alluvial groundwater bodies within LANL boundaries have been primarily characterized by drilling wells in locations where impacts from LANL operations are most likely to occur. Generally, only wells in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey indicate the continually saturated alluvial groundwater bodies (Purtymun 1995). More information on the canyon-bottom alluvium and groundwater bodies for Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and for Cañada del Buey is presented in Table 4.3–1.

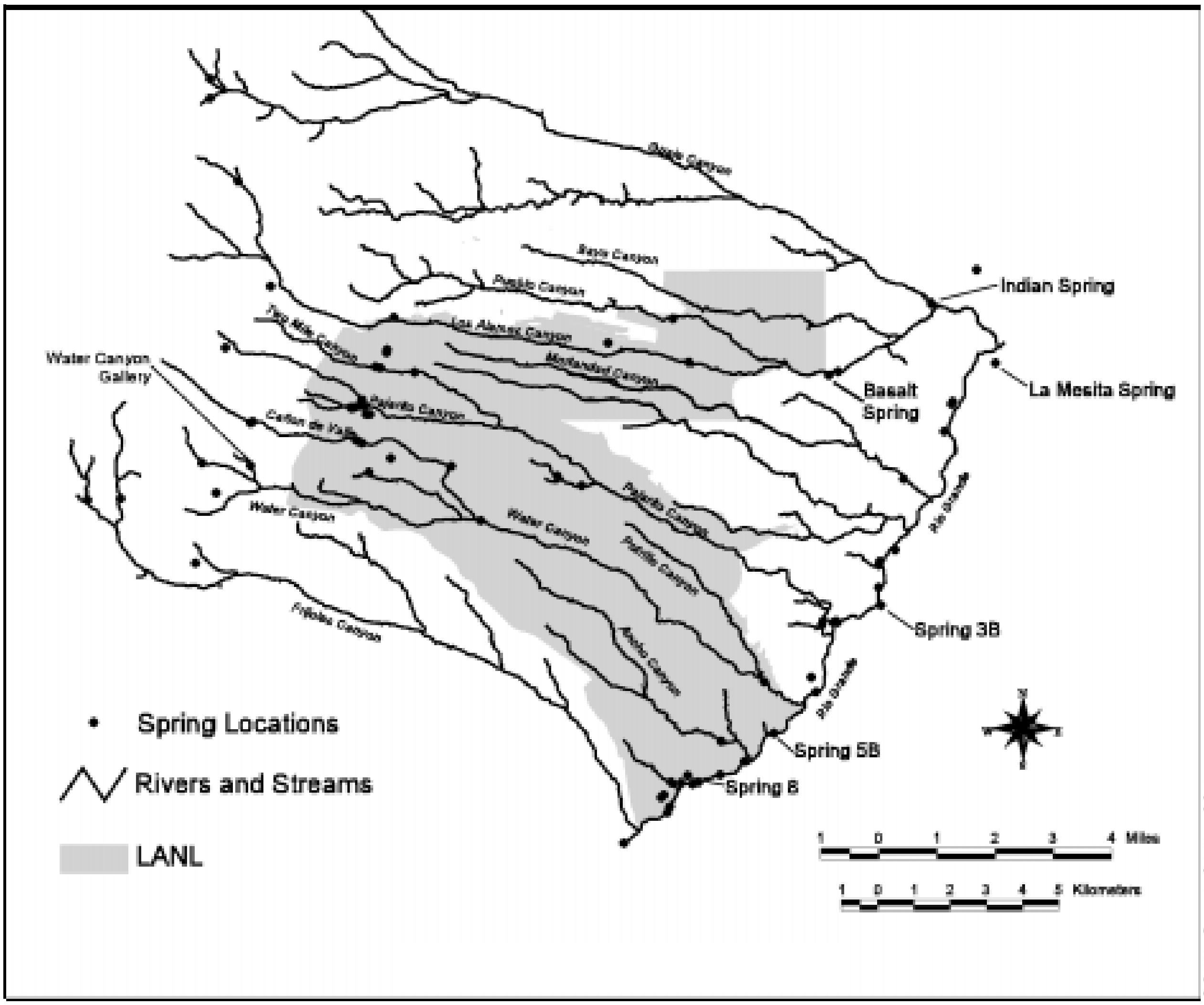
Intermediate perched groundwater bodies of limited extent occur beneath the alluvium in portions of Pueblo, Los Alamos, and Sandia Canyons; in volcanic rocks on the sides of the Jemez Mountains to the west of LANL; and on the western portion of the Pajarito Plateau (LANL 1996i, LANL 1993a, and Purtymun 1995). Undiscovered intermediate perched groundwater bodies may exist, as the drilling coverage for these groundwater bodies has been relatively limited. The depth to perched water from the surface ranges from approximately 90 feet (27 meters) in the middle of Pueblo Canyon to 450 feet (137 meters) in lower Sandia Canyon (LANL 1993a).

The main aquifer is separated from alluvial and intermediate perched zone groundwater bodies by 350 to 620 feet (107 to 189 meters) of unsaturated volcanic tuff and sediments (Purtymun 1995). Recharge of the main aquifer is not fully understood nor characterized. Recent investigations suggest that the majority of water pumped to date has been from storage, with minimal recharge of the main aquifer (Rogers et al. 1996). Groundwater in the main aquifer to the west of the Rio Grande generally flows from the northwest to the southeast toward the Rio Grande. Groundwater in the main aquifer to the east of the Rio Grande generally flows westward from the Sangre de Cristo Mountains toward the Rio Grande. Groundwater flowing from these opposite directions converges in the approximate vicinity of the Rio Grande, then flows southwest.

As a result, shallow groundwater in the main aquifer does not flow across the Rio Grande from either side (Frenzel 1995). Groundwater may flow beneath the Rio Grande deeper in the basin, but conditions at lower depths have not been characterized.

Springs in the LANL area flow from alluvial and intermediate perched groundwater bodies and the main aquifer (Figure 4.3.2–1). Springs can be found in Guaje, Pueblo, Los Alamos, Pajarito, Frijoles, and White Rock Canyon watersheds (LANL 1996i). Information regarding these springs is presented below.

- The Water Canyon Gallery was previously a source of potable water for LANL. Since 1989, Water Canyon Gallery has not been used as a potable water supply due to the high sediment content of its water (Purtymun et al. 1995).
- Contaminants that appear to be from LANL NPDES-permitted discharges at TA–16 have been detected in the recently discovered springs in Pajarito and Water



SOURCE: LANL 1997c

FIGURE 4.3.2–1.—*Springs in the LANL Area.*

Canyon watersheds, indicating a hydrogeological connection. However, the source of these springs has not been determined.

- Twenty-seven springs discharge from the main aquifer into White Rock Canyon. White Rock Canyon springs and main aquifer discharges contribute an estimated 6 to 7 cubic feet (0.17 to 0.20 cubic meters) per second to the Rio Grande (LANL 1993a).

4.3.2.1 *Groundwater Monitoring*

Groundwater monitoring is conducted within and near LANL. One of the objectives of LANL's groundwater monitoring program is to provide indications of the potential for human and environmental exposure from contaminated groundwater sources. Groundwater may accumulate contaminants from discharges to surface water or from leakage of liquid effluent storage systems. Though hydrogeologic conditions around LANL greatly protect the main aquifer from near-surface activities, groundwater monitoring is conducted to detect any threats to the resource. Groundwater monitoring and protection requirements are included in DOE Order 5400.1, General Environmental Protection Program. The order requires LANL to prepare a Groundwater Protection Management Program Plan (GWPMPP) and to implement the program outlined by that plan. The plan also requires development of a groundwater monitoring plan. The groundwater monitoring plan identifies all DOE requirements and regulations applicable to groundwater protection and includes strategies for sampling, analysis, and data management. LANL's GWPMPP was approved by DOE on March 15, 1996 (LANL 1996f).

DOE Order 5400.1 requires that groundwater monitoring needs be determined by site-specific characteristics and, where appropriate, that groundwater monitoring programs be designated and implemented in accordance with RCRA regulations. The section also requires that monitoring for radionuclides be in accordance with DOE Order 5400.5, Radiation Protection of the Public and the Environment.

In addition to DOE Order 5400.1, Module VIII of the LANL RCRA permit requires LANL to collect information to supplement and verify existing information on the environmental setting at the facility and collect analytical data on groundwater contamination. Under Task III, LANL is required to conduct a program to evaluate hydrogeological conditions and is required to conduct a groundwater investigation to characterize any plumes of contamination at the facility.

In 1995, the NMED requested DOE develop a comprehensive groundwater monitoring program plan that addresses both site-specific and LANL-wide groundwater monitoring objectives. This was in part satisfied with submittal of the GWPMPP. In August 1995, NMED requested a Hydrogeologic Workplan. This workplan was submitted to NMED for review in December 1996. The Hydrogeologic Workplan was approved by NMED on March 25, 1998, and finalized on May 22, 1998 (LANL 1998b).

Through the LANL Environmental Surveillance and Compliance Program, samples are collected annually from alluvial groundwater, intermediate perched groundwater, main aquifer test and supply wells, and springs. Module VIII of LANL RCRA permit specifically requires monitoring of the canyon alluvial groundwater system in Pueblo, Los Alamos, Sandia, Mortandad, Potrillo, Fence (a tributary of Potrillo), and Water Canyons. Figures 4.3.2.1–1 and 4.3.2.1–2 show groundwater sampling locations for (1) alluvial and intermediate observation wells and (2) springs and deep wells, respectively. Groundwater samples are analyzed annually to evaluate compliance with applicable standards for radionuclides, water quality chemistry parameters, and metals. One-third of the

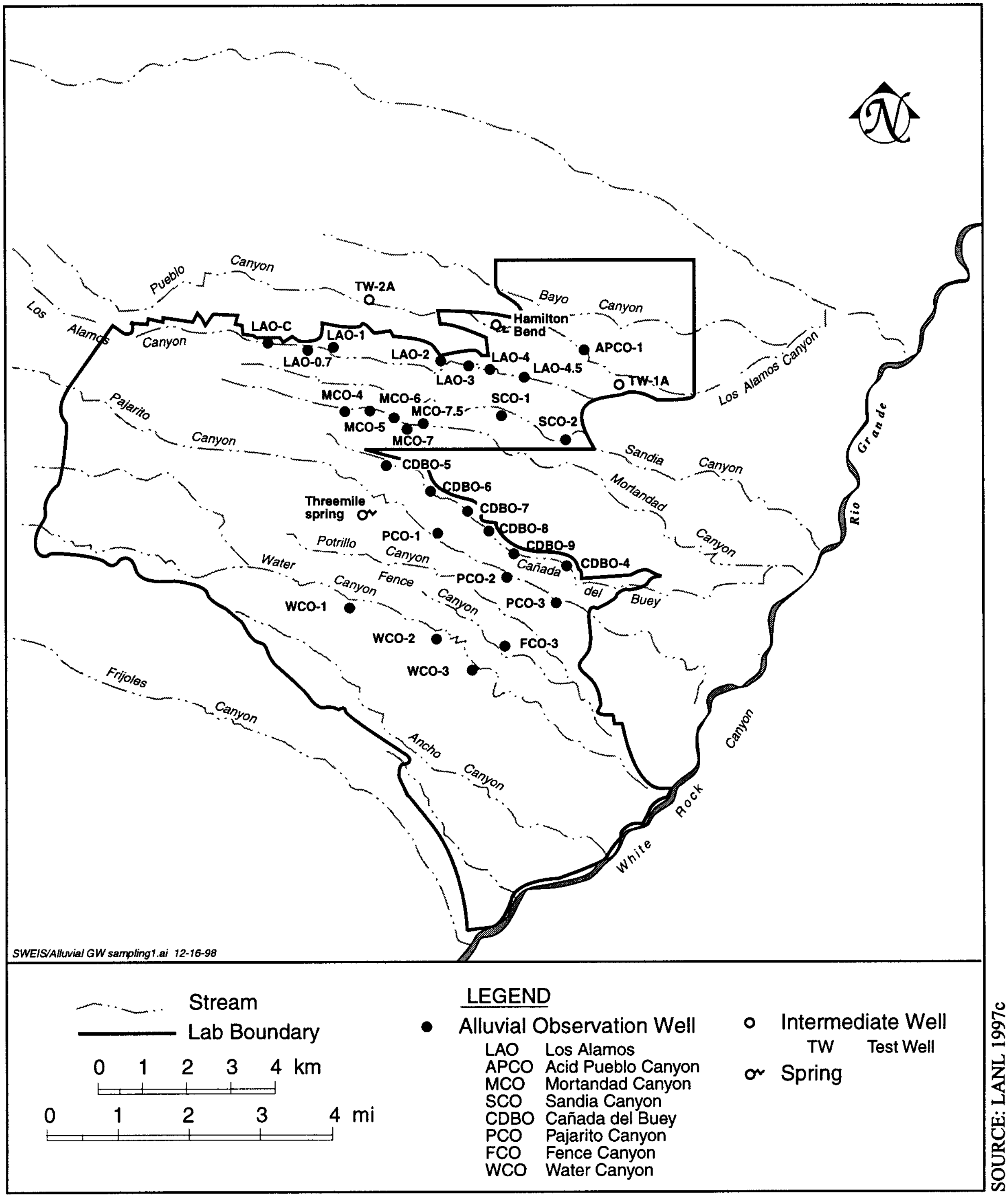


FIGURE 4.3.2.1–1.—*Observation Wells and Springs Used for Alluvial and Intermediate Groundwater Sampling.*

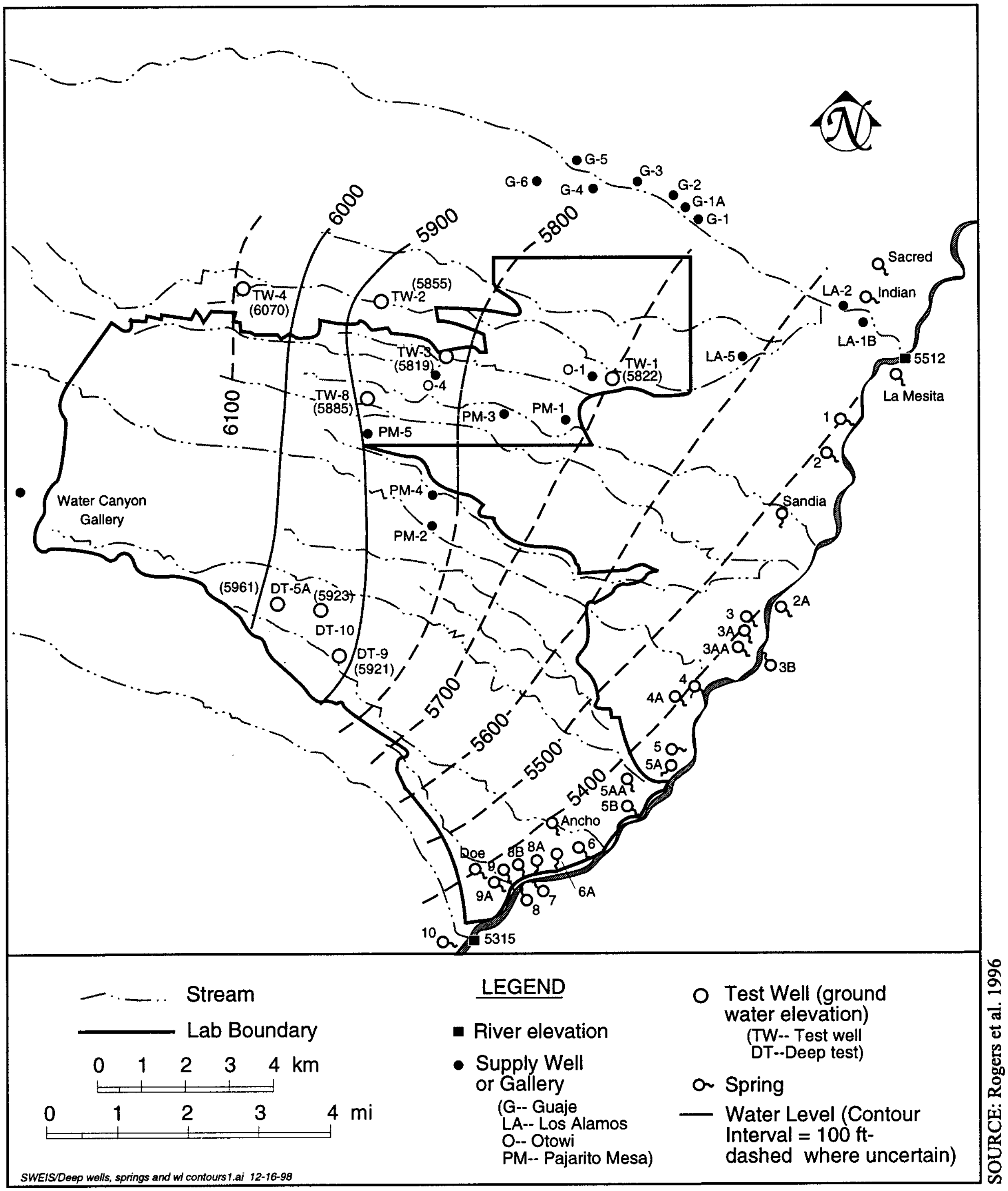


FIGURE 4.3.2.1–2.—*Regional Aquifer Test Wells, Supply Wells, Springs, and Water Level Contours*

(**Note:** Contours are Based on 1993 Data from Test Wells.)

groundwater samples collected from the well and spring locations are analyzed for organic compounds annually, with the samples from all locations analyzed for organics at least once every 3 years. The quality of water in the regional aquifer is tested at various locations. There are 8 deep test wells and 14 supply wells that belong to DOE. There also are several regional aquifer wells near the Rio Grande that do not belong to DOE. These wells are on San Ildefonso Pueblo land and are sampled under the Memorandum of Understanding (MOU) between the U.S. Bureau of Indian Affairs and DOE. In addition, there are many springs along the Rio Grande that are sampled. Since 1987, groundwater has been sampled annually from 13 wells and 4 springs on Pueblo of San Ildefonso land in accordance with the MOU (BIA 1987).

4.3.2.2 *Groundwater Quality*

Groundwater Quality Standards

There are numerous federal, state and DOE requirements related to groundwater protection and management. The State of New Mexico protects groundwater via NMWQCC regulations, which address liquid discharges onto or below ground surface. Under these regulations, a groundwater discharge plan must be submitted to and approved by the NMED for a discharging facility. Subsequent discharges must be consistent with the terms and conditions of the discharge plan. In 1996, LANL had three Groundwater Discharge Plans in effect. The NMWQCC regulations were significantly expanded in 1995 with the adoption of comprehensive abatement regulations. The purpose of these regulations is to abate surface and subsurface contamination for designated or future uses. Of particular importance to DOE is the contamination that may be present in the main aquifer.

Concentrations of radionuclides in environmental water samples from the main aquifer, the alluvial perched water in the canyons, and the intermediate depth perched systems, whether collected within the LANL boundaries or off the site, may be evaluated by comparison with DCGs for ingested water calculated from DOE's public dose limits. Concentrations of radioactivity in samples of water supply wells completed in the Los Alamos main aquifer are also compared to the NMED, New Mexico Environmental Improvement Board (NMEIB), and EPA safe drinking water standards or to the DOE-DCGs applicable to radioactivity in DOE drinking water systems, which are more restrictive in a few cases. EPA has given NMED authority to administer and enforce federal drinking water regulations and standards in New Mexico.

EPA drinking water standards are only directly applicable to a public water supply. In particular they would only apply to the supply wells in the main aquifer that are the source of the Los Alamos public water supply. EPA drinking water standards may be useful for comparison purposes in some cases. For example, because LANL shallow alluvial groundwater is not a source of municipal or industrial water but may feed surface water springs and seeps used by livestock and wildlife, shallow alluvial groundwater must meet the Standards for Groundwater or Livestock and Wildlife Watering established by the NMWQCC. However, for many elements there are no established livestock and wildlife standards. When this is the case, although generally much more conservative than the livestock and wildlife standards, EPA drinking water standards are used herein for comparison purposes.

Alluvial and Perched Water Quality

Data derived from groundwater samples taken from test wells indicate that LANL operations and activities have influenced some of the alluvial and intermediate perched zone groundwater quality in the LANL region. Primary LANL sources of contamination include historic discharges of treated and untreated wastes, discharges from the RLWTF (Mortandad Canyon) and leaks from the Omega West Reactor (Los Alamos Canyon). Other sources of contamination are from past and present LAC sanitary treatment plant releases (Pueblo Canyon). Details on alluvial and perched water quality can be found in the annual LANL Environmental Surveillance and Compliance Reports. Summary alluvial and perched water quality data tables derived from the 1991 to 1996 LANL Environmental Surveillance and Compliance Reports are presented in volume III, appendix C (Tables C–6 and C–7). However, in order to provide a general understanding of the alluvial and perched water quality at LANL, information from the 1990 to 1994 Environmental Surveillance Reports are summarized in the following text.

- EPA *Safe Drinking Water Act* (SDWA) (40 CFR 141) standard for strontium-90 (8 picocuries per liter) was exceeded in at least 50 percent of the alluvial groundwater samples collected from Los Alamos and Mortandad Canyons from 1990 through 1994, and EPA SDWA standard for tritium (20 nanocuries per liter) was exceeded in 20 of 22 of the alluvial groundwater samples collected in Mortandad Canyon during this same period. The more applicable New Mexico livestock and wildlife standard for tritium is the same as the SDWA standard of 20 nanocuries per liter and there are no livestock and wildlife comparison values for strontium-90. Standards for americium-241, cesium-137, plutonium-238 and plutonium-239, and nitrates also were exceeded during the period 1990 through 1994 in Mortandad Canyon.
- Standards for some water quality parameters and metals were exceeded in samples from the alluvial groundwater in Pueblo and Pajarito Canyons and Cañada del Buey from 1990 through 1994. These water quality parameters and metals occur naturally in the groundwater system within the LANL region and are also released through some of LANL's NPDES-permitted discharges (LANL 1994b, LANL 1995f, and LANL 1996e).
- Tritium and nitrates were detected in samples collected from the intermediate perched groundwater in Pueblo and Los Alamos Canyons. The levels of tritium detected were below the EPA standard of 20 nanocuries per liter, but nitrate as nitrogen concentrations exceeded the EPA standard of 10 milligrams per liter in all samples taken in 1994 from the two wells in the Pueblo and Los Alamos Canyon watersheds and Basalt Spring. The nitrate concentrations in these wells ranged from less than 0.04 to 19.4 milligrams per liter (LANL 1994b, LANL 1995f, and LANL 1996e).
- HE, VOCs, and nitrates were found in samples collected from the recently discovered springs in Pajarito Canyon watershed. VOCs (tetrachloromethane) were detected at 15 micrograms per liter, which is above the EPA SDWA standard of 5 micrograms per liter. High explosives (Hexahydron-1,3,5-trinitron-1,3,5-triazine) were detected in samples at 100 micrograms per liter (EPA standard is 0.61 micrograms per liter) and nitrates (2-amino-[2,4]-6-dinitrotoluene) were detected at 3.31 micrograms per liter, which is above the EPA standard of 0.99 micrograms per liter (Yanicak 1996). The water quality in these springs may improve as a result of the new LANL industrial wastewater treatment plants coming on line in TA–16 in 1997 and a reduction of effluent volume from the NPDES-permitted outfalls (Purtymun 1995).

Although groundwater data have been collected and will continue to be collected as a part of the Environmental Surveillance and Compliance Program, many questions remain regarding where groundwater occurs, groundwater quality, and potential contaminant migration (section 4.3.2.3).

Main Aquifer Water Quality

As a part of the Environmental Surveillance and Compliance Program, samples are collected from main aquifer test wells to ensure the quality of this groundwater body that provides the drinking water for LAC, LANL, and BNM. SDWA standards for all radionuclides were met in all samples taken from the main aquifer from 1990 through 1994. However, trace amounts of tritium, plutonium-239 and plutonium-240, americium-241, and strontium-90 have been detected in samples collected from the main aquifer. The presence of plutonium-239 and plutonium-240, americium-241, and strontium-90 has not been duplicated in previous or subsequent samples (section 4.3.2.3). Radioactive and hazardous waste has been generated and disposed at LANL since LANL's inception in 1943. LANL materials disposal areas and the PRSs identified by the ER Project (chapter 2, section 2.1.2.5) are potential sources of contamination. An additional possible source of groundwater contamination is the historic and current practice of discharging treated effluents in canyons near the northern boundary of LANL. While all canyons have received some industrial and sanitary discharges, Los Alamos, Sandia, Mortandad, and Pueblo Canyons are particular areas of concern because of the NPDES outfalls that discharge into these canyons. Tritium was first detected using a special sensitive method at Los Alamos in 1992. This analytical method was more sensitive than the EPA method for drinking water compliance monitoring in use. The levels measured were less than 2 percent of EPA SDWA (Dale and Yanicak 1996, LANL 1994b, LANL 1995f, and LANL 1996e) (also see section 4.3.2.3). Radioactivity, sodium, and metals all occur naturally in groundwater, and the detected concentrations are similar to those observed elsewhere in the Española Basin (LANL 1994b, LANL 1995f, LANL 1996e, and NMED 1995).

Organic compounds have been detected in samples taken from main aquifer test wells at TA–49 (DT–5A, DT–10, and DT–9; Figure 4.3.2.1–2). The largest detection was for pentachlorophenol from the TA–49 test well DT–9 (Figure 4.3.2–1) of 110 parts per billion. The EPA SDWA standard for pentachlorophenol is 1 part per billion. The sources of the contaminants detected in the TA–49 test wells are not known (LANL 1993b, LANL 1994b, LANL 1995f, LANL 1996e, and LANL 1996i). Test well DT–9 was retested in 1996, and no organic compounds were detected. However, the LANL Hydrogeologic Workplan (LANL 1998b) proposes the installation of borehole R–27 to further characterize the source of these contaminants. The TA–49 test wells are approximately 2 miles (3.2 kilometers) away and cross-gradient of the nearest public water supply well (PM 2) (Figure 4.3.2.1–2), and no public supply wells exist down-gradient of the TA–49 test wells. Therefore, the presence of organic compounds in these samples does not suggest a danger to the existing public water supply (Purtymun 1995).

The SDWA standard for nitrate (10 milligrams per liter) was exceeded in TW–1 in 1994 and 1995 (23.0 milligrams per liter and 12.9 milligrams per liter, respectively). This test well has shown nitrate levels in the range of about 5 to 25 milligrams per liter since early 1980. The source of the nitrate could be infiltration from sewage treatment effluent in Pueblo Canyon (LANL 1996i).

Details on main aquifer water quality can be found in the annual LANL Environmental Surveillance and Compliance Reports. Summary main aquifer water quality data tables derived from the 1991 to 1996 LANL Environmental Surveillance and Compliance Reports are presented in volume III, appendix C (Table C–6 and C–7).

4.3.2.3 *Transport of Radionuclides and Chemicals*

In the LANL region, uncertainties exist about the nature and extent of contaminant migration from alluvial groundwaters to deeper groundwaters (intermediate perched groundwaters or the main aquifer) and from intermediate perched groundwaters to the main aquifer (LANL 1993b, LANL 1994b, LANL 1995f, LANL 1996e, and LANL 1996i). The intermediate perched groundwater bodies beneath mid-Pueblo and lower Pueblo and Los Alamos Canyons are known to be hydraulically connected to surface water and alluvial groundwater in Pueblo Canyon. Therefore, groundwater movement from alluvial groundwater bodies to deeper intermediate perched groundwater bodies or the main aquifer may be a contaminant transport pathway in specific locations (LANL 1993a).

Of all hydrogeologic settings at LANL, contaminant transport from dry mesa top material disposal areas (e.g., Area G where contaminated wastes are treated, stored, and disposed) through the rock matrix to the main aquifer potentially takes the longest time. Evaluation of existing data and modeling results indicates potential transport of some radionuclides requires thousands of years to reach the main aquifer, and many other radionuclides will decay completely before arrival (Birdsell et al. 1995, DOE 1995b, Rosenberg et al. 1993, and Devaurs 1989).

The potential exists for contaminants to migrate more quickly from alluvial groundwater bodies through the rock matrix below to the main aquifer. Due to the hydrogeologic complexity of the LANL area, these pathways are not fully understood and may vary substantially from one hydrogeologic setting to another. Tritium in the main aquifer was first reported in the 1992 LANL Environmental Surveillance Report. This is when several advanced techniques not commonly applied to groundwater samples were first used. The levels measured were less than 2 percent of the EPA SDWA.

Although the exact recharge mechanism(s) is not known, some additional possible transport pathways from those discussed previously could be: (1) contaminants infiltrating along well shafts or boreholes, (2) contaminants moving through the unsaturated (vadose) zone, and (3) contamination infiltrating areas of high fault or fracture density. The tritium detected in TW–3 and TW–8 in Los Alamos Canyon and Mortandad Canyon, respectively, suggests a continual presence of a small recharge contribution from the surface in the main aquifer from an unknown source. As mentioned previously, one of the possible transport pathways is along the well bore of inadequately constructed or inappropriately designed older wells. Many of the wells at LANL were constructed as early as the 1940's. Tritium has been detected in samples taken from observation wells LA–1A and Test Wells TW–1, TW–1A, TW–2, TW–2A, TW–4, and TW–8. In all of these cases, it is possible that tritiated waters from the surface have seeped along the well bore due to an inadequate seal. These wells, as well as borings and coreholes that might present a pathway for contamination, may need to be plugged and abandoned in accordance with the NMED and New Mexico State Engineers Office requirements to ensure that contaminant transport pathways to intermediate depth perched groundwater and the main aquifer are properly closed off (LANL 1996f).

The primary solution to understanding the extent of the effects of LANL activities on the main aquifer is to obtain more site characterization information (i.e., construct more monitoring wells). This new site characterization information should provide data for researchers to gain a better understanding of how contaminants are transported from discharge sites. Because of the many questions concerning the hydrogeologic characterization of the Pajarito Plateau, such as the recharge mechanisms for the main aquifer and the lack of hydrologic detail, LANL personnel have prepared a Hydrogeologic Workplan that was approved by NMED in March 1998. The workplan proposes the installation of new wells to address these uncertainties. Well placement and other characterization activities as presented in the proposed plan will focus on providing more information on the hydrogeologic and stratigraphic settings (specifically, vertical hydraulic gradients, saturated hydraulic conductivities, vertical stratification, depth and direction of groundwater flow, recharge to the main aquifer, and water quality in the main aquifer). The workplan also proposes the placement of additional wells between known contaminated sources and water supply wells in order to provide detection of approaching contaminants (LANL 1998b).

4.3.2.4 *Public Water Supply*

DOE water supply system supplies potable water from the main aquifer to LANL, the Los Alamos townsite, the community of White Rock and BNM. Three well fields (Pajarito, Guaje, and Otowi) constitute the current DOE water supply system. Other than chlorine disinfection of the water supply, no other water treatment is required.

DOE's water rights allow the withdrawal of about 5,540 acre feet or 1.8 billion gallons (6.83 billion liters) per year from the main aquifer (DOE 1995a). In addition, DOE has a contractual agreement for Rights to Water for 1,200 acre feet or 0.39 billion gallons (1.48 billion liters) per year from the San Juan-Chama Transmountain Diversion Project of the U.S. Bureau of Reclamation (DOE 1995a). DOE obtained these Rights to Water in 1976 based on a concern that future use would exceed DOE's water rights for the main aquifer. No infrastructure exists for conveyance of water from the San Juan-Chama to LAC. DOE has not used and currently has no plans to use the San Juan-Chama Rights to Water (PC 1996c).

For the period from 1947 through 1994, LAC's, BNM's, and LANL's combined water usage peaked at 96 percent of DOE water rights in 1976. From 1990 through 1994, total water rights usage ranged from 81 percent in 1993 to 91 percent in 1990. LANL's use has been approximately 500 million gallons (1.89 billion liters) per year since the late 1970's (PC 1996c). Additional information on drinking water supplies can be found in section 4.9, Socioeconomics.

Historic water level measurements in main aquifer wells have indicated water level declines in the area due to pumping and natural discharges exceeding recharge and inflow. From 1947 through 1991, average water level declines in the four DOE supply well fields ranged from 24 to 76 feet (7 to 23 meters) (Purtymun 1995). Aquifer water level declines are shown pictorially, as in Figure 4.3.2.4–1; however, the water level declines are speculative. As expected, water level declines are most evident around water supply wells in the middle and northern part of Los Alamos County. Dashed contour lines on Figure 4.3.2.4–1 show declines on the order of 100 feet in the areas around the Guaje water supply well field diminishing in all directions away from it. Since the Los Alamos well field has been almost shut down (i.e., with the exception of LA–5, which supplies San Ildefonso - Totavi), water levels are returning to near-normal levels toward the east in the vicinity of the Rio Grande (Purtymun et al. 1995).

Water storage calculations which were made (based on the USGS regional model [Frenzel 1995]) for the total 5,600-foot (1,707-meter) thickness of the main aquifer indicate that approximately 21.8 trillion gallons (82,513 million cubic meters) of water are contained in the LANL region beneath the Pajarito Plateau (Frenzel 1995). If DOE used its

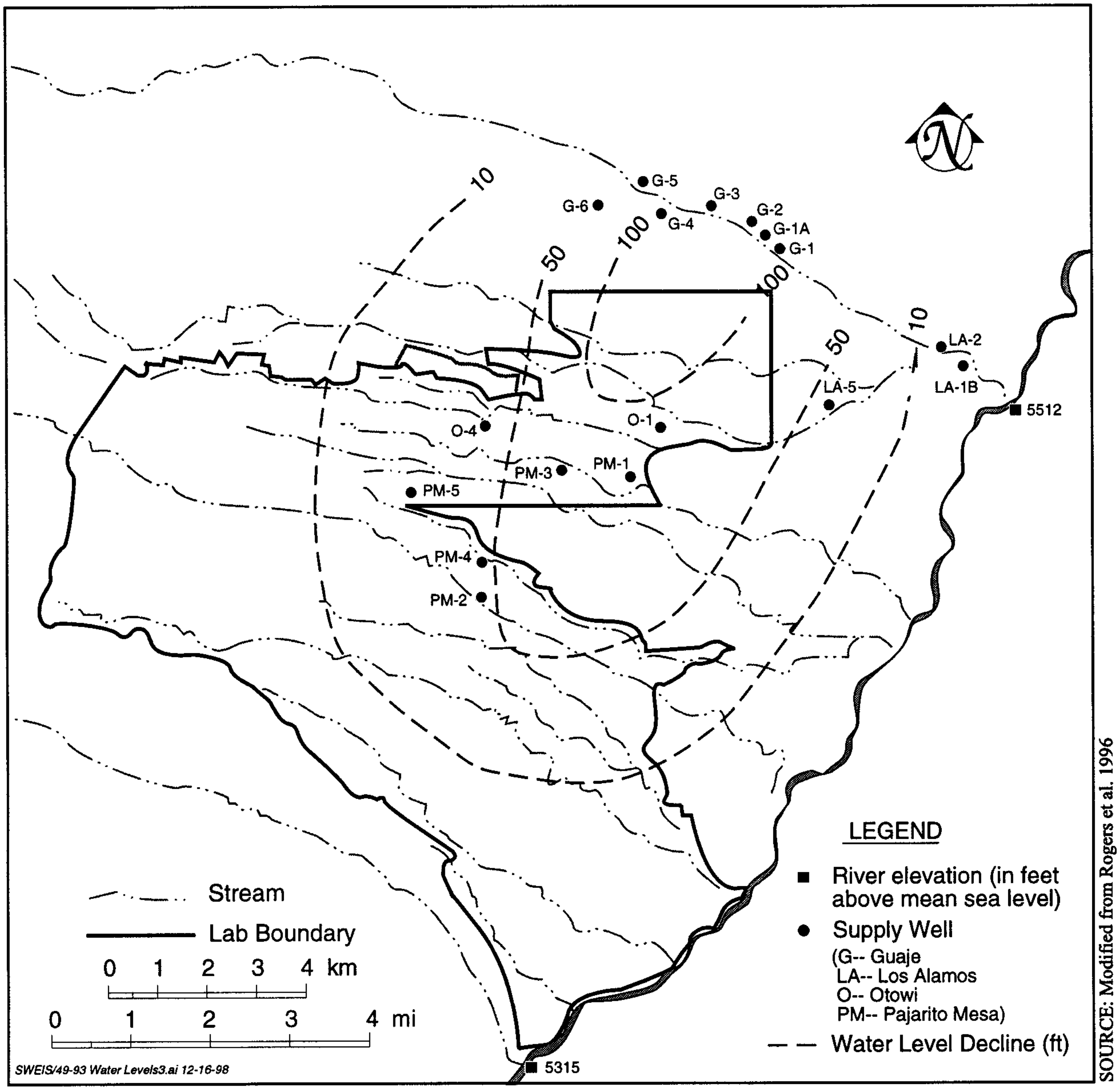


FIGURE 4.3.2.4–1.—*Approximate Aquifer Water Level Decline from 1949–1950 to 1993.*

full water rights at a rate of 1,805 million gallons (6.83 million cubic meters) per year, this storage volume represents a 12,109-year supply. However, because water quality will generally worsen with increasing depth, the volume of water suitable for drinking may be less. Available data are insufficient for modeling water quality degradation with depth, but water supply wells screened as deep as 1,830 feet (558 meters) into the main aquifer indicate that water at that level would meet SDWA standards. By comparison, storage calculations based on annual use at DOE water rights rate indicate a water supply for 2,839 years for the upper 1,275 feet (389 meters) of the main aquifer and 4,453 years for the upper 2,000 feet (610 meters) of the main aquifer.

A similar calculation for the water stored in the Española Basin (in which the main aquifer lies) indicates that 106 trillion gallons (401,210 billion liters) of water are stored in this aquifer. If the water rights of all major users (e.g., DOE, Santa Fe, and Española) were used at their capacity, the upper 1,275 feet (389 meters) of the Española Basin would be capable of supplying water for 2,982 years; and if the upper 2,000 feet (610 meters) of the water in the Española Basin were used, the basin would be capable of supplying water to current users for 4,637 years (PC 1996a). The calculations, assumptions, and data used for the Española Basin and main aquifer storage analyses are presented in volume III, appendix A.

Public Water Supply Quality

The DOE public water supply system is monitored to ensure compliance with the SDWA. Samples are collected from wellheads, the water distribution system, and residential taps. An evaluation of public water supply quality data indicates that all constituents analyzed were in compliance with applicable standards, with the exception of bacteria, which exceeded SDWA standards in August 1993. The bacteria were observed in samples taken from the distribution system for TA–33 and TA–39, which are both served by an infrequently used dead-end water main. The water was brought into compliance by flushing and disinfecting the water main. In response to this incident, LANL has increased minimum chlorination concentrations, sampling frequencies, and the frequency of flushing of dead-end water lines to prevent bacterial overgrowth (Dale and Yanicak 1995, LANL 1994b, LANL 1995f, LANL 1996e, LANL 1996i, and LANL 1993b).

DOE also monitors the drinking water wells for a number of radionuclides in order to assess whether LANL operations impact the quality of water in the main aquifer. Sample results for the radionuclides, which do not have limits under SDWA are compared to DOE-DCGs. All sample results from 1990 through 1994 indicate that radionuclide concentrations are well below the DCGs.

EPA has proposed standards for uranium (20 micrograms per liter) and radon (300 picocuries per liter) in groundwater (LANL 1995f). The movement of groundwater through uranium-rich rocks and sediments in the eastern portion of the Española Basin results in locally high concentrations of natural uranium and/or radon in the groundwater. During a study of residential wells in northern Santa Fe County, total uranium concentrations ranged from 0.1 to 930 micrograms per liter (PC 1997d). Analyses of water samples taken from the DOE water supply wells indicate that water from these wells exceed the proposed radon standard by 1.4 to 4.2 times (LANL 1995f). If the proposed EPA standard is adopted, treatment processes will need to be added to the DOE water supply system in order for the public water supply system for LAC to meet the radon standard. Uranium and radon in these wells is naturally occurring.

4.3.2.5 *Regional Groundwater*

In response to public and agency concerns about potential off-site groundwater contamination, data for the Buckman well fields and the Pueblos of San Ildefonso, Santa Clara, Cochiti, and Jemez were evaluated. Evaluations of groundwater quality, flow directions, and supply indicate that the Pueblos of Santa Clara, Cochiti, and Jemez are located outside of the hydrogeologic influence of LANL. Therefore, a baseline characterization of groundwater quality for these Pueblos is not included in this evaluation.

Buckman Well Field

The Buckman well field supplies approximately 41 percent of the city of Santa Fe's municipal drinking water supply. The Buckman well field is located east of LANL and the Rio Grande. An evaluation of NMED's Safe Drinking Water electronic database indicated that all samples collected were in compliance with the SDWA requirements for all constituents measured. Additionally, a joint study conducted by UC and NMED in 1990 found radionuclides in samples taken from the Buckman wells, nearby springs, and the Rio Grande to be below regulatory standards (Gallegos 1990 and Gunderson 1993).

Pueblo of San Ildefonso Groundwater Quality

During the period of 1990 through 1994, uranium was found in groundwater samples collected from 6 of the 18 Pueblo of San Ildefonso wells at concentrations that exceed the proposed EPA SDWA standard (20 micrograms per liter), and ranged from less than 1.0 to 55 micrograms per liter. Three of the six wells are located east of the Rio Grande and three wells are located west of the Rio Grande.

In May 1994, EPA sampled groundwater at all 18 Pueblo of San Ildefonso wells to investigate possible groundwater contamination and analyzed the samples for radionuclides. No plutonium or tritium was found in the groundwater. Uranium concentrations above background were detected in two of the wells. Based on uranium isotopic ratios in the samples, EPA stated, "These data indicate that the source of excess uranium present in these samples is probably natural" (EPA 1995). Regarding possible contamination of groundwater from LANL releases through surface water or sediments pathways, EPA made the following statement that was based on the uranium isotope ratios in surface water and sediment samples. "These data suggest that the elevated uranium concentrations are not a result of releases from the LANL operations and activities, but rather from a natural source that is different from that of the background samples. It is most likely from a geologic formation containing much higher than normal levels of uranium" (EPA 1995).

In 1994, SDWA standard for nitrate was exceeded in three of the Pueblo of San Ildefonso supply wells (LANL 1996e). Potential sources of nitrates in Pueblo of San Ildefonso groundwater include agricultural fertilizers, septic tanks, and sewage treatment plant discharges. Existing data do not allow the source(s) of nitrates detected in a sample to be identified. Therefore, the source of the nitrates in Pueblo of San Ildefonso groundwater is unknown. Analyses performed as a part of the groundwater sampling program in 1994 and 1995 did not find nitrate concentrations that exceeded the SWDA standard in the five main aquifer wells sampled on Pueblo of San Ildefonso land (Dale and Yanicak 1995).

4.4 AIR QUALITY AND CLIMATE

This section describes the air quality for LANL and the surrounding areas. The discussion includes the climatology and meteorology of the region, descriptions of radiological and nonradiological air emissions from recent operations, and a characterization of existing levels of air pollutants. Additional detail and information on the material in this section are presented in volume III, appendix B.

4.4.1 Climatology and Meteorology

Los Alamos has a semi-arid, temperate mountain climate. This climate is characterized by seasonable, variable rainfall with precipitation ranging from 10 to 20 inches (25 to 51 centimeters) per year. The climate of the Los Alamos townsite is not as dry (arid) as that part near the Rio Grande, which is arid continental (Nyhan et al. 1978). Meteorological conditions within Los Alamos are influenced by the elevation of the Pajarito Plateau. Climatological averages for atmospheric variables such as temperature, pressure, winds, and precipitation presented in this subsection are based on observations made at the official Los Alamos meteorological weather station from 1961 to 1990. The current official weather station, which has five sample heights (36 feet, 76 feet, 151 feet, 160 feet, and 302 feet [11 meters, 23 meters, 46 meters, 49 meters, and 92 meters]), is located at TA–6. Four other meteorological towers are also used by LANL. The locations of all five meteorological towers are shown on Figure 4.4.1–1 (LANL 1992a).

Normal (30-year mean) minimum and maximum temperatures for the communities of Los Alamos and White Rock are presented in Figure 4.4.1–2. Temperatures in Los Alamos vary with altitude, averaging 5 degrees Fahrenheit (°F) (3 degrees Celsius [°C]) higher in and near the Rio Grande Valley, which is 6,500 feet (1,981 meters) above sea level, and 5°F to 10°F (3°C to 5.5°C) lower in the Jemez Mountains, which are 8,500 to 10,000 feet (2,600 to 3,050 meters) above sea level. Los Alamos townsite temperatures have dropped as low as -18°F (-28°C) and have reached as high as 95°F (35°C) (LANL 1992a).

A Look Back in Time

During the winter I was usually at my breakfast table in time to watch the sun rise. There in front of the window was the rugged chain of the Rocky Mountains, a dark silhouette about thirty miles away. The sky above them grew lighter and lighter; the lightness began to contract to one particular point; and then suddenly, with blinking intensity, the first little segment of the sun. Within two minutes the breakfast room was filled with brilliant sunshine, every morning; all through the winter there was hardly ever a cloud to be seen, except for the occasional snowstorm which supplied what we needed for skiing. In the evening we would see the mountain chain turn red as the sun sank below the horizon, a lovely spectacle which had given the mountains the local name of el Sangre de Cristo. It was fascinating country, unlike anything I had ever seen.

Source: Frisch 1979

Normal (30-year mean) precipitation for the communities of Los Alamos and White Rock is presented in Figure 4.4.1–3. The normal annual precipitation for Los Alamos from 1961 to 1990 was approximately 19 inches (48 centimeters). Annual precipitation rates within the county decline toward the Rio Grande Valley, with the normal precipitation for White Rock at approximately 14 inches (34 centimeters). The Jemez Mountains receive over 25 inches (64 centimeters of precipitation) annually. The lowest recorded annual precipitation in Los Alamos townsite was 7 inches (17 centimeters) and the highest was 30 inches (1 meter) (LANL 1992a).

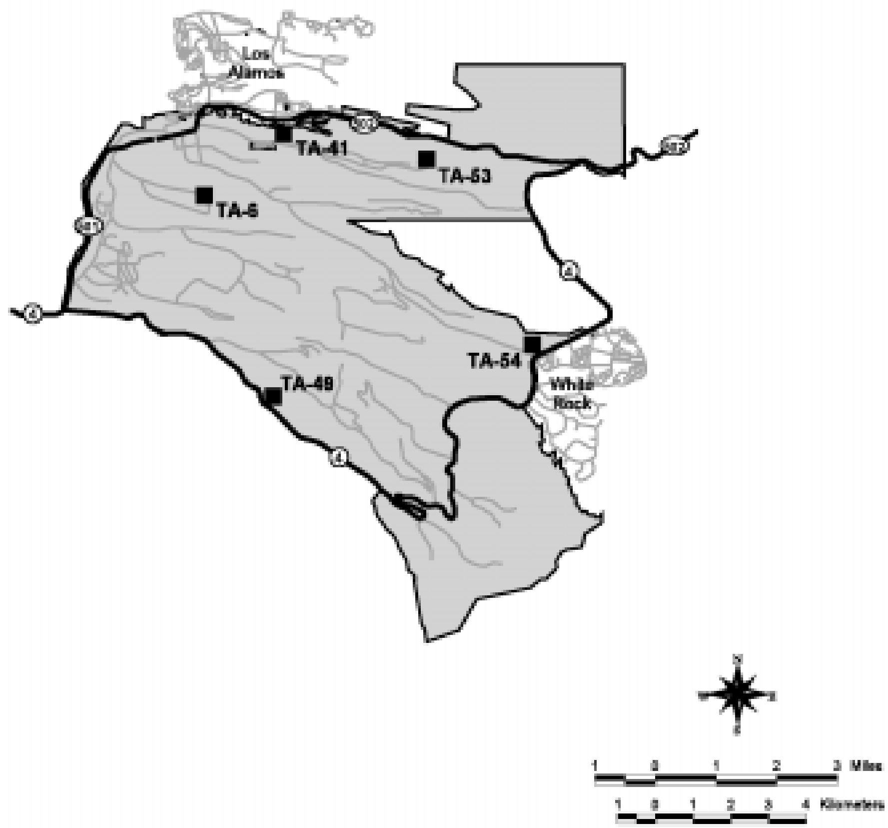


FIGURE 4.4.1–1.—*LANL Meteorological Stations.*

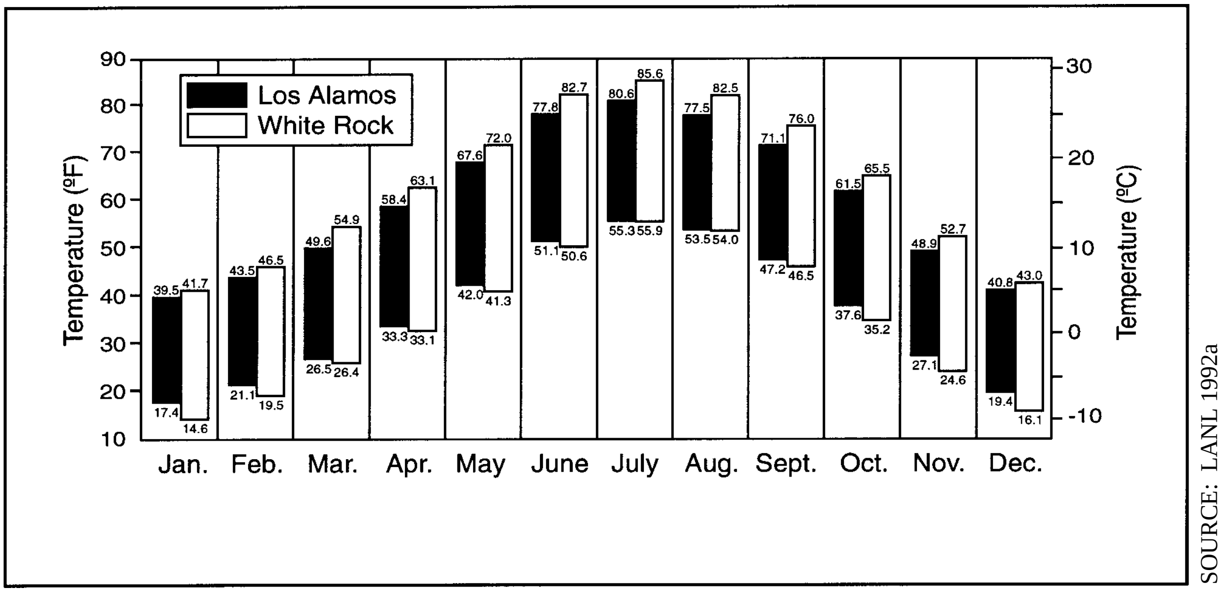


FIGURE 4.4.1–2.—*Mean High and Low Temperatures for Los Alamos (1961 to 1990) and White Rock (1965 to 1990).*

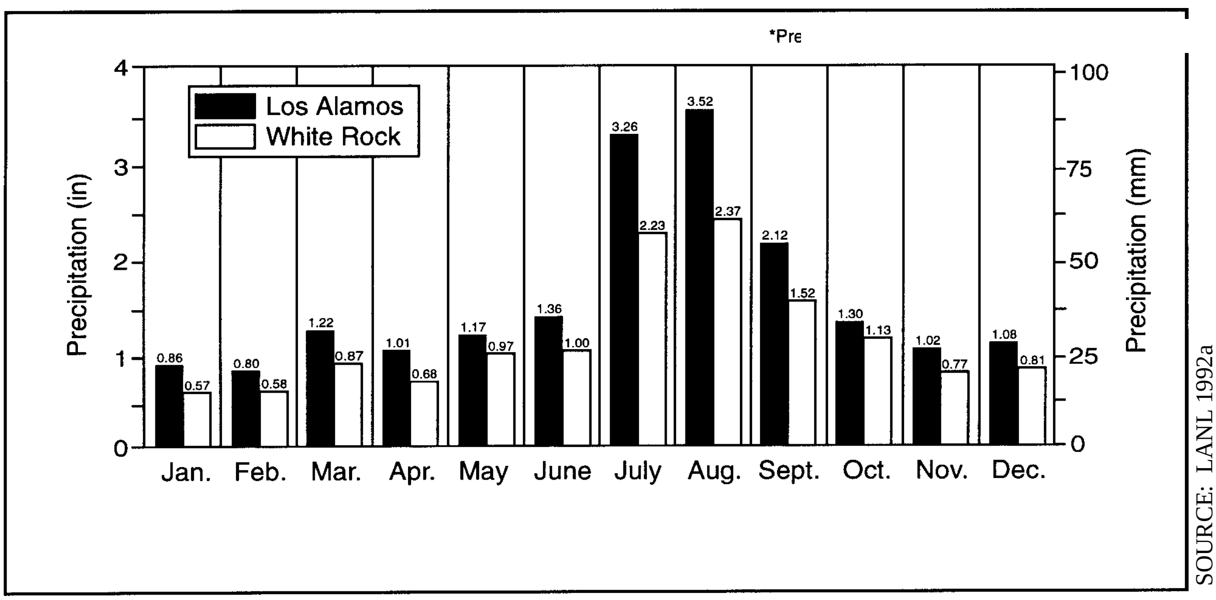


FIGURE 4.4.1–3.—*Mean Precipitation for Los Alamos (1961 to 1990) and White Rock (1965 to 1990).*

Approximately 36 percent of the annual precipitation for Los Alamos County and LANL results from thundershowers that occur in July and August. Winter precipitation falls primarily as snow. Average annual snowfall is approximately 59 inches (150 centimeters), but can vary considerably from year to year. Annual snowfall ranges from a minimum of 9 inches (24 centimeters) to a maximum of 153 inches (389 centimeters). The single-storm snowfall record is 4 feet (122 centimeters) (LANL 1992a).

4.4.1.1 *Wind Conditions*

Meteorological wind conditions are important with regard to air dispersion. The direction and strength of the wind are pertinent to air quality analysis. Los Alamos County winds average 7 miles per hour (3 meters per second). Wind speeds vary throughout the year, with the lowest wind speeds occurring in December and January. The highest winds occur in the spring (March through June) due to intense storms and cold fronts. The highest recorded wind in Los Alamos County was 77 miles per hour (34 meters per second). Surface winds often vary dramatically with the time of day, location, and elevation due to Los Alamos' complex terrain. Average wind direction and wind speed for the five measurement stations are plotted in wind roses and presented in Figure 4.4.1.1–1. A wind rose is a vector representation of wind velocity and duration. It appears as a circle with lines extending from the center representing the direction from which the wind blows. The length of each spoke is proportional to the frequency at which the wind blows from the direction indicated. The frequency of calm winds (less than 1 mile per hour [0.5 meter per second]) is presented in the center of the wind rose.

In addition to seasonal changes in wind conditions, surface winds often vary with the time of day. An up-slope air flow often develops over the Pajarito Plateau in the morning hours. By noon, winds from the south usually prevail over the entire plateau. The prevalent nighttime flow ranges from the west-southwest to northwest over the western portion of the plateau. These nighttime winds result from cold air drainage off the Jemez Mountains and the Pajarito Plateau.

Analyses of Los Alamos Canyon wind data indicate a difference between the atmospheric flow in the canyon and the atmospheric flow over the Pajarito Plateau. Cold air drainage flow is observed about 75 percent of the time during the night and continues for an hour or two after sunrise until an up-canyon flow forms. Nighttime canyon flows are predominantly weak drainage winds from the west. Because of the stability of these nighttime canyon flows and the relatively weak mesa winds, the development of rotors at night in the canyon is rare (LANL 1992a and LANL 1994b). This flow can develop into a turbulent longitudinal whirl or "rotor" that fills the canyon when the wind over the Pajarito Plateau has a strong cross-canyon component.

The irregular and complex terrain and rough forest surfaces in Los Alamos and surrounding areas also affect atmospheric dispersion. The terrain and forests increase horizontal and vertical turbulence and dispersion. The dispersion generally decreases at lower elevations where the terrain becomes smoother and less vegetated. The canyons surrounding LANL channel the air flow, which also limits dispersion. Clear skies and light winds, typical of the summer season, enhance daytime vertical air dispersion, thus lowering the concentrations at breathing height.

Light wind conditions under clear skies can create strong, shallow surface inversions that trap the air at lower elevations and severely restrict dispersion. These light wind conditions occur primarily during the autumn and winter months, with intense surface air inversions occasionally occurring during the winter. Air inversions are most severe during the night and

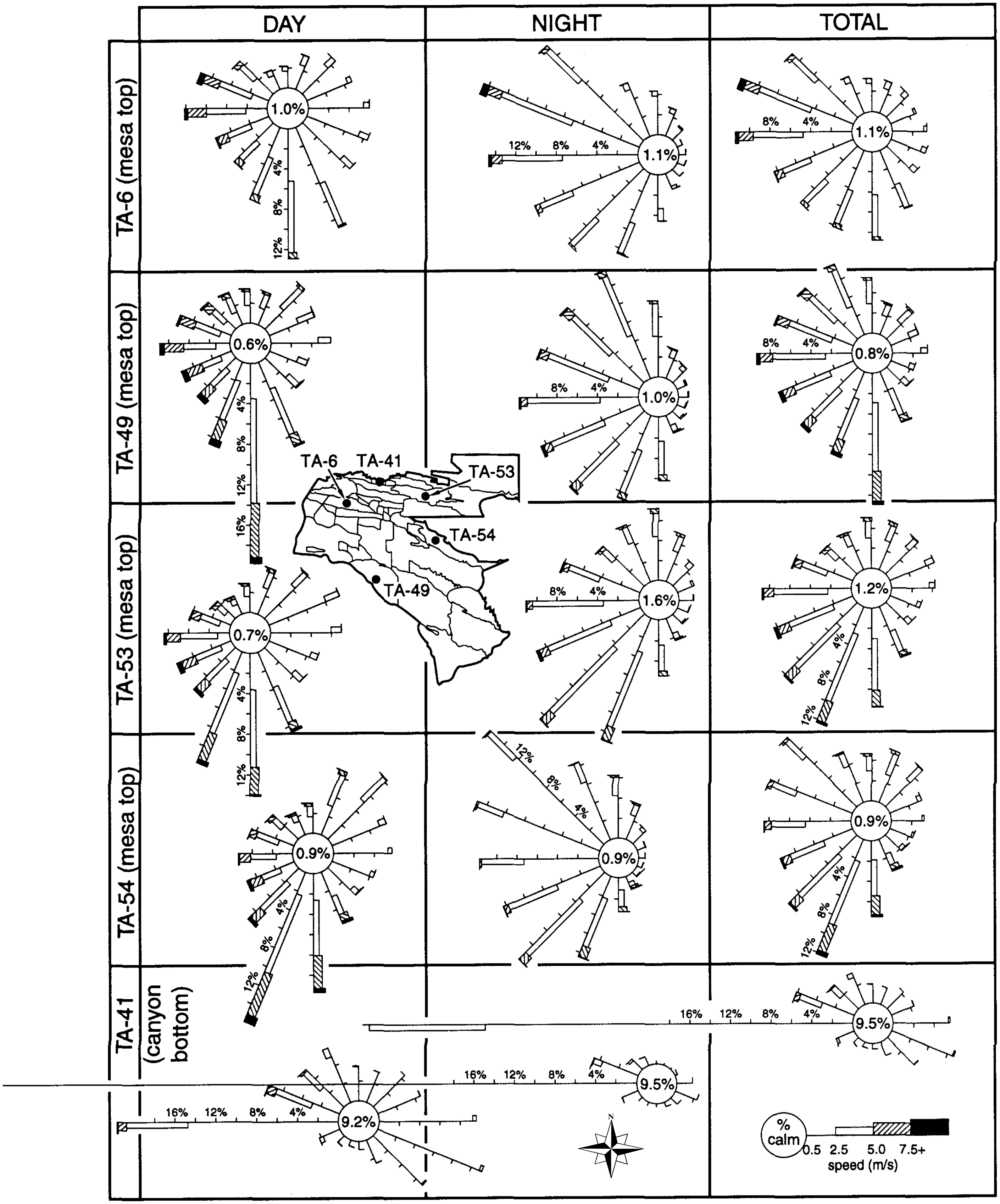


FIGURE 4.4.1.1–1.—*LANL Meteorological Stations with Associated Wind Rose Data.*

early morning. Overall dispersion is greater in the spring during strong winds. However, vertical dispersion is greatest during summer afternoons (LANL 1992a). Deep vertical mixing occurs in the summer afternoons, lowering concentrations at breathing height.

4.4.1.2 *Severe Weather*

Thunderstorms are common in Los Alamos County, with an average of 60 thunderstorms occurring in a year. Lightning can be frequent and intense. The average number of lightning-caused fires, for the years 1990 through 1994, in the 2,727 acres (1,104 hectares) of BNM, is 12 per year (BNM 1995). Because lightning can cause occasional power outages, lightning protection is an important design factor for most facilities at LANL and the surrounding area.

Frequent hailstorms occur in Los Alamos County that can produce measurable hail accumulations on the ground. Typically, hailstones have diameters of approximately 0.25 inch (0.63 centimeter) and do not cause heavy damage to property or plants. An extremely damaging hailstorm occurred in 1990 when golf ball- and baseball-sized hail pummeled the White Rock area (LANL 1992a).

Large-scale flooding is not common in New Mexico. There are no recorded instances of large-scale flooding in Los Alamos County. However, flash floods from heavy thunderstorms are possible in areas such as arroyos, canyons, and low-lying areas. For example, in 1991 a heavy downpour, combined with already saturated soil, caused flash flooding that washed out sewer lines in Pueblo Canyon, which is located between North Mesa and Los Alamos townsite. This incident caused extensive flooding of streets and basements in the Los Alamos townsite (LANL 1992a).

No tornadoes are known to have touched the ground in the Los Alamos area. However, funnel clouds have been observed in Santa Fe County (LANL 1992a).

Remnants of hurricanes and tropical storms originating in the Gulf of Mexico and the Pacific Ocean occasionally reach New Mexico during the summer and autumn. These storms are weak by the time they reach northern New Mexico and do not produce strong winds. However, these storms can produce widespread, strong thunderstorms and heavy rains (LANL 1992a).

4.4.2 Nonradiological Air Quality

LANL operations can result in the release of nonradiological air pollutants that may affect the air quality of the surrounding area. Information regarding the applicable air quality standards and guidelines and existing nonradiological air quality will be presented in this section.

4.4.2.1 *Applicable Requirements and Guidelines*

The *Clean Air Act* (CAA) mandated that EPA establish National Ambient Air Quality Standards (NAAQS) for pollutants of nationwide concern. These pollutants, known as criteria pollutants, are carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, lead, and particulate matter. As of September 16, 1997, in addition to the particulate matter (PM) equal to or less than 10 microns in aerodynamic diameter (PM_{10}) NAAQS, a new NAAQS became effective for particulate matter equal to or less than 2.5 microns (2.5 micrometers) in aerodynamic diameter ($PM_{2.5}$). These new standards will not require imposition of local area controls until 2005, and compliance determinations will not be required until 2008. The recently promulgated 8-hour 0.08 parts per million ozone standard now applies in those areas in which EPA has identified that the 1-hour 0.12 parts per million ozone standard does not apply (63 FR 31014). Los Alamos

County has been identified by EPA as an area where the new 8-hour 0.08 parts per million standard now applies. A primary NAAQS has been established for carbon monoxide and both primary and secondary standards have been established for the remaining criteria pollutants. National primary air quality standards define levels of air quality judged necessary, with an adequate margin of safety, to protect public health. National secondary ambient air quality standards define levels of air quality judged necessary to protect public welfare from any known or anticipated adverse effects of a pollutant. There are only three nonattainment areas in New Mexico, and the area encompassing LANL and Los Alamos County is classified as an attainment area for all six criteria pollutants.

The State of New Mexico has also established ambient air quality standards for carbon monoxide, sulfur dioxide, nitrogen dioxide, total suspended particulates (which is not PM_{10}), hydrogen sulfide, and total reduced sulfur. Additionally, New Mexico established guidelines for toxic air pollutants. Toxic air pollutants are chemicals that are generally found in trace amounts in the atmosphere, but that can result in chronic health effects or increase the risk of cancer when they are present in amounts that exceed established occupational exposure limits. Because of the financial constraints and the unavailability of sufficient information on the effects of toxic air pollutants, New Mexico has yet to establish ambient standards for toxic chemicals. To approach this issue, New Mexico has developed guidelines that are used by the NMED for determining if a new or modified source emitting a toxic pollutant would be issued a permit (20 New Mexico Administrative Code [NMAC] 2.72.402). Additionally, the EPA has established exposure levels for toxic air pollutants, which are known or suspected human carcinogens.

Almost all operations at LANL were in existence before August 31, 1972. Therefore, air quality permits were not required. Air quality permits were obtained from the State Air Quality Bureau for beryllium operations that were modified or constructed after August 31, 1972. In accordance with Title V of the CAA, as amended, and 20 NMAC 2.72.402, UC and DOE submitted a CAA operating permit application to NMED in December 1995. The primary purpose of this permit program is to identify all state and federal air quality requirements applicable to LANL operations so that a single site-wide permit can be granted. Under this permit, UC would track pollutant emissions by reporting annual emissions, based on chemical purchase data, knowledge of operations, and suitable emission factors. NMED has conducted an initial review of this application and issued a Notice of Completeness, but has yet to issue an operating permit.

The New Mexico ambient air pollutant guideline values were used to evaluate toxic air pollutants in the SWEIS. Additional information pertaining to applicable federal and state air quality regulations is presented in chapter 7.

4.4.2.2 *Sources of Nonradiological Emissions*

Criteria pollutants released from LANL operations are emitted primarily from combustion sources such as boilers, emergency generators, and motor vehicles. Table 4.4.2.2–1 presents information regarding the major existing combustion sources that were analyzed for the SWEIS. Toxic air pollutant emissions from LANL activities are released primarily from laboratory, maintenance, and waste management operations. Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility with great fluctuations in both the types of chemicals emitted and their emission rates. DOE has a program to review all new operations for their potential to emit

TABLE 4.4.2.2–1.—*Combustion Sources at LANL*

MAJOR SOURCES[a]	LOCATION	FUEL	POLLUTANTS OF INTEREST
Steam Plant	TA–3–22–1	Natural gas/oil #2	Nitrogen dioxide Sulfur dioxide PM_{10} Total suspended particulates
Steam Plant	TA–21–257–1	Natural gas/oil #2	Nitrogen dioxide Sulfur dioxide PM_{10} Total suspended particulates
Boiler	TA–16–4	Natural gas	Nitrogen dioxide
Boiler	TA–16–5	Natural gas	Nitrogen dioxide
Boiler	TA–16–6	Natural gas	Nitrogen dioxide
Boiler	TA–16–13	Natural gas	Nitrogen dioxide
Asphalt Heater	TA–3–73–2	Oil #2	Nitrogen dioxide Sulfur dioxide PM_{10} Total suspended particulates
Water Pump	TA–54–1013	Natural gas	Nitrogen dioxide

PM_{10} = Particulate matter less than 10 microns in aerodynamic diameter

[a] Emissions from the following smaller combustion sources were also considered:

- 62 miscellaneous boilers at various technical areas (residential size);
- 149 standby emergency generators (7 natural gas, 50 diesel, and 92 gasoline-fueled).

toxic air pollutants. Because past reviews demonstrate that LANL's toxic air pollutant emissions are below the state's permitting threshold limits, DOE is not required to monitor LANL's toxic air pollutant emissions. However, air toxic estimates were made based on chemical use at LANL and assumed stack and building parameters as discussed in chapter 5, section 5.1.4.1.

4.4.2.3 *Existing Ambient Air Conditions*

Only a limited amount of monitoring of the ambient air has been performed for nonradiological air pollutants within the LANL region. NMED operated a DOE-owned ambient air quality monitoring station adjacent to BNM between 1990 and 1994 to record sulfur dioxide, nitrogen dioxide, ozone, and PM_{10} levels (Table 4.4.2.3–1). LANL and NMED discontinued operation of this station in fiscal year 1995 because recorded values were well below applicable standards. New Mexico State had ambient air quality control standards for beryllium, which were repealed in 1995. To ensure that LANL's beryllium emissions did not exceed those standards, ambient air monitoring of beryllium was performed at LANL from 1989 to December 1995. This monitoring was performed at four on-site stations, four perimeter performed at four on-site stations, four perimeter stations, and one regional station. The recorded beryllium levels were low, and as a result, beryllium monitoring was discontinued after December 1995.

4.4.3 Radiological Air Quality

Individuals are continuously exposed to airborne radioactive materials. These materials come primarily from natural sources such as

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TABLE 4.4.2.3–1.—*Nonradiological Ambient Air Monitoring Results at TA–49 (1991 Through 1994)*

CONTAMINANT	AVERAGING TIME	UNIT	NEW MEXICO STANDARD	NAAQ STANDARD		1991	1992	1993	1994
				PRIMARY	SECONDARY				
Sulfur Dioxide	Annual	ppm	0.02	0.03		0.001	0.0005	0.002	0.001
	24 hours	ppm	0.10	0.14					0.009
	3 hours	ppm			0.05				
	1 hour	ppm				0.008	0.009	0.006	0.011
Nitrogen Dioxide	Annual	ppm	0.05	0.053	0.053	0.003	0.002	0.003	0.003
	24 hours	ppm	0.10						0.006
	1 hour	ppm				0.01	0.02	0.027	0.013
Ozone	1 hour	ppm		0.12	0.12	0.087	0.076	0.077	0.09
PM_{10}	Annual	$\mu g/m^3$		50	50	7	8	8	8
	24 hours	$\mu g/m^3$		150	150	15	21	30	29

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
PM_{10} = Particulate matter less than 10 microns in aerodynamic diameter
NAAQ = National Ambient Air Quality
Sources: LANL 1994b, LANL 1995f, LANL 1996e, and LANL 1993b

radium and its daughters, including radon. However, airborne radioactive materials can also be emitted by manmade operations. For example, in 1993 the average Los Alamos resident received a radiation dose of 200 millirems from exposure to naturally occurring radon gas and a radiation dose of 0.15 millirems from LANL nuclear operations (LANL 1995f). Descriptions of the radiation doses received by individuals within Los Alamos County from recent routine LANL operations are presented in this subsection.

Some LANL operations may result in the release of radioactive materials to the air from point sources such as stacks or vents or from nonpoint (or area) sources such as the radioactive materials in contaminated soils. The concentration of radionuclides in point-source releases is continuously sampled or estimated based on knowledge of the materials used and the activities performed. Nonpoint-source emissions are directly monitored or sampled or estimated from airborne concentrations outdoors. Radionuclide emissions from LANL point and nonpoint sources include several radioisotopes such as tritium, uranium, strontium-90, and plutonium.

4.4.3.1 *Radiological Emissions and Monitoring*

Manmade sources of airborne radiological emissions include radioactive materials or radiation-producing equipment. At LANL, radiation sources are used in operations, primarily to support nuclear weapons research and development. Many LANL organizations or work groups use radioactive materials. These work groups are located in TAs throughout LANL.

The number of stacks that are continuously monitored for radiological air emissions varies, and is dependent on DOE operational and EPA radiological air emission monitoring requirements. As of August 1996, 33 stacks were continuously monitored to measure the air emissions for radioactive materials. DOE also operates an ambient air monitoring program (AIRNET) at LANL to measure the level of radionuclides in the air. In 1994, there were 35 on-site monitoring stations, 15 site perimeter monitoring stations, and 3 off-site monitoring stations at the Pueblos of San Ildefonso, Taos, and Jemez. Three background monitoring stations are also operated in Española, Pojoaque, and Santa Fe (Fong 1995). As activities with potential for increased releases change, on-site, site perimeter, and off-site monitoring stations will be added to the ambient air monitoring program (AIRNET) consistent with the requirements of the operational changes.

Currently, the largest contributors to LANL radiological point-source emissions are LANSCE and the tritium operations. LANL nonpoint sources of radiological emissions include fugitive emissions from the LANSCE bay area and holding ponds, the PHERMEX facility at TA–15, the dynamic testing facility at TA–36, and low-level radioactive waste (LLW) disposal at Material Disposal Area (MDA) G. A list of radionuclides emitted from LANL operations during the period of 1990 through 1995 is presented in volume III, appendix B.

4.4.3.2 *Radiological Emission Standards*

Radiological air emission requirements are specified in 40 CFR 61, Subpart H, "National Emissions Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities." During 1991 and 1992, EPA cited DOE for exceeding the dose standard in 1990 and for LANL operations not being in full compliance with these requirements. Although there was a program for measuring emissions of radioactive materials, the program did not meet all of the provisions of Subpart H, including sample probe design criteria, placement, and quality assurance requirements. Upon enactment of Subpart H, LANL began assessing its existing air monitoring program in light of these new regulations (enacted in December 1989), and investigating the means to achieve compliance with those regulations. In June 1996, DOE and EPA signed a Federal Facility Compliance Agreement that specifies how UC will meet the requirements of 40 CFR 61, Subpart H (EPA 1996a). Since June 1996, DOE and UC have asserted that LANL operations are in full compliance.

4.4.3.3 *Radiation Doses from LANL Airborne Emissions*

EPA regulations for radionuclide air emissions (40 CFR 61, Subpart H) require that doses be modeled in order to demonstrate compliance with the standard. Doses are also directly monitored as part of routine environmental monitoring but do not include some of the modeled pathways. The measured and modeled radiological doses for the maximally exposed individual (MEI) are presented in Table 4.4.3.3–1 for the period of 1990 through 1995. The location of the LANL MEI is assumed to be 2,625 feet (800 meters) north-northeast from the LANSCE ES–3 stack, where the maximum dose from the air pathway is received. The CAA Assessment Package for 1988 (CAP–88), an EPA-approved model, was used to calculate the dose to MEI. Different assumptions are used to estimate the measured and modeled doses. The CAP–88 model assumes that the MEI is stationary throughout the year and does not account for shielding from clothing or buildings. This model also assumes that the MEI ingests some food, milk, vegetables, and fruits grown at that location; inhales radioactive materials; and receives external exposure to radiation. This model also uses conservative dose conversion factors. Therefore, the modeled dose is generally higher than the actual measured dose.

Measured doses are based on actual monitoring data taken from the monitoring station at the

TABLE 4.4.3.3–1.—*Dose to the MEI from Exposure to LANL Airborne Radionuclide Emissions (1990 Through 1995)*

YEAR	MEASURED DOSE[a]		MODELED DOSE[b]	
	DOSE (millirem/year)	PERCENT OF EPA STANDARD	DOSE (millirem/year)	PERCENT OF EPA STANDARD
1990	3.1	31	15.3[c]	153
1991	Not Above Background[d]	-	6.5	65
1992	Not Above Background[d]	-	7.9	79
1993	3.1	31	5.6	56
1994	3.5	35	7.6	76
1995	2.3	23	5.1	51

[a] *Sources*: LANL 1994b, LANL 1995f, LANL 1996e, LANL 1996i, LANL 1993b, and LANL 1992b
[b] No shielding and an occupancy factor of 1.0 were used for calculating the modeled dose.
[c] This modeled dose is based on an MEI location that is 800 meters north/northeast of the LANSCE ES–3 stack. In 1990, no one resided at this location.
[d] In 1991 and 1992, the monitoring devices at the MEI location did not show doses above the background levels. This was because the monitoring devices were not sensitive enough to pick up small doses.

MEI location. This includes thermoluminescent dosimeters (TLDs) and air sampling stations. The measured doses do not take into account the inhalation or ingestion (breathing in or eating) of radioactive materials that are accounted for in the modeled dose.

EPA requires that emissions of radioactive materials to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 millirem. DOE received a notice of noncompliance from EPA for its emissions during 1990. This notice was issued because DOE applied a shielding factor (a factor that reduces the calculated dose to take credit for materials, such as clothing or walls of a residence, that can shield the MEI from the effects of radioactive emissions) in calculating the MEI dose without prior EPA approval; the MEI dose without use of the shielding factor exceeded the 10 millirem limit for 1990.

4.4.4 Visibility

In accordance with CAA, as amended, and New Mexico regulations, the BNM and Wilderness Area have been designated as a Class I area (i.e., wilderness areas that exceed 10,000 acres (4,047 hectares) where visibility is considered to be an important value (40 CFR 81 and 20 NMAC 2.74) and requires protection. Visibility is measured according to a standard visual range, how far an image is transmitted through the atmosphere to an observer some distance away. Visibility has been officially monitored by the NPS at the BNM since 1988 (Table 4.4.4–1 reflects average visibility from 1991 through 1994). The view distance at BNM has been recorded from approximately 40 to 103 miles (77 to 166 kilometers). The visual range has not deteriorated during the period for which data are available (ARSI 1994).

TABLE 4.4.4–1.—*Average Visibility Measurements at Bandelier National Monument (1991 to 1994)*

SEASON	1991		1992		1993		1994	
	miles	**kilometers**	**miles**	**kilometers**	**miles**	**kilometers**	**miles**	**kilometers**
Winter	77	124	70	113	67	107	92	148
Spring	77	124	73	117	77	124	63	102
Summer	70	113	65	104	83	133	73	117
Fall	67	107	68	110	63	102	85	137

Source: ARSI 1994

4.5 ECOLOGICAL RESOURCES AND BIODIVERSITY

4.5.1 Ecological Resources

LANL is located in a region of diverse landform, elevation, and climate—features that have contributed to producing in New Mexico one of the world's most diversified plant and animal communities. The combination of these features, including past and present human use, has given rise to correspondingly diverse, and often unique, biological communities and ecological relationships in Los Alamos County and the region as a whole. Plant communities range from urban and suburban areas to grasslands, wetlands, shrublands, woodlands, and mountain forest, and provide habitat for a wealth of animal life. This richness of animal life includes herds of elk and deer, bear, mountain lions, coyotes, rodents, bats, reptiles, amphibians, invertebrates, and a myriad of resident, seasonal, and migratory bird life. In addition, numerous threatened, endangered, species of concern, and other sensitive species utilize LANL resources. Because of restricted access to LANL lands and management of contiguous BNM for natural biological systems, much of the region provides a refuge for wildlife.

The interfingering of deep, steep-sided canyons with narrow mesas that descend the east slopes of the Jemez Mountains and an inversion of the normal altitudinal distribution of vegetation communities along the canyon floors result in many transitional overlaps of plant and animal communities and increased biological diversity. It is this dominant feature of the Pajarito Plateau, in combination with an elevational descent of almost a mile from mountain ridges to the Rio Grande, that has made a major contribution to the species richness and diverse ecological relationships that characterize the Pajarito Plateau.

Since the turn of the century, logging has been an important industry on the Pajarito Plateau. Sawmills were small and easily portable, dragged from place to place to follow the loggers. The output, mostly poles and railroad ties, was hauled by wagon to lumber yards along the Denver and Rio Grande Western Railroad. One small mill site lies at the head of Alamitos mesa. This was McCurdy's mill, one of a number of logging camps that itinerant lumberman H.T. McCurdy established on the Pajarito Plateau in the 1920's. Now little remains to mark the location but a round clearing and some mill debris. Elk bed in the tall grass and western tanagers sing from the tree tops.Source: Los Alamos Outdoors (Hoard nd)

4.5.1.1 *A Regional Approach*

Administrative boundaries do not often coincide with ecological boundaries, which are frequently boundaries that vary in space and time and at multiple scales. LANL facilities, infrastructure, operations, and impacts (positive, negative, and undetermined) are immersed in the patterns and processes of a complex and fragile regional landscape. Weather, geomorphic and elevational variation, soils, plant, and animal communities, and major canyon systems are continuous across the jurisdictional boundaries of LANL, the NPS, the USFS, the regional Pueblos, and other regional land stewards. Seasonal migration routes for thousands of elk and deer in the region and foraging or hunting ranges of black bears and mountain lions ignore map boundaries such as fences that define these boundaries on the landscape. Migratory birds from as far away as Central and South America breed throughout the region during the spring and summer. Because of this ecological continuity and "interconnectedness" of patterns of vegetation and wildlife populations, along with the ecological processes that shape and sustain them, the "site" to be analyzed in this SWEIS is the larger regional ecosystem.

Two landscape-based organizational themes are used to present the data in this section from a regional ecosystem perspective: watershed units and major vegetation zones. The general area included for analysis is shown in Figure 4.5.1.1–1, LANL Technical Areas and Watersheds. Descriptions of specific vegetation ecosystem components such as air, soils and sediments, and surface and groundwater can be found in other subsections of this report and associated technical reports.

Watershed Unit

Traditionally, environmental impact assessments have considered air quality, water resources, wildlife, and human communities as separate entities for analysis. Recognition of the interconnectedness of land, water, and human resources has encouraged many federal and state agencies to undertake ecosystem or watershed approaches to environmental protection (CEQ 1997). For example, EPA is promoting multi-organizational, multi-objective, watershed management projects across the nation. This shift toward comprehensive watershed management has helped lead EPA toward a "place-based approach" to environmental problem solving (EPA 1994).

Watersheds are natural boundaries that provide a common template for integrating multiple tasks, including ecological resource description, analysis, and management, thereby enhancing efficiency and economy. The complex canyon/mesa topography and pronounced elevational gradients of LANL region are particularly well suited to this approach because regional watersheds:

- Are relatively discrete landscape units with a hierarchical structure.
- Are relatively closed systems in terms of many ecological components and processes such as hydrologic regime, nutrient cycling, contaminant transport, erosion, and sedimentation.
- Provide an ecologically consistent template for organizing information on ecosystem components, such as landscape-wide vegetation zones as well as resident and migratory wildlife populations (including threatened and endangered species, and wetlands).

The regional LANL ecosystem has been more precisely delineated by incorporating watershed boundaries as shown in Figure 4.5.1.1–1. As mapped, this area includes 14 regional watersheds bounded by Guaje Canyon on the north, Frijoles Canyon on the south, the crest of the Jemez Mountains on the west, and the Rio Grande on the east. Because of their downstream hydrologic connection to LANL and the function boundary of Cochiti Dam, the White Rock Canyon stretch of the Rio Grande and Cochiti Lake were also included in this analysis. Summary information is presented in Table 4.5.1.1–1.

Major Vegetation Zones

While watersheds traverse all or part of the elevational gradient, major vegetation zones are organized into elevation- and aspect-defined bands across this gradient. Increasing temperature and decreasing moisture along the approximately 12-mile (19-kilometer) wide, 5,000-foot (1,500-meter) elevational gradient from the peaks of the Jemez Mountains to the Rio Grande are primarily responsible for the formation of five broad bands, containing six major vegetation zones. These vegetation zones are defined by the dominant vegetation species. Plant and animal communities similar to those found throughout the southern Rocky Mountain region live within these vegetation zones (Bailey 1980).

From the western crest of the Pajarito Plateau to the Rio Grande, the six vegetation zones that characterize the LANL region consist of

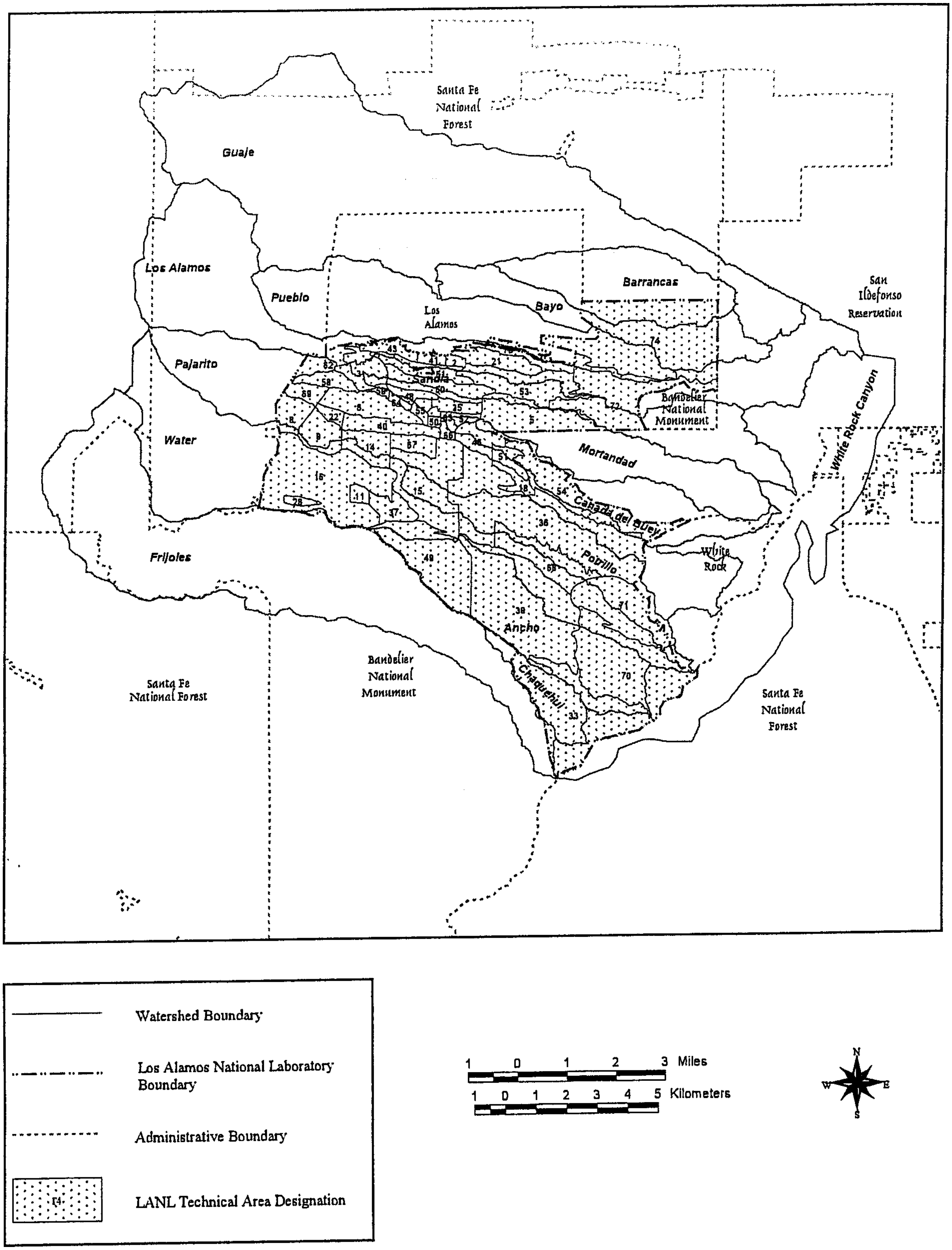

FIGURE 4.5.1.1–1.—*LANL Technical Areas and Watersheds.*

TABLE 4.5.1.1–1.—*Regional Watershed Summary*

WATERSHED	AREA (square feet)	AREA (acres)
Ancho	188,052,531	4,317
Barrancas	137,219,762	3,150
Bayo	110,280,543	2,532
Cañada del Buey	119,458,359	2,742
Chaquehui	43,866,574	1,007
Frijoles	532,030,496	12,214
Guaje	736,234,029	16,902
Los Alamos	391,865,822	8,996
Mortandad	168,145,908	3,860
Pajarito	357,109,578	8,198
Potrillo	125,618,752	2,884
Pueblo	232,544,591	5,338
Sandia	153,152,776	3,516
Water	402,236,668	9,234
White Rock Canyon	449,075,835	10,309
Total Area	4,146,892,223	95,200

montane grasslands, spruce-fir forest, mixed-conifer forest (with aspen forest), ponderosa pine forest, pinyon-juniper woodland, and juniper savannah. These vegetation zones are depicted on Figure 4.5.1.1–2. The major plant communities of each watershed and areal coverage are depicted in Table 4.5.1.1–2. The montane grassland, spruce-fir, and mixed conifer vegetation zones are located primarily west of LANL with little representation on the laboratory proper. The vegetation zones and associated ecotones provide habitat, including breeding and foraging territory, and migration routes for a diversity of permanent and seasonal wildlife species. This diversity is illustrated by the presence of over 900 species of vascular plants; 57 species of mammals; 200 species of birds, including 112 species known to breed in Los Alamos County; 28 species of reptiles; 9 species of amphibians; over 1,200 species of arthropods; and 12 species of fish (primarily found in the Rio Grande, Cochiti Lake and the Rito de los Frijoles). No fish species have been found within LANL boundaries.

Characteristics of each zone are presented in Table 4.5.1.1–3. The Fenton Hill site (TA–57) is on the southwestern side of the Valles Caldera, on a mesa top location (Lake Fork Mesa) on the Jemez Plateau. This site is at an elevation of 8,660 feet (2,640 meters), and its vegetation characteristics at this elevation are those described in Table 4.5.1.1–3. Table 4.5.1.1–4 is a summary of conditions for each vegetation zone that existed about 1850, human and natural disturbances that have altered these historic conditions, and current conditions resulting from these ecological perturbations.

4.5.1.2 *Wetlands*

Wetlands are transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of the National Wetlands Inventory, conducted by the FWS, which included an inventory of wetlands in the LANL region, wetlands must have one or more of the following attributes:

- At least periodically, the land supports predominantly hydrophytes (plants adapted to abundant water such as cattails and willows).
- The substrate is predominantly undrained hydric soil (e.g., marshes, wet meadows).
- The substrate is nonsoil (e.g., gravel, stones) and is saturated with water or covered by shallow water at some time during the growing season of each year.

A 1990 survey (based on interpretation of aerial photographs) identified a total of 39 acres (16 hectares) of wetlands within LANL boundaries (FWS 1990). A 1996 field survey by LANL personnel identified an estimated 50 acres (20 hectares) of wetlands within

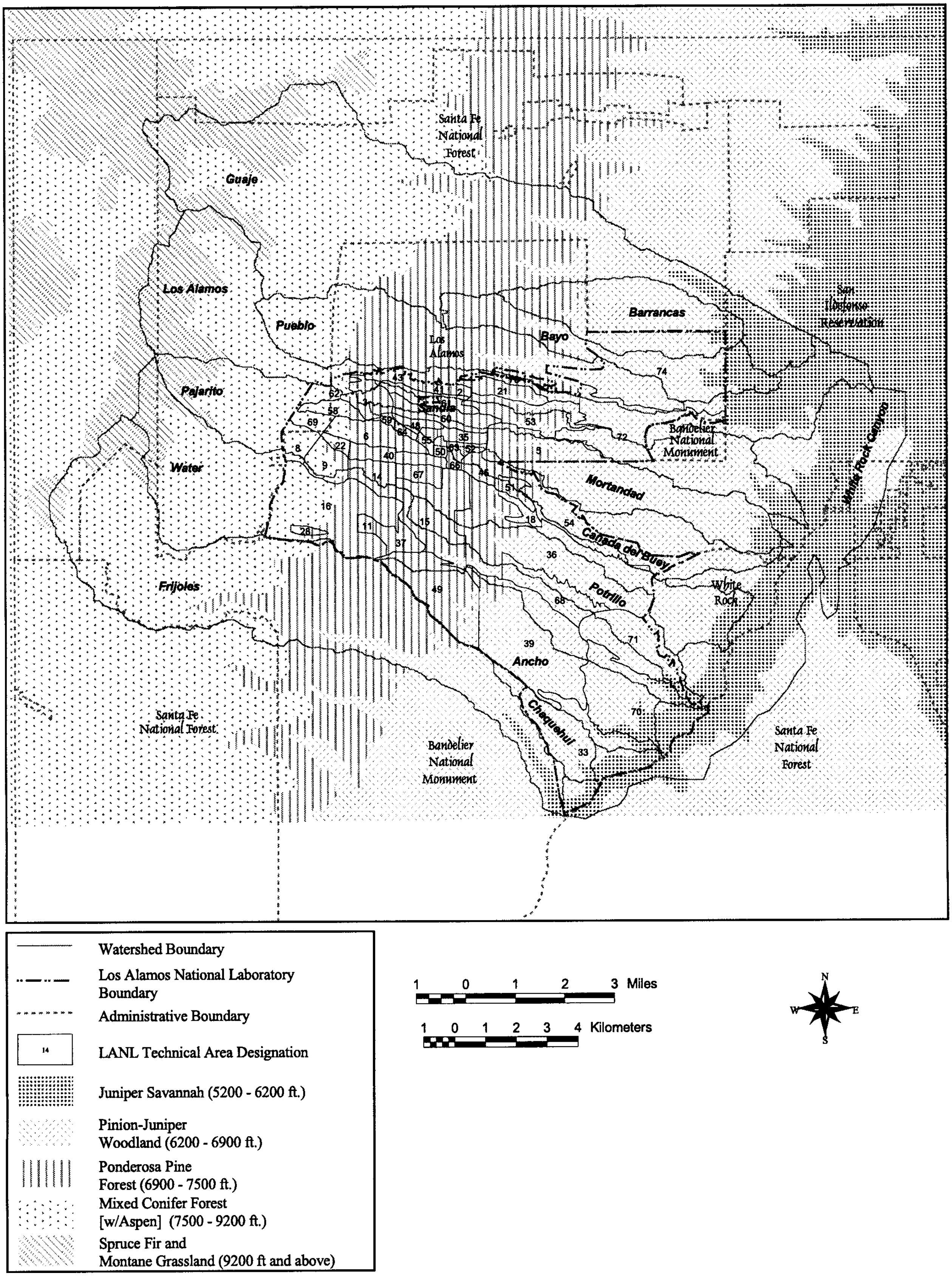

FIGURE 4.5.1.1–2.—*LANL Technical Areas and Watersheds with Vegetation Zones.*

TABLE 4.5.1.1–2.—*Areal Extent of Major Vegetation Zones by Watershed*

WATERSHED	VEGETATION RANGE (BASED ON ELEVATION)	AREA (square feet)	AREA (acres)
Ancho	Juniper Savannah	14,297,807	328
Ancho	Pinyon-Juniper Woodland	133,915,070	3,074
Ancho	Ponderosa Pine Forest	39,839,654	915
Barrancas	Juniper Savannah	10,073,560	231
Barrancas	Pinyon-Juniper Woodland	102,969,882	2,364
Barrancas	Ponderosa Pine Forest	24,176,321	555
Bayo	Juniper Savannah	22,090,862	507
Bayo	Pinyon-Juniper Woodland	52,558,313	1,207
Bayo	Ponderosa Pine Forest	35,631,368	818
Cañada del Buey	Juniper Savannah	2,692,403	62
Cañada del Buey	Pinyon-Juniper Woodland	96,741,792	2,221
Cañada del Buey	Ponderosa Pine Forest	20,024,164	460
Chaquehui	Juniper Savannah	2,092,897	48
Chaquehui	Pinyon-Juniper Woodland	41,773,677	959
Frijoles	Juniper Savannah	11,871,528	273
Frijoles	Mixed Conifer Forest (includes Aspen)	249,513,490	5,728
Frijoles	Pinyon-Juniper Woodland	79,998,306	1,837
Frijoles	Ponderosa Pine Forest	157,547,985	3,617
Frijoles	Spruce Fir Forest & Montane Grasslands	33,099,186	760
Guaje	Juniper Savannah	46,782,112	1,074
Guaje	Mixed Conifer Forest (includes Aspen)	325,620,902	7,475
Guaje	Pinyon-Juniper Woodland	68,220,346	1,566
Guaje	Ponderosa Pine Forest	181,335,133	4,163
Guaje	Spruce Fir Forest & Montane Grasslands	114,275,536	2,623
Los Alamos	Juniper Savannah	68,170,275	1,565
Los Alamos	Mixed Conifer Forest (includes Aspen)	99,349,119	2,281
Los Alamos	Pinyon-Juniper Woodland	70,685,022	1,623
Los Alamos	Ponderosa Pine Forest	57,650,780	1,323
Los Alamos	Spruce Fir Forest & Montane Grasslands	96,010,627	2,204
Mortandad	Juniper Savannah	8,610,636	198
Mortandad	Pinyon-Juniper Woodland	114,783,354	2,635
Mortandad	Ponderosa Pine Forest	44,751,918	1,027
Pajarito	Juniper Savannah	11,269,977	259
Pajarito	Mixed Conifer Forest (includes Aspen)	119,271,954	2,738
Pajarito	Pinyon-Juniper Woodland	82,916,322	1,903
Pajarito	Ponderosa Pine Forest	118,337,174	2,717
Pajarito	Spruce Fir Forest & Montane Grasslands	25,314,152	581

TABLE 4.5.1.1–2.—*Areal Extent of Major Vegetation Zones by Watershed*-Continued

WATERSHED	VEGETATION RANGE (BASED ON ELEVATION)	AREA (square feet)	AREA (acres)
Potrillo	Juniper Savannah	911,331	21
Potrillo	Pinyon-Juniper Woodland	95,475,889	2,192
Potrillo	Ponderosa Pine Forest	29,231,531	671
Pueblo	Mixed Conifer Forest (includes Aspen)	67,279,650	1,545
Pueblo	Pinyon-Juniper Woodland	56,892,435	1,306
Pueblo	Ponderosa Pine Forest	108,372,506	2,488
Sandia	Juniper Savannah	12,911,421	296
Sandia	Mixed Conifer Forest (includes Aspen)	63,567	1
Sandia	Pinyon-Juniper Woodland	95,838,989	2,200
Sandia	Ponderosa Pine Forest	44,338,799	1,018
Water	Juniper Savannah	8,447,744	194
Water	Mixed Conifer Forest (includes Aspen)	184,932,126	4,245
Water	Pinyon-Juniper Woodland	78,110,286	1,793
Water	Ponderosa Pine Forest	96,311,587	2,211
Water	Spruce Fir Forest & Montane Grasslands	34,434,926	791
White Rock Canyon	Juniper Savannah	316,447,111	7,265
White Rock Canyon	Pinyon-Juniper Woodland	132,628,723	3,045
Total Area		4,146,892,223	95,200

TABLE 4.5.1.1–3.—*Characteristics of the Major Vegetation Zones in the LANL Area*

MAJOR VEGETA-TION ZONE	ACRES AND PERCENT OF LANL	TYPICAL ELEVATION RANGE	AVERAGE PRECIPITATION	COMMON TREES	COMMON SHRUBS OR FLOWERS	COMMON GRASSES	COMMON ANIMALS	COMMON BIRDS	THREATENED AND ENDANGERED SPECIES POTENTIALLY PRESENT
Spruce-Fir Forest	None[a]	Above 9,500 ft[b] (2,895 m)	35 in. (90 cm)	• Engelmann spruce • Corkbark fir • White fir • Douglas fir	• Arizona peavine • Whortleberry • Creeping barberry • Western thimbleberry	• Pine dropseed • Timothy • Interior bluegrass	• Black bear • Elk • Mule deer • Mountain lion • Bobcat	• Warbling vireo • Blue grouse • Wild turkey • Clark's nutcracker	Yes
Montane Grassland	None[a]	Above 9,500 ft[b] (2,895 m)[c]	35 in. (90 cm)	• Ponderosa pine • Douglas fir	• Mariposa lily • Rocky Mountain iris • Gentiant	• Timber oatgrass • Thurber fescue • Orchard grass	• Black bear • Elk • Mule deer • Mountain lion • Bobcat	• Mountain bluebird • Golden-crowned kinglet • Northern flicker	Yes
Mixed-Conifer Forest (includes a minor amount of Aspen)	Approximately 367 ac (147 ha), 3.3 percent	7,500 to 9,500 ft (2,285 to 2,896 m)	18 to 30 in. (46 to 76 cm)	• Ponderosa pine • Douglas fir • White fir • Limber pine • Aspen	• Ninebark • Oceanspray • Cliffbush • Bracken fern • Mountain lover	• June grass • Arizona fesque • Fringed brome • Pine dropseed • Common timothy • Mountain brome	• Black bear • Elk • Mule deer • Mountain lion • Bobcat • Raccoon	• Dark-eyed junco • Yellow-rumped warbler • Olive-sided flycatcher	Yes
Ponderosa-Pine Forest	Approximately 8,092 ac (3,637 ha), 29.3 percent	6,900 to 7,500 ft (2,100 to 2,285 m)	16 to 18 in. (40 to 46 cm)	• Ponderosa pine • Gambel oak	• Kinnikinik • New Mexico locust	• Pine dropseed • Mountain muhly • Little bluestern	• Black bear • Elk • Mule deer • Mountain lion • Bobcat • Coyote • Skunk • Raccoon • Deer mouse • Abert's squirrel	• Western bluebird • Solitary vireo • Grace's warbler • Western tanager • Black-headed grosbeak	Yes

TABLE 4.5.1.1–3.—*Characteristics of the Major Vegetation Zones in the LANL Area*-Continued

MAJOR VEGETATION ZONE	ACRES AND PERCENT OF LANL	TYPICAL ELEVATION RANGE	AVERAGE PRECIPITATION	COMMON TREES	COMMON SHRUBS OR FLOWERS	COMMON GRASSES	COMMON ANIMALS	COMMON BIRDS	THREATENED AND ENDANGERED SPECIES POTENTIALLY PRESENT
Pinyon-Juniper Woodland	Approximately 12,770 ac (5,108 ha), 46.2 percent	6,200 to 6,900 ft (1,890 to 2,100 m)	12 to 16 in. (30 to 41 cm)	• One-seed juniper • Pinyon pine	• Wavy-leaved oak • Mountain mahogany • Chamisa • Yucca	• Blue grama • Galleta • Needle and thread	• Elk • Mule deer • Mountain lion • Bobcat • Coyote • Deer mouse	• Cassin's kingbird • Cliff swallow • Ash-throated flycatcher • Brown-headed cowbird	Yes
Juniper Savannah	Approximately 1,035 ac (414 ha), 3.7 percent	5,200 to 6,200 ft (1,585 to 1,890 m)	10 in. (25 cm)	• One-seeded juniper	• Big sagebrush • Perky sue • Yucca	• Blue grama • Side-oats grama • Indian rice grass • Black grama	• Elk • Mule deer • Mountain lion • Bobcat • Coyote • Ringtail	• Black-headed grosbeak • Rufous-sided towhee • Rock wren • Scrub jay	Yes

Nonvegetated: 2,432 acres (ac) (984 hectares [ha]), 8.8 percent
Water: 6 acres (2 hectares), 0 percent

[a] Although the spruce-fir forest and montane grassland vegetation zones do not occur within LANL boundaries, many of the region's watersheds originate from and are influenced by these communities.
[b] Spruce-fir forest and montane grassland share the same elevational band. Montane grasslands occur primarily on south-facing slopes.
Sources: Allen 1989, Jacobs 1989, Foxx and Tierney 1985, Travis 1992, Koch et al. 1997, BNM nd, NPS 1992, and NPS 1986

TABLE 4.5.1.1–4.—*Vegetation Zones—Disturbances and Current Ecological Conditions*

ECOSYSTEM CONDITIONS	MAJOR VEGETATION ZONES					
	SPRUCE-FIR FOREST	**MONTANE GRASSLAND**	**MIXED-CONIFER FOREST (INCLUDING ASPEN)**	**PONDEROSA-PINE FOREST**	**PINYON-JUNIPER WOODLAND**	**JUNIPER SAVANNAH**
Existing About 1850	• Greater number of corkbark fir • Fewer Engelmann spruce • Larger number of meadows on south-facing slopes and valleys • Intense fires occurred every 150 years • Diverse habitats and wildlife	• Zone was twice the size • Increased number of surface fires resulting in frequent tree thinning • Extensive summer range for elk • Diverse habitats and wildlife	• Existence of an open, old-growth forest (about 50 per ac [124 per ha]) with aspens and more grass and flowers • Low-intensity fires occurred about every 10 years • Diverse habitats and wildlife	• Open forests with lower tree density (about 40 per ac [99 per ha]) • Larger meadows with more grasses, shrubs, and flowers • Low-intensity surface fires occurred every 5 to 10 years • Diverse habitats and wildlife	• Open woodlands with low tree density and large grassy meadows • Low-intensity surface fires occurred every 15 to 40 years • Diverse habitats and wildlife	• Open woodlands with low tree density and large grassy meadows • Low-intensity surface fires occurred every 15 to 40 years
Human Disturbances	• Logging • Cattle and sheep grazing • Fire suppression • Land development • Increased recreational use • Elk overpopulation	• Cattle and sheep grazing • Fire suppression • Land development • Hunting • Increased recreational use	• Logging • Cattle and sheep grazing • Fire suppression • Land development • Hunting • Increased recreational use	• Logging • Cattle and sheep grazing • Fire suppression • Land development • Hunting • Increased recreational use	• Logging • Cattle and sheep grazing • Fire suppression • Land development • Hunting • Increased recreational use	• Logging • Cattle and sheep grazing • Fire suppression • Land development • Hunting • Increased recreational use
Natural Disturbances	• Climate variability • Flash flooding • Lightning-caused fires	• Climate variability • Flash flooding • Lightning resulting in fires • Insect outbreaks	• Climate variability • Flash flooding • Lightning resulting in fires • Insect outbreaks	• Climate variability • Flash flooding • Lightning resulting in fires • Insect outbreaks	• Climate variability • Flash flooding • Lightning resulting in fires • Insect outbreaks	• Climate variability • Flash flooding • Lightning resulting in fires • Insect outbreaks

TABLE 4.5.1.1–4.—*Vegetation Zones—Disturbances and Current Ecological Conditions*-Continued

ECOSYSTEM CONDITIONS	MAJOR VEGETATION ZONES					
	SPRUCE-FIR FOREST	MONTANE GRASSLAND	MIXED-CONIFER FOREST (INCLUDING ASPEN)	PONDEROSA-PINE FOREST	PINYON-JUNIPER WOODLAND	JUNIPER SAVANNAH
Current Condition Resulting from Ecological Disturbances	• Current condition more similar to previous than any other zone • Loss of old-growth forests and critical habitats • High-fuel loads • Shrinking meadows • Habitat fragmentation • Stressed habitats • Loss of grasslands • Higher soil erosion rates • Soil erosion and windthrow • Increased potential for fires • Death of trees and reduction of critical habitats	• Ingrowth of conifers, aspens, and woody shrubs are now the dominant species • On average, 55 percent reduction in grasslands size from 1920 to 1932 • High fuel loads and shrinking grasslands • Habitat fragmentation and altered wildlife use patterns • Species loss • Stressed habitats • Soil erosion and windthrow • Increased potential for fires • Death of trees and reduction of critical habitats	• Reduction of old-growth forests and critical habitats • Dense forests, smaller trees (up to about 5,000 per ac [12,350 per ha]), fewer aspen, more white fir and Douglas fir; grasses, shrubs, and flowers • Habitat fragmentation and altered wildlife use patterns • Species loss • Stressed habitats • Soil erosion and windthrow • Increased potential for fires • Death of trees and reduction of critical habitats	• Reduction of old-growth forests and critical habitats • Cessation of natural fires with dense forests with “dog hair thickets,” 2,000 to 8,000 small-diameter trees per ac (4,940 to 19,750 per ha), little grass, shrubs, flowers; high fuel loads • Habitat fragmentation and altered wildlife use patterns • Species loss • Stressed habitats • Soil erosion and windthrow • Increased potential for fires • Death of trees and reduction of critical habitats	• Reduction of native grasses, loss of ground-cover vegetation • Cessation of natural fires resulting in high tree density expanding into former meadows • Habitat fragmentation and altered wildlife use patterns • Species loss • Stressed habitats • Soil erosion and windthrow • Increased potential for fires • Death of trees and reduction of critical habitats	• Reduction of native grasses, loss of ground-cover vegetation • Cessation of natural fire resulting in invasion of juniper trees and severe soil erosion • Habitat fragmentation and altered wildlife use patterns • Species loss • Stressed habitats • Canyons/Rio Grande sediment/ contaminant transport • Increased potential for fires • Death of trees and reduction of critical habitats

TABLE 4.5.1.1–4.—*Vegetation Zones—Disturbances and Current Ecological Conditions*-Continued

ECOSYSTEM CONDITIONS	MAJOR VEGETATION ZONES					
	SPRUCE-FIR FOREST	MONTANE GRASSLAND	MIXED-CONIFER FOREST (INCLUDING ASPEN)	PONDEROSA-PINE FOREST	PINYON-JUNIPER WOODLAND	JUNIPER SAVANNAH
Affected Management Jurisdictions	• Los Alamos County (LAC) • Santa Fe County • Santa Fe National Forest (SFNF) • Bandelier National Monument (BNM) • Pueblo of Santa Clara • Private lands	• SFNF • BNM • Pueblo of Santa Clara • Private lands	• DOE (LANL) • LAC • SFNF • BNM • Pueblo of Santa Clara • Private lands	• DOE (LANL) • LAC • SFNF • BNM • Pueblo of Santa Clara • Private lands	• DOE (LANL) • LAC • SFNF • BNM • Pueblos of Santa Clara, San Ildefonso, Cochiti, and Jemez • Private lands	• DOE (LANL) • LAC • SFNF • BNM • Pueblos of Santa Clara, San Ildefonso, Cochiti, and Jemez • Private lands

Sources: Allen 1989, Dunmire and Tierney 1995, Foxx and Tierney 1982, and Rothman nd

LANL boundaries, based on the presence of wetland vegetation (hydrophytes). The LANL survey determined that more than 95 percent of the identified wetlands are located in the Sandia, Mortandad, Pajarito, and Water Canyon watersheds (Bennett 1996). Wetland locations in the general area of LANL are shown on Figure 4.5.1.2–1.

Wetlands in the general LANL region provide habitat for reptiles, amphibians, and invertebrates (e.g., insects), and potentially contribute to the overall habitat requirements of the peregrine falcon, Mexican spotted owl, southwestern willow flycatcher, and spotted bat, all of which are federal- or state-listed species, or both. Wetlands also provide habitat, food, and water for many common species such as deer, elk, small mammals, and many migratory birds and bats. The majority of the wetlands in the LANL region are associated with canyon stream channels or are present on mountains or mesas as isolated meadows containing ponds or marshes, often in association with springs or seeps. Cochiti Lake and the area near the LANL Fenton Hill site (TA–57) support lake-associated wetlands. There are also some springs within White Rock Canyon.

Currently, about 13 acres (5 hectares) of wetlands within LANL boundaries are caused or enhanced by process effluent wastewater from 38 NPDES-permitted outfalls. These artificially created wetlands are afforded the same legal protection as wetlands that stem from natural sources. In 1996, the effluent from NPDES outfalls, both storm water and process water, contributed 108 million gallons (407 million liters) to wetlands within LANL boundaries (Garvey 1997). Nearly half of the NPDES outfalls at LANL are probable sources of drinking water for large mammals (Foxx and Edeskuty 1995). Data regarding the wetlands that occur within the LANL region are presented by watershed in Table 4.5.1.2–1. Information pertaining to wetlands in the general LANL area and their previous condition, current condition, and the human disturbances that have influenced and shaped them are presented in Table 4.5.1.2–2.

4.5.1.3 *Canyons*

The complex interactions of geology, water, climate, vegetation, and other living organisms are still carving the deep, vein-like canyon systems into the relatively soft Bandelier Tuff of the Pajarito Plateau. From their narrow, thickly forested beginnings on the flanks of the Jemez Mountains, to their confluence with the Rio Grande, major canyons are associated with the six major vegetation zones present in the LANL region. The plateau canyons range in depth from about 200 to 600 feet (60 to 180 meters). The steeply sloping, north-facing canyon walls and canyon bottoms are shadier and cooler and have higher levels of humidity and soil moisture than the often nearly vertical, south-facing canyon walls, which are sunnier, hotter, and more arid. These differences in slope, aspect, sunlight, temperature, and moisture cause a dramatic shift in major vegetation zones on canyon walls and in canyon bottoms beyond their typical range of elevation. This "canyon-effect" is responsible for the fingers of coniferous forest extending down regional canyons.

Canyons in this region reflect the effects of natural and human-caused disturbances on the surrounding environment. Data on the interactions of the disturbances within the region and some effects of these interactions on canyon ecosystems is presented in Table 4.5.1.3–1.

While the Rito de los Frijoles in BNM and the Rio Grande are the only truly perennial streams in the region, many canyon floors contain reaches of perennial surface water, such as the perennial streams draining LANL property from lower Pajarito and Ancho Canyons to the Rio Grande (Cross et al. 1996). Wetlands are common features of these isolated stretches of perennial water in the canyons where springs

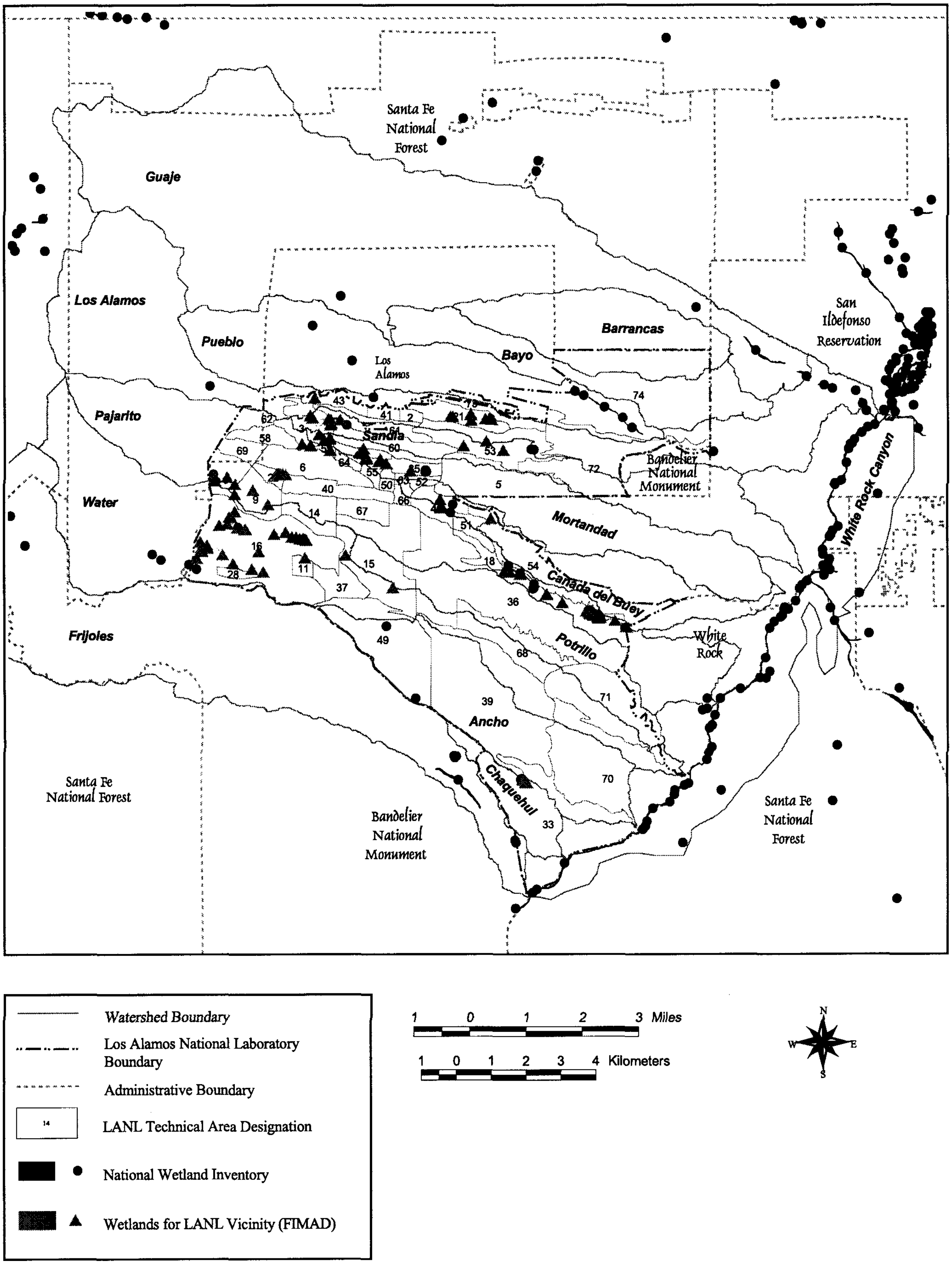

FIGURE 4.5.1.2–1.—*LANL Technical Areas and Watersheds with Wetland Locations.*

TABLE 4.5.1.2–1.—*Regional Watersheds and Wetlands in Association with Los Alamos National Laboratory Outfalls*

	WATERSHEDS WITHIN THE LANL REGION															
	GUAJE	BAR-RANCAS	BAYO	PUEBLO	LOS ALAMOS	SANDIA	MORTAN-DAD	CAÑADA DEL BUEY	PAJARITO	POTRILLO	WATER	ANCHO	CHAQUE-HUI	FRIJOLES	WHITE ROCK	TOTAL
Total watershed area	16,901	3,150	2,532	5,338	8,996	3,516	3,860	2,742	8,198	2,178	9,940	4,317	1,007	12,213		84,887
Watershed area[a] within LANL boundaries and percent of total watershed	0	742	1,020	999	2,186	1,588	1,249	1,122	4,667	2,029	5,881	4,316	864	132	1,016	27,810
	0	24%	40%	19%	24%	45%	32%	41%	57%	93%	59%	100%	86%	1%	0	
Total area of wetlands within watershed	16	0	0	.82	15	7	4	.01	30	0	10	0	.18	37		120
Wetlands area within LANL boundaries	0	0	0	0	.64	7	4	.01	29	0	9	0	.18	0	0	50
Total number of LANL outfalls	7	0	0	1	12	11	12	3	17	0	21	2	1	0	0	87
Number of LANL outfalls supporting wetlands	0	0	0	0	4	3	10	1	5	0	14	0	1	0	0	38
Estimated total flow from LANL outfalls (MGY)	1	0	0	1	20	108	53	6	9	0	30	0	6	0	0	233
LANL outfall flow supporting wetlands (MGY)	0	0	0	0	6.4	13	44	5.3	7.1	0	27	0	5.8	0	0	108
Percentage of LANL outfall flow supporting wetlands	0	0	0	0	32%	12%	83%	83%	77%	0	90%	0	100%	0	0	46%
Area of wetlands supported by outfalls	0	0	0	0	0.21	0.06	3.6	0.01	0.27	0	8.9	0	0.01	0	0	13
Dominant wetland vegetation	NA	NA	NA	NA	Cattails (Typha spp.)	Cattails (Typha spp.)	Cattails (Typha spp.)	Willows (Salix spp.)	Rushes & Sedges (Carex & Juncus spp.)	5	Cattails (Typha spp.)	NA	Cattails (Typha spp.)	NA	NA	—

[a] Area is presented in acres. Hectares = acres 0.405.
[b] Outfalls include NPDES-permitted outfalls.
[c] Flow is shown in million gallons per year (MGY). Liters = gallons 3.785
Sources: LANL ESH-20, National Wetlands Inventory database; Garvey 1997; National Wetlands Inventory; FIMAD (LANL 1996h); GRAM Team Geographic Information System
NA = Not applicable

TABLE 4.5.1.2–2.—*Wetlands—Disturbance and Current Ecological Conditions*

PREVIOUS CONDITION (ABOUT 1850)	HUMAN DISTURBANCES	CURRENT CONDITION RESULTING FROM HUMAN DISTURBANCES	AFFECTED MANAGEMENT JURISDICTIONS
• More streamside wetlands • Fewer mesa top wetlands	• Grazing by cattle and sheep • Fire suppression • Land development (e.g., roads, buildings) • NPDES outfall effluents • Contamination • Dams • Introduction of exotic plants and resulting reduction of native plants • Agriculture	• Destruction of wetlands by cattle and sheep • Increased number of trees in region reducing surface water available for wetlands within the canyons • Diverting of water away from historic channels • Of 87 LANL NPDES outfalls, 38 support 13 acres (5.3 hectares) of wetlands • Presence of Cochiti Lake resulting in development of large wetlands in White Rock Canyon and in Santa Fe River arm of lake	• DOE/LANL • LAC • BNM • Santa Fe National Forest • Corps of Engineers • Pueblo of Santa Clara • Pueblo of San Ildefonso • Pueblo of Cochiti • Pueblo of Jemez • Private lands

Sources: Allen 1989, Jacobs 1989, Durkin et al. 1995, Crawford et al. 1993, and Hink and Ohmart 1984

TABLE 4.5.1.3–1.—*Canyons—Disturbance and Current Ecological Conditions*

PREVIOUS CONDITION (ABOUT 1850)	HUMAN AND NATURAL DISTURBANCES	CURRENT CONDITION RESULTING FROM HUMAN AND NATURAL DISTURBANCES	AFFECTED MANAGEMENT JURISDICTIONS
• Lower tree density • Natural stream flow • Surface fires every 7 to 19 years • Floristically diverse vegetation in canyon mouth deltas near the Rio Grande (cottonwoods, willows, junipers, ponderosa pines) • Diverse aquatic and terrestrial habitats and wildlife	**Human** • Grazing by cattle and sheep and farming in canyon bottoms • Fire suppression • Land development (e.g., roads, buildings) • Increased recreational use • Contamination • Flood control in White Rock Canyon **Natural** • Climate variability • Flash floods • Lightning-caused fires • Occasional landslides	• Increased tree density in canyon bottoms • Ingrowth of nonnative trees • Increased tree density and decrease in habitat richness • Alteration of surface water flow and reduction of size of habitats • Increased stress on habitats and wildlife • Drought resulting in soil erosion and increased availability of sediments and concentrated wildlife use of canyons • Soil erosion, sedimentation of stream channels, and reduction of grasses • Large-scale fires • Soil erosion and altered stream flow	• DOE/LANL • LAC • BNM • Santa Fe National Forest • Pueblo of Santa Clara • Pueblo of San Ildefonso • Pueblo of Cochiti • Pueblo of Jemez • Private lands • Corps of Engineers

Sources: Allen 1989, Durkin et al. 1995, and Promislow and Fettig 1996 and seeps return groundwater to the surface throughout the year. As stated, many wetlands are caused or enhanced by process effluent water from 38 NPDES-permitted outfalls. Surface water flow occurs in canyon bottoms seasonally, or intermittently, as a result of spring snowmelt and summer rain. A few, short sections of riparian vegetation of cottonwood and willow and other water-loving plants are present in scattered locations on LANL as well as along the Rio Grande in White Rock Canyon. The relatively abundant moisture concentrated between the temperature moderating canyon walls allows a diverse array of plant and animal species to exist in these canyons at elevations that exceed the normal upper and lower elevational limits for these species.

Wildlife is abundant and diverse in the canyons. The canyons contain a more complex mix of habitats than the adjacent mesa tops and provide nest and den sites, food, water, and travel corridors. Mammals and birds are especially evident in these environments. Large mammals, such as black bears (*Ursus americanus*), mountain lions (*Felis concolor*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), elk (*Cervus elaphus nelsoni*), and mule deer (*Odocoileus hemionus*) are known to use some portion of nearly all regional canyons.

Regional canyon systems also are essential to a variety of state-protected and federally protected species. The north-facing slopes of these canyons provide habitat for isolated populations of rare species, like the state-endangered yellow lady slipper orchid (*Cypripedium calceolus L.* var. *pubescens (Willd.) Correll)* as well as the Jemez Mountains salamander (*Plethodon neomexicanus*), a federal species of concern and state-threatened species (section 4.5.2). Mexican spotted owls (*Strix occidentalis lucida*) and American peregrine falcons (*Falco pereginus anatum*) are known to nest in the canyons of the region, and bald eagles (*Haliaeetus leucocephalus*) roost in canyon mouths along the Rio Grande during the winter. The southwestern willow flycatcher (*Empidonax traillii extimus*) is a likely migrant. Numerous bat species, including nine federal species of concern, use canyons in this region for roosting, breeding, and foraging.

4.5.1.4 *Rio Grande*

The watersheds draining the Jemez Mountains and the Pajarito Plateau are tributary to the Rio Grande, the fifth largest watershed in North America (Durkin et al. 1995). Approximately 11 miles (18 kilometers) of LANL's eastern boundary border on the rim of White Rock Canyon or descend to the Rio Grande. The riverine, lake, and canyon environment of the Rio Grande as it flows through White Rock Canyon makes a major contribution to the biological resources and significantly influences ecological processes of the LANL region.

The Rio Grande, like most rivers in North America, has been significantly altered throughout much of its length. The collective actions of humans, particularly since about 1850, have significantly altered, and continue to alter, its hydrogeologic regime and plant and animal communities as a consequence of water storage and flood control facilities, irrigated agriculture, watershed degradation, drainage, floodplain development, fragmentation, and the introduction of nonnative plants and animals. These consequences are particularly evident south of LANL in the middle Rio Grande Valley. The relatively recent construction of Cochiti Dam at the mouth of White Rock Canyon for flood and sediment control, recreation, and fish and wildlife purposes, has contributed to these changes and has significantly changed the features of White Rock Canyon and introduced new ecological components and processes. Water storage, particularly high floodwater storage during 1979 and 1985 to 1987, inundated riparian vegetation dominated by one-seeded juniper

(*Juniperus monosperma* Engelm. *Sarg.*) and isolated individuals and small stands of cottonwood (*Populus fremontii* var. *Wislizenii Wats.)*, willow (*Salix* spp.), boxelder (*Acer negundo L.*), and ponderosa pine (*Pinus ponderosa* Laws. var. *Scopulorum* Engelm.), and associated understory vegetation. Some of the denser concentrations of riparian vegetation were located at the mouths of tributary canyons. Sediment deposited along the banks of the river has been colonized by nonnative plants such as salt cedar (*Tamarix pentandra Pall.*), Russian olive (*Eleagnus angustifolia L.)*, and mullein (*Verbascum thapsus L.*).

Water storage in Cochiti Lake has greatly expanded aquatic communities and has fostered the development of two large wetlands, one on the Santa Fe River arm of the lake and the other at the expanding delta at the head of Cochiti Lake. The presence of these aquatic features has benefited a wide diversity of wildlife, including waterfowl, shorebirds, and threatened and endangered species such as the bald eagle and the peregrine falcon.

Summary information pertaining to the past and present conditions of the Rio Grande is presented in Table 4.5.1.4–1. This table generally focuses on the Rio Grande above Cochiti Dam.

4.5.1.5 *Protected and Sensitive Species*

The presence and use of LANL by protected and sensitive species is influenced not only by the actual presence and operation of the facility, but by management of contiguous lands and resources, and, importantly, by 150 years of human use.

TABLE 4.5.1.4–1.—*Rio Grande Disturbance and Current Ecological Conditions*

PREVIOUS CONDITION	HUMAN AND NATURAL DISTURBANCES	CURRENT CONDITION RESULTING FROM ECOLOGICAL DISTURBANCES	AFFECTED MANAGEMENT JURISDICTIONS
• Natural flow regime with spring floods of limited depth and duration • Several springs along lower canyon walls • Deeper channel through most of White Rock Canyon, numerous rapids • Streamside vegetation (cottonwoods, willows, junipers, grasslands) • Natural fire cycle • Diverse aquatic and terrestrial habitats and wildlife	**Human** • Dams and other structures for irrigation, flood and sediment control • Extensive upstream and downstream floodplain agriculture • Introduction of non-native plants and fish • Increased recreational use • Contamination **Natural** • Climate variability • Flash floods • Lightning-caused fires • Seasonal flooding	• Altered flow and flood regime, flood-kill of streamside and canyon mouth vegetation (cottonwoods, willows, junipers, ponderosa pines) • Expansion of habitat for threatened and endangered species • Sedimentation of channel and banks • Introduction of invasive nonnative plants and trees (e.g., salt cedar, Russian olive) • Reduction of native fish species • Transport of contaminants downstream of sources (e.g., fertilizers, LANL legacy contaminants) • Reduction of rapids • Creation of two large wetlands at Cochiti Lake that attract resident and migratory waterfowl and wintering bald eagles	• DOE/LANL • LAC • BNM • Santa Fe National Forest • Pueblo of Santa Clara • Pueblo of San Ildefonso • Pueblo of Cochiti • Private lands • Corps of Engineers

Sources: Allen 1989, Durkin et al. 1995, Jacobs 1989, and Promislow and Fettig 1996

A number of regionally protected and sensitive (rare or declining) species have been documented in the LANL region. These consist of 3 federally endangered species, 2 federally threatened species, and 18 species of concern (species that may be of concern to FWS but do not receive recognition under the *Endangered Species Act,* and that FWS encourages agencies to include in NEPA studies). Species listed as endangered, threatened, or rare or sensitive by the State of New Mexico are also included in this listing. The New Mexico "sensitive" taxa are those taxa that, in the opinion of a qualified New Mexico Department of Game and Fish (NMDGF) biologist, deserve special consideration in management and planning, and are not listed as threatened or endangered by the State of New Mexico. A summary of the available habitat and pertinent siting information for these species is presented in Table 4.5.1.5–1. DOE and LANL coordinate with the NMDGF and FWS to locate and conserve these species (LANL 1998c).

For the consultation procedures of the *Endangered Species Act of 1973* (42 U.S.C. §1531) and section 7(c) of the 1978 amendments, DOE has compiled information on five threatened and endangered species that are present, or potentially present, on LANL to assess possible effects that the proposed action, including the two project-specific proposals, would have on these species. None of these species have been found on or in the vicinity of Fenton Hill site (LANL 1995g). A biological assessment has been formally submitted to the FWS. The FWS provided comments on this biological assessment as part of its response to the draft SWEIS. These comments are being addressed and an amended biological assessment will be submitted to the FWS in continuation of the Section 7 consultation process.

Species Listed as Endangered or Threatened Under the *Endangered Species Act*

The species listed below utilize LANL as seasonal residents or during migration.

Endangered Species. American Peregrine Falcon (*Falco peregrinus anatum*). The peregrine falcon (state-listed as threatened) is a summer resident and migrant on the Pajarito Plateau. Peregrines do not nest within LANL boundaries but do nest on surrounding lands in the Jemez Mountains. Both adult and immature birds have been observed foraging on LANL, with the entire site providing suitable foraging habitat (LANL 1998c). The preferred prey of peregrine falcons includes doves, pigeons, and waterfowl, all captured in flight. Peregrine falcons also use the Rio Grande corridor during migration.

The southwestern willow flycatcher (*Empidonax traillii extimus*) (state-listed as endangered) occurs in riparian habitats along rivers, streams, or other wetlands, where dense growths of willows (*Salix* and *Baccharis* sp.), arrowweed (*Pluchea* sp.), tamarisk (*Tamarix* sp.), or other plants are present, often with a scattered overstory of cottonwood (*Populus* sp.). A possible migrant southwestern willow flycatcher was located on LANL during May 1997. Potential suitable nesting habitat is present on LANL but, in general, is limited. Southwestern willow flycatchers have been observed at higher elevations in the Jemez Mountains west of LANL and at lower elevations along the Rio Grande in the vicinity of Española.

Whooping cranes (*Grus americana*) in New Mexico (state-listed as endangered) are part of an experimental "cross-fostering" population that was established at Grays Lake National Wildlife Refuge, Idaho, in 1975. These birds migrate southward to winter in New Mexico in the autumn, and most winter in the middle Rio Grande Valley. Here, whooping cranes occupy the same habitats as their foster-parent sandhill

TABLE 4.5.1.5–1.—*Protected and Sensitive Species*

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
ANIMAL SPECIES				
American Peregrine Falcon (*Falco peregrinus anatum*)	Endangered	Threatened	• Uses the juniper savannah, pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Requires cliffs for nesting	• Forages on LANL. Nests and forages on adjacent lands.
Whooping Crane (*Grus americana*)	Endangered	Endangered	• Requires rivers and marshes • Roosts on sand bars	• Migratory visitor along the Rio Grande and Cochiti Lake
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)	Endangered	Endangered	• Requires riparian areas and vegetation • Requires dense riparian vegetation	• Potential presence on LANL and White Rock Canyon • Potential nesting area on LANL • Present in Jemez Mountains • Present in riparian zone near Española
Bald Eagle (*Haliaeetus leucocephalus*)	Threatened	Threatened	• Rivers and lakes	• Observed as a migratory and winter resident along the Rio Grande and on adjacent LANL lands
Mexican Spotted Owl (*Strix occidentalis lucida*)	Threatened	Sensitive (informal)	• Mixed conifer, ponderosa pine • Prefers tall, old-growth forest in canyons and moist areas for breeding • Forages in forests, woodlands, and rocky areas	• Breeding resident on LANL, LAC, BNM, and Santa Fe National Forest (SFNF) lands • Critical habitat designated on SFNF lands
Jemez Mountain Salamander (*Plethodon neomexicanus*)	Species of Concern	Threatened	• Uses the mixed-conifer forest vegetation zone • Requires north-facing, moist slopes	• Permanent resident on LANL, LAC, BNM, and SFNF lands
Baird's Sparrow (*Ammodramus bairdii*)	Species of Concern	Threatened	• Uses the pinyon-juniper woodland, ponderosa pine forest and mixed-conifer forest vegetation zones	• Observed on SFNF lands

TABLE 4.5.1.5–1.—*Protected and Sensitive Species*-Continued

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
Spotted Bat (*Euderma maculatum*)	Species of Concern	Threatened	• Uses the pinyon-juniper woodland, ponderosa pine forest, and spruce-fir forest vegetation zones • Requires riparian areas • Roosts in cliffs near water	• Permanent resident on BNM and SFNF lands • Seasonal resident on LANL
New Mexico Jumping Mouse (*Zapus hudsonius luteus*)	Species of Concern	Threatened	• Uses the mixed-conifer and spruce-fir forest vegetation zones • Requires riparian areas • Requires water nearby	• Permanent resident on LAC and SFNF lands • Overwinters by hibernating
Flathead Chub (*Platygobio gracilis*)	Species of Concern	Unlisted	• Requires access to perennial rivers	• Permanent resident of the Rio Grande between Española and the Cochiti Reservoir
Ferruginous Hawk (*Buteo regalis*)	Species of Concern	Unlisted	• Uses the juniper savannah and pinyon-juniper woodlands vegetation zones	• Observed as a breeding resident on LAC, LANL, BNM, and SFNF lands
Northern Goshawk (*Accipiter gentilis*)	Species of Concern	Sensitive (informal)	• Uses the mixed-conifer, ponderosa pine, spruce-fir forest vegetation zones	• Observed as a breeding resident on LAC, LANL, BNM, and SFNF lands
White-Faced Ibis (*Plegadis chihi*)	Species of Concern	Unlisted	• Requires perennial rivers and marshes	• Summer resident and migratory visitor on the Rio Grande and SFNF lands
Loggerhead Shrike (*Lanius ludovicianus*)	Species of Concern	Unlisted	• Uses the juniper savannah, pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones	• Observed on LAC, BNM, and SFNF lands
Big Free-Tailed Bat (*Nyctinomops macrotis*)	Species of Concern	Sensitive (informal)	• Uses the juniper savannah, pinyon-juniper woodland, and ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts on cliffs	• Migratory visitor on LAC, BNM, and SFNF lands
Fringed Myotis (*Myotis thysanodes*)	Species of Concern	Sensitive (informal)	• Uses the juniper savannah, pinyon juniper woodland, ponderosa pine forest vegetation zones • Roosts in caves and buildings	• Observed on LANL, BNM, and SFNF lands

TABLE 4.5.1.5–1.—*Protected and Sensitive Species*-Continued

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
Long-Eared Myotis (*Myotis evotis*)	Species of Concern	Sensitive (informal)	• Uses the ponderosa pine forest, mixed-conifer, and spruce-fir forests vegetation zones • Roosts in dead ponderosa pine trees	• Summer resident on LANL, BNM, and SFNF lands
Long-Legged Myotis (*Myotis volans*)	Species of Concern	Sensitive (informal)	• Uses the pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts in dead conifer trees	• Summer resident on LANL, LAC, BNM, and SFNF lands
Small-Footed Myotis (*Myotis ciliolabrum*)	Species of Concern	Sensitive (informal)	• Uses the juniper savannah, pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts in cliffs and caves	• Observed on LANL, BNM, and SFNF lands • Overwinters by hibernating
Yuma Myotis (*Myotis yumanensis*)	Species of Concern	Sensitive (informal)	• Uses the juniper savannah and pinyon-juniper woodland forest vegetation zones • Roosts in cliffs and caves near water	• Summer resident on LANL, LAC, and SFNF lands
Occult Little Brown Bat (*Myotis lucifugus occultus*)	Species of Concern	Sensitive (informal)	• Uses the pinyon-juniper woodland and ponderosa pine forest vegetation zones • Requires riparian areas • Forages over water	• Observed on SFNF lands
Pale Townsend's Big-Eared Bat *(Plecotus townsendii pallescens)*	Species of Concern	Sensitive (informal)	• Uses the pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts in caves	• Observed on LANL and BNM lands • Overwinters by hibernating
Goat Peak Pika (*Ochotona princeps nigrescens*)	Species of Concern	Sensitive (informal)	• Uses the mixed-conifer and spruce-fir forests vegetation zones • Requires boulder piles and rockslides	• Observed on LAC and BNM lands

TABLE 4.5.1.5–1.—*Protected and Sensitive Species*-Continued

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
Gray Vireo (*Vireo vicinior*)	Unlisted	Threatened	• Uses riparian areas in the juniper savannah and pinyon-juniper forests vegetation zones	• Observed on LAC, BNM, and SFNF lands
PLANT SPECIES				
Wood Lily (*Lilium philadelphicum L.* var. *andinum* (Nutt.) Ker)	Unlisted	Endangered	• Grows in the ponderosa pine forest, mixed-conifer, and spruce-fir forests vegetation zones • Requires riparian areas	• Observed on LAC, BNM, and SFNF lands
Yellow Lady's Slipper Orchid (*Cyprepedium calceolus L.* var. *Pubescens* (Willd.) Correll)	Unlisted	Endangered	• Requires riparian areas • Grows in the mixed-conifer forest vegetation zones • Requires moist soil	• Observed on BNM lands
Helleborine Orchid (*Epipactis gigantea* Dougl.*)*	Unlisted	Rare and sensitive	• Requires riparian areas • Grows in the juniper savannah and pinyon-juniper woodland forests vegetation zones • Requires springs, seeps, or other wet areas	• Observed on LAC lands

Note: This listing was developed with information and guidance provided by biologists from LANL; the FWS; the USFS; the NPS; the National Biological Service; the NMDGF; the New Mexico Energy, Minerals, and Natural Resources Department; and the New Mexico Natural Heritage Program, as well as consultations with independent consultants and reviews of the technical literature.

cranes. Foraging areas are generally agricultural fields and valley pastures, particularly where there is waste grain or sprouting crops. Both species of cranes roost together, typically on sand bars in the Rio Grande. The cross-fostering program was terminated in 1989 because the birds were not pairing and the mortality rate was too high to establish a self-sustaining population. Only three whooping cranes remain.

Three whooping cranes were led from Idaho to Bosque del Apache National Wildlife Refuge in New Mexico in 1997 as part of a research project to determine if captive-reared cranes can be taught to follow an ultralight aircraft along a migration route and, when released on a wintering area, will migrate north in spring to their natal area without human assistance. Survivors will be left in the wild.

The association of whooping cranes with LANL has been limited to overflights and possible occasional roosting (the latter on sandbars in White Rock Canyon). Limited night roosting at the Santa Fe River arm of Cochiti Lake has been observed during migration.

A proposal to designate the Rocky Mountain whooping cranes as "experimental nonessential" was published in the *Federal Register* (FR) in February 1996. A final ruling was published on July 21, 1997. For purposes of the Section 7(a)(2) consultation procedures under the *Endangered Species Act*, this designation will result in the treatment of the Rocky Mountain whooping cranes as a species proposed to be listed under Section 4 of the *Endangered Species Act*.

Threatened Species. Bald Eagle (*Haliaeetus leucocephalus*). In the general LANL area the bald eagle (state-listed as threatened) is a common late fall and late winter migrant and winter resident (November through March). The wintering bald eagle population in the general area has significantly increased since 1975 as a consequence of both the creation of nearby Cochiti Lake and a general increase in bald eagle populations. The Rio Grande in White Rock Canyon and connecting Cochiti Lake are focal use areas and are used by wintering bald eagles to forage for fish and waterfowl. Trees and rock cliffs that border the Rio Grande in White Rock Canyon are used as hunting and loafing perches, and canyons that dissect the Pajarito Plateau are used as night roosts. Bald eagles have been observed soaring over LANL, and some limited foraging for small mammals and carrion probably occurs over much of LANL. There is no evidence of historical or present nesting in the general region.

Critical Habitat

The specific areas within the geographic area occupied by a species on which are found those physical and biological features: (1) essential to the conservation of the species, (2) that may require special management considerations or protection, and (3) include specific areas outside the geographical area occupied by a species at the time it is listed, but are areas which are essential for the conservation of the species.

Mexican Spotted Owl (*Strix occidentalis lucida*). The Mexican spotted owl is a strictly nocturnal bird that prefers tall, old-growth forests in narrow, steep canyons where little light penetrates and cool temperatures and moist areas are present. Small mammals, especially wood rats, make up the bulk of the owl's diet. The Jemez Mountains, including areas within LANL and contiguous lands administered by the NPS, USFS, and the BLM provide habitat for the Mexican spotted owl. Nesting occurs on LANL as well as adjacent areas. Critical habitat has been designated on Santa Fe National Forest lands that are contiguous with LANL's western boundary.

4.5.1.6 *Management Plans*

There are two plans in progress or in the planning stage that are being developed for management of ecological resources and biodiversity at LANL. These plans consist of a Threatened and Endangered Species Habitat Management Plan and a Natural Resources Management Plan. Descriptions of these plans follows.

Threatened and Endangered Species Habitat Management Plan

The Record of Decision (ROD) for the *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement* (60 FR 53588) commits DOE to prepare a habitat management plan for federally listed endangered and threatened species within LANL boundaries. This plan has been completed and, in addition to federally listed species, also addresses species of concern and species listed by the State of New Mexico as threatened, endangered, and sensitive. Stated goals of the management plan are to: (1) develop a comprehensive management plan that protects undeveloped portions of LANL that are suitable, or potentially suitable habitat for threatened and endangered species, while allowing current operations to continue and future development to occur with a minimum of project or operational delays, or additional costs related to protecting species or their habitats; (2) facilitate DOE compliance with the *Endangered Species Act* and related federal regulations by protecting and aiding in the recovery of threatened and endangered species; and (3) promote good environmental stewardship by monitoring and managing threatened and endangered species and their habitats using sound scientific principles (LANL 1998c). This management plan is currently being reviewed by the FWS as part of the *Endangered Species Act*'s Section 7 consultation procedures.

Natural Resource Management Plan

A team has been established and is currently formulating a plan for development of a Natural Resource Management Plan. The purpose of natural resource management at LANL will be to determine conditions and to recommend management measures that will restore, sustain, and enhance the biological quality and ecosystem integrity at LANL within the context of a dynamic Pajarito Plateau ecosystem. The guiding principle of natural resource management will be to integrate the principles of ecosystem management into the critical missions of LANL to protect ecosystem processes and biodiversity. A Natural Resource Management Plan will provide policies, methods, and recommendations for long-term management of LANL facilities, infrastructure, and natural resources to ensure responsible stewardship of LANL resources that have been entrusted to DOE. Integral to natural resource management will be continuing guidance to operations managers with which to make management decisions based on a scientific understanding of the Pajarito Plateau ecosystem. The Threatened and Endangered Species Habitat Management Plan will be integrated into the Natural Resource Management Plan.

4.5.1.7 *Environmental Surveillance*

LANL's Environmental Surveillance and Compliance Program is described on page 4–1. As part of this program, biological studies are conducted at LANL on all major trophic levels. Contamination data analyzed under this program are also used for ecological risk assessments to evaluate the likelihood that adverse effects are occurring or may occur as a result of exposure to radioactive and nonradioactive materials. A qualitative discussion of ecological risk is presented later in this section as well as in chapter 5.

4.5.2 Biodiversity Considerations

Biodiversity is a new and more explicit expression of one of the fundamental concepts of ecology, popularly stated as "everything is connected to everything else" (CEQ 1993). Simply defined as "the variety of life and its processes," components of diversity consist of regional ecosystem diversity, local ecosystem or community diversity, and species diversity. The importance of biodiversity on local, regional, and global scales has been recognized in the U.S. by the Council on Environmental Quality (CEQ), resource management agencies, and the public. The heightened interest in biodiversity presents an opportunity to address environmental problems holistically, rather than the traditional and fragmentary species-by-species, stress-by-stress fashion (Noss 1990). "The biological world is not a series of unconnected elements, and the richness of the mix of elements and their connections are what maintains the system as a whole" (CEQ 1993).

Because knowledge of biodiversity as described above can be applied to improve decision-making in the areas of land use and resource management (Keystone 1991) and because it complements and informs the ecosystem approach, biodiversity considerations are an integral part of this impact analysis. For the purposes of this document, biodiversity considerations are intended to be synonymous with a healthy, functioning ecosystem.

The major human-caused disturbance factors identified by the CEQ (CEQ 1993) as responsible for the decline in biodiversity at multiple scales, including global, regional, and site-specific scales, are the following:

- Physical alteration of the landscape
- Over harvesting
- Disruption of natural processes, such as flooding and fires
- Introduction of nonnative (exotic) species
- Pollution
- Global climate change (which is considered outside the scope of this analysis) (CEQ 1993)

These human-caused disturbance factors provide a convenient framework for categorizing the causes of biodiversity loss, but these categories often overlap and are inevitably connected to each other in chains of ecological consequences.

The LANL regional area has also been affected by these major human-caused disturbance factors. Human occupation of the Jemez Mountains and the Pajarito Plateau (particularly since about the mid 19th Century) and accompanying disturbance actions, have worked in concert with one another and with natural disturbances to mold and continue to mold the environment in which LANL operates. These factors induce and perpetuate system-wide changes in the composition, structure, and function of plant and animal communities in all of the major vegetation zones.

As a consequence of historic and recent disturbances, several major issues affecting ecosystem sustainability and biodiversity currently confront DOE, LANL, and neighboring land administrators and owners such as the NPS, BNM, USFS, U.S. Army Corps of Engineers, and Native American Pueblos. The following discussions provide a summary of some issues of regional import and serve to describe ecosystem dynamics on a landscape scale and to illustrate the necessity of incorporating knowledge of these dynamics into the management and planning process.

4.5.2.1 *Physical Alteration of the Landscape*

Accelerated Soil Erosion

Historical overgrazing has been cited as the primary disturbance causing the continuing decline of local soils (Allen 1989 and

Rothman 1992). Extensive grazing by cattle and sheep in the pinyon-juniper woodland and juniper savanna vegetation zones has resulted in a decline in the fragile surface soils, which continues today (Allen 1989 and Potter 1977). Because of long-term restricted grazing on LANL, soil erosion is less of a concern than surrounding areas where continuing erosion represents an impediment to long-term stability and productivity.

Habitat Fragmentation

Fragmentation is the division of natural habitat areas into smaller segments or the destruction of animal access corridors between natural areas. It may reduce or enhance landscape productivity. Consideration of fragmentation is important in land use planning, because larger blocks of natural habitat are generally better for conserving biodiversity, and connected blocks of natural habitat are better than isolated ones. The edge to interior ratio of habitat patches is also an important consideration.

Developed areas, roads, and fenced areas either directly eliminate habitat, inhibit habitat use, or alter the dispersal and distribution patterns of wildlife, depending on the species being considered. Allen (Allen 1989) contrasts roadway development in the LANL regional area in 1935 with that present in 1989, demonstrating an appreciable increase in road expansion and accompanying habitat fragmentation. A comparison of disturbed (buffered to take into account the impact of features on their immediate surroundings) and nondisturbed areas within the 14 watersheds in which LANL is located demonstrated that of a total of 95,200 acres (38,080 hectares), 6,672 acres (2,669 hectares) have been disturbed. This represents about 7 percent of the land area analyzed. Most development is in pinyon-juniper woodland and ponderosa pine forest. Generally, many of the developed areas are concentrated in the flat lands formerly cleared for agricultural use, which has tended to limit fragmentation. However, there is some development in canyon areas, which has resulted in habitat loss and disturbance in areas with high biodiversity.

4.5.2.2 *Disruption of Natural Processes*

Natural processes can be disrupted even when many components of the ecosystem appear intact. Resource management activities may alter ecosystem dynamics through fire suppression, modification of surface water or groundwater flow, and alteration of predator-prey relationships (CEQ 1993). Natural fires helped to shape, structure, and sustain ecosystems throughout the Southwest (Allen et al. 1995). The tree-ring record for the Jemez Mountains reflects a virtual cessation of natural fire in about 1890. At higher elevations (i.e., the conifer forests, including ponderosa pine, mixed conifer, and spruce-fir forests), vigorous suppression of wildfire has had serious environmental consequences. In the absence of natural fires, ground-fuel loads and tree density have increased to high levels, favoring large-scale, high-intensity crown fires such as the 1954, 1977, and 1996 fires that occurred on or near LANL. Fires of this magnitude are recent phenomena.

DOE and LANL are members of the Los Alamos Wildfire Cooperators, an organization with representatives for the Santa Fe National Forest, American Red Cross, Cooperative Extension Service, LAC, BNM, and New Mexico Forestry Division. The goals of this organization are to develop a cooperative urban interface plan and to develop wildfire protection requirements for LAC. In response to the Dome Fire of 1996, an Interim Fire Management Team was formed with representatives from the DOE Los Alamos Area Office, Santa Fe National Forest, Los Alamos Fire Department, NMED, BNM, and LANL (PC 1996p). This team, drawing on regional expertise in fire management, is planning ways to reduce LANL's vulnerability to catastrophic wildfires.

The chair of this team has stated that wildfire is the number one threat to LANL (LAM 1996b).

4.5.2.3 *Overharvesting*

In addition to habitat loss and modification, physical alteration is linked to the disruption of natural wildlife patterns and processes and ensuing loss of biodiversity throughout the region. One increasingly troublesome result is the imbalance in the regional elk population. The current "elk problem" is due to excess numbers, which seems to suggest under harvesting. Although this is another example of an ecological cascade involving multiple disturbance regimes and intertwined ecological processes, the origins of the problem are grounded in the over harvest of multiple species.

The native population of Rocky Mountain elk was eliminated from the entire State of New Mexico by 1909. The current elk herds developed from 86 elk reintroduced into the Jemez Mountains in 1948 and 1964 through 1965. Since the 1970's, local elk populations have exhibited high growth rates (USFS 1996), and current estimates of herd size indicate that over 10,000 elk now inhabit the Jemez Mountains and the Pajarito Plateau (Allen 1994). A lack of predators such as the gray wolf (*Canis lupus*) and mountain lions has contributed to the abundance of the reintroduced herds. Hunting is not allowed within LANL nor in BNM, allowing them to be elk refuges.

The 1977 La Mesa Fire created about 15,000 acres (6,000 hectares) of grassy winter habitat adjacent to and extending into LANL property. Elk are expanding their range into lower elevation foraging areas and are using these areas throughout the year rather than migrating to summer pasture at higher elevations (USFS 1996). Existing information is inadequate to predict how elk numbers and distribution will respond to landscape changes resulting from the 16,500-acre (6,678-hectare) Dome Fire of 1996. An interagency work group consisting of representatives from the Jemez and Española Ranger Districts of the Santa Fe National Forest, BNM, LAC, and the NMDGF has been formed for the exploration of the problems and potential solutions related to elk overpopulation.

4.5.2.4 *Introduction of Nonnative (Exotic) Species*

Nonnative species of plants and animals are emerging worldwide as one of the leading threats to native species, ecosystem processes, and biodiversity. The introduction of nonnative species can result in the elimination of native species thorough predation, competition, genetic modification, and disease transmission (CEQ 1993). The botanical inventory of BNM, which is a reasonable representation of LANL flora, lists 150 plants as nonnative. These exotics comprise about 17 percent of the approximately 900 species inventoried (PC 1996r). LANL is currently developing a database, derived from the report *Status of the Flora of the Los Alamos National Environmental Research Park, Checklist of Vascular Plants of the Pajarito Plateau and Jemez Mountains* (Foxx and Tierney 1985) for exotic species and their distribution. Some of the exotic plant species of concern to local resource managers and LANL biologists are salt cedar (*Pall.*), tree of heaven (*Ailanthus altissima (Mill.) Swingle*), cheatgrass (*Bromus tectorum L.*), and Russian thistle *(Salsola kali L.* var. *tenui Folia Tausch*). Salt cedar may be of most concern for the future. Salt cedar, as well as Russian olive, possess certain phenological and reproductive characteristics that differ from those of the common native riparian species that gives them advantages in colonization of certain types of disturbed sites or during certain times of the year. In addition, salt cedar consumes prodigious amounts of groundwater, exudes salt from leaf glands that inhibits the growth of other plants, and has lower species density and diversity (e.g., birds) than native cottonwood or willow forests. It is present on LANL and BNM and in the mouths of canyons in White Rock Canyon.

4.5.2.5 *Pollution*

Pollution impacts on ecosystems include direct lethal, sub-lethal, and reproductive effects (including those resulting from bioaccumulation) and degradation of habitat (CEQ 1993). Sub-lethal effects of environmental contamination may indirectly cause mortality at widely varying temporal scales and on widely varying levels of ecological organization. Possible mechanisms include immunological effects enhancing susceptibility to disease, alteration of nutrient cycles through effects on bioavailability or uptake mechanisms, metabolic effects, and behavior modification affecting ability to feed, hunt, avoid predation, or breed (Hodgson and Leve 1987). The contribution of pollutants to environmental media by LANL operations is due primarily to past practices. Long-term monitoring of soils, sediment, water, and air and biomonitoring have not demonstrated levels of contaminants that would pose a health risk, nor have there been obvious toxic effects observed. Potential for ecological risk is discussed in greater detail in the following section. There is no evidence that would indicate any contaminant levels that would pose a risk to recreational fishing in the Rio Grande and downstream of Cochiti Lake.

Studies that have been completed to date or that have sufficient progress so as to report preliminary conclusions generally conclude (based on current levels of understanding) a lack of biological harm or lack of alterations to ecological processes. These studies include Lusk 1998, Ford-Schmid 1996, UNM 1998, Ferenbaugh et al. 1998, Gallegos et al. 1997a, Gallegos et al. 1997b, Gonzales et al. 1997, Gonzales et al. 1998a, Gonzales et al. 1998b, Haarmann 1997, Haarmann 1998a, Haarmann 1998b, Hansen 1997, Fresquez et al. 1996a, Fresquez et al. 1996b, LANL 1997c, Fresquez et al. 1995a, Fresquez et al. 1995b, Fresquez et al. 1995c, and Brooks 1989. Species, communities, and other areas that have been studied or are being studied include bees, rock squirrel, mule deer, elk, bald eagle, southwestern willow flycatcher, aquatic benthic invertebrates, plant communities, and foodstuffs.

4.5.3 Ecological Risk Considerations

Risk to biological communities and associated ecological processes have been assessed qualitatively, utilizing LANL Environmental Surveillance and Compliance Program Reports on the distribution and concentration of contaminants and biomonitoring data, existing ecological risk assessments, and general and species-specific knowledge of the presence, biology, and behavioral characteristics of biotic resources. Although no adverse effects to plants and animals have been observed (recognizing the absence of intensive, long-term research regarding such potential effects) from chemical and radioactive materials and populations appear healthy and thriving, more quantitative ecological risk analysis will be undertaken as part of the ER Project.

4.5.3.1 *Background on Contamination at LANL*

The following are parameters that are considered in an ecological risk assessment. Portions of this section have been summarized from more detailed discussions earlier in this chapter.

Soils

As discussed in section 4.2.3.1, soils in and adjacent to LANL contain chemicals and radioactive materials, including those that are naturally occurring as well as those due to past

LANL activities and worldwide fallout. Most of the contamination of concern at LANL is what is sometimes referred to as legacy waste or legacy contamination. This is residual waste or contamination that is found at certain locations throughout LANL as a result of historical processes. These past processes or practices were associated with surface impoundments and disposal areas; experimental reactors; inactive firing sites; above-ground and underground storage tanks; PCB transformers; incinerators; chemical processing; shop machining that resulted in radioactive waste; and operations to develop, fabricate, and test explosives components for nuclear weapons. Other sources of radionuclides in soil may include natural minerals, atmospheric fallout from nuclear weapons testing, burn-up of nuclear-powered satellites, and planned or unplanned releases or radioactive gases, liquids, or solids. Naturally occurring uranium is present in relatively high concentrations in soil due to the regional geologic setting. Sources of plutonium include LANL operations and atmospheric fallout. Metals in soil may be naturally occurring or may result from LANL releases or both.

A rough estimate, based on information from LANL's database, FIMAD, which has areal estimates of their priority release sites, demonstrated that less than 3 percent of LANL's approximately 43 square miles (111 square kilometers) is of potential concern. The areal extent of this 3 percent does not include the canyons because they are not classified under the FIMAD database as PRSs. However, recent cleanup activities for the PRSs have resulted in a smaller spacial area of cleanup than originally estimated. The exact areal extent of PRSs has yet to be determined. As discussed in chapter 2, section 2.1.2.5, the ER Project was instituted to assess and remediate potentially contaminated sites resulting from historical treatment, storage, and disposal practices. ER activities include identification of potentially contaminated sites, characterization of sites, risk assessment, and restoration actions, where appropriate.

LANL on-site and perimeter soil samples are collected and analyzed for radiological and nonradiological constituents, and compared to regional (background) locations. Soils monitoring data (detection statistics) for organics, inorganics, and radiochemistry by watershed are presented in volume III, appendix C, Tables C–8 and C–9. The concentration of most radionuclides sampled and activity levels in soils collected from perimeter stations were not significantly different from those collected from regional background concentrations. While the levels of uranium, plutonium-238, and gross gamma activity were higher than background soils, they were below the LANL SALs that are used to identify the presence of contaminants of concern.

For 1995 on-site soil samples, only plutonium-239, plutonium-240 and total uranium were detected in significantly higher concentrations as compared to off-site background soils. However, these levels were still far below LANL SALs. In general, the higher concentration of radionuclides, particularly uranium and plutonium isotopes, in perimeter soils (as compared to background soils) may be due in part to LANL operations, but are mostly due to worldwide fallout and to naturally occurring radioactivity in geologic formations; whereas, higher radioactivity in soils from on-site areas may be due to worldwide fallout, natural radioactivity, and to LANL operations (Fresquez et al. 1995d).

Trend analyses show that most radionuclides and radioactivity, with the exceptions of plutonium-238 and gross alpha, in soils from on-site and perimeter areas have been decreasing over time. This trend is likely due to: (1) the cessation of widespread, aboveground nuclear weapons testing, (2) weathering, and (3) radioactive decay (Whicker and Schultz 1982).

Soils were also analyzed for trace and heavy metals, and most metals were well below LANL SALs (LANL 1996i and LANL 1997c). Only beryllium and lead, both products of firing site activities, exhibited any kind of trend; that is, both were consistently higher in perimeter and on-site soils than in background soils. Average concentrations of beryllium and lead in perimeter soils decreased during the 1992 to 1995 time period. Similarly, beryllium in on-site soils decreased during this period; however, lead increased slightly.

Surface Water

The analysis of surface water quality in section 4.3.1.5 indicates that historic activities and radiological releases have had an effect on surface water within LANL boundaries, particularly in Acid, Pueblo, Los Alamos, and Mortandad Canyons. Stated historical activities and operational releases that have contributed to contamination in these canyons include historic nuclear materials research, a former industrial liquid waste treatment plant at TA–21, discharges from the LANSCE sanitary sewage lagoon system, discharges from the RLWTF, and NPDES-permitted effluent discharges. Surface water monitoring data (detection statistics) by location (on-site, perimeter, and regional) and analyte are presented in volume III, appendix C, Tables C–2 and C–3.

In 1996, radiochemical analyses results for surface water samples were below DOE-DCGs for the public, and the majority of the result were near or below detection limits. None of the nonradiochemical measurements in water from areas receiving effluents exceeded standards except for some pH measurements above 8.5. Aluminum, iron, and manganese concentrations (including naturally occurring metals) exceeded EPA secondary drinking water standards at most locations. Selenium values exceeded the New Mexico Wildlife Habitat stream standard at numerous locations around LANL.

National Pollutant Discharge Elimination System Outfalls

Primary sources of potential impact to surface water consist of the NPDES outfalls. With few exceptions, outfall discharges comply with NPDES permit limits. Examples of materials that have been involved in NPDES exceedances include arsenic, chlorine, total suspended solids, cyanide, vanadium, copper, iron, oil and grease, silver, phosphorus, and radium. TA–50, the RLWTF, has continued to discharge residual radionuclides into Mortandad Canyon. LANL is working to continue to upgrade the treatment process to correct these problems. Nearly every on-site drainage has historically received liquid industrial or sanitary effluents that contribute to the flow and water quality characteristics. NPDES detection statistics by watershed, 1994 to 1996, are presented in appendix C, Table C–1.

Sediments

As with soils, sediment in the LANL region contain naturally occurring chemical and radionuclides, chemical and radionuclides resulting from historic uses, and very small amounts of radionuclides resulting from worldwide fallout from atmospheric testing of nuclear weapons and re-entry burn-up of satellites containing plutonium power sources. Sediment detection statistics by location (on-site, perimeter, and regional) and analyte, 1991 to 1996 are presented in appendix C, Tables C–4 and C–5. As discussed in section 4.3.1.4, there are no standards for radionuclides or metals in sediments. Therefore, regional comparison levels were developed for the purposes of the SWEIS.

Sediment from all individual LANL sampling locations exceeded the regional comparison value for at least one metal. Most of the metals that were above the regional comparison value occur naturally in the environment as a constituent of the sediments. In 1996, three samples in Mortandad Canyon were in excess of

LANL's SALs for cesium; however, no other radiochemical analyses of sediment in 1996 samples showed any values that exceeded respective SAL values. Levels of plutonium-239 and -240 in sediments in Acid, Pueblo, and Los Alamos Canyons were found to be above regional comparison levels and are believed to result from historic releases from LANL operations and worldwide fallout from atomic testing. However, these levels are very low and no environmental risk is associated with them (Ferenbaugh et al. 1994). A study that evaluated the deposition of plutonium in sediments in the northern portion of the Rio Grande estimated LANL contribution to the contamination (Graf 1993). The study found that, when averaged over several decades, 90 percent of the plutonium in the sediment moving into the northern Rio Grande system could be attributed to atmospheric fallout. The remaining 10 percent could be attributed to historic releases from LANL operations.

Sediment transport studies by LANL have shown that off-site transport of sediments with elevated plutonium-239 and -240 levels has taken place. Sediments collected from Cochiti Lake contained mean plutonium-239 and -240 levels higher than levels found in sediment from background monitoring stations at Abiquiu Reservoir and Embudo station. However, these low levels are very small as compared to area background, and again, there is no associated environmental risk.

Biomonitoring

Biomonitoring to measure the amounts of contaminants in plants and animals and their effects on biological systems and processes is being accomplished as a component of the Environmental Surveillance and Monitoring Program. A limited amount of biomonitoring data has been obtained for produce, fish, honey, milk, elk, mule deer, pinyon pine, shrubs, grasses, and forbs. In volume III, appendix D presents many of these "foodstuffs," analytes detected, and their concentrations. These biomonitoring data indicate no immediate environmental concerns.

4.5.3.2 *Ecological Risk Assessments Performed for Threatened and Endangered Species*

Three preliminary, quantitative assessments have been conducted of the potential risk from legacy waste to the Mexican spotted owl (Gallegos et al. 1997a), the American peregrine falcon (Gallegos et al. 1997b), and the bald eagle (Gonzales et al. 1998a). Updates to these preliminary assessments are reflected in the *Second Annual Review Update Preliminary Risk Assessment of Federally Listed Species at the Los Alamos National Laboratory* (Gonzales et al. 1997). The objectives of the risk assessments were to: (1) quantitatively appraise the potential for contaminants (organic, inorganic, and radionuclide) to impact threatened and endangered species in or around LANL and (2) identify where further assessment is required. Potential habitats were evaluated for these species. Each consisted of a predetermined potential nesting/roosting zone and a calculated foraging area. Estimated doses were compared against toxicity reference values (benchmarks to which estimated intake rates of chemicals can be compared to determine whether a risk may exist) to generate hazard indices (the ratio of the estimated exposure to the estimated safe exposure) that included a measure of cumulative effects from multiple contaminants (radionuclides, metals, and organic chemicals). Data used in these assessments included various subsets of ER watershed data that is presented in appendix C. These assessments concluded that, on the average, there is a small potential for impact to the peregrine falcon from contaminants at LANL, but no appreciable impact is expected to the spotted owl nor the bald eagle.

4.5.3.3 *Ecological Risk*

A qualitative assessment of ecological risk based on findings of the Environmental Surveillance and Compliance Program (as discussed above in section 4.5.3.2) and assessment of risk to selected threatened and endangered species (4.5.3.3) is that there is little potential for risk, and this is primarily due to legacy contamination. Recent operations have little potential for contributing to ecological risk, and with recent programs, actions, and plans to clean up legacy waste (i.e., the ER program, reduced sources of operational contaminants, and institution of management measures to protect and manage natural resources), the overall potential for risk decreases over time.

4.6 HUMAN HEALTH: WORKER AND PUBLIC HEALTH IN THE REGION AFFECTED BY LANL OPERATIONS

The following sections summarize historical and current information on public and worker health in and around LANL. The information is presented in three major topics: (1) public health including the radiation and chemical exposures from LANL operations and summaries of health studies conducted in the area; (2) LANL worker health including recent accidents/incidents, the history of worker health at LANL and the dosimetry, radiation protection, hygiene and safety programs implemented at LANL; and (3) a description of the emergency preparedness, management, and response programs implemented at LANL to protect the public and workers.

4.6.1 Public Health in the LANL Vicinity

4.6.1.1 *Radiation in the Environment Around LANL*

Major sources of background radiation exposure to individuals in the vicinity of LANL are shown in Figure 4.6.1.1–1. Background doses will be accrued regardless of LANL operations. In 1996, the total effective dose equivalent (TEDE) to residents was 360 millirem at Los Alamos and 340 millirem at White Rock from all natural sources. The individual components of the background dose for Los Alamos and White Rock and the average effective dose equivalent (EDE) of 53 millirem per year to members of the U.S. population from medical and dental uses of radiation (NCRP 1987) are listed in Table 4.6.1.1–1.

Releases of radionuclides to the environment from LANL operations provide another source

Understanding Human Health Studies
Useful Terms

Absorbed Dose*. The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).*

Collective Effective Dose Equivalent*. The product of the effective dose equivalent (rem) to those exposed and the number of persons in the exposed population. The units are in person-rem.*

Committed Dose Equivalent (CDE)*. The dose equivalent calculated to be received by an organ or tissue over a 50-year period after the intake of a radionuclide into the body.*

Committed Effective Dose Equivalent (CEDE). *The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.*

Deep Dose Equivalent*. The dose equivalent derived from external radiation at a depth of 1 centimeter in tissue.*

Dose*. A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, or total dose equivalent.*

Dose Conversion Factor*. A factor used to convert radionuclide intake to the resultant dose (rem).*

Dose Equivalent*. The product of the absorbed dose in rad (or gray) in tissue, a quality factor, and all other modifying factors at the location of interest. The units of dose equivalent are the rem and the sievert (1 rem = 0.01 sievert).*

Effective Dose Equivalent (EDE)*. The sum of the products of the dose equivalent received by specified tissues of the body and the appropriate weighting factor. It includes the dose from radiation sources internal and/or external to the body. Effective dose equivalent is expressed in terms of rem or sievert.*

Hazard Index (HI). *An indicator of potential toxicological hazard from exposure to a specific chemical (ratio of intake/ exposure divided by the chemical-specific reference dose, as determined by EPA).*

Maximally Exposed Individual (MEI)*. A hypothetical person placed and remaining where the greatest exposure can occur, who takes no protective actions, and who behaves in such a manner as to get the maximum possible dose at that location.*

Reference Dose*. The estimate of daily exposure to humans that is likely to occur without deleterious effects during a portion or all of a lifetime.*

Rem. *The common unit of dose equivalent, CEDE or TEDE.*

Total Effective Dose Equivalent (TEDE)*. The sum of the effective dose equivalent (for external exposure) and the committed effective dose equivalent (for internal exposure). Deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures.*

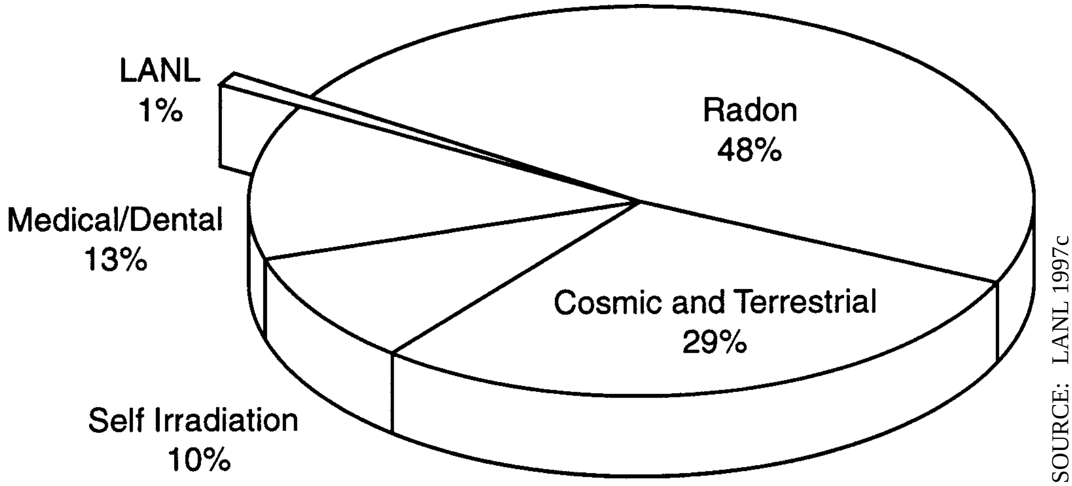

FIGURE 4.6.1.1–1.—*Total Contributions to 1996 Dose for LANL's Maximally Exposed Individual.*

TABLE 4.6.1.1–1.—*Total Effective Dose Equivalent (millirem/year) from Natural or Manmade Sources*

	LOS ALAMOS	WHITE ROCK
Radon	200	200
Self-Irradiation[a]	40	40
Total External[b] (cosmic and terrestrial)	120	100
Total Effective Background Dose	360	340
Medical and Dental	53	53

[a] Dose from radionuclides occurring naturally within the body, such as potassium-40.
[b] Includes correction for shielding.
Source: Adapted from LANL 1997c

of radiation exposure to individuals in the vicinity of LANL. Figure 4.6.1.1–2 summarizes LANL's contribution to dose by pathway for its hypothetical MEI (LANL 1997c).

The 1.93 millirem dose reported in the annual Environmental Surveillance and Compliance Report for 1996 (LANL 1997c) is similar to the following reported doses but is derived solely from an EPA-approved air transport model. The doses estimated below were based on actual measurements as well as transport modeling (CAP–88, an EPA-approved model for calculating collective public dose) (volume III, appendix B, section B.1.1.2 describes this model). Both methods of dose calculation are valid and are included here to provide a range for consideration.

Maximum Individual Dose—Off-Site Locations (1996)

The maximum EDE (or dose) was calculated at various locations to assess the maximum radiological impact from LANL to areas inhabited by the public. The East Gate area was found to be the location of the maximum off-site dose. This maximum EDE is the total dose from all potential routes of radiation exposure and is based on data gathered by both the Environmental Surveillance and Compliance Program and radiological effluent monitoring. The maximum dose, or the 95th percentile value, was 5.3 millirem, and the median value (50th percentile) for this estimate was 1.4 millirem (Table 4.6.1.1–2).

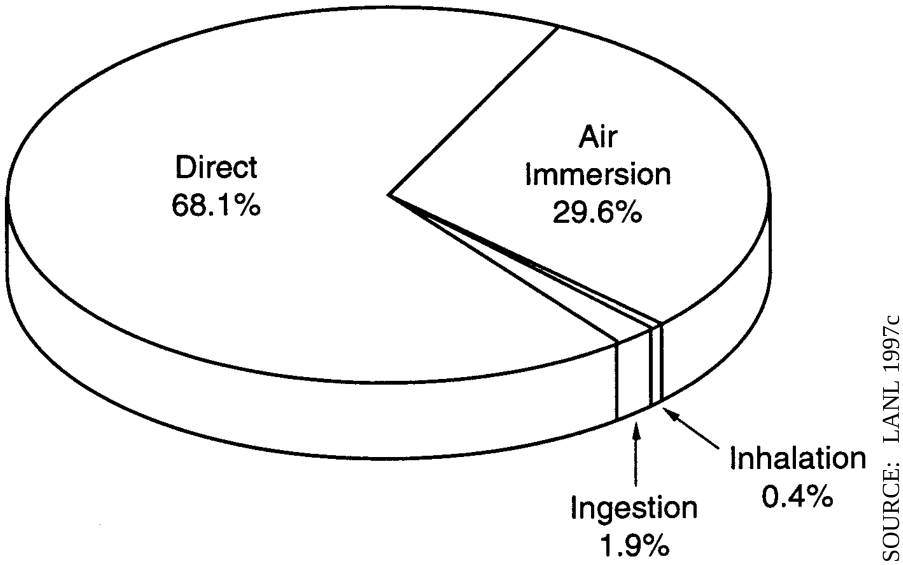

FIGURE 4.6.1.1–2.—*LANL's Contribution to Dose by Pathway for LANL's Maximally Exposed Individual.*

TABLE 4.6.1.1–2.—*Estimated Dose to Maximally Exposed Members of the Public from LANL Operations for 1996*

RECEPTOR	LOCATION	EDE (millirem/year) MEDIAN VALUE	EDE (millirem/year) 95TH PERCENTILE VALUE
Hypothetical Off-Site MEI	East Gate	1.4	5.3
Hypothetical On-Site MEI	Pajarito Road near TA–18	2.9	8.0

Source: LANL 1997c

Maximum Individual Dose—On-Site Locations (1996)

Potential doses that an individual who is not a LANL worker could have received while within the LANL boundary were calculated as 8.0 millirem for the maximum dose, or 95th percentile value, and 2.9 millirem for the median dose, or 50th percentile value. The location of the maximum potential exposure is a section of Pajarito Road near TA–18. The frequency and amount of time a member of the public may spend traveling this section of Pajarito Road, as well as the operational cycles of the TA–18 facility, were factored into the above dose calculations, which also used readings of external penetrating radiation measurements taken at TA–18 during the operation of criticality experiments. Potential doses to public members from TA–18 operations are limited using well-established principles of controlling exposure level, frequency, and duration. The section of Pajarito Road near TA–18 is closed during experiments when TA–18-generated doses to the public may exceed 1 millirem. For experiments involving lower dose levels, the road is controlled so that public members may pass by but not remain near TA–18. The 8.0 millirem maximum dose is a conservative estimate. An actual dose to an average public member who regularly commutes on Pajarito Road is estimated to be much lower.

External Radiation

The external penetrating radiation dose to Los Alamos and White Rock residents due to LANL operations in 1996 were estimated to be 0.2 millirem and 0.01 millirem, respectively. However, note the median EDE contribution estimated for a member of the public passing by on the road near TA–18 is 2.9 millirem for 1996 (see Table 4.6.1.1–2). In addition, one of the monitoring locations near TA–21 indicated a reading of 267±10 millirem in 1996. This value is consistent with values observed at this location in the past and is attributed to cesium-137 on the ground (due to past outfall effluents). Applying the occupancy factor for industrial settings of 0.01 (Robinson and Thomas 1991) to the annual exposure rate, the maximum (i.e., the 95th percentile value) external penetrating dose to an individual frequenting the access road north of TA–21 is estimated at 2.9 (2.67 + 0.2) millirem per year (LANL 1997c).

Inhalation

The net committed effective dose equivalent (CEDE) resulting from exposure, primarily through inhalation, to airborne emissions as measured by the LANL air monitoring network in 1996 for the town sites of Los Alamos and White Rock are 0.05 millirem and 0.04 millirem, respectively (LANL 1997c). These potential doses to the public are below the EPA standard of 10 millirem per year for airborne emissions (40 CFR 61.92).

Ingestion

Using the 1996 maximum consumption rate (LANL 1997c), the maximum difference between the total positive CEDE at sampling locations in the Los Alamos area and the regional background locations for each food group is as follows: fruits and vegetables, 0.77 millirem; milk, 0.083 millirem; honey, 0.036 millirem; eggs, 0.12 millirem; fish (bottom feeders), 0.083 millirem; fish (higher level feeders), 0.03 millirem; elk muscle, 0.011 millirem; elk bone, 1.4 millirem; deer muscle, 0.013 millirem; deer bone, 1.1 millirem; and tea, 0.24 millirem. Assuming one individual consumed the total quantity for each food group (except bone tissue), the total net positive difference for the CEDE in 1996 was 1.7 millirem.

The environmental surveillance data used in the analysis presented in chapter 5 for human health consequence analysis via ingestion are found in volume III, appendix C and appendix D, section D.3.5.

4.6.1.2 *Chemicals in the Environment Around LANL*

Environmental media and foodstuffs have been selectively analyzed for chemical contaminants since the early 1990's. Appendix C presents summaries of the numbers of analyses, numbers of samples with detectable concentrations, and average and 95th percentile concentrations of these chemicals. For those chemicals in the surveillance program, there are no significant differences in concentrations between media at the perimeter of the site and those of the general region (see appendix D, section D.3.4). In fish, concentrations of some metals are higher upgradient from LANL than downgradient (LANL 1997c).

Appendix C also contains summaries of contaminated site concentrations of inorganic and organic chemicals. These on-site data were developed to characterize the contaminated sites in order to determine whether remediation was needed. These media are not significant contributors to public exposures by any exposure pathways under the current circumstances.

Ingestion

Appendix D, section D.3.3 contains detailed analysis of ingestion risks to the hypothetical resident, recreational, and special pathways receptors. The risk of ingestion of metals by the public is expected to remain the same or be reduced by continued dilution and dispersion in the environment. The risk due to ingestion is believed to be that posed by ingestion in the general region of LANL and to be less than 1×10^{-6} excess latent cancer fatalities (LCFs) across all chemicals contributing to ingestion risk. Arsenic and beryllium may be regional ingestion risks. (That is, the background levels of these chemicals in the region may pose an incremental risk to human health.) The contribution to ingestion risk by current LANL operations is believed to be negligible. The beryllium and arsenic ingestion in the region of LANL is conservatively estimated (based on 95^{th} percentile) in appendix D and is highly uncertain (appendix D, section D.3.4)

Inhalation

Chemical emissions are sufficiently small from LANL operations so that they are not routinely measured. Emissions from high explosives (HE) testing are periodically monitored and included in the annual environmental surveillance reports (for example, for 1996, LANL 1997c, Table 4-13). In volume III, appendix B describes a series of screening steps used to identify chemical emissions (toxic and carcinogenic) of concern for the purpose of impact analysis for the operational alternatives. These screening steps also supply information related to potential impacts from current emissions and likely emissions from the recent past, since 1990 and 1995 chemical inventory and purchase information were used in the initial screening steps to identify chemicals of concern. No recent chemical usage was found to result in emissions of significance from the standpoint of potential human health effects.

4.6.1.3 *Cancer Incidence and Mortality in the Los Alamos Region*

During public scoping, a review of the current understanding of cancer incidence and mortality in the Los Alamos area was requested for inclusion in this SWEIS. DOE provided funding to the New Mexico Department of Health to conduct a study in response to citizen concerns about brain cancer in the area near LANL.

Detailed discussion of these studies and recent National Institutes of Health/National Cancer Institute studies under the Surveillance, Epidemiology and End Results (SEER) Program are presented in appendix D, section D.1.2. The SEER results, which provide a basis for comparison with the Los Alamos County studies, include a study population of New Mexico Native Americans. Rates of cancer mortality among white Hispanics (nationwide), white nonhispanics (nationwide), and New Mexican Native Americans are presented in appendix D, section D.1.2.3.

Los Alamos Cancer Rate Study

The Los Alamos Cancer Rate Study (Athas and Key 1993) was a study of cancer incidence among populations residing near LANL. The study was conducted in response to community concerns about an alleged recent large excess occurrence of brain cancer in Los Alamos County, particularly among residents of the Western Area neighborhood. Results presented in the report comprise the major findings of a descriptive epidemiologic study of cancer incidence in Los Alamos County for the time period 1970 through 1990. Incidence rates per 100,000 people for brain and nervous system cancer and 22 other major cancers were calculated for Los Alamos County using data of the population-based New Mexico Tumor Registry. The county rates were then compared to rates derived from a New Mexico reference population and a national reference population as represented by the National Cancer Institute's SEER Program (summary by county for all cancers, both sexes, incidence 1983 to 1987 and 1988 to 1991, Table 4.6.1.3–1).

Results of the incidence study showed that Los Alamos County experienced a 70 to 80 percent excess of brain cancer as compared with the New Mexico reference population and national statistics. The incidence of brain and nervous system cancer within different neighborhoods of Los Alamos County was examined by comparing incidence rates calculated for the five census tracts situated in the county. For the 11-year period from 1980 to 1991, all census tract rates were higher than the New Mexico reference rate. The highest incidence occurred in the census tract that corresponds to the Western Area neighborhood; however, there were only three cases, and they were confined to the 2-year period of 1986 to 1987. Additional descriptive studies showed that the brain cancer rates for Los Alamos County were within the rates observed across New Mexico counties from 1983 to 1986 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.

A review of incidence rates for 22 other major cancers and childhood cancers showed that the incidence of some cancers in Los Alamos County was greater than that observed in the reference populations, while the incidence of other cancers was lower than or comparable to that observed in the reference populations. Cancers with incidence rates consistently elevated in Los Alamos County during 1970 to 1990 included melanoma of the skin, prostate cancer, non-Hodgkin's lymphoma, ovarian cancer, and female breast cancer. Leukemia and major cancers of the respiratory and digestive systems occurred at or below the incidence levels observed in the reference populations. Several cancers showed distinct temporal patterns of increasing incidence. Most notable was the marked increase in thyroid cancer incidence observed in the mid 1980's. Thyroid cancer incidence in Los Alamos County during 1986 to 1990 was nearly four times higher than that observed in the New Mexico reference population. Based on the findings of the study, a study of the elevated thyroid cancer incidence in Los Alamos County was made (Athas 1996).

Investigation of Excess Cancer Incidence in Los Alamos County

The investigation was limited to a review of all causes of thyroid cancer diagnosed among Los Alamos County residents between 1970 and 1995 identified by the New Mexico Tumor Registry, a state-wide population-based cancer registry.

Results of the investigation showed the incidence of thyroid cancer in Los Alamos County fluctuated slightly above the statewide incidence between 1970 and the mid 1980's before rising to a statistically significant, four-fold elevated level during the late 1980's and early 1990's. Age-adjusted thyroid cancer incidence in Los Alamos County during 1988 to 1992 was 20.7 per 100,000 (n = 22, 95 percent CI = 12.6 to 30.9) compared to 4.5 per 100,000 in the state. Surveillance data collected from 1994 to 1995 indicated a decline in the number of cases diagnosed.

The higher than expected number of thyroid cancer cases could be accounted for by temporal changes in the diagnosis of thyroid cancer among Los Alamos County residents. The majority of all cases were detected following palpation of an asymptomatic neck mass by health care practitioners located at the local community hospital or LANL. None of the thyroid cancer cases had been detected by thyroid ultrasonography, nor was a temporal shift toward more incidental diagnoses of small occult thyroid cancers observed. A notably higher percentage of male cases had their tumor discovered at LANL compared to females, suggesting an impact from occupational

TABLE 4.6.1.3–1.—*All Cancer: All Races, Both Sexes, Age-Adjusted[a] Incidence Rates[b] (1983 Through 1987 and 1988 Through 1991)*

	CASES 1983–1987	RATE 1983–1987	LOWER 95% CI[c]	UPPER 95% CI	CASES 1988–1991	RATE 1988–1991	LOWER 95% CI	UPPER 95% CI
New Mexico	20,685	296.5	292.38	300.62	19,925	320.3	315.76	324.84
County								
Bernalillo	7,073	330.9	323.03	338.77	7,242	373.2	364.43	381.97
Catron	49	313.2	223.71	402.69	32	231.8	149.65	313.75
Chaves	1,140	324.6	305.37	343.83	914	311.1	290.52	331.68
Cibola	893	327.1	305.21	348.99	873	335.0	312.32	357.68
Colfax	214	236.1	205.55	270.65	188	268.8	229.59	308.01
Curry	568	276.1	252.93	299.27	501	289.9	264.00	315.80
De Baca	68	312.4	236.63	386.17	57	308.2	226.56	389.84
Doña Ana	1,403	282.5	267.42	297.58	1,436	298.3	282.56	314.04
Eddy	991	311.2	291.43	330.97	811	313.6	291.58	335.62
Grant	382	249.0	223.52	274.48	352	252.1	225.23	278.97
Guadalupe	70	276.9	210.71	343.09	62	305.4	227.83	382.97
Harding	24	281.9	166.81	396.99	14	165.4	76.99	253.81
Hidalgo	91	291.2	230.15	352.25	53	206.0	149.41	262.59
Lea	612	204.7	186.15	221.25	549	237.3	217.04	257.56
Lincoln	222	280.2	242.59	317.81	234	343.2	298.33	388.07
Los Alamos	293	347.9	307.25	388.55	302	408.5	361.49	455.51
Luna	414	313.3	282.50	344.10	370	307.4	275.44	339.36
McKinley	462	233.8	212.05	255.55	420	239.4	216.04	262.76
Mora	74	260.7	200.09	321.31	45	196.6	137.99	255.21
Otero	531	255.8	233.60	278.00	491	259.5	236.08	282.92
Quay	206	263.8	227.04	300.56	158	254.9	214.34	295.46
Rio Arriba	436	291.2	263.31	319.09	379	288.7	259.04	318.36

TABLE 4.6.1.3–1.—*All Cancer: All Races, Both Sexes, Age-Adjusted[a] Incidence Rates[b] (1983 Through 1987 and 1988 Through 1991)*-Continued

	CASES 1983–1987	RATE 1983–1987	LOWER 95% CI[c]	UPPER 95% CI	CASES 1988–1991	RATE 1988–1991	LOWER 95% CI	UPPER 95% CI
Roosevelt	255	270.8	236.88	304.72	202	264.5	227.28	301.72
Sandoval	775	355.3	329.77	380.83	810	340.4	316.48	364.32
San Juan	813	228.8	212.75	244.85	886	294.5	274.71	314.29
San Miguel	333	251.8	224.20	279.40	286	259.3	228.63	289.97
Santa Fe	1,292	306.3	289.26	323.34	1,264	312.5	294.92	330.08
Sierra	302	288.6	255.39	321.81	308	329.4	291.86	366.94
Socorro	219	322.7	279.09	366.31	174	295.4	250.61	340.19
Taos	289	250.5	221.03	279.97	302	298.5	264.15	332.85
Torrance	123	262.1	214.83	309.37	146	335.3	279.80	390.80
Union	91	250.1	197.66	302.54	64	289.5	217.13	361.88
Valencia	893	327.1	305.21	348.99	873	335.0	312.32	357.68

[a] 1970 U.S. Standard Population
[b] Rates are for 100,00 persons per year
[c] CI = Confidence interval
Source: Athas and Key 1993

medical surveillance. Additional analysis suggests that increased medical surveillance and greater access to medical care were responsible for the recent excess in Los Alamos County.

Results from this investigation showed that the 1988 to 1995 cases included people who had moved to Los Alamos County at different points in time and had lived in the county for varying lengths of time prior to diagnosis. Most of the cases had not lived in Los Alamos County prior to 1970; about half had resided in the county more than 20 years prior to diagnoses; about 20 percent had resided in the county 2 years or less prior to diagnosis; and four had resided in Los Alamos County during childhood.

The investigation described in this report did not identify a specific cause of the unusually high number of thyroid cancers diagnosed in Los Alamos County. The likelihood is that the excess had multiple causes. Potential risk factors for thyroid cancer include therapeutic irradiation, genetic susceptibility, occupational radiation exposure, and weight.

4.6.1.4 *LANL Environmental Surveillance and Compliance Program*

The LANL Environmental Surveillance and Compliance Program (described on page 4–1) monitors LANL and surrounding region foodstuffs, air, water, and soil for radiation, radioactive materials, and hazardous chemicals. This information is used for continually determining time trends and to assess potential risks to human health and the environment.

4.6.2 LANL Worker Health

This section summarizes operational health risk experience at LANL, including exposures of workers to radioactive materials and hazardous materials resulting in intakes and recordable incidents due to exposure or physical injuries from workplace hazards. The LANL Worker Health and Safety Program is summarized also.

4.6.2.1 *Summary of Radiological and Chemical Exposure and Physical Hazard Incidents Affecting Worker Health During the 1990's*

The working conditions at LANL have remained essentially the same during the 1990's. Few construction projects (e.g., DARHT) have been undertaken. More than half the work force is routinely engaged in activities that are typical of office and computing (analysis) industries. Much of the remainder of the work force is engaged in light industrial and bench-scale research activities. Approximately one-tenth of the general work force at LANL (UC; Johnson Controls, Inc.; and other UC subcontractors) is engaged in operations (including maintenance) and research and development within nuclear and moderate-hazard facilities (LANL 1998a). Uniform data have been reported since 1993 due to DOE requirements. Therefore, the information below addresses 1993 through 1996.

There have been five major (fatal, serious injury, or near miss) accidents affecting worker safety during this period. These were:

- *December 1994*—During a training exercise, a security officer (Protection Technology of Los Alamos) was accidentally shot and killed.
- *November 1995*—A forklift accident resulted in serious worker injury; the worker fully recovered.
- *January 1996*—An electrical accident resulted in near death; injured worker remains in coma.
- *July 1996*—An electrical accident resulted in serious worker injury; the worker fully recovered.

- *November 1996*—An explosion and fire in Chemistry and Metallurgy Research (CMR) Wing 9 (hot cell facility) resulted in property damage; this accident is considered a near-miss in terms of serious injuries or fatalities.

LANL's worker health and safety performance is reported and is a portion of UC's performance indicators within its contract with DOE.

The new DOE-UC contract contains objective standards of performance for environmental safety and health (modification number M440 Supplemental Agreement to Contract Number W-7405-ENG-36, Appendix F, Section B, Part II, Section II-2, F-10 to F-26) (October 1997). These provide specific performance objectives, criteria, and performance measures. These will continue to be used to evaluate LANL performance in the areas of safety, health, and environmental protection.

Table 4.6.2.1–1 presents representative examples of accidental radiological and chemical exposures and physical incidents resulting in worker injuries at LANL from 1993 to 1996. DOE required that dose estimates for radiological intakes be reported as CEDE starting in 1993. Three workers received doses above the regulatory limits of 5 rem due to intakes of plutonium isotopes in 1993. Two individuals were exposed while checking argon flow in an experimental metal preparation operation within a glovebox. The other individual was exposed following an incident involving the unbolting of a valve during a decommissioning operation. Physical accidents that resulted in hospitalization overnight or fatalities are listed, as are incidents that involved more than three workers. Chemical exposures at LANL between 1993 and 1996 are also listed in Table 4.6.2.1–1. These are potential exposures because it is difficult to confirm intake of many of the chemicals with which routine operations are conducted.

Table 4.6.2.1–2 presents the total recordable and lost work day (more than one-half day lost due to injury and treatment) cases rates per year at LANL (1990 through 1995). Recordable incidents are any occupational injuries or illnesses that result in: (1) fatalities, regardless of the time between the injury and death or the length of the illness; (2) or lost work day cases, other than fatalities, that result in lost work days; (3) or nonfatal cases without lost work days that result in transfer to another job, termination of employment, or require medical treatment (other than first aid), or involve loss of consciousness or restriction of work or motion. This category also includes any diagnosed occupational illnesses that are reported to the employer but are not classified as fatalities or lost work day cases (29 CFR 1904.12). Lost work days are a subset of recordable incidents. These comparisons were based on the LANL Occupational Safety and Health Administration (OSHA) 200 logs maintained by LANL's ESH-5, Industrial Hygiene Group, compared to eight other DOE facilities for the same time frame (LANL 1992b, LANL 1993a, LANL 1994b, LANL 1995f, LANL 1996e, and LANL 1996i). These logs allow comparisons of organizations performing similar activities by comparison of the recordable case rate (the number of fatalities, injuries, or illnesses per full-time equivalent worker, assuming 40 hours per week and 50 weeks per year worked). This methodology is standardized by the U.S. Department of Labor, Bureau of Labor Statistics, and is required reporting for employers with 11 or more employees in the previous year. The use of the total reportable injuries/illness case rates allows for comparisons to other DOE facilities.

LANL has experienced recordable and lost work day cases at a rate that is within the operational experience of DOE facilities (Table 4.6.2.1–2) and with that of research and development facilities in the U.S., both U.S. Nuclear Regulatory Commission (NRC) licensed and institutions such as Battelle

TABLE 4.6.2.1–1.—*Representative Examples of Recorded Radiological and Chemical Exposures and Physical Accidents Affecting Workers at LANL 1993 Through 1996*

DATE	LOCATION	DESCRIPTION OF INCIDENT/EXPOSURE
EXTERNAL RADIATION EXPOSURE		
1993 to 1996	LANL-wide	None to individual workers exceeding 5 rem/year.
RADIOLOGICAL INTAKE EXCEEDING 100 MREM		
January 19, 1993	TA–55, PF–4	11.3 rem CEDE plutonium-239 to one worker and 18.4 rem CEDE plutonium-239 to second during operation to clear reaction debris from line; continuous air monitor (CAM) alarm sounded, nasal smears confirmed potential exposure, CEDE quantified by bioassay.
August 30, 1993	TA–55, PF–4	1.2 rem CEDE plutonium-239 to one worker during a decontamination operation; CAM alarm sounded, nasal smears confirmed potential exposure, CEDE quantified by bioassay.
August 24, 1994	TA–3–29, CMR	3.5 rem CEDE plutonium-239 to one worker who received puncture wound in thumb through glovebox glove puncture; intake was quantified by bioassay.
April 30,1996	TA–55, PF–4	380 millirem CEDE plutonium-239 to one worker during a pump replacement operation; nasal smears confirmed potential exposure, CEDE quantified by bioassay.
July 5-11,1996	TA–55, PF–4	1.3 millirem CEDE plutonium-239 to one worker detected as a result of reviews of routine health physics survey of fixed head air sample data. Intake confirmed and quantified via bioassay.
POTENTIAL CHEMICAL EXPOSURES (NONE REQUIRED HOSPITALIZATION)		
March 8, 1995	TA–00	Six people confirmed to receive lead to blood 40 to 70 µg/dl as a result of removing paint from a water tank.[a]
April 12, 1995	TA–55, PF–4	Several employees exposed briefly to dilute acid fumes (hydrofluoric and nitric in water) during solution disposal down the acid drain line.
April 26, 1995	TA–3, SM–30 Warehouse	Four people became briefly ill due to release from chemical package containing 100 milliliters of ethyl mercaptan.
December 1, 1995	HRL, TA–43	Technician splashed 10% bleach being used for biological sterilization into his eyes.
December 7, 1995	TA–54, Area G	Personnel monitoring devices detected silica in three workers breathing zones exceeding the OSHA TLV-TWA[b] for crystalline silica during training.
February 23, 1996	TA–48	Two employees briefly exposed to HCL in excess of OSHA ceiling of 5 ppm during the failure of exhaust system in work station.
May 17, 1996	CMR	Disturbance of asbestos-containing material (ACM) on pipe during the installation of conduit for communications.
August 22, 1996	TA–3–40 Physics Complex	Elemental mercury identified on floor during remodeling, airborne concentrations exceeded OSHA Permissible Exposure Limits for ceiling level concentrations.
September 25, 1996	Cooling Tower CT–2	Nonfriable asbestos detected, improbable exposure, during the removal of filter media in cooling tower.

TABLE 4.6.2.1–1.—*Representative Examples of Recorded Radiological and Chemical Exposures and Physical Accidents Affecting Workers at LANL 1993 Through 1996*-Continued

DATE	LOCATION	DESCRIPTION OF INCIDENT/EXPOSURE
December 10, 1996	High Explosives Testing Site	Unknown puff of gas caused temporary discomfort, coughing to worker resulting from application of disinfectant and dechlorination operation.
PHYSICAL INJURIES (REQUIRING MINIMUM ONE NIGHT HOSPITALIZATION, RESULTING IN FATALITY OR AFFECTING 3 OR MORE WORKERS)		
April 9,1993	TA–33–114	Insect bite resulted in immuno-reaction requiring hospitalization.
April 19, 1993	TA–3	Employee kneeling on chair fell and struck adjacent pipe and was hospitalized overnight for observation.
May 24, 1993	TA–55	Injury sustained in basement when standing up and striking overhead obstruction.
August 24, 1993	TA–52 (HazMat Mobile Unit)	Sustained burns to right hand, face and neck while attempting to light the propane-fired water heater in mobile unit.
October 15, 1993	TA–3	Worker sustained broken hip in 5-foot fall from wooden pulpit ladder.
January 24, 1994	TA–59 Pajarito Road	LANL truck pulling trailer that came loose; trailer struck a privately owned vehicle causing it to veer off road; driver sustained hip injury and baby sustained concussion.
February 15, 1994	CMR, Wing 7	Worker broke arm in fall at floor level.
July 1, 1994	TA–54, Area L	Near miss lightning strike, worker hospitalized overnight for observation.
December 15, 1994	TA–48	Worker falls from ladder; the fall directly resulted in injury to the worker and subsequent hospitalization. Worker dies after surgery.
December 20, 1994	TA–72	Security guard fatally wounded by gunshot in training exercise.
May 20, 1995	East Jemez Road	Collision occurred between government-owned and private vehicle. Three of four individuals injured were hospitalized overnight.
June 13, 1995	TA–46	Injury to right foot from backhoe bucket hit during removal of earth from an excavation to expose a water line.
October 31, 1995	TA–55	Worker hospitalized overnight after fainting in the machine shop and hitting head on floor in the fall.
November 22, 1995	TA–35–128 Outside	Forklift wheel rolled off edge of concrete and rolled with driver into the adjacent ditch pinning worker's neck against overhead guard and foot beneath body of vehicle; 2 1/2 week hospitalization resulted but worker released to work without restrictions.
January 17, 1996	TA–21 TSFF	A mason tender (worker) was injured when he hit 13,200-volt buried electrical line with jack hammer while excavating through pavement; worker burned and rendered unconscious, sustained in comatose state.
February 8, 1996	TA–3–132	Worker broke finger on unguarded pinch point of a Tommy lift gate.
July 18, 1996	TA–53, MPF–14	Student worker injured by electrical shock while experimenting with commercial microwave oven; was rendered unconscious, regaining consciousness within a few hours; worker recovered fully.
October 21, 1996	Fenton Hill	Worker injured while inserting drill pipe into Well GT-2; worker fully recovered.

[a] 40 to 70 μg/dl means 40 to 70 micrograms of lead in any form in the blood of the person.
[b] TLV-TWA threshold limit value, time weighted average under OSHA.

TABLE 4.6.2.1–2.—*Total Recordable and Lost Workday Cases Rates[a] at LANL and at Other DOE Facilities (1990 Through 1995)[b]*

YEAR	LANL	LLNL	BNL	SNL	ORR	ANL	HS	RFS	INEEL
TOTAL RECORDABLE CASE RATE PER 100 WORKERS									
1990	6.6	2.9	5.8	4.4	5.8	2.7	3.5	6.7	4.5
1991	7.2	3.8	4.7	4.6	5.4	1.6	3.7	6.2	5.2
1992	9.4	5.1	5.2	4.4	5.5	2.4	4.3	6.0	3.7
1993	6.6	5.6	4.2	4.3	4.5	3.4	5.0	6.2	3.4
1994	5.9	4.7	5.6	4.0	4.3	2.4	5.2	5.1	3.3
1995	4.6[c]	4.7	4.2	3.4	4.2	1.6	4.7	4.6	3.6
LOST WORKDAY CASE RATE PER 100 WORKERS									
1990	2.8	2.2	3.2	1.9	1.8	1.0	1.3	4.2	2.2
1991	2.4	2.4	2.9	2.2	1.7	0.8	1.7	4.3	2.6
1992	3.3	2.6	3.6	2.0	2.1	1.1	2.0	3.8	1.7
1993	2.1	2.8	3.2	2.0	1.4	1.2	2.0	3.7	1.6
1994	2.3	2.2	3.7	1.9	1.6	0.9	2.2	3.0	1.4
1995	2.0	1.8	2.9	1.7	1.4	0.4	1.7	2.7	1.7

ANL = Argonne National Laboratory, BNL = Brookhaven National Laboratory, HS = Hanford Site, INEEL = Idaho National Engineering and Environmental Laboratory, LANL = Los Alamos National Laboratory, LLNL = Lawrence Livermore National Laboratory, ORR = Oak Ridge Reservation, RFS = Rocky Flats Environmental Technology Site, SNL = Sandia National Laboratories

Sources: LANL 1992b, LANL 1993b, LANL 1994b, LANL 1995f, LANL 1996e, and LANL 1995e

[a] Recordable occupational injuries or illnesses are any occupational injuries or illnesses that result in: (1) fatalities, regardless of the time between the injury and death, or the length of the illness; (2) or lost work day cases, other than fatalities, that result in lost work day; (3) or nonfatal cases without lost work days that result in transfer to another job, termination of employment, or require medical treatment (other than first aid), or involve loss of consciousness or restriction of work or motion. This category also includes any diagnosed occupational illnesses that are reported to the employer but are not classified as fatalities or lost work day cases (29 CFR 1904.12).

[b] The U.S. Department of Labor, Bureau of Labor Statistics, reported total reportable and lost work case rates of 8.5 and 3.8, respectively, for the period 1991 to 1995.

[c] Worker population in 1995 was 9,081.

Memorial Institute or Proctor and Gamble Corporation.

DOE is establishing a Chronic Beryllium Disease Prevention Program in response to the current prevalence of approximately 1 percent confirmed cases among DOE workers who have been included in a worker health surveillance program for chronic beryllium disease (CBD). CBD is a chronic, irreversible, and debilitating lung disease. In volume III, appendix D, section D.2.2.3, discusses beryllium exposure groups and contains more information about CBD. Worker health surveillance programs for CBD initiated in 1991 at DOE's Rocky Flats Environmental Technology Site (REFETS), the Oak Ridge Y–12 Plant, and Mound provide screening to current and former beryllium workers and employees who may have received incidental exposures. Data from these programs confirm that CBD remains an ongoing problem. Through December 1997, about 104 cases of CBD have been diagnosed (64 confirmed by bronchoscopy) and 40 probable cases of CBD (not confirmed by bronchoscopy [includes biopsy of lung tissue and Lymphocyte Proliferation Test of white blood cells washed from the lung]). This is from a population of 8,838 workers evaluated.

Anecdotally, an estimated eight cases of CBD have been diagnosed in former LANL site employees. Six cases are possibly the result of beryllium exposure at Los Alamos during the Manhattan Project; however, there are no records on site that support the diagnosis of CBD or level of beryllium exposure. Two cases were the result of exposure to beryllium at the University of Chicago in the early 1940's with no known subsequent beryllium exposure at LANL. There are no known cases of CBD in current LANL employees. There are two cases of beryllium sensitization in former Rocky Flats employees who are at LANL. No cases of confirmed beryllium sensitization have been found in LANL beryllium workers participating in a study of methods to improve the lymphocyte proliferation test.

The occupational health community does not have sufficient exposure and health outcome data to satisfy the majority of occupational health practitioners in either confirming that the current beryllium limit is adequate or establishing a lower limit. Peer-evaluated journal articles (Kreiss et al. 1996, Stange et al. 1996, and Banard et al. 1996) indicate a high prevalence of CBD where average exposures were reported to be below the 2 micrograms per cubic meter limit; but the reported exposure data have been challenged as not representing the true exposures that the CBD cases received. Adding to the uncertainty are unpublished data from the United Kingdom Atomic Weapons Establishment Cardiff Facility that suggest that controlling their facility to 2 micrograms per cubic meter resulted in no cases of CBD among their workers (UK et al. 1997).

Though workers having the highest levels of exposure are at greatest risk for CBD, individual susceptibility may play a role in who does or does not develop CBD. It has long been suspected that genetics plays a role in determining who will become ill, and recent research suggests that a genetic predisposition may play some role in determining who develops CBD (Richeldi et al. 1993). Currently, however, there is no reliable genetic test that identifies highly susceptible individuals.

At LANL, there have been ongoing operations using beryllium, primarily at Sigma (TA–3–141), but also at the Main Shops (TA–3–39 and TA–102), and the high explosives testing facilities (especially TA–15, TA–36, and TA–39). The Beryllium Technology Facility (TA–3–141) has been redesigned and upgraded as part of the DOE nonnuclear reconfiguration and is intended to be a state-of-the-art facility for these operations. It is expected to be in operation in 1998. (LANL 1998a and appendix D, section D.3.4, provide additional information on beryllium at LANL.)

Beryllium medical surveillance is part of the ongoing medical surveillance program at LANL as described in the laboratory requirements document "Occupational Medicine Program." All identified beryllium workers are required to participate in the beryllium medical surveillance program. The Occupational Medicine Group maintains beryllium-specific examination requirements and employee medical surveillance records.

4.6.2.2 *Ionizing Radiation Exposures of Workers*

Occupational radiation exposures for workers at LANL are summarized in Table 4.6.2.2–1. The collective dose, the sum of all measurable doses to workers, has fluctuated around 200 person-rem per year. LANL is one of seven major DOE sites that collectively contribute over 80 percent of DOE's total dose. The number of LANL workers with measurable dose has varied from about 1,400 to 2,600. The average measurable dose has been less than 150 millirem in recent years, which is considerably less than average doses in the nuclear power industry, for example.

For 1996, tritium produced measurable doses in 49 individuals for a collective dose of 0.305 person-rem, and an average CEDE of 0.006 rem. Plutonium produced measurable dose in two workers for a collective dose of 4.8 person-rem for an average of 2.4 rem. Uranium isotopes were measurable in 39 workers for a collective dose of 0.182 person-rem, averaging 0.005 rem per worker. As is generally the case at most DOE facilities, the collective dose to workers is almost entirely from external radiation.

4.6.2.3 *Nonionizing Radiation Exposure*

There are three types of nonionizing radiation within LANL operations that could affect workers. These are discussed below.

Electromagnetic Radiation

The incidence of exposure to electromagnetic radiation at LANL are very low, and therefore, are difficult to identify from historical records. There are no monitoring devices available such as those used for monitoring ionizing radiation. In-place monitoring devices interfere with or disrupt the nonionizing radiation field or beam resulting in inaccurate readings. Magnetic sources are normally controlled inside of buildings or behind fenced areas, thus limiting access to the field and limiting the size of the

TABLE 4.6.2.2–1.—*Baseline Radiological Exposure to LANL Workers*

YEAR	COLLECTIVE DOSE (person-rem) TEDE	NUMBER OF WORKERS WITH MEASURABLE DOSE	AVERAGE MEASURABLE DOSE (rem)
1992	230.4	1,724	0.134
1993	199.2	1,391	0.143
1994	190.0	2,448	0.078
1995	234.9	2,583	0.091
1996	184.1	1,984	0.093
1993 to 1995	208.0	2,141	0.097

Sources: Data from DOE Occupational Radiation Exposure reports for 1992 through 1994 (DOE nda), 1995 (DOE ndb), and 1996 (DOE ndc).

field (metal construction materials interfere with the magnetic field). No reported incidents of exposure to nonionizing radiation were found during the review of the OSHA 200 logs (LANL 1996c), Environmental Surveillance and Compliance Program Reports (LANL 1992b, LANL 1993b, LANL 1994b, LANL 1995f, LANL 1996e, and LANL 1996i) or of DOE's Occurrence Reporting and Processing System (ORPS) reports (DOE ORPS 1990–1996).

Laser Radiation

Most forms of nonionizing radiation are easily controlled. Light sources such as lasers are line-of-sight devices. Infrared and manmade ultraviolet light sources are normally contained or housed out of sight and without direct access in typical operating environments.

Microwave Radiation

In addition to the typical use of microwaves in cafeterias and lunchrooms, LANL is designated as an Experimental Operation Station for DOE by the U.S. Department of Commerce, National Telecommunications and Information Administration. As such, the operation of experimental microwave transmitters occurs within TA–49. In volume III, appendix D, section D.2.2.2 provides details of potential risk to human health from operating this transmitter. These risks are very low (i.e., resulting in less than measurable effects on human health).

4.6.2.4 *Summary of Worker Health Studies at LANL*

There have been several long-term studies of workers employed at LANL. A mortality study of 224 white males with internal depositions of plutonium (10 nanocuries or more) was conducted by Voelz (Voelz et al. 1985). All causes of death, and all malignant neoplasms were lower than expected when compared with death rates for U.S. white males. Cancers of interest for plutonium exposure, including cancers of the bone, lung, and liver, were infrequent or absent.

A cohort mortality study (Wiggs et al. 1994) examined the causes of death among 15,727 white males hired at LANL between 1943 and 1977. The study examined plutonium deposition and external ionizing radiation in relation to worker mortality. 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; the remainder were "nonexposed." One case of rare bone cancer, osteogenic sarcoma, 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.

Dose-response relationships were observed for cancers of the brain/central nervous system, the esophagus, and Hodgkin's disease among the 10,182 workers monitored for external ionizing radiation and tritium. When plutonium workers were excluded from the analyses, kidney cancer and chronic lymphocytic cancer also showed a dose response.

A lifetime medical study was conducted on 26 workers who received the largest internal depositions of plutonium (Voelz and Lawrence 1991) between the years 1944 and 1945. Seven deaths had occurred by 1990 compared with 16 expected based on death rates for U.S. white males, adjusted for age and calendar year. All cause mortality and all cancer mortality were similar to death rates among LANL workers. One of the seven reported deaths was due to bone sarcoma, as noted above. No additional deaths were reported in the cohort mortality study through 1995 (Voelz et al. 1997).

Wiggs (Wiggs 1987) conducted a mortality study among 6,970 women employed at LANL between 1943 and 1979. The mortality rates for all causes of death combined and all cancers combined were 24 percent and 22 percent below the rate for the U.S. population. Although the overall rates are low, women occupationally exposed to ionizing radiation had elevated rates for ovarian and pancreatic cancer relative to those not exposed. Unexpectedly, female radiation workers experienced a statistically significant excess of death from suicide. In an in-depth study, past employment as a radiation worker was significantly associated with death from suicide. No significant associations for duration of employment, plutonium exposure, or marital status were seen (Wiggs et al. 1988).

As result of a reported excess of malignant melanoma (a type of skin cancer) among workers at the Lawrence Livermore National Laboratory (LLNL) in California (Austin et al. 1981) and similarities with occupational exposures and prevailing sunshine conditions at Los Alamos, an investigation was undertaken to assess the risk of melanoma at LANL. Incidence data were obtained from the New Mexico Tumor Registry. No excess risk for melanoma was detected at LANL among 11,308 laboratory workers (Acquavella et al. 1982a). 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 study (Acquavella et al. 1982b) of 15 melanoma cases did not detect any associations between melanoma and exposure to any external radiation as measured by film badges, neutron exposures, plutonium body burden based on urine samples, or employment as a chemist or physicist. However, the melanoma cases were more educated than the comparison group; a finding consistent with other reports of malignant melanoma according to the authors. The numbers in this study were small, and therefore, could only detect large excesses.

4.6.2.5 *LANL Worker Health Programs*

Radiation Protection

The LANL radiation protection program has the objective of managing and controlling below applicable limits (ALARA) (10 CFR 835). To accomplish this objective, several preventative measures are applied, such as protective clothing, respirators, and use of shielding. Other technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning incorporate the radiological protection criteria in the early planning stages. The federal limit for personnel exposure is 5 rem (TEDE) per year.

The ALARA program uses administrative controls as one tool to monitor and control exposures. Administrative control levels (ACLs) for radiation doses have been established at a level below the regulatory limits. These ACLs provide a method by which increasing employee radiation doses are monitored, evaluated, and reviewed well before the regulatory limits are approached. Higher level management approval is required before an ACL can be exceeded.

The radiation protection services at LANL are provided by the Environment, Safety and Health (ES&H) Division. The mission of this division is to protect the workers, the public, and the environment from radiation associated with LANL operations. The Laboratory Assessment Office collects and publishes a quarterly report of performance indicators, which are parameters that indicate how well LANL has performed in areas of general importance. These performance indicators are used to identify trends, evaluate performance, allocate resources, assess conduct of operations, and facilitate continuous improvement. The radiation protection performance indicators for the various LANL activities include external dosimetry, internal dosimetry, radiation monitoring instruments, sample analysis, workplace radiological monitoring, nuclear criticality safety, radiological training, and maintaining radiological records.

Chemical Hygiene and Occupational Safety and Health Administration Safety Program

DOE implements OSHA requirements for employees at their facilities through DOE Order 440.1, *Worker Protection*. The order requires that contractors and contractor employees adhere to U.S. Department of Labor OSHA standards (29 CFR 1910). The applicable standards and requirements are included in the DOE-UC contract for LANL operations. LANL is required to furnish employees a place of employment free from recognized hazards that might cause injury or death. Routine and special medical examinations are used as surveillance tools to monitor worker health. LANL has a workplace monitoring program that collects more than 2,000 samples each year for analyses of more than 200 chemicals.

OSHA 200 Log—Recordable incidents in LANL workplaces are investigated and reported to DOE. A review of this log and of the ORPS database for the LANL facility for the period of 1993 through 1996 indicates that there were several potential exposures to chemicals—asbestos, crystalline silica, mercaptan (a gas), lead, elemental mercury, hydrochloric acid, and hydrofluoric acid vapor (Table 4.6.2.1–1).

Accident Investigating and Reporting Program

The LANL Accident/Occurrence Investigating and Reporting Program investigates accidents and incidents meeting defined criteria to determine appropriate corrective actions that may prevent future similar events or help in mitigating their consequences. These investigations also provide information required by programs external to LANL, such as data required by the state worker's compensation program, the OSHA 200 log, the DOE Computerized Accident/Incident Reporting System, the DOE Performance Indicator Program, and the DOE ORPS.

Chemical Hygiene Plan

The LANL Chemical Hygiene Plan is the LANL standard that helps to prevent overexposure of employees to hazardous substances. It includes necessary work practices, procedures, and policies to ensure the protection of employees. Additional requirements include employee training and information, medical consultation and examinations, hazard identification, the respirator protection program, and record-keeping. This plan is available on-line at LANL and allows personnel to tailor specific procedures and experimental plans to minimize risk.

Carcinogen Control

The Carcinogen Control Program involves the identification, evaluation, and control of occupational exposures to chemicals identified as known or suspected human carcinogens. The program encompasses the use, storage, or generation of carcinogens at LANL. Work areas where carcinogens are used, stored, or generated are governed by either the LANL Hazard Communication Standard or the Chemical Hygiene Plan. These areas are labeled, and controls for use of these materials are available at the work site or laboratory.

Lockout/Tagout (Red Lock Procedure)

The LANL Lockout/Tagout (Red Lock Procedure) Program describes the minimum requirements of the lockout/tagout procedures used for protecting personnel from accidental releases of hazardous energy while they are servicing, maintaining, or modifying machinery, equipment, or systems. Each facility may have facility-specific requirements for equipment operability checks, maintenance, and operability assurance.

Nonionizing Radiation

The Nonionizing Radiation Program helps to minimize the exposure of LANL workers to laser, radiofrequency/microwave, and subradiofrequency electric and magnetic fields, and establishes the frequency-dependent exposure limits at LANL. The program institutes requirements for anticipating, identifying, evaluating, and controlling the occupational exposure of workers to nonionizing radiation.

Occupational Medicine

The Occupational Medicine Program is maintained to provide continuing medical surveillance for workers to ensure the early detection and treatment of illnesses. It also applies early preventative medical measures. Activities include physical examinations, clinic visits, immunizations, drug testing, and counseling. For hazardous chemical and radiation workers, specific surveillances are often required.

Personal Protective Equipment

The Personal Protective Equipment Program is required in LANL work areas where hazards are not effectively controlled by other means (such as engineering controls) or are unknown (such as site characterization at waste management units) or are controlled, but require additional specific protection. Various types of personal protective equipment provide specialized protection for the respiratory system, eyes, face, feet, and head, as well as entire body.

Workplace Monitoring

The Workplace Monitoring Program helps to ensure that personnel exposures to radiological, chemical, physical, and biological hazards are kept ALARA and below the occupational exposure limit. Monitoring data are analyzed and evaluated to determine whether the control measures are effective, and then the data are documented.

Additional institutional health and safety program areas include biohazards, electrical safety, ergonomics, hearing conservation, ventilation systems, and safety and health training. Detailed information of each subprogram can be obtained from the Occupational Safety and Health Manual (LANL 1993c) and corresponding program requirement documents.

4.6.3 Emergency Response and Preparedness Program

DOE maintains equipment and procedures to respond to situations where human health or the environment are threatened. These include specialized training and equipment for the local fire department, local hospitals, state public safety organizations, and other government entities that may participate in response actions, as well as specialized response teams such as the Radiological Assistance Teams (DOE Order 151.1, *Comprehensive Emergency Management System*). These programs also provide for notification of local governments whose constituencies may be threatened. A broad range of exercises are run to ensure the systems are working properly, from facility-specific exercises (e.g., fire drills) to regional responses (major exercises involving several government organizations). Additionally, the emergency response procedures are periodically utilized in response to actual events, such as the Dome Fire in the spring of 1996.

4.6.3.1 *Emergency Management and Response*

LANL has an institutional emergency planning, preparedness, and response program as required by federal regulations. Emergency Management and Response (EM&R) personnel are responsible for the emergency planning, preparedness, and response necessary to minimize adverse operational impacts. They are available on a 24-hour basis for emergencies, and they provide a 24-hour notification service capable of contacting all LANL employees, even those on travel, should this assistance be needed. The EM&R Program also equips and trains both a Crisis Negotiations Team and a Hazardous Devices Team. It maintains an Emergency Operations Center 24 hours per day to coordinate emergency responses, and maintains an alternate emergency operations center as required by DOE. To effectively operate during an emergency, memoranda of understanding have been established among DOE, Los Alamos County, and the State of New Mexico to provide mutual assistance during emergencies and to provide open access to medical facilities. In addition, the EM&R Program supports development and deployment of a DOE-directed complex-wide data handling and display system.

To assist emergency responders, the EM&R Program maintains a database with facility-specific information such as building managers, phone numbers, building locations, chemicals of concern, etc. In addition, the EM&R Program has an Emergency Management Plan that contains all procedures for mitigating emergencies and collecting response data (LANL Emergency Preparedness).

4.6.3.2 *Emergency Response for Explosions*

LANL has procedures to be followed in case of an explosion. The procedures require a 911 call and a response by fire and medical personnel. EM&R personnel will respond to ensure that the situation is mediated prior to re-entry of the facility.

4.6.3.3 *Fire Protection*

LANL's fire protection program ensures that personnel and property are adequately protected against fire or related incidents. This involves all aspects of traditional fire protection, wildland fire prevention, and life safety as detailed in the National Fire Protection Association Code.

4.7 ENVIRONMENTAL JUSTICE

> ***Agency Responsibilities***
>
> *To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.*
>
> *Source: Executive Order 12898*

President Clinton, in Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, required federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of federal programs, policies, and activities on minority and low-income populations. The order also requires agencies to ensure greater public participation in their decision-making practices.

For the purpose of this assessment, minority refers to people who classified themselves in the 1990 U.S. Census as African Americans, Asian or Pacific Islanders, American Indians, Hispanics of any race or origin, or other non-White races. A minority population refers to an area where minority individuals comprise 25 percent or more of the population (DOC 1990b).

Low-income population refers to a community in which 25 percent or more of the population is characterized as living in poverty (50 FR 192). The U.S. Bureau of the Census uses statistical poverty thresholds to determine the number of individuals below the poverty level. The number of individuals below the poverty level is the sum of the number of persons in poor families and the number of unrelated individuals in poverty. The 1990 poverty threshold was a 1989 income of $12,674 for a family of four (DOC 1993).

4.7.1 Region and Population Considered

The area considered for the SWEIS environmental justice analysis was the area within a 50-mile (80-kilometer) radius of LANL. The center of the area is the emissions stack at the LANSCE in TA–53. The LANSCE stack was chosen because it is the primary source of LANL airborne radionuclide emissions. The use of a 50-mile (80-kilometer) radius circle was patterned after the methodology used by the NRC for assessing potential risks to populations from nuclear power plants and is intended to encompass the potential impacts from LANL operations across all areas of analyses (e.g., water, air, cultural resources).

The racial and ethnic diversity and geographic distribution of the populations within this region require the region be separated into smaller spatial portions (sectors) to assist DOE in identifying minority and low-income populations. To divide the region, four additional circles, centered on the LANSCE stack with radii at 10-mile (16-kilometer) intervals, were overlaid on the 1990 U.S. Census map for this region. The concentric circles were divided by 16 arcs, each 22.5 degrees in width (the resulting sectors are not of equal area). The minority and low-income population data for each sector were derived from U.S. Census Bureau data using Geographic Information System software.

This map will be used to overlay impacts to enable DOE to determine if any LANL operations result in disproportionately high and adverse human health or environmental impacts on minority and low-income populations. Figure 4.7.1–1 presents the area analyzed, the 1990 U.S. Bureau of Census-defined places within this area, and the resulting 80 sectors (discussed above). Eight counties, including all of Los Alamos County and parts of Rio Arriba, Taos, Mora, San Miguel, Santa Fe, Bernalillo, and Sandoval Counties are within the region. Many villages and other rural settlements (not depicted in this figure) are scattered throughout the area but were too small to have been defined as distinct places for the 1990 U.S. Census. Figure 4.7.1–2 presents the 80 sectors, highlighted with the low-income or minority populations greater than 25 percent of the total sector population (based on the information in Table 4.7.1–1). All minority population and income data used in this assessment are based on 1990 U.S. Census data (DOC 1993).

The 50-mile (80-kilometer) region includes at least portions of 15 American Indian Pueblos and 1 American Indian Reservation. These Pueblo and Tribal communities are presented in Figure 4.7.1–1. Only uninhabited or sparsely inhabited sectors of the Pueblo of Taos and Jicarilla Apache Indian Reservation fall within the 50-mile (80-kilometer) circle.

The Pueblo communities in closest proximity to LANL are the Pueblo of San Ildefonso, Pueblo of Santa Clara, Pueblo de Cochiti, and Pueblo of Jemez. DOE has signed intergovernmental agreements (accords) with these sovereign nations to improve cooperation and dialogue regarding LANL operations (section 4.8, Cultural Resources).

The total 1990 population within the 50-mile (80-kilometer) region is 212,771. This population was calculated by summing the populations of all the census tracts within the 50-mile (80-kilometer) radius. Census block data were used when the 50-mile (80-kilometer) radius split a census tract. Twenty-five of the sectors have populations of less than 200, while 3 sectors contain 57 percent of the regional population. The sectors containing 57 percent of the population are: (1) the Santa Fe metropolitan area (62,015); (2) the Rio Rancho, Pueblo of Sandia, and Sandia Heights areas (44,293); and (3) the Pueblo of Santa Clara, Española, and the Pueblo of San Juan (15,182). Table 4.7.1–1 presents the population, percentage of minorities, and percentage of the population living below the poverty level within each sector.

4.7.2 Minority Population

Nearly 54 percent of the population within the 50-mile (80-kilometer) radius area is minority. The area's largest minority group is the Hispanic population (97,378 or about 46 percent), followed by American Indians (14,308 or about 7 percent), African Americans (1,264 less than 1 percent), and Asians or Pacific Islanders (1,142 less than 1 percent). Within New Mexico, minorities make up 49.6 percent of the total state population. Minorities are about 15 percent of Los Alamos County's population, with Hispanics being the largest minority group (11 percent).

Hispanics reside throughout the 50-mile (80-kilometer) radius area, but most are located in the Española Valley and in the Santa Fe metropolitan area. Sixty-two percent of the Hispanics living within this area reside within a transportation corridor that extends north from Santa Fe, along U.S. 84/285 through its junction with NM 502, and north toward Española and its neighboring communities.

4.7.3 Low-Income Population

In 1989, the median household income for New Mexico was $24,087, while 21 percent of the population lived below the poverty threshold ($12,674 for a family of four). Los Alamos County had the highest median income

($54,801) within the state. Fifteen percent of the total population living within the 50-mile (80-kilometer) area had 1989 incomes below the poverty level. Los Alamos County had the lowest percentage (2.4 percent) of individuals living below the poverty level when compared to other census county divisions in the area.

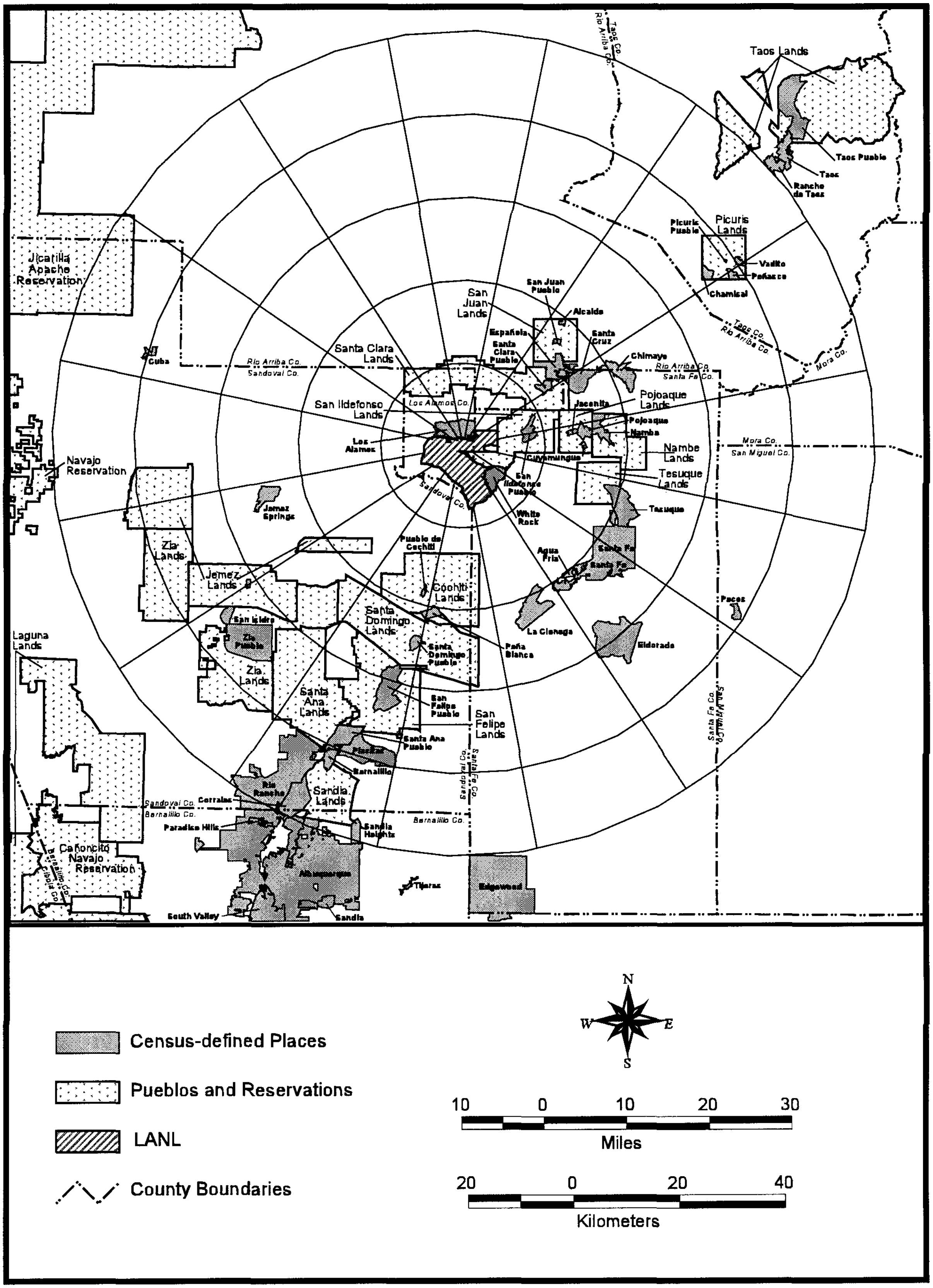

FIGURE 4.7.1–1.—*Sectors Used for Environmental Justice Analysis Within 50 Miles (80 Kilometers) of LANL.*

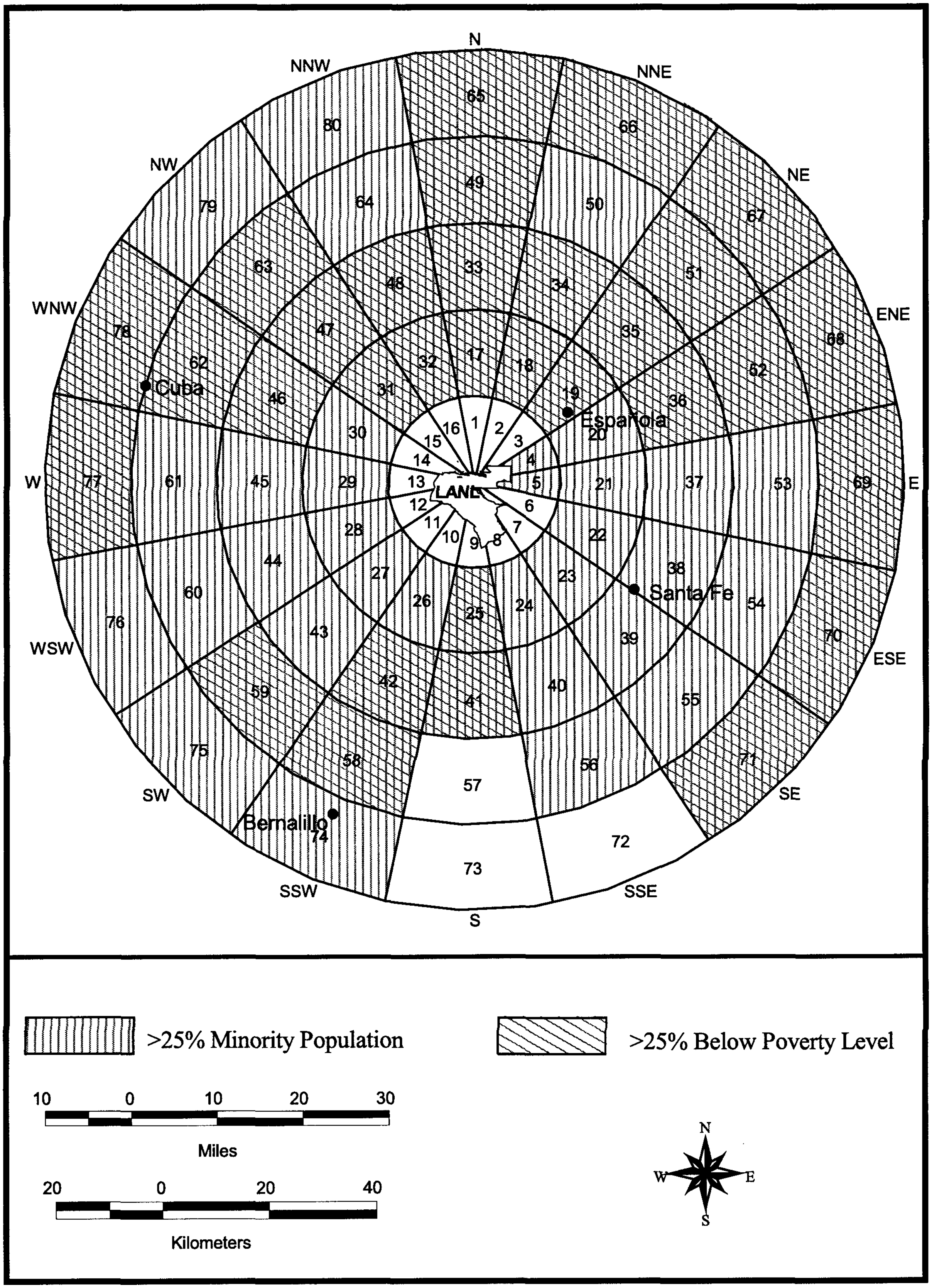

FIGURE 4.7.1–2.—*Sectors with Minority and Low-Income Populations Greater Than 25 Percent of the Sector Population.*

TABLE 4.7.1–1.—*Environmental Justice Areas Within a 50-Mile (80-Kilometer) Radius of LANL*

MAP SECTOR[a]	COMMUNITIES, LAND STATUS IN SECTOR	TOTAL POPULATION IN 1990	PERCENT MINORITIES	PERCENT PERSONS BELOW POVERTY LEVEL
1	Los Alamos townsite, Pueblo of Santa Clara, Santa Fe National Forest	799	8	1
2	Los Alamos townsite, Pueblo of Santa Clara, Santa Fe National Forest	422	8	1
3	Santa Fe National Forest, Pueblo of Santa Clara	132	12	2
4	LANL, Pueblo of San Ildefonso, and CDP	404	54	10
5	LANL, Pueblo of San Ildefonso and CDP	314	61	9
6	LANL, Bandelier National Monument, Pueblo of San Ildefonso, BLM	95	14	8
7	Pueblo of San Ildefonso, White Rock, Santa Fe National Forest	5,742	12	3
8	LANL, Bandelier National Monument, Santa Fe National Forest, edge of White Rock	358	7	0
9	LANL, Bandelier National Monument	63	8	0
10	LANL, Bandelier National Monument, Santa Fe National Forest	0	0	0
11	LANL, Bandelier National Monument	0	0	0
12	LANL, Bandelier National Monument, rural private	36	6	0
13	LANL, Los Alamos, Santa Fe National Forest	399	11	4
14	Los Alamos, Santa Fe National Forest	6,063	18	3
15	Los Alamos, Santa Fe National Forest, Pueblo of Santa Clara	2,912	17	2
16	Los Alamos townsite, Santa Fe National Forest, Pueblo of Santa Clara	1,196	11	1
17	Pueblo of Santa Clara, Santa Fe National Forest	123	83	31
18	Hernandez village, rural private, Santa Fe National Forest	1,920	90	26
19	Santa Clara CDP, Española, Pueblo of San Juan	15,182	89	27
20	Pueblos of San Ildefonso, Santa Clara, and Pojoaque; Española and Santa Cruz; rural private	6,755	82	19
21	LANL; Pueblos of San Ildefonso, Pojoaque, Nambe, and Tesuque; Jaconita, Pojoaque, Nambe CDPs	4,797	71	12
22	BLM, Pueblo of Tesuque, CDP, edge of Santa Fe metro	1,076	58	11
23	BLM, rural private	1,436	52	8
24	Santa Fe National Forest, La Cienega village	327	70	10
25	Cochiti Lake, Pueblo de Cochiti	66	91	26
26	Pueblo de Cochiti, Cochiti village	886	70	19
27	Santa Fe National Forest, Pueblo of Jemez	1	100	0
28	Santa Fe National Forest, Ponderosa village	226	32	15
29	Valle Grande scenic area, Santa Fe National Forest, rural private	71	42	11
30	Santa Fe National Forest, rural private	29	41	10
31	Santa Fe National Forest, rural private	36	94	50
32	Santa Fe National Forest, rural private	23	87	35
33	Abiquiu village, Santa Fe National Forest, rural private	879	82	33
34	Medanales village, rural private	451	87	29
35	Velarde village, rural private	2,470	89	26
36	Chimayo and Truchas villages, rural private	2, 832	93	27
37	Pueblo of Nambe, Santa Fe National Forest	166	49	8

TABLE 4.7.1–1.—*Environmental Justice Areas Within a 50-Mile (80-Kilometer) Radius of LANL*-Continued

MAP SECTOR[a]	COMMUNITIES, LAND STATUS IN SECTOR	TOTAL POPULATION IN 1990	PERCENT MINORITIES	PERCENT PERSONS BELOW POVERTY LEVEL
38	Santa Fe metro, Tesuque CDP, Santa Fe National Forest	7,932	30	8
39	Santa Fe metro	62,015	53	13
40	La Cienega village, rural private	5,204	69	15
41	Pueblo de Cochiti, Pueblo of Santo Domingo; Peña Blanca village	843	97	29
42	Pueblo de Cochiti, Pueblos of Santo Domingo and San Felipe	2,906	98	32
43	Pueblos of Jemez, Zia, and Santo Domingo	159	60	21
44	Jemez Springs, Santa Fe National Forest	747	34	14
45	Santa Fe National Forest, Fenton Lake State Park, rural private	190	33	12
46	Santa Fe National Forest, rural private	44	66	30
47	Coyote and Youngsville villages, Santa Fe National Forest	231	90	45
48	Abiquiu Reservoir, Santa Fe National Forest, rural private	331	84	37
49	El Rito village, Santa Fe National Forest, rural private	887	82	32
50	Ojo Caliente and La Madera villages, Santa Fe National Forest	432	73	24
51	Dixon, Chamisa, and Vadito villages; Pueblo of Picuris	2,538	88	36
52	Las Trampas and Peñasco villages, Carson National Forest	1,699	88	33
53	Santa Fe National Forest, rural private	32	84	22
54	Santa Fe National Forest, Pecos village	2,236	79	22
55	Lamy and Glorieta villages	2,420	32	8
56	Cerrillos, Madrid, and Galisteo villages	1,230	35	16
57	Pueblo of San Felipe, rural private	345	23	12
58	Pueblos of San Felipe and Santa Ana, Bernalillo, Placitas village	3,777	76	26
59	Pueblos of Jemez, Zia, and Santa Ana	2,614	98	34
60	Pueblo of Jemez	181	41	11
61	Pueblo of Jemez, rural private	63	71	24
62	Cuba village, San Pedro Wilderness Area	752	82	33
63	Santa Fe National Forest, rural private	505	75	27
64	Santa Fe National Forest, rural private	57	72	9
65	Santa Fe National Forest, rural private	399	85	25
66	Santa Fe National Forest, rural private	223	74	46
67	Pueblo of Picuris, Talpa village, Ranchos de Taos town	2,483	77	31
68	Carson National Forest, rural private	367	89	42
69	Santa Fe National Forest, Cowles and Tererro villages	391	78	29
70	Santa Fe National Forest, rural private	377	76	27
71	San Jose and San Miguel villages, Santa Fe National Forest	411	85	42
72	Stanley village, rural private	77	23	12
73	Sandia National Forest, Cedar Crest village, rural private	2,872	21	8
74	Rio Rancho, Pueblo of Sandia, Sandia Heights village, North Albuquerque	44,293	34	8
75	Pueblo of Zia	5	60	20
76	Pueblos of Jemez and Zia	5	80	20
77	Rural Private	55	80	42

TABLE 4.7.1–1.—*Environmental Justice Areas Within a 50-Mile (80-Kilometer) Radius of LANL*-Continued

MAP SECTOR[a]	COMMUNITIES, LAND STATUS IN SECTOR	TOTAL POPULATION IN 1990	PERCENT MINORITIES	PERCENT PERSONS BELOW POVERTY LEVEL
78	La Jara, Regina villages, Jicarilla Apache	1,233	75	32
79	Gallina village, Santa Fe National Forest	260	67	18
80	Cebolla and Canjilon villages, Santa Fe National Forest	263	86	8
Totals		212,771	54	15

[a] Map sector refers to the 80 subareas within a 50-mile (80-kilometer) radius of LANL shown in Figure 4.7.1–2. The center point of the circle is in TA–53 on LANL (DOE) property.

Sources: DOC 1993, standard tape files 1 and 3, and tiger line files; data and map lines compiled and analyzed with an atlas GIS by the Bureau of Business and Economic Research at the University of Nevada, Reno, Nevada, 1995.

CDP = Census Designated Place; GIS = geographic information system; BLM = Bureau of Land Management; Metro = Metropolitan Area.

4.8 CULTURAL RESOURCES

> *Traditional cultural values are often central to the way a community or group defines itself, and maintaining such values is often vital to maintaining the group's sense of identity and self respect. Properties to which traditional cultural value is ascribed often take on this kind of vital significance, so that any damage to or infringement upon them is perceived to be deeply offensive to, and even destructive of, the group that values them. As a result, it is extremely important that traditional cultural properties be considered carefully in planning; hence it is important that such properties, when they are eligible for inclusion in the NRHP, be nominated to the NRHP, or otherwise identified in inventories for planning purposes.*
>
> *Source:* NPS 1990

Cultural resources are any prehistoric or historic sites, buildings, structures, districts, or other places or objects (including biota of importance) considered to be important to a culture, subculture, or community for scientific, traditional, or religious purposes, or for any other reason. They combine to form the human legacy for a particular place. The cultural resources present within the LANL region are complex because of the great diversity in the culture of the inhabitants of this region. As the structure and physical environment of the Jemez Mountains and Pajarito Plateau changed over time, cultures changed in response, as reflected in the settlement patterns and technology that evolved over time.

The early hunter-gatherers maintained a mobile society that pursued the large game of the Pleistocene era and also used the vegetation present in the region. Archaic hunter-gatherers responded to a warmer and drier climate by increasing their gathering activities and hunting smaller game. The advent of agriculture permitted leisure time for the inhabitants within the region and also allowed the specialization of labor. Along the Rio Grande and the adjacent Pajarito Plateau, American Indian Pueblo cultures developed and moved through a succession of changes in where they settled, from the mesa tops and cliff faces to finally resting on the Rio Grande floodplain (Figure 4.8–1). After the Spanish conquest, the area remained agricultural until the Pajarito Plateau became home to a science and technology center, LANL.

While not all cultural resource elements need to be preserved, those with significance require identification and preservation so that future generations may be informed and enriched by the past. The standards and criteria used for evaluating impacts to cultural resources for the SWEIS are based on the system developed for the National Register of Historic Places (NRHP), which was established by the *National Historic Preservation Act*. The NRHP is a list of architectural, historical, archaeological, and cultural sites of local, state, or national importance.

The cultural resources present within the LANL boundaries and the region have been classified into three categories: prehistoric, historic, and traditional cultural properties (TCPs). Information pertaining to cultural resources that occur within the LANL site boundaries or the region is presented in this section.

Cultural resource data evaluated for the SWEIS are limited to information that is known about prehistoric resources present on the LANL site, historic evidence of cultures on the LANL site, and the TCPs of both American Indian and Hispanic communities on the LANL site and the surrounding areas that may be affected by LANL operations. Information pertaining to how ongoing cultural practices within the region are related to LANL and other land that could be affected by LANL operations is

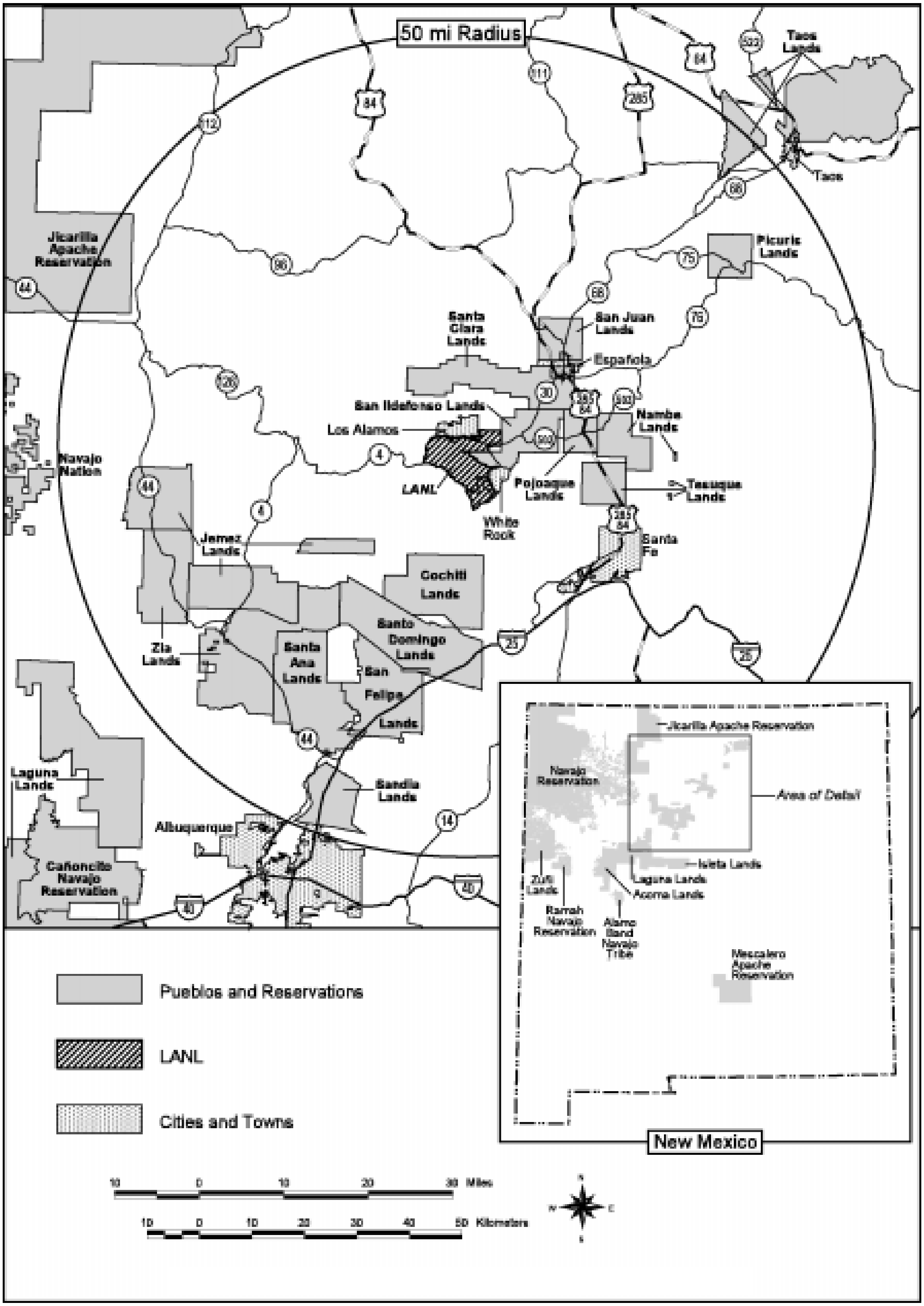

FIGURE 4.8–1.—*Pueblos and Reservations in the LANL Region*.

presented in subsection 4.8.3, Traditional Cultural Properties.

Sources used to assess the cultural resources present in the LANL region include systematic archeological surveys of cultural resources present on the LANL site that were conducted by or for DOE and recorded in the LANL cultural resource database, consultations with 23 American Indian tribal sovereign governments, consultations with Hispanic communities, and literature reviews of American Indian and Hispanic traditional cultural properties. In volume III, appendix E contains expanded discussions of previous studies of cultural resources in the LANL region, a cultural background of the LANL region, applicable regulations, methodologies used for acquiring cultural resource data and assessing impacts to cultural resources, and cultural resources management and resources within LANL boundaries.

4.8.1 Prehistoric Period

Prehistoric cultural resources refer to any material remains and items used or modified by people before the establishment of a European presence in the upper Rio Grande Valley in the early seventeenth century. Socio-historical time lines have been developed based on changes in how people lived and what they ate as reflected by the cultural material remains. Table 4.8.1–1 contains a typical classification scheme for sites in northern New Mexico.

Archeological surveys have been conducted of approximately 75 percent of the land within LANL boundaries (with 60 percent of the area surveyed receiving 100 percent coverage) to identify the cultural resources present. The majority of these surveys emphasized prehistoric American Indian cultural resources. Information on prehistoric cultural resources was obtained from the LANL cultural resources

TABLE 4.8.1–1.—*Archaeological Periods of Northern New Mexico*

PREHISTORIC PERIOD	10,000 B.C. TO A.D. 1600	CHARACTERISTIC CULTURAL EVIDENCE
Paleoindian	10,000 to 4,000 B.C.	• Bones of mammoth and bison • Stone butchering tools • Flakes and chips of stones from making stone tools • Distinctive lance-shaped projective points
Archaic	4,000 B.C. to A.D. 600	• Caves and rock shelters • Burned rock features • Scatters of tools and stone flakes and chips • Isolated hearths • End of the Archaic period (approximately A.D. 1 to 700) may have pottery, grinding stones, and charred corn
Developmental	A.D. 600 to 1100	• Ceramic storage and service vessels • Smaller projectile points reflecting the adoption of the bow and arrow • Grinding tools • Dwellings increased in size and complexity from semisubterranean pithouses to small adobe or crude masonry structures
Coalition	A.D. 1100 to 1325	• Early sites are rectangular structures of adobe and masonry with basin-shaped, adobe-lined fire pits, usually in the center of the room or against a wall • Comparatively small; pueblos average 28 rooms • Later Coalition sites contain plazas and room blocks of more than 100 rooms.
Classic	A.D. 1325 to 1600	• Large masonry structures of multiple-room blocks • For the Pajarito Plateau, three site clusters, one of which includes Navawi, Otowi, Tsankawi, and Tsirege • Associated one- or two-room isolated structures

Sources: Cordell 1979, Cordell 1984, Stuart and Gauthier 1981, Wolfman 1994, and Wendorf 1954 database, which is a listing of the cultural resources identified through surveys and excavations and recorded over the last decade. The database is organized primarily by site type and records 1,295 prehistoric sites (Table 4.8.1–2). Of the 1,295 prehistoric sites in the LANL database, 1,192 have been assessed for potential nomination to NRHP. Of these, 770 sites are eligible, 322 sites are potentially eligible, and 100 sites are ineligible. The remaining 103 sites, which have not been assessed for nomination to NRHP, are assumed to be potentially eligible until further assessment.

4.8.2 Historic Period

Historic cultural resources include all material remains and any other physical alteration of the landscape that has occurred since the arrival of Europeans in the region. The historic resources present within LANL boundaries and on the Pajarito Plateau can be attributed to three phases: Spanish Colonial, Early U.S. Territorial/Statehood, and the Nuclear Energy Period. Because of the very well-defined changes in the function of LANL, the Nuclear Energy Period is further broken into three periods: World War II/Early Nuclear Weapon Development, Early Cold War, and Late Cold War. No systematic survey has been conducted of the Historic Period resources present within LANL boundaries.

TABLE 4.8.1–2.—*Prehistoric Site Types and Number of Sites Recorded in the LANL Cultural Resources Database*

SITE TYPE	NUMBER OF SITES
Simple Pueblos	665
Complex Pueblos	62
Rock Shelters, Cavate (small cave) Pueblos	213
Rock Art	40
Water Control Features, Game Traps	56
Trails, Steps	20
Highly Eroded Pueblos, Rubble	29
Artifact Scatter, Lithic (made of stone) Scatter, Rock Rings	210
TOTAL	1,295

Sources: Cordell 1979, Cordell 1984, Stuart and Gauthier 1981, Wolfman 1994, and Wendorf 1954

Through LANL site surveys, 214 historical resources have been recorded; the remaining 2,105 resources were identified by reviewing the construction dates presented in the following LANL facility listings:

- Capital Asset Management Process Report for fiscal year 1997
- The Facility for Information Management, Analysis, and Display database
- As-built structure location maps
- The LANL ER Project decommissioning summary
- The LANL cultural resources database

The temporal phases of these historic periods, characteristic cultural evidence, number of known artifacts or sites, and eligibility for the NRHP are presented in Table 4.8.2–1, Historic Site Types and Number of Sites Recorded in the Los Alamos National Laboratory Cultural Resources Database. Numbers given are approximate because nonbuilding resources (e.g., barricades, fences, utility support structures, etc.) have not been identified and demolition actions are ongoing.

LANL is currently documenting Nuclear Energy period resources as part of a DOE-wide historic preservation program focusing on World War II and Cold War properties. This study was not completed in time for inclusion in the SWEIS.

4.8.3 Traditional Cultural Properties

A TCP is a significant place or object associated with historical and cultural practices or beliefs

TABLE 4.8.2–1.—*Historic Site Types and Number of Sites Recorded in the LANL Cultural Resources Database*

HISTORIC PERIOD	DATES	CHARACTERISTIC CULTURAL EVIDENCE	NUMBER OF KNOWN ARTIFACTS OR SITES	NATIONAL REGISTER OF HISTORIC PLACES ELIGIBILITY
Spanish Colonial	A.D. 1600 to 1849	• Wagons • Iron hardware • Horse equipment • Pueblo V artifacts	0	
Early U.S. Territorial/ Statehood	A.D. 1850 to 1942	• European and Hispanic homesteads • Commercial ranching concerns/guest ranches: Pond Cabin, Anchor Ranch, and the Los Alamos Ranch School	87	22 sites are eligible for the NRHP. One site is also listed on the State Register of Cultural Properties.[a]
Nuclear Energy	A.D. 1943 to present			
a. World War II/ Early Nuclear Weapon Development Period	A.D. 1943 to 1948	• Original Los Alamos townsite • World War II Manhattan Project facilities where the design and manufacture of the “Trinity Site” bomb; Hiroshima bomb, “Little Boy,” and Nagasaki bomb, “Fat Man” occurred • LANL sites where all U.S. Nuclear Weapons were made from 1946 to 1950 • Common remains consist of buildings, security fences and stations, barricades, roads, and reinforced protective structures.	515	77 sites are eligible for the NRHP (1943–1956). One is also listed on the State Register of Cultural Properties.[a]
b. Early Cold War Period	A.D. 1949 to 1956	Pronounced expansion of facilities		
c. Late Cold War period	A.D. 1957 through 1989	Continued expansion of facilities	1,717	These LANL buildings have not been assessed for NRHP eligibility.
Total number of sites:			2,319	

Sources: LANL 1995a, LANL 1996h, LANL 1995c, McGehee 1995, and NMHPD 1995

[a] The Ashley Pond Cabin is listed twice because its occupation and use spans two historic periods.

of a living community that is rooted in that community's history and is important in maintaining the continuing cultural identity of the community (LAHS nd). TCPs are essential in preserving cultural identity through social, spiritual, political, and economic uses. Federal guidelines established by the NPS identify TCPs to include:

- Natural resources
- Prehistoric and historic archaeological sites
- Traditional-use areas in the cultural landscape that do not reveal evidence of human use
- A rural community whose organization, buildings and structures, or patterns of land use reflect the cultural traditions valued by its long-term residents
- An urban neighborhood that is the traditional home of a particular cultural group and that reflects its beliefs and practices
- A location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historical identity (NPS 1990)

An area may have TCP significance depending upon a variety of factors such as if the site is remembered in prayers or tribal stories, if the traditional ritual knowledge of the place is passed on to other members of the community, or if traditional customs continue to be practiced by members of a community. TCPs that are considered culturally important by traditional communities include shrines, trails, springs, rivers, acequias, plant and mineral gathering areas (also referred to as ethnobotanical sites), traditional hunting areas, ancestral villages and grave sites, and petroglyphs (Harrington 1916 and Henderson and Harrington 1914). However, TCPs are not limited to ethnic minority groups. Americans of every ethnic origin have properties to which they ascribe traditional cultural value.

Within LANL's limited access boundaries, there are ancestral villages, shrines, petroglyphs, sacred springs, trails, and traditional use areas that could be identified by Pueblo and Athabascan communities as TCPs. DOE, together with the LANL Cultural Resource Management Team (CRMT), has a program in place to manage on-site cultural resources for compliance with the *Native American Graves Protection and Repatriation Act* and *American Indian Religious Freedom Act*. When an undertaking is proposed, DOE and LANL arrange site visits by tribal representatives with San Ildefonso, Santa Clara, Jemez, and Cochiti Pueblos to solicit their concerns and to comply with applicable requirements and agreements. Provisions for coordination among these four Pueblos and DOE is contained in formal agreements called Accords that were entered into in 1992 for the purpose of improving communication and cooperation among federal and tribal governments. According to the DOE compliance procedure, American Indian tribes may request permission for visits to sacred sites within LANL boundaries for ceremonies (PC 1997f).

American Indian TCPs located on lands outside LANL boundaries such as tribal lands, state lands, federally managed lands, and private lands, could potentially be affected by LANL operations. Other federal agencies that administer lands in the LANL vicinity that may have TCPs include the following:

- U.S. Forest Service—Santa Fe and Carson National Forests
- National Park Service—Bandelier National Monument
- Bureau of Land Management—Taos Resource Area

As part of the SWEIS process, a TCP study was conducted. This study involved consultations with 19 American Indian tribes and two Hispanic communities to identify cultural properties important to them in the LANL region. Contacts were made with 23 American Indian tribes; however, four chose not to participate in the consultations. All of the consulting groups stated that they had at least some TCPs present on or near LANL. Categories of TCPs identified and number of consultations identifying the presences of TCPs are summarized in Table 4.8.3–1. These resources are present throughout LANL and adjacent lands identified above. No specific features or locations were identified. A more expanded discussion of this study and its results are presented in volume III, appendix E, Cultural Resources.

Spiritual Concerns

In addition to physical cultural entities, concern has been expressed that "spiritual," "unseen," "undocumentable" or "beingness" aspects can be present at LANL that are an important part of Native American culture and may be adversely impacted by LANL's presence and operation.

4.8.4 Cultural Resource Management at LANL

Cultural resources management at LANL is handled by DOE and the LANL CRMT of the Environmental Assessments and Resource Evaluations Group of the ES&H Division. The CRMT follows the LANL compliance procedure outlined in the *LANL Cultural Resource Overview and Data Inventory 1995*. The procedure is designed to ensure DOE compliance with the *National Historic Preservation Act of 1966*; the *Archaeological Resources Protection Act of 1979*, Section 4(c); the *American Indian Religious Freedom Act*, Section 2*; Native American Graves Protection and Repatriation Act;* Executive Order 13007, Section 2(b)*; National Environmental Policy Act*; and DOE's *American Indian Tribal Government Policy* (DOE Order 1230.2). As stated, coordination of cultural resource issues with the four Accord tribes of San Ildefonso, Santa Clara, Jemez, and Cochiti is an integral part of this cultural resource compliance (chapter 7, section 7.2.4). In addition to the compliance procedure, measures are taken to provide American Indian tribes with access to information and input to the process of cultural resource management.

The DOE and LANL are active participants in the East Jemez Resource Council recently formed to foster conservation and preservation of the natural and cultural resources of the east Jemez Mountains.

A cultural resource management plan has not been prepared for LANL, although one is planned for the near future.

TABLE 4.8.3–1.—*Traditional Cultural Properties Identified by Consulting Communities on or near LANL Property*

	CEREMONIAL AND ARCHAEOLOGICAL SITES	NATURAL FEATURES	ETHNO-BOTANICAL SITES	ARTISAN MATERIAL SITES	SUBSISTENCE FEATURES
Number of Consultations Indicating the Presence of TCPs on or near LANL	15	14	10	7	8

4.9 SOCIOECONOMICS, INFRASTRUCTURE, AND WASTE MANAGEMENT

4.9.1 Socioeconomics

The geographic area most affected by changes at LANL is the region comprising Los Alamos, Rio Arriba, and Santa Fe Counties. Demographic, social, and economic conditions in these counties are described in this section, as are matters relating to local government finance, public services, and public utilities.

4.9.1.1 *Demographics*

Approximately 90 percent of LANL-affiliated employees reside in the counties of Los Alamos, Rio Arriba, and Santa Fe. This Tri-County region includes the following (LANL 1996g):

- The communities of Los Alamos and White Rock
- The cities of Santa Fe and Española
- The American Indian Pueblos of San Ildefonso, Santa Clara, San Juan, Nambe, Pojoaque, Tesuque, and part of the Jicarilla Apache Indian Reservation
- Several small villages, unincorporated communities, and widely dispersed farm and ranch holdings

The 1990 population of the region and the distribution by race and ethnicity are presented in Table 4.9.1.1–1. Projections for the region through the year 2006, based on the University of New Mexico's Bureau of Business and Economic Research estimates, are presented in Table 4.9.1.1–2 (UNM 1994).

4.9.1.2 *Regional Incomes*

In the year 1989, Los Alamos had the highest family and per capita incomes of all New Mexico counties. In fact, Los Alamos' median family income was the highest of all counties in the U.S. (DOC 1996). Income data for the LANL region are presented in Table 4.9.1.2–1.

A Look Back in Time

Around Los Alamos, the earliest known (historic) occupancy was by the summer bean farmers who came up from the valley. Bences Gonzales, who retired from his Laboratory employment in 1959 at the age of 66, recalls spending summers near Anchor Ranch (now GT site) where his father had been the first settler in 1891. His wife's grandfather, Antonio Sanchez, was the first homesteader on Pajarito Mesa (above present Pajarito site) in 1885, he recalls. Some scraggly peach trees and a tumbledown log cabin are all that are left of the old ranch. Because of unusually heavy snow the ranch was never occupied in the winter, Gonzales recalls.

Source: LAHS nd

In 1989, approximately 2 percent of Los Alamos County, 13 percent of Santa Fe County, and nearly 28 percent of Rio Arriba County populations lived below the poverty line. The 1989 poverty threshold was $12,674 for a family of four (DOC 1993). Since 1989, the percentage of those living below the poverty line is believed to have remained the same in Los Alamos and Santa Fe Counties and risen slightly in Rio Arriba County. The 1996 poverty threshold was $15,600 for a family of four and $7,740 for an unrelated individual (61 FR 42).

4.9.1.3 *Regional Labor Force and Educational Attainment*

The income and poverty rates for the Tri-County region are mirrored in unemployment rates, as illustrated in the regional data presented in Table 4.9.1.3–1. Unemployment rates for Rio Arriba County historically have been approximately double those for the U.S. at

TABLE 4.9.1.1–1.—*1990 Population by Race and Ethnicity for the Tri-County Region*

ALL PERSONS, RACE/ ETHNICITY	LOS ALAMOS COUNTY		RIO ARRIBA COUNTY		SANTA FE COUNTY		TOTAL	
	NUMBER	PERCENT[a]	NUMBER	PERCENT[a]	NUMBER	PERCENT[a]	NUMBER	PERCENT[a]
All Persons	18,115	100	34,365	100	98,928	100	151,408	100
Caucasian	15,467	85	4,375	13	46,450	47	66,292	44
African American	88	0.5	117	0.3	505	0.5	710	0.5
American Indian[b]	112	0.6	4,830	14	2,284	2	7,226	5
Asian/Pacific Islander	421	2	40	0.1	439	0.4	900	0.6
Hispanic of Any Race[c]	2,008	11	24,955	73	48,939	50	75,902	50
Other Races	19	0.1	48	0.1	311	0.3	378	0.3

[a] Percentages may not total to 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the “other” category given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
Source: DOC 1991

TABLE 4.9.1.1–2.—*Tri-County Population Projections Through the Year 2006*

COUNTY	1990	1996	2001	2006	PERCENT OF CHANGE
Los Alamos	18,115	18,211	18,336	18,503	2
Rio Arriba	34,365	36,156	37,551	38,864	8
Santa Fe	98,928	111,571	122,556	134,546	21
Total Region	151,408	165,938	178,443	191,913	16

Source: UNM 1994, with linear projections for 1996, 2001, and 2006, based on prior years.

TABLE 4.9.1.2–1.—*Income Data for the LANL Region*

AREA	MEDIAN FAMILY INCOME		PER CAPITA INCOME	
	1989 $	1996 $	1989 $	1994 $
Los Alamos County	60,798	NA	24,473	29,762
Rio Arriba County	21,144	27,200	8,590	11,731
Santa Fe County	34,073	NA	16,679	22,531

NA = Not available
Sources: DOC 1993, DOC 1996, and HUD 1996

TABLE 4.9.1.3–1.—*Regional Civilian Labor Force, Employment, Unemployment, and Unemployment Rates (1995)*

COUNTY	CIVILIAN LABOR FORCE	EMPLOYED	UNEMPLOYED	UNEMPLOYMENT RATE
Los Alamos	11,005	10,792	213	1.9
Rio Arriba	17,434	15,364	2,070	11.9
Santa Fe	62,225	59,564	2,661	4.5
Tri-County Region	90,664	85,720	4,944	5.5
State of New Mexico	787,856	738,448	49,409	6.3

Source: NMDL 1996

5.6 percent and the State of New Mexico at 6.3 percent. During the past 6 years, Rio Arriba County's unemployment rates peaked in 1991 and 1992 at 14.6 percent, fell to 10.7 percent in 1994 because of new hires in the Native American casinos, and edged upward to 11.9 percent in 1995 (NMIGA 1996).

In 1990, of all counties in the nation, Los Alamos County had the highest percentage of adults 25 years and over with a bachelor's degree or higher (54 percent). The figure for the U. S. was 20 percent. Thirty-two percent of adults in Santa Fe County and 10 percent of the adults in Rio Arriba County had at least one degree. Approximately 34 percent of adults in Rio Arriba County did not have a high school diploma, compared to 17 percent of adults in Santa Fe County and 5 percent in Los Alamos County, which was the fourth lowest rate for counties in the country (DOC 1994).

4.9.1.4 *The Regional Economy*

In 1994, nearly 6,000 business establishments, government agencies, and government enterprises operated in Los Alamos, Santa Fe, and Rio Arriba Counties (OPM 1994). Collectively, these entities paid approximately $2.5 billion in wages and salaries, which was an increase of 47 percent over 1989. Of this amount, approximately $473 million, or 19 percent, was paid to the LANL work force residing in the Tri-County area. The LANL work force wage and salary data are for fiscal year (FY) 1995. The regional wage and salary data are for calendar year (CY) 1994. Detailed breakdowns of earnings are presented in Table 4.9.1.4–1 (OPM 1994).

Nearly 29 percent of the 6,000 enterprises were service businesses that employed less than 33 percent of the employed work force in the area and paid 30 percent of the earnings reported in 1993 (the principal components of earnings are proprietors' incomes and employee wages and salaries). Approximately 21 percent of the enterprises in the Tri-County area were farms and ranches, but these enterprises employed less than 2 percent of the employed work force and provided only 0.3 percent of the 1993 earnings in the area. Another 21 percent of the business and government operations in the area were retail trade establishments that employed slightly more than 17 percent of the employed work force and paid 12 percent of the earnings reported in 1993. Businesses in each of the other industry sectors were less than 10 percent of all establishments in the Tri-County area (DOC 1996).

Thirty-six percent of the nearly 6,000 sources of employment and earnings in the Tri-County area were government agencies and enterprises, including federal agencies and departments, state government, counties, cities, school districts, and tribal governments. Government

TABLE 4.9.1.4–1.—*Earnings for Tri-County Region (Thousands of Dollars)*

EARNINGS BY INDUSTRY	1989 DOLLARS	1994 DOLLARS	1989–1994 CHANGE IN DOLLARS	PERCENT CHANGE
Farm Earnings	NA	5,348	NA	NA
Private Earnings	980,135	1,571,619	591,484	60
Government Earnings	739,408	964,221	224,813	30
Federal Civilian	59,430	84,338	24,908	42
Military	5,590	6,042	452	8
State and Local	674,388	873,931	199,543	30
Subtotals	1,725,406	2,541,188	815,782	47
Earnings from Dividends, Interest, and Rents	502,429	725,709	223,280	44
Transfer Payments	293,909	464,484	170,575	58
Total Personal Income	2,349,069	3,506,728	1,157,659	49

NA = Not available
Source: DOC 1996

agencies and enterprises employed nearly 29 percent of the Tri-County workforce and paid nearly 40 percent of the total area earnings reported in 1993. Government operations and service sector businesses are clearly the dominant sectors of the economy in the region (DOC 1996).

4.9.1.5 *The LANL-Affiliated Workforce*

The LANL-affiliated work force includes employees of the prime contractor, UC, and its subcontractors, of which the major employers are Johnson Controls, Inc. (JCI), and Protection Technology Los Alamos (PTLA). LANL employs both technical and nontechnical subcontractors, as well as consultants from around the world on a temporary basis. A distribution of the LANL-affiliated work force, for which data were available by county of residence as of March 1996, is presented in Table 4.9.1.5–1. The addition of nontechnical contract labor and consultants brings the total LANL-affiliated work force to 12,837 at the end of March 1996. Race/ethnicity data for the same work force are presented in Table 4.9.1.5–2. Because student employment fluctuates greatly from month to month, students were separated from the total UC employees to better describe LANL's work force composition (LANL 1996g).

Organizational support staff and general support staff fulfill secretarial, computational, and other support functions. Race/ethnicity distribution varies greatly among the LANL UC employees' job categories, as illustrated in Table 4.9.1.5–3.

The LANL UC work force received approximately $421 million in wages and salaries in 1996. Over 97 percent of salaries were paid to employees residing in New Mexico. In the Tri-County area, approximately $267 million, or 63 percent, went to Los Alamos County; approximately $47 million, or 11 percent, went to Rio Arriba County; and approximately $77 million, or 18 percent, went to Santa Fe County. In fiscal year 1996, PTLA salaries totaled $15.5 million, and JCI salaries totaled $36.9 million. A comparison of work force to salary shares for UC employees at LANL by race/ethnicity is presented in Table 4.9.1.5–4 (OPM 1994).

TABLE 4.9.1.5–1.—*Employees of the LANL-Affiliated Work Force by County of Residence (March 1996)*

COUNTY OF RESIDENCE	NUMBER OF PERSONS EMPLOYED BY[a]:				TOTAL	PERCENT OF WORKFORCE[b]
	UC	TECHNICAL CONTRACTOR	JCI	PTLA		
Los Alamos	4,632	440	226	83	5,381	51
Rio Arriba	1,296	129	555	169	2,149	20
Santa Fe	1,443	134	300	90	1,967	19
Other NM	382	54	223	40	699	7
Total NM	7,753	757	1,304	382	10,196	96
Outside NM	366	23	8	0	397	4
Total	8,119	780	1,312	382	10,593	100
Percent of Total[b]	77	7	12	4	100	

[a] Data not available for nontechnical contractors or consultants.
[b] Percentages may not total to 100 due to rounding.
Source: LANL 1996g

TABLE 4.9.1.5–2.—*LANL-Affiliated Work Force by Race and Ethnicity*

	UC EMPLOYEES	UC STUDENT[a]	TECHNICAL CONTRACTORS	JCI EMPLOYEES	PTLA EMPLOYEES	PERCENT OF TOTAL LANL WORKFORCE[b]
Caucasian	4,734	670	418	377	102	60
Hispanic of Any Race[c]	1,746	372	176	878	269	33
African American	28	31	0	8	1	0.6
Asian/ Pacific Islander	232	75	1	4	0	3
American Indian	107	25	9	45	10	2
Unclassified	54	45	176	0	0	3
Total	6,901	1,218	780	1,312	382	100

[a] The number shown is a head count of students employed and does not reflect the number of hours worked per year.
[b] Percentages may not total 100 due to rounding.
[c] This term is used throughout section 4.9 to describe those who classify themselves as Hispanic for consistency with 1990 Census practices (see Table 4.9.1.1–1).
Source: LANL 1996g

TABLE 4.9.1.5–3.—*Percentage of University of California Employees by Race/Ethnicity (March 1996)*

CATEGORY	UNCLASSIFIED	WHITE	HISPANIC	AFRICAN-AMERICAN	ASIAN/ PACIFIC ISLANDER	AMERICAN INDIAN	TOTAL[a]
Technical Staff Members	1	86	6	0.4	6	1	100
Special Staff Members	0.5	68	29	0.4	1	1	100
Technical Support Personnel	0.4	51	45	0.5	0.06	3	100
Organizational Support	0.5	39	58	0.2	0.2	2	100
General Support	0	30	65	0.0	1	4	100
UC Total	1	67	26	0.7	1	4	100

[a] Percentages may not total 100 due to rounding.
Source: LANL 1996g

TABLE 4.9.1.5–4.—*Salary and Work Force Shares of University of California Employees by Race/Ethnicity (1986)[a]*

RACE/ETHNICITY	PERCENT OF UC WORK FORCE	PERCENT OF UC SALARIES
Unclassified	1	1
Caucasian	67	75
Hispanic of Any Race[b]	26	19
African-American	0.7	0.4
Asian/Pacific Islander	4	4
American Indian	2	1
Total[c]	100	100

[a] Work force figures are for March 1996, while salary figures are for the 1996 calendar year. The difference in the number of employees is minimal, with the maximum percentage difference by job category being 0.6 percent. Salary figures include terminated employees.
[b] This term is used throughout section 4.9 to describe those who classify themselves as Hispanic for consistency with 1990 Census practices (see Table 4.9.1.1–1).
[c] Percentages may not total 100 due to rounding.
Source: LANL 1996g

4.9.1.6 *University of California Procurement*

Data on purchase of goods and services from fiscal year 1993 to fiscal year 1995 are presented in Table 4.9.1.6–1. From a peak of $657.5 million in contracts during fiscal year 1993, overall procurement declined to $592.1 million in fiscal year 1995. New Mexico businesses and government agencies received approximately 62 percent of the dollar volume of UC purchase orders during the past three years, ranging from $406.8 million in fiscal year 1994 to $360.5 million in fiscal year 1995.

Distribution of UC procurement dollars within New Mexico counties during fiscal year 1995 is presented in Figure 4.9.1.6–1. UC spent $238 million, or 66 percent, of the contract dollars distributed within New Mexico in Los Alamos, Santa Fe, and Rio Arriba Counties; and Los Alamos County received 91 percent of that Tri-County total. Bernalillo County received the majority of the remaining 33 percent of in-state UC contract dollars.

Procurement data include temporary technical and nontechnical contract personnel. At the end of fiscal year 1995, there were 819 temporary technical contract staff and 331 temporary nontechnical contract staff working at LANL. Big business procurement data presented in Table 4.9.1.6–1 also includes the salaries of JCI and PTLA employees (LANL 1996g).

4.9.1.7 *Role of LANL in the Regional Economy*

A University of New Mexico, New Mexico State University, and DOE study of the impact of UC fiscal year 1995 operations on the economy of Los Alamos, Rio Arriba, and

TABLE 4.9.1.6–1.—*University of California Procurement for Fiscal Years 1993 Through 1995*

	FY 1993		FY 1994		FY 1995	
	DOLLAR AMOUNT	PERCENT[a]	DOLLAR AMOUNT	PERCENT[a]	DOLLAR AMOUNT	PERCENT[a]
NEW MEXICO ORDERS						
Big Business	237,883,405	59	234,988,709	58	218,234,176	61
Small Business[b]	151,657,164	38	159,236,526	40	132,763,856	37
Government and Educational Institutions	11,041,404	3	12,622,145	3	9,459,319	3
Total	400,581,973	100	406,847,380	100	360,457,351	100
OUTSIDE NEW MEXICO ORDERS						
Big Business	106,783,817	42	106,353,084	44	124,958,188	54
Small Business[b]	120,314,120	47	98,387,003	41	89,211,352	39
Government and Educational Institutions	29,778,157	12	36,040,517	15	17,476,520	8
Total	256,876,094	100	240,780,604	100	231,646,060	100
Total FY Procurement	657,458,067		647,627,984		592,103,411	

[a] Percentages may not total to 100 due to rounding.
[b] Businesses with 500 or fewer employees are classified as small businesses.
Source: PC 1995d

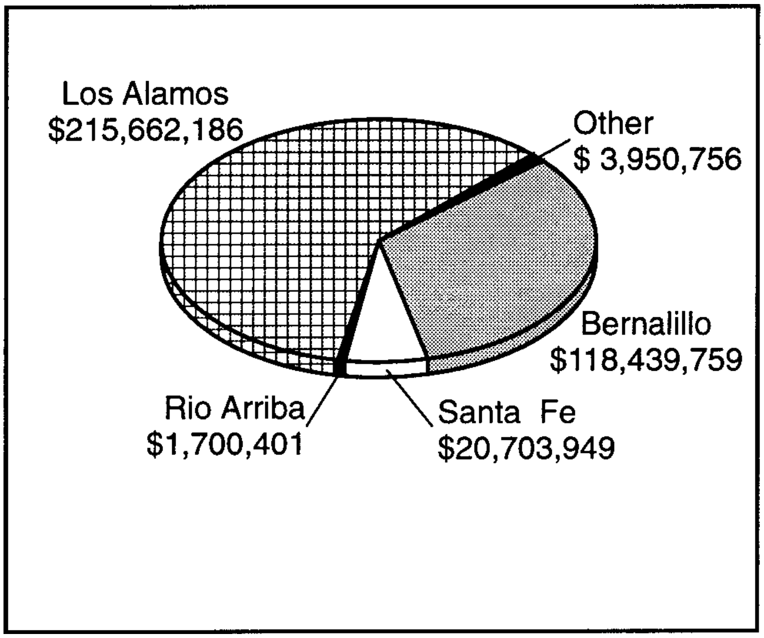

FIGURE 4.9.1.6–1.—*University of California Procurement in New Mexico Counties, Fiscal Year 1995.*

Santa Fe Counties resulted in the following conclusions (Lansford et al. 1996):

- Every 100 LANL jobs produce an additional 171 non-LANL jobs.
- $100 in LANL wages and salaries produce an additional $95 in non-LANL wages and salaries.
- $100 in LANL expenditures produce an additional $189 in non-LANL economic activity.

Multipliers are ratios of the indirect effects on the economy, for example, the number of jobs created or induced in the rest of the economy when jobs are created at LANL. Thus, if 100 jobs are created at LANL, 171 additional jobs will be created elsewhere in the economy, primarily in the Tri-County LANL region. The same logic applies to the multipliers for wages and salaries and expenditures. Using the multipliers described above, LANL directly and indirectly accounted for 27,282 jobs in these three counties, representing 32 percent of the total employment in the area during fiscal year 1995. A total of $1.03 billion in wages and salaries were directly and indirectly attributable to LANL during fiscal year 1995, representing 29 percent of total personal income in the three counties at the time. LANL's purchase of goods and services directly and indirectly accounted for a total of $3.4 billion in economic activity in the three counties, and 30 percent of the $11.35 billion total economic activity in the area during fiscal year 1995 (Lansford et al. 1996).

The new contract between the DOE and UC contains special provisions for performance over the first 2 years of the contract on regional involvement with particular emphasis on support of education, economic development, and community relations. The contract includes appendices enabling: (1) the establishment and funding of a nonprofit foundation to support education, economic development, and social services; (2) enhancing regional procurement; and (3) promoting commercialization of LANL technology.

4.9.1.8 *Community Resources and Social Services*

This subsection describes community resources and social services, primarily focusing on Los Alamos County. Discussions are centered on those resources and services that could be affected by LANL procurement policies and hiring practices, including the following:

- Local government finances
- Housing
- Public schools
- Health services
- Police protection
- Fire protection
- Utilities

Local Government Finance

LANL activities directly and indirectly account for more than a third of employment, wage and salary income, and business activity in the Tri-County LANL region. If there is a change in employment, employee incomes, or procurement at LANL, these changes will have an immediate and direct effect on city and county revenues, such as the gross receipts tax, in the Tri-County region (Lansford et al. 1996).

Municipal and county general fund revenues in the Tri-County area are presented in Table 4.9.1.8–1. The general funds of these communities support the ongoing operations of their governments as well as community services such as police protection and parks and recreation. In Los Alamos County, the fire department serving LANL and the community is funded through a separate fund derived from DOE contract payments. In addition to the general fund, most governments have separate enterprise funds for utilities and capital improvements. Enterprise funds are excluded from the tabulations in Table 4.9.1.8–2 from Los Alamos County and the cities of Española and Santa Fe, because the funds are not sensitive to changes in employment, incomes, and purchases and do not impact basic local government services (NMFMB 1996).

Revenue figures presented in Tables 4.9.1.8–1 and 4.9.1.8–3 demonstrate the heavy dependence of New Mexico communities on the gross receipts tax: a tax levied on most sales and service transactions, excluding automobiles and fuel. Gross receipts tax yields respond quickly to changes in employment, income, procurement, and construction contracting.

In recent years, retail and service sales in the Tri-County area have experienced little growth. In fact, in Los Alamos, gross receipts from retail and service sales decreased dramatically from 1993 to 1994. In the city of Santa Fe, the growth was lower than the rate of inflation. Because Santa Fe is a major regional retail trade and service center, a large state government employer, and a destination tourist location with a small industrial base, its dependence on gross receipts yield is unusually high.

Employment, salary payments, procurement, and contracting by UC are not compartmentalized by county. Therefore, a reduction in employment of LANL personnel who reside in Los Alamos and Rio Arriba Counties has an immediate effect on gross receipts tax proceeds in Santa Fe, where a high percentage of nonfood purchases are made by those employees.

Another source of general fund revenue is property taxes. This tax responds slowly to changes in regional economies, and then only in terms of delinquencies and diminished growth or expansion; effects that are felt over several years rather than immediately. Property taxes in New Mexico are limited by statute to a 5 percent annual increase on any single property.

Los Alamos County Finance

Historically, Los Alamos County and its school district have depended heavily on assistance payments from DOE for operational support.

TABLE 4.9.1.8–1.—*Municipal and County General Fund Revenues in the Tri-County Region (Fiscal Year 1995)*

REVENUE BY SOURCE	LOS ALAMOS COUNTY		RIO ARRIBA COUNTY		CITY OF ESPAÑOLA		SANTA FE COUNTY		CITY OF SANTA FE	
	$	PERCENT[a]	$	PERCENT[a]	$	PERCENT[a]	$	PERCENT[a]	$	PERCENT[a]
Property Tax	3,001,910	14	2,504,037	22	262,707	5	9,819,861	34	964,507	2
Gross Receipts Tax	10,361,829	50	663,626	6	3,930,810	72	4,233,441	15	46,986,752	79
Lodgers Tax	172,874	1	NA	NA	57,785	1	NA	NA	3,636,295	6
Others	921,854	4	205,451	2	671,746	13	1,325,943	4	3,244,930	5
Fees, Fines, Charges, Forfeits, Licenses, and Permits	2,427,527	12	132,857	1	373,620	7	1,458,675	5	3,853,266	7
Oil and Gas Taxes	NA	NA	3,319,900	30	NA	NA	NA	NA	NA	NA
Miscellaneous Income	4,033,998	19	1,306,555	12	153,686	3	1,428,134	5	1,185,088	2
Restricted Funds	NA	NA	3,091,129	28	NA	NA	10,822,381	37	NA	NA
Total Revenues	20,919,195	100	11,223,555	100	5,450,354	100	29,088,435	100	59,870,838	100

NA = Not available
[a] Percentages may not total 100 due to rounding.
Source: NMFMB 1996

TABLE 4.9.1.8–2.—*Municipal General Fund Revenues in Tri-County Region (Fiscal Year 1995)*

REVENUE BY SOURCE	LOS ALAMOS COUNTY		CITY OF ESPAÑOLA		CITY OF SANTA FE	
	ACTUAL	PERCENT[a]	ACTUAL	PERCENT[a]	ACTUAL	PERCENT[a]
Property Tax	3,001,910	14	262,707	5	964,507	2
Cigarette Tax	8,547	.04	46,811	1	136,504	.2
Franchise Tax	330,919	1	177,228	3	2,018,816	3
Gas Tax	380,737	2	362,883	7	817,992	1
Gross Receipts Tax	10,361,829	50	3,930,810	72	46,986,752	79
Lodgers Tax	172,874	1	57,785	1	3,636,295	6
Motor Vehicle Tax	200,851	1	84,824	2	271,618	.5
Total Taxes	14,457,667	69	4,923,048	90	54,832,484	92
Fee and Charges	2,113,272	10	135,315	3	2,697,675	5
Fines and Forfeits	99,939	.5	179,373	3	265,526	.4
Licenses and Permits	214,319	1	58,932	1	890,065	2
Misc. (Includes DOE Assistance to Los Alamos County)	4,033,998	19	153,686	3	1,185,088	2
Total General Fund Revenue	20,919,195	100	5,450,354	100	59,870,838	100

[a] Percentages may not total to 100 due to rounding.
Source: NMFMB 1996

TABLE 4.9.1.8–3.—*Rio Arriba and Santa Fe Counties Revenues (Fiscal Year 1995)*

REVENUE BY SOURCE	RIO ARRIBA COUNTY		SANTA FE COUNTY	
	$	PERCENT[a]	$	PERCENT[a]
Property Taxes	2,504,037	22	9,819,861	34
Oil, Gas and Mineral Taxes	3,319,900	30	NA	NA
Gross Receipts Taxes	663,626	6	4,233,441	15
Motor Vehicle Taxes	118,151	1	289,015	1
Other Taxes, Penalties and Interest	87,300	0.8	1,036,928	4
Licenses, Permits, Fees and Service Charges	132,857	1	1,458,675	5
Miscellaneous Income	1,306,555	12	1,428,134	5
Restricted Funds	3,091,129	28	10,822,381	37
Total Receipts	11,223,555	100	29,088,435	100

[a] Percentages may not total 100 due to rounding.
NA = Not available
Source: NMFMB 1996

DOE financial assistance payments to Los Alamos County and the Los Alamos School District are presented in Table 4.9.1.8–4.

DOE has agreed upon a one-time buyout from the DOE assistance programs for $22.6 million (as identified in the *Energy and Water Development Appropriations Act* of 1997). The agreement does not cover payments made to the Los Alamos School District (PC 1997a). Based upon this agreement, DOE's assistance payments to Los Alamos County ended on June 30, 1997. As of March 1998, $17.6 million of these buyout funds have been paid to Los Alamos County.

Public Schools

New Mexico is divided into 88 school districts, 4 of which are predominantly within the Tri-County area. The State Equalization Guarantee Distribution accounts for over 90 percent of operational revenue received by New Mexico's public schools (NMDE 1995a). Information regarding school district operations for the school districts within the Tri-County region is presented in Table 4.9.1.8–5.

The Los Alamos School District receives 36 percent of its funding from the federal government, over 56 percent from the State Equalization Guarantee Distribution, and 6.5 percent from local sources such as the property tax levy and surplus school space rental (PC 1995b). The district receives direct, formula-based funding from DOE in lieu of property taxes on nontaxable federal property in the district. The district also receives Public Law (PL) 874 funding in lieu of property taxes for children residing on federal land or having parents employed on federal property (PL 874). The total school budget for fiscal year 1997 is projected to be $24.5 million.

PL 874 funding for Los Alamos public schools will run through fiscal year 1998 (PL 874). The school district is not eligible for many of the federal programs that assist schools and students, because the majority of its student body is not low income. The school district is at the legal limit in its ability to raise local taxes for operational funds.

In the Los Alamos School District, enrollment increased 6.5 percent during the period of 1990 through 1995. However, enrollment for the 1996–1997 school year is projected to decrease 1.2 percent. The district owns four surplus school facilities: one it leases to DOE and the University of New Mexico at Los Alamos, and three it leases to LANL and LANL contractors. These four facilities could potentially accommodate approximately 1,275 students. Capacities differ at each school now in use, but as a whole, schools currently in use could accommodate approximately 1,560 more students in the coming years (PC 1995b and PC 1996n).

Enrollment at the Española Public School District has remained relatively stable over the past 5 years. Full-time equivalent enrollment

TABLE 4.9.1.8–4.—*DOE Payments to Los Alamos County (Fiscal Year 1997)*

RECIPIENT	DOE DOLLARS	TOTAL BUDGET DOLLARS	DOE PERCENT OF TOTAL
County Fire Department	8,349,934	8,625,965	97
County General Fund	2,600,000	19,956,702	13
School District	8,700,000	24,500,000	36
Total	19,649,934	53,082,667	37

Source: PC 1996n

TABLE 4.9.1.8–5.—*Public School Statistics in the LANL Region (1995–1996 School Year)*

DISTRICT	STUDENT ENROLLMENT[a]	TEACHERS[a]	TEACHER/ STUDENT RATIO	PER STUDENT OPERATIONAL EXPENDITURES
Los Alamos	3,606	253.8	1:14.2	$6,640
Santa Fe	12,789.5	706.1	1:18.1	$3,665
Española	5,130.0	283.5	1:18.1	$3,986
Pojoaque	1,852.5	103.5	1:17.9	$4,011
State Average			1:17.0	$4,009

[a] These are full-time equivalent figures.
Source: NMDE 1995b

for the 1996–1997 school year is projected to increase 0.6 percent. The district has the capacity to accommodate approximately 150 more students in the schools outside of the city of Española proper and 225 more students within Española. The district is planning to build a middle school in the next 5 to 10 years that will accommodate approximately 800 students (PC 1996o).

Enrollment in the Santa Fe Public School District from 1990 to the 1995–1996 school year has increased 4.1 percent. Full-time equivalent enrollment for the 1996–1997 school year is projected to increase 0.2 percent (PC 1995f).

At the Pojoaque Public School District from 1990 to the 1995–1996 school year, enrollment has increased 4.4 percent. Full-time equivalent enrollment for the 1996–1997 school year is projected to increase by 0.2 percent. The district is currently recruiting students from other districts to attend classes in Pojoaque (PC 1995f).

Housing

The 1990 housing statistics for the Tri-County region are presented in Table 4.9.1.8–6. In Los Alamos, between 1990 and the end of 1996, building permits were issued for 256 single-family units and a single rental property with 36 units. This brought the total housing inventory to 7,857 units, representing a 3.9 percent increase since 1990 (DOC 1990a). For information on land use in Los Alamos County, see section 4.1, Land Resources.

The American Chamber of Commerce Researchers Association estimated that housing costs for a middle-management household in Los Alamos were 47 percent above the national average during the third quarter of 1995 (LAEDC 1995). The median home price in Santa Fe was $179,000 in the first quarter of 1995, down from $181,062 in the first quarter of 1994. From the first quarter of 1993 to the first quarter of 1995, the number of active listings in Santa Fe County and Española increased from 947 to 1,305 (PC 1996j).

Health Services

Three hospitals serve the Tri-County region: Los Alamos Medical Center, Española Hospital, and St. Vincent Hospital in Santa Fe. These hospitals have a licensed bed capacity of 53, 81, and 268, respectively. St. Vincent Hospital is the second-busiest in the state and houses the only trauma center in the area (Ortiz 1995). The number of bed-days is a measure of the number of licensed beds at a hospital multiplied by the number of days in a year. If bed-days are compared to the number of people discharged at each hospital times the average number of days they stayed, the following use characteristics at each hospital are derived: Los Alamos,

TABLE 4.9.1.8–6.—*Regional Housing Summary for the Tri-County Region (1990)*

	LOS ALAMOS COUNTY		RIO ARRIBA COUNTY		SANTA FE COUNTY	
	NUMBER	PERCENT[a]	NUMBER	PERCENT[a]	NUMBER	PERCENT[a]
Total Housing Units	7,565	100	14,357	100	41,464	100
Occupied	7,213	95	11,461	80	37,840	91
Owner-Occupied	5,367	75	9,218	80	25,621	68
Renter Occupied	1,846	24	2,243	20	12,219	32
Vacant	352	5	2,896	20	3,624	9
For Sale Only	42	12	128	4	354	10
For Rent	101	29	326	11	927	26
Other	209	59	2,442	84	2,343	65
Median Home Value	$125,100	NA	$57,900	NA	$103,300	NA
Median Contract Rent	$403	NA	$189	NA	$422	NA

NA = Not available
[a] May not total 100 due to rounding
Source: DOC 1990a

26 percent bed-days used; Española, 32 percent bed-days used; and Santa Fe, 51 percent bed-days used. It appears that each hospital as a unit has the capacity to accommodate more patients; however, figures may differ for each section of hospital activity (PC 1995g).

The Los Alamos Medical Center and St. Vincent Hospital have signed agreements with DOE to provide facilities for treating patients from LANL in the event of an emergency or any type of accident that involves the release of radioactive materials and subsequent contamination of individuals. DOE has agreed to educate hospital personnel and provide contamination control supplies and equipment for use at the hospitals. The current agreements are reviewed annually (DOE 1994a and DOE 1994b).

Police Protection

The Los Alamos County Police Department has 39 officers and 4 detention staff with an approved fiscal year 1997 budget of $3.7 million. The police department responds to approximately 1,700 service calls monthly and is involved in various community programs. The ratio of commissioned police officers in Los Alamos County was 2.14 officers per 1,000 of population in January 1997. This is a higher level of police manpower than in Albuquerque (2.10) or Santa Fe (2.02) (Kirk 1995).

Fire Protection

The Los Alamos County Fire Department facilities and equipment are owned by DOE and operated through contract by Los Alamos County (fire department personnel are county employees). The fire department provides fire suppression, medical/rescue, wildland fire suppression and fire prevention services to both LANL and the Los Alamos County community. There are five continuously manned fire stations located on government property, including two at LANL, and a training facility at the Fire Department headquarters. An additional reserve station and training facility on DP Road may dispatch fire fighters when it is occupied.

Because of the potential severity of the consequences of a LANL emergency, the fire department has been specially trained to respond to a variety of incidents. Fire losses at LANL are reported as being far below industry expectations (BH&A 1995).

4.9.2 LANL Infrastructure and Central Services

LANL has about 8 million square feet (743,224 square meters) of structural space. Approximately 7.3 million square feet (678,192 square meters) of this total exist in 1,835 buildings, and about 0.7 million square feet (65,032 square meters) exist in 208 other structures such as meteorological towers, manhole covers, and small storage sheds. Approximately 30 percent of these buildings and structures are over 40 years old, and about 80 percent are over 20 years old. This means most structures are at the age where major building systems begin to fail and maintenance and operating costs increase.

According to the LANL's Needs and Institutional Plan (fiscal year 1997 to fiscal year 2002), administration occupies 25 percent of LANL space, and storage and services including power facilities occupy approximately 23 percent. Thus, central services and infrastructure account for almost half of LANL's structural space. These activities include:

- *Administrative/Technical Services*—facilities used for support functions that include the Director's Office, Business, Human Resources, Facilities, Security and Safeguards Division, Environment, Safety and Health Division, and communications.
- *Public/Corporate Interface*—facilities, both restricted and unrestricted, that allow public and corporate access and use. These include such facilities as the Oppenheimer Building, Bradbury Museum, and special research centers.
- *Physical Support and Infrastructure*—facilities used for physical support of other LANL facilities. These include warehouses, general storage, utilities, and wastewater treatment.

The other 52 percent of LANL space is occupied by a wide variety of laboratories, fabrication facilities, production and testing facilities, and other structures dedicated to research and development.

4.9.2.1 *Utilities*

Ownership and distribution of utility services are split between DOE and Los Alamos County. DOE owns and distributes most utility services to LANL facilities, and the county provides these services to the communities of White Rock and Los Alamos. DOE also owns and maintains several main lines for electrical, natural gas, and water distribution located throughout the town's residential areas. The County Department of Public Utilities taps into these main lines at a number of locations and owns and maintains the final distribution systems.

Utility systems at LANL include electrical service, natural gas, steam, water, sanitary wastewater, and refuse. Electrical service includes DOE ownership of a 115-kilovolt power transmission line from the Norton substation, a steam/power plant at TA–3 used on a as-needed basis. Secondary power consists of approximately 34 miles of 13.2-kilovolt distribution lines connecting to the input side of low-voltage transformers at LANL facilities. The natural gas system includes a DOE-owned high-pressure main and distribution system to Los Alamos County and pressure reducing stations at LANL buildings. Steam systems include generation and distribution at TA–3 and TA–21. The water system includes supply wells, water chlorination, pumping stations, storage tanks, and distribution systems. Sanitary wastewater systems include septic tanks and a new centralized sanitary wastewater collection system and treatment plant. Refuse collection and disposal is handled by the Support Services Subcontractor and combined with refuse from Los Alamos County in a DOE-owned, Los Alamos County managed landfill.

Gas

Los Alamos County purchases natural gas from Meridian Oil Company in the San Juan Basin of northwestern New Mexico. DOE independently purchases gas through a DOE–DoD Federal Defense Fuels Procurement. DOE currently owns the main gas supply line to Los Alamos and customers in Española, Taos, and Red River areas (PNM 1996). DOE has agreed to sell this line to Public Service Company of New Mexico (PNM). Figure 4.9.2.1–1 reflects the existing natural gas lines and distribution system in the region near LANL.

The county and LANL both have delivery points where gas is monitored and measured. In 1994, the county used approximately 946,000 decatherms of gas compared to the 1.682×10^6 decatherms used by LANL (DOE 1995f and JCUS 1996). About 80 percent of the gas used by LANL was used for heating (both steam and hot air). The remainder was used for electrical generation. The electrical generation was used to fill the difference between peak loads and the electric contractual import rights.

An increased demand for electricity could be accommodated by modifying (e.g., increasing the capacity) the electric power transmission system or by burning natural gas to generate additional electric power. Portions of the existing gas distribution system are 47 years old, and will require modification and upgrades in the future to support the latter option. For example, a second full-capacity border station and an upgrade to the existing 4-inch (10-centimeter) gas line on East Jemez Road would be needed. There is only one full-capacity border station at present on the distribution system.

As shown in Table 4.9.2.1–1, LANL burns natural gas to generate steam to heat buildings at three technical areas (TA–3, TA–16, and TA–21). The use of gas to produce steam remained relatively constant over the 5 years from 1991 to 1995. Peak use occurred in 1993 when the TA–3 steam/power plant used about 775,000 decatherms of gas to generate steam and about 412,000 decatherms of gas to generate electricity. The low-pressure steam is supplied to the TA–3 district heating system and the electricity is routed into the power grid. The TA–3 steam distribution system has about 5.3 miles (8.5 kilometers) of steam supply and condensate return lines. Most of the condensate return lines are old and corroded, resulting in the loss of up to 20 million gallons per year (7.5708×10^7 liters per year) of treated condensate. In addition, operation and maintenance costs for the district heating system (supplying steam heat) are three to four times that of natural gas at about $5 million per year. Without upgrades, these costs will increase dramatically.

The gas use at the TA–16 and TA–21 steam plants is smaller than that at the TA–3 power plant. In addition, the TA–16 district heating system has been replaced by small natural-gas-fired distributed heaters and boilers under a shared savings contract by JCI. Using 1993 data, gas consumption at the old TA–16 steam plant was about 336,500 decatherms, and gas consumption at the TA–21 steam plant was 81,500 decatherms.

Electricity

In the year 1985, DOE and Los Alamos County formally agreed to pool their electrical generating and transmission resources and to share bulk power costs based on usage. The Electric Resource Pool (the Pool) currently provides bulk electricity to LANL and customers within the communities of White Rock and Los Alamos, as well as BNM. Pool resources currently provide 72 to 94 megawatts (contractually limited to 72 megawatts during

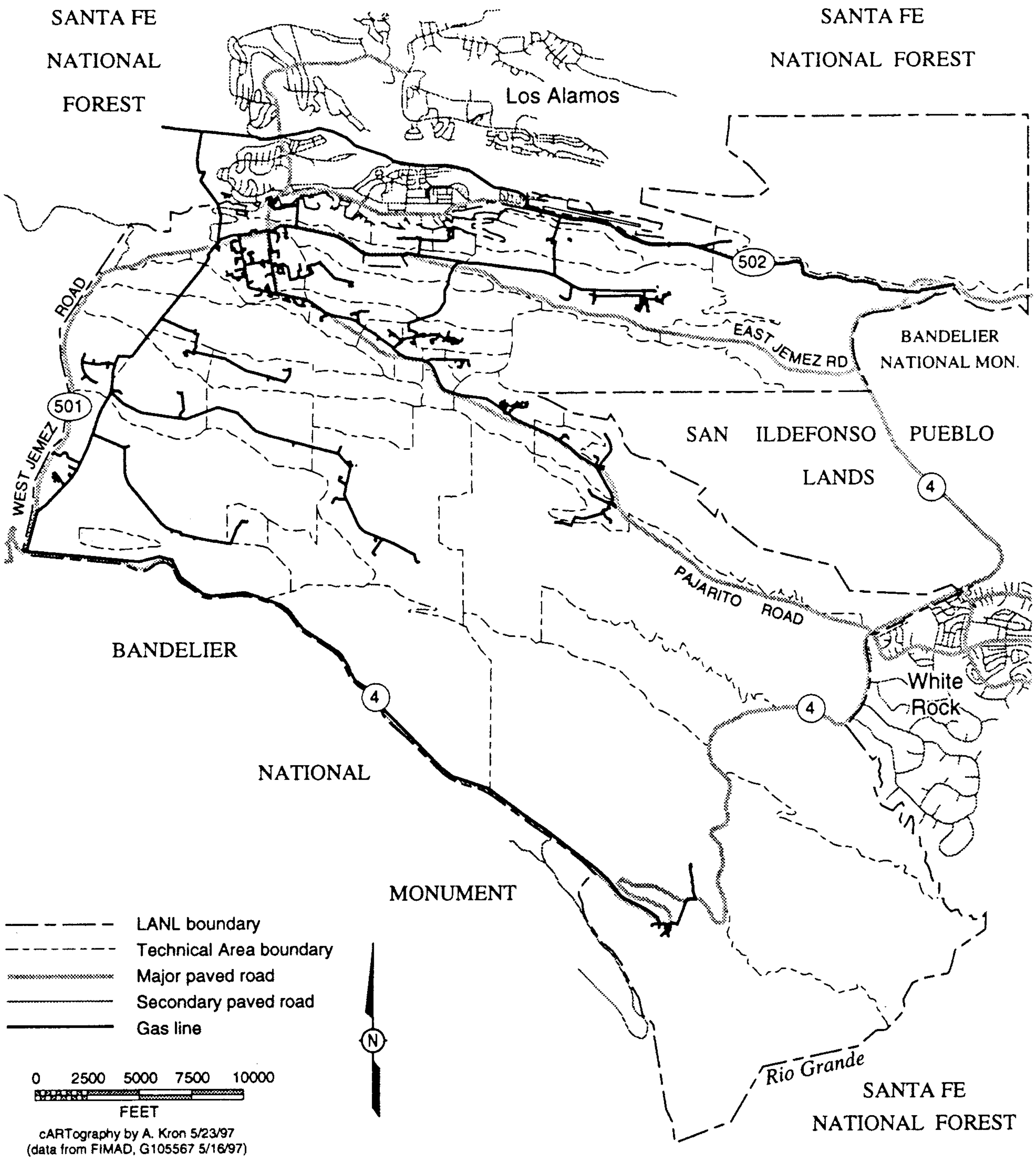

FIGURE 4.9.2.1–1.—*Los Alamos Area Natural Gas Distribution System.*

TABLE 4.9.2.1–1.—*Gas Consumption (Decatherms) at LANL (Fiscal Years 1991 to 1995)*

	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995
Total LANL Consumption	1,480,789	1,833,318	1,843,936	1,682,180	1,520,358
Total Used for Electric Production	64,891	447,427	411,822	242,792	111,908
Total Used for Heat Production	1,415,898	1,385,891	1,432,113	1,439,388	1,408,450
TA–3 Steam Production	471,631	387,421	774,750	719,769	583,229
TA–16 Steam Production	252,916	282,206	336,543	314,430	328,332
TA–21 Steam Production	78,621	74,673	81,510	60,613	65,026
Total Steam Production	803,168	744,300	1,192,803	1,094,812	976,587

Source: Rea 1997

winter months, when El Vado and Abiquiu hydroelectric output is negligible, and to about 94 megawatts during the spring and early summer months) from a number of hydroelectric, coal, and natural gas power generators throughout the western U.S. Excess power is sold by the Pool to other area power utilities. Power delivered to the Pool is limited by the two existing regional 115-kilovolt transmission lines owned by PNM and Plains Electric Generation and Transmission Cooperative. The two 115-kilovolt electric power transmission lines come to the Bernalillo-Algodones substation near Albuquerque and the Norton substation near White Rock. Many northern New Mexico communities, including Santa Fe and Española, also receive power from these substations (PNM nd). Figure 4.9.2.1–2 reflects the current electrical power distribution system in the LANL area. On-site electric generating capacity for the Pool is limited to the existing TA–3 steam/power plant, which has an operating capacity of 12 megawatts in the summer and 15 megawatts in the winter (LANL 1997d).

Table 4.9.2.1–2 and Table 4.9.2.1–3 show peak demand and annual use of electricity for fiscal years 1991 to 1995. Usage by LANL ranged from about 352,000 megawatt-hours (fiscal year 1994) to about 382,000 megawatt-hours (fiscal year 1992). Most of this fluctuation was a result of power consumption by LANSCE. Peak demand declined from about 76,000 kilowatts in fiscal year 1991 to about 66,000 kilowatts in fiscal year 1995. Again, this reduction is attributable to the decline in power demand at LANSCE.

The existing electric transmission system has been evaluated and found to be deficient in a study conducted by technical representatives of PNM, Plains Electric, and the Pool. An operating plan for improved load monitoring, equipment upgrades and optimization of some available power sources has been discussed. The plan, if implemented, would be intended to minimize exposure to complete loss of service (LM&A 1994).

Historically, off-site power system failures have disrupted operations in LANL facilities. Therefore, all facilities that require safe

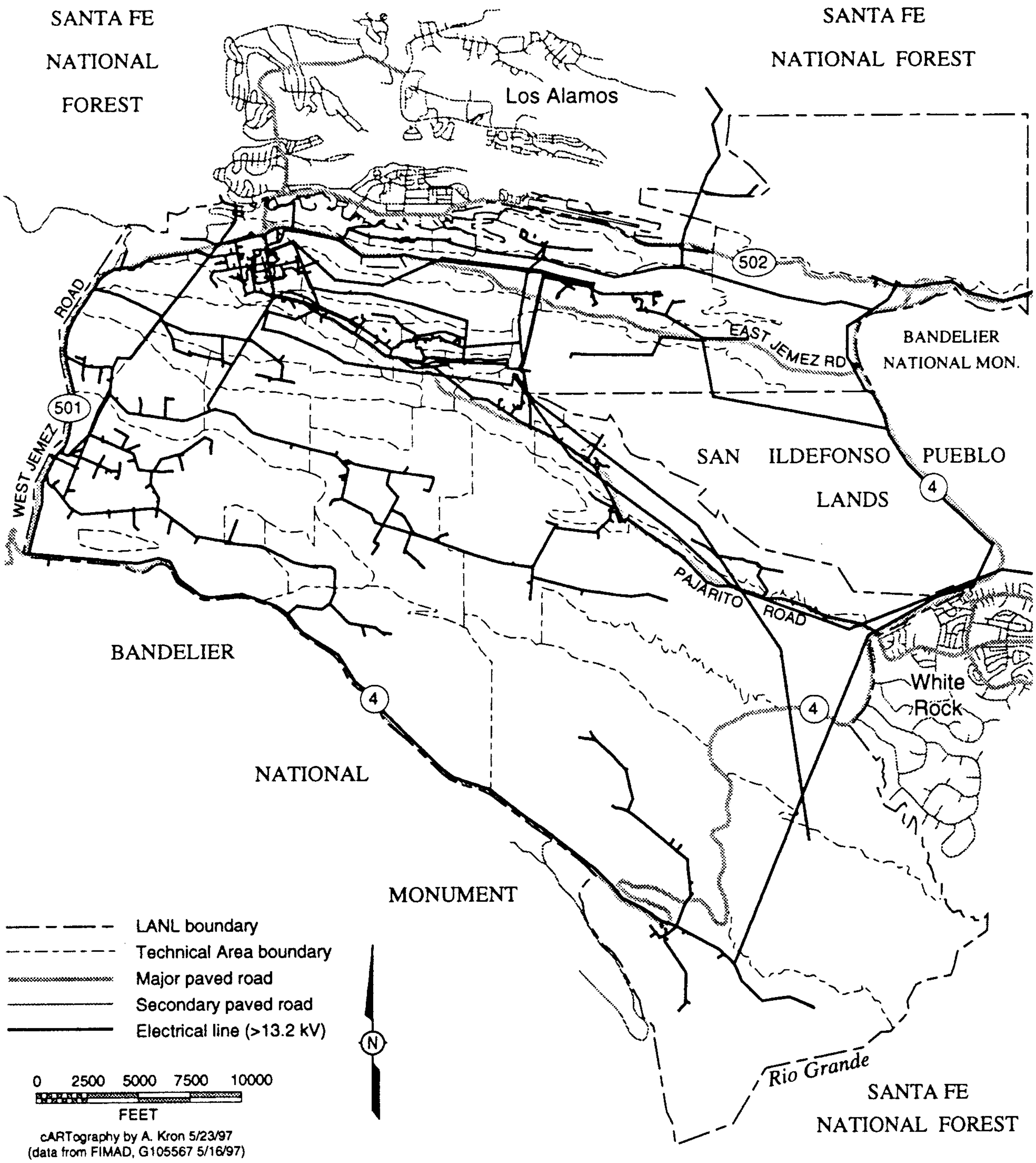

FIGURE 4.9.2.1–2.—*Los Alamos Area Electrical Power Distribution System*.

TABLE 4.9.2.1–2.—*Electric Peak Coincidental Demand (Kilowatt) (Fiscal Years 1991 to 1995)*

FISCAL YEAR	LANL BASE	LANSCE	LANL TOTAL	COUNTY TOTAL[a]	POOL TOTAL
1991	43,452	32,325	75,777	11,471	87,248
1992	39,637	33,707	73,344	12,426	85,770
1993	40,845	26,689	67,534	12,836	80,370
1994	38,354	27,617	65,971	11,381	77,352
1995	41,736	24,066	65,802	14,122	79,924

Source: Rea 1997
[a] Includes communities of Los Alamos, White Rock, and Bandelier National Monument.

TABLE 4.9.2.1–3.—*Electric Consumption (Megawatthour) (Fiscal Years 1991 to 1995)*

FISCAL YEAR	LANL BASE	LANSCE	LANL TOTAL	COUNTY TOTAL[a]	POOL TOTAL
1991	282,994	89,219	372,213	86,873	459,086
1992	279,208	102,579	381,787	87,709	469,496
1993	277,005	89,889	366,894	89,826	456,720
1994	272,518	79,950	352,468	92,065	444,533
1995	276,292	95,853	372,145	93,546	465,691

Source: Rea 1997
[a] Includes communities of Los Alamos, White Rock, and Bandelier National Monument.

shutdown capability for power outages are equipped with emergency generators to assure these needs are met. This includes nuclear facilities such as TA–55 and CMR, which require uninterrupted power for critical ventilation, control systems, and lighting.

The TA–3 steam/power plant currently provides the additional electric power needed to meet peak load demands when demand exceeds the allowable supply, delivered by two 115-kilovolt transmission lines. When electric power generation is required, steam generation is increased (additional gas is burned), and the extra steam is routed to three steam turbines for power generation. Typically, this occurs for only a few months out of the year when LANSCE is fully operational. Loss of power from the regional electric distribution system results in system isolation where the TA–3 steam/power plant is the only source of sufficient capacity to prevent a total blackout. The TA–3 steam/power plant is over 40 years old, and various upgrades of the steam turbine generators, battery banks, circuit breakers, metering, and power generation controls are needed. In addition, though the steam/power plant has a design capacity of 20 megawatts, the existing cooling system (composed of low-pressure steam condensers, pumps, valves and piping) limits the generating capacity to 14 megawatts.

The majority of LANL's 120-mile (200-kilometer) 115/13.8-kilovolt transformers, switchgear, and 13.8-kilovolt overhead electrical distribution system are past or nearing the end of their design life. Backup and replacement transformers and their ancillary equipment are needed to increase system reliability because of the increasing likelihood of component failure and the fact that many components are no longer readily available. Most of LANL's 480/277-volt and 208/120-volt systems would fall below industry reliability standards if used to supply additional power. In addition, the TA–3 substation requires an additional thyristor switched capacitor to maintain system stability during lightening storms. Finally, about 18.6 miles (30 kilometers) of 40-year-old underground cables and 13.8-kilovolt switchgear will require replacement within the next 10 years.

Water

DOE currently supplies potable water to all of the county, LANL, and BNM, and supplies some nonpotable water to LANL for industrial use. DOE has rights to withdraw 5,541.3 acre feet or about 1,806 million gallons (6,830 million liters) of water per year from the main aquifer. In addition, DOE obtained the right to purchase 1,200 acre feet or about 391 million gallons (1.48 billion liters) of water per year from the San Juan-Chama Transmountain Diversion Project in 1976. Although these San Juan-Chama water rights exist, no delivery system is in place, and DOE has no plans at this time to exercise this right (PC 1996c).

Potable water is obtained from deep wells located in three well fields (Gauje, Otowi, and Pajarito). This water is pumped into production lines, and booster pump stations lift this water to reservoir storage tanks for distribution. Figure 4.9.2.1–3 shows the existing water distribution system in the area near LANL. The entire water supply is disinfected with chlorine prior to distribution. DOE potable water production system consists of 14 deep wells, 153 miles (246 kilometers) of main distribution lines, pump stations, storage tanks, and 9 chlorination stations. DOE is currently negotiating with Los Alamos County for possible transfer of most of this system to county ownership. Los Alamos County already owns and maintains the distribution system for the communities of Los Alamos and White Rock (PC 1996e).

Portions of the LANL water system have been in place for about 50 years, including pressure reducing valves, block valves, hydrants, and 8,400 feet (2,600 meters) of transite asbestos fiber piping. In addition, another 30 miles (48 kilometers) of distribution piping is near the end of its useful life and needs replacement.

During fiscal year 1994, DOE withdrew 1,450 million gallons (5,490 million liters) from the aquifer. The county used about 66 percent of this total or about 958 million gallons (3.6 billion liters) (Westervelt 1995 and LAC 1995). The National Park Service used about 5 million gallons (19 million liters) for Bandelier, Tsankawi and Ponderosa Camp Grounds (LANL nd), and the remainder, approximately 487 million gallons (1,843 million liters), was used by LANL. (For more information on the potable water supply and quality see section 4.3.2, Groundwater Resources.)

Nonpotable water is supplied to the TA–16 steam plant from the Water Canyon Gallery. This system consists of about 1 mile (1.6 kilometers) of water line and a catchment basin improvement to a spring. In 1994, this gallery produced about 12 million gallons (45 million liters) of water.

4.9.2.2 *Safeguards and Security*

Safeguards and security operations are conducted at LANL to provide protection of national security interests, proprietary information, personnel, property and the general public. Items needing physical protection include special nuclear material (SNM), vital equipment, sensitive information, property, and facilities. Physical protection strategies are based on a graded approach utilizing threat analysis, risk assessments, and cost benefit analysis.

The Safeguards and Security Management Program provides support to LANL operations

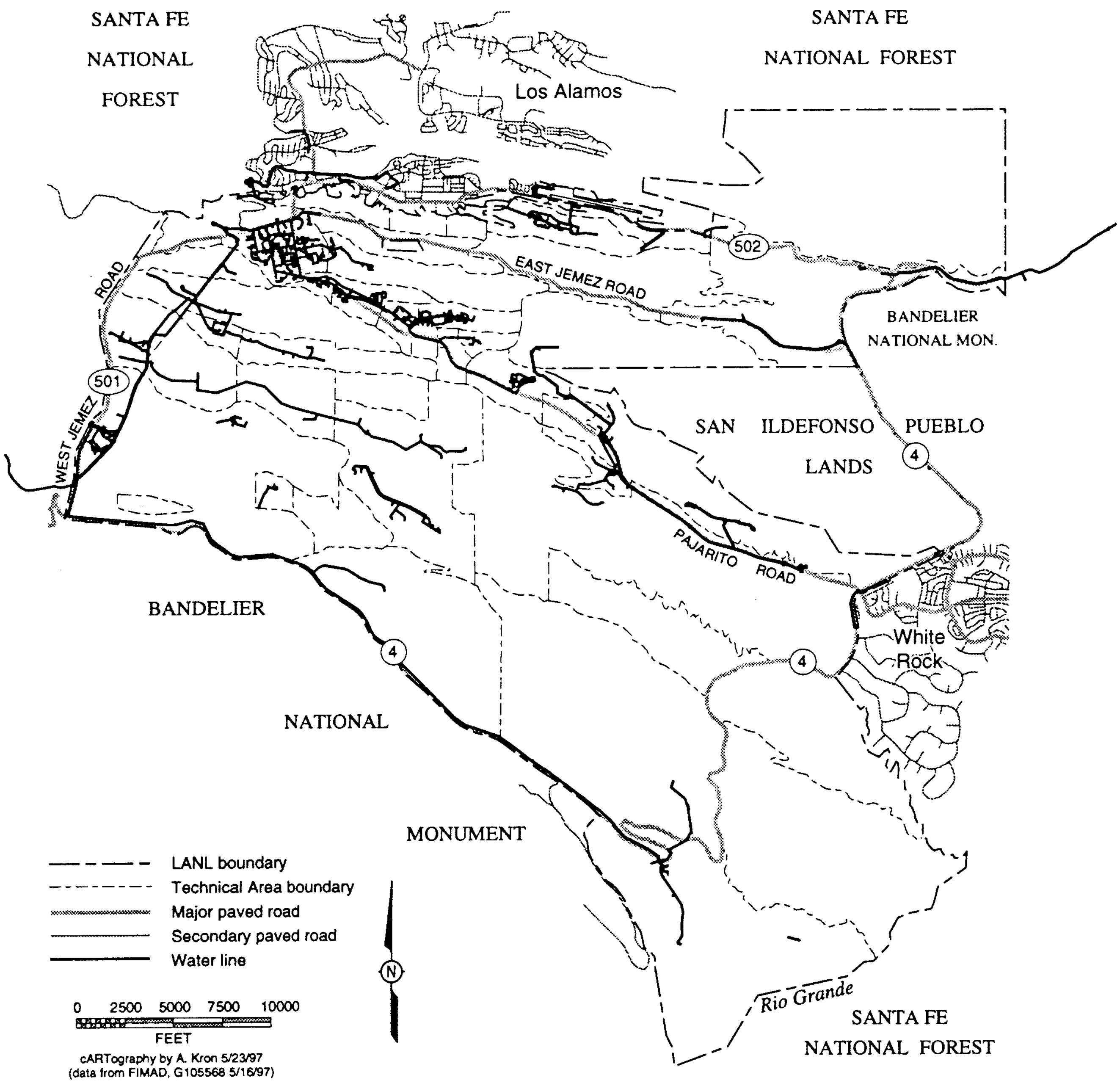

FIGURE 4.9.2.1–3.—*Los Alamos Area Water Distribution System.*

and includes the issuing and use of DOE identification badges with clearance levels and special access authorizations as well as physical security, including protective forces and electronic systems, nuclear material control and accountability, property protection, personnel security assurance, computing and communications, and personnel/information security. Some elements of this program were the subject of public interest during the SWEIS public scoping meetings; due to this interest, information security, material security, and the role of the protective force are explained further below.

Information Security

Some information at LANL is classified and requires protection because of national security interests. Information generated and received is reviewed to determine the proper level of classification, the extent to which the information may be disseminated, and the extent to which the information must be protected. Safes and vaults are used to protect sensitive, classified, or proprietary information. Persons wishing to use this information must have the appropriate level of DOE security clearance and a legitimate need for access to the information (referred to as "need to know"). Personal information about salaries, performance evaluations, and medical conditions, including radiation exposures, are also protected in accordance with laws intended to protect the privacy of individuals.

Material Security

At all DOE sites, including LANL, nuclear materials are controlled by a materials control and accountability program to deter, prevent, detect, and respond to unauthorized use, possession, or sabotage of these materials by employees or the public. This system provides:

- Real-time tracking of nuclear material movements
- A database for tracking inventories and providing transaction audit trails (including records of material movement internal to LANL and between LANL and other sites)
- Early detection of inventory inconsistencies (e.g., the form, location, and quantity of material)
- A variety of material measurement capabilities, including a formal program to monitor the performance of measurement equipment and to ensure measurement equipment is operating effectively

Access controls, materials surveillance procedures and physical containment (alarms, barriers, and guards) are determined based on the quantity and form of the material. Employee background checks and human reliability programs are used to screen personnel who have access to these nuclear materials. In addition, LANL organizations that have and use nuclear materials are required to maintain records of quantities and locations of these materials and provide for their safe storage.

Guard Force

LANL maintains a guard force through the services of PTLA. PTLA provides patrols of LANL properties, protection and escort for dignitaries, on-site demonstration containment, traffic and hazardous materials spill support in emergencies, and general plant security services. PTLA coordinates its activities with other DOE, local, state, and federal law enforcement offices as appropriate.

In cases where criminal activity has occurred (e.g., theft or vandalism), LANL contacts the appropriate law enforcement agency (in most cases it is the Los Alamos County Police Department, see section 4.9.1.8 for additional information). When appropriate, LANL also notifies the Federal Bureau of Investigation and the DOE Inspector General.

4.9.2.3 *Fire Protection*

LANL's fire protection program ensures that personnel and property are adequately protected against fire or related incidents, as described in section 4.6.3.3.

4.9.3 Waste Management

4.9.3.1 *Wastewater Treatment and Effluent Reduction*

LANL has three primary sources of wastewater: sanitary liquid wastes, HE-contaminated liquid wastes, and industrial effluent.

Sanitary Liquid Wastes

Sanitary liquid wastes are delivered by dedicated pipelines to the SWSC plant at TA–46. The plant has a design capacity of 600,000 gallons (2.27 million liters) per day, and in 1995 processed a maximum of about 400,000 gallons (1.5 million liters) per day (PC 1996l). Some septic tank pumpings are delivered periodically to the plant for treatment via tanker truck. Sanitary waste is treated by an aerobic digestion process (i.e., a digestion process which utilizes living organisms in the presence of oxygen). After treatment, the liquid from this process is recycled to the TA–3 power plant for use in cooling towers or is discharged to Sandia Canyon adjacent to the power plant under an NPDES permit and groundwater discharge plan. Under normal operating conditions, the solids from this process are dried in beds at the SWSC plant and are applied as fertilizer as authorized by the existing NPDES permit.

According to the LANL Utilities and Infrastructure Group, the TA–3 sewer lines between Pajarito Road and Diamond Drive and between Diamond Drive and the SWSC connection are 40 years old, and the current capacity is 58 to 68 percent of the original capacity due to deterioration and infiltration. In addition, the S-Site wastewater collection system is also 40 years old and repair or replacement of 12,000 feet (3,600 meters) of this line is also needed.

In addition to the SWSC, there are also 36 approved septic systems still in use at facilities located in 16 TAs (PC 1996l).

Separate from the LANL sanitary waste treatment system, Los Alamos County sanitary waste is processed at two separate facilities. The Bayo Canyon facility processes sewage from the Los Alamos townsite and the DOE Los Alamos Area Office building. This facility has a design capacity of 1.37 million gallons (5.2 million liters) of waste per day and in 1996 was processing approximately 0.9 million gallons (3.4 million liters) per day. The White Rock sewage treatment facility processes sewage from the White Rock community and has a design capacity of 0.82 million gallons (3.1 million liters) per day. In 1996, the facility processed about 0.5 million gallons (1.9 million liters) per day (PC 1996l).

High Explosives Contaminated Liquid Wastes

Wastewater contaminated with high explosives (HE wastewater) is generated at LANL. DOE is currently installing the equipment necessary to filter and recycle this HE wastewater. These actions are being taken to improve wastewater management from HE research and development and meet current and new regulatory standards for wastewater discharge. In addition to the new equipment, existing equipment is being modified by replacing water-sealed vacuum pumps and wet HE collection systems with systems that do not use water. When these modifications are completed, they are expected to reduce the amount of water used in HE processing (currently about 130,500 gallons [493,995 liters] per year) by approximately 99 percent.

To process the HE wastewater, solvents will be extracted at the existing processing facility (TA–16). Then, the HE wastewater will be filtered and recycled using the new equipment (located in an adjacent facility); HE wastewater will be trucked, as needed, to the HE Wastewater Treatment Facility (HEWTF). The HEWTF further treats the wastewater through filtering and then discharges to an NPDES-permitted outfall. The reader is referred to DOE–EA–1100 for a detailed description of the wastewater treatment system upgrade and impacts associated with its installation and use (DOE 1995c).

Sources of non-HE industrial wastewater are being eliminated from the HE processing areas. Outfall piping is being decontaminated (the HE removed), and stormwater will be allowed to discharge through these decontaminated pipes.

Industrial Effluent

DOE has decided to eliminate the effluent from several industrial outfalls at LANL to comply with new regulatory requirements and the discharge limitations specified in LANL's NPDES permit (section 4.3.1.3). The reader is referred to DOE/EA–1156 for a detailed description of the activities being undertaken and for an evaluation of consequences (DOE 1996a). Information regarding these effluents and their relationship to wetlands in the area is discussed in sections 4.3 and 4.5.

4.9.3.2 *Solid Waste*

Both LANL and Los Alamos County use the same county landfill located on DOE property. The Española area solid waste disposal site has been closed. Los Alamos has also contracted with Española to receive selected waste from that community. The Los Alamos landfill received about 22,013 tons (20 million kilograms) of solid waste from all sources during the period of July 1995 through June 1996, with LANL contributing about 22 percent, the city of Española contributing about 32 percent, and Los Alamos County contributing about 46 percent of the solid waste. At the current rate of input, the anticipated life of the landfill is estimated to be about 18 years (Zimmerman 1996).

4.9.3.3 *Radioactive and Hazardous Waste*

LANL generates radioactive and hazardous waste as a result of operations, as well as maintenance and construction activities. Annual waste generation rates have varied due to the level of operations at the various facilities, suspension of operations at various times in these facilities, construction activities, changes in the types of operations, and implementation of waste minimization initiatives. Waste generation across the key facilities was examined from 1990 through 1995; those years during this period that had atypical interruptions or operations were ignored, and the remaining years were used to establish an average waste generation rate for use as the "baseline" generation rate. Waste generation rates for the non-key facilities were averaged for the period from 1990 through 1995 for use as baseline for these facilities. Table 4.9.3.3–1 shows the range of waste generation rates over these periods by facility and the "baseline" generation rates used for the purposes of waste projections. (The baseline used for each waste type, by facility, is identified in the tables presented in section 3.6.)

Radioactive liquid waste generation is not measured at all facilities; therefore, the amounts received historically at TA–50 (section 2.2.2.14) were examined. These influents indicated a waste generation range of between 16.5 and 21.9 million liters per year, with an index of 20 million liters per year.

In addition to the waste generation rates presented in this section, LANL has a backlog of previously generated waste that is being

TABLE 4.9.3.3–1.—*Historical Waste Generation Ranges and Annual Baseline[a] Generation Rates at LANL (1990 Through 1995)*

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		RANGE	BASELINE	RANGE	BASELINE	RANGE	BASELINE	RANGE	BASELINE	RANGE	BASELINE
Plutonium Facility Complex[c]	TA–55	2,363 - 8,685	4,200	308 - 630	590	2 - 39	11	29 - 88	84	2 - 30	25
Tritium Facilities	TA–16 and 21	119 - 3,713	1,100	20.06 - 64.04	40	0.7 - 6.27	2	NA	NA	NA	NA
Chemical and Metallurgy Research Building	TA–3	1,818 - 6,488	4,760	243 - 1,453	781	1.0 - 11.2	5.1	0.2 - 51.0	14.9	2.2 - 13.3	6.5
Pajarito Site	TA–18	361 - 4,856	2,000	11 - 218	71	0 - 3.72	0.75	NA	NA	NA	NA
Sigma Complex	TA–3	2,626 - 7,517	2,800	118 - 640	220	0.0 - 14.2	1	NA	NA	NA	NA
Materials Science Laboratory (MSL)[d]	TA–3	0 - 298	300	0	0	0 - 1	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	748 - 4,171	1,900	0.0 - 11.9	5	0.0 - 0.17	0.2	NA	NA	NA	NA
Machine Shops	TA–3	21,771 - 107,641	23,700	17 - 150	20	0.06 - 10.25	3.3	NA	NA	NA	NA
High Explosive Processing Facilities	TA–8, TA–9, TA–11, TA–16, TA–28 and TA–37	10,676 - 105,285	9,200	0 - 44	6	0.0 - 17.2	0.2	NA	NA	NA	NA
High Explosive Testing Facilities	TA–14, 15, 36, 39, 40	3,221 - 68,497	23,900	45 - 110	80	0.0 - 0.2	0.1	NA	NA	NA	NA
Los Alamos Neutron Science Center	TA–53	2,368 - 27,557	16,600	51 - 468	100	0.3 - 7.7	1[e]	NA	NA	NA	NA
Health Research Laboratory (HRL)[f]	TA–43	4557 - 15,250	4,900	7.99 - 85.7	23	0.01 - 2.73	0.42	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	542 - 12,573	2,000	97 - 903	150	0.07 - 17.0	2	NA	NA	NA	NA

TABLE 4.9.3.3–1.—*Historical Waste Generation Ranges and Annual Baseline[a] Generation Rates at LANL (1990 Through 1995)*-Continued

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		RANGE	BASELINE	RANGE	BASELINE	RANGE	BASELINE	RANGE	BASELINE	RANGE	BASELINE
Radioactive Liquid Waste Treatment Facility[g]	TA–50 and 21	92 - 4,400	2,200	120 - 180	150	8 - 68	38	0 - 11	3	0	0
Solid, Radioactive and Chemical Waste Treatment, Storage, and LLW Disposal Facilities[g]	TA–54 and 50	18,000 - 160,000	110,000	28 - 150	88	1 - 65	3	0 - 33	27	0	0
Non-Key Facilities		375,000-1,062,000	651,000	173 - 1,416	520	1.1 - 117	30		0		0
Grand Total[h]			860,600		2,840		98		129		31.5

Source: LANL 1996b

NA indicates that this facility did not routinely generate these types of waste.

[a] The index for waste generation for each key facility is provided in chapter 3 (section 3.7).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity); is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste; or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under the *Toxic Substances Control Act* (TSCA). This waste type also includes biomedical waste.

[c] The TA–55 TRU and mixed TRU index was established as 1988 through 1990, because the activities during this period that generate TRU and mixed TRU waste most closely approximate the level of activity defined in the No Action Alternative. Since that period, generation of these wastes has been substantially lower. The generation rates for 1988 to 1990 are included in the ranges presented for TRU and mixed TRU waste.

[d] MSL has generated relatively low quantities of waste, and its waste generation history is not maintained on the Waste Management database. Historical generation average values were provided by the Waste Coordinator for this facility.

[e] No index was established for low-level radioactive mixed waste (LLMW). The LLMW moratorium in the mid 1990's caused changes in operations and procedures such that no more that 1 cubic meter of LLMW is expected under any of the alternatives (this is consistent with the LLMW generation from 1993 to 1995).

[f] HRL generates biomedical waste, a subcategory of the chemical waste category shown in this table, and has since 1992. The HRL generated biomedical waste is from 18 kilograms to 705 kilograms. The index value used for biomedical waste generation is 130 kilograms.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities. The index for LLMW is 1994 to 1995. The index for TRU waste is 1987 to 1991.

[h] The total reflected here is attributed to facility operations, and does not include the waste generated from the ER actions that have been completed from 1990 to 1995. Numbers are rounded.

stored at LANL. These consist of 27,096 cubic feet (759 cubic meters) of low-level radioactive mixed waste (LLMW) and 321,800 cubic feet (9,014 cubic meters) of transuranic (TRU) waste.

Finally, LANL has historically received small quantities of waste (LLW or TRU) from off-site locations (average of about five shipments a year from 1991 to 1996). Typically, these are wastes generated by LANL activities at other locations (e.g., due to LANL activities at the Nevada Test Site); however, there have also been cases where LLW or TRU generated at DOE locations without an on-site disposal capability send such waste to LANL for disposal. (In recent years these sites have included the Pantex Plant in Amarillo, Texas, the Kansas City Plant, and DOE facilities on Kirtland Air Force Base in Albuquerque, New Mexico.) Such off-site waste shipments would be expected to continue in the future at about the same rate as has been experienced in recent years (5 to 10 LLW and TRU waste shipments per year). These shipments, although not specifically listed in the waste generation rates and waste shipments analyzed, are within the quantities and shipment numbers projected due to the conservatism in these projections and the relatively small amounts of off-site waste anticipated for shipment to LANL.

4.9.4 Contaminated Space Within LANL Facilities

The information in this section provides an estimate of the existing radioactively contaminated space within LANL facilities as a basis for comparison with the changes in contaminated space presented as impacts in chapter 5 (sections 5.1.9, 5.2.9, 5.3.9, and 5.4.9). The intent is to provide an understanding of the gross effects of the alternatives on the decontamination or decommissioning liability associated with radioactive contamination in LANL facilities and equipment. There is no existing database or information source that identifies and tracks the amount of contaminated space at LANL; therefore, the estimates were generally made on the basis of process knowledge and "walkdowns" of the facilities.

While there are no existing guidelines or regulations directly related to contaminated space in this context, several guidelines, regulations, and management practices do indirectly influence the amount of radioactively contaminated space in DOE facilities. These existing guidelines, regulations, and management practices include ALARA (the concept of limiting exposures to levels that are as low as reasonably achievable), nuclear materials accountability (the routine measurement and accounting activities to control and track nuclear materials throughout DOE [including within LANL facilities and operations]), maintenance practices (including good housekeeping practices, ease and cost of maintenance, and ease and cost of replacement or refurbishment of equipment), and nuclear materials management (nuclear materials inventory management and control). Each of these factors leads to minimization of contaminated space in facilities.

While these pressures tend to minimize the amount of material that contaminates LANL facilities and equipment as well as the total amount of contaminated space, it takes very little radioactive material to effect a substantial increase in the difficulty and cost associated with eventual clean-up actions. For this reason, the approach to estimating contaminated space was relatively conservative. In most cases, a room containing glovebox systems was not counted as contaminated space unless there was no better way of including that process area. In general, the contaminated space within plutonium facilities, hot cells, process gloveboxes, and general laboratory areas was estimated on a footprint (square footage) basis. Duct or plenum space was presented on a volume or linear distance basis. Table 4.9.4–1 presents the contaminated space associated with the plutonium facility at TA–55, the CMR facility at TA–3, the Radiochemistry Facility at TA–48, the Tritium Facilities, TA–50, and TA–53. Pajarito Site (TA–18), TA–54, the Health Research Laboratory (HRL), the Materials Science Laboratory (MSL), the main shops, Sigma, the HE processing facilities, the firing sites, and the Target Fabrication Facility at TA–35, as well as the non-key facilities, have little or no contaminated space, as compared to the facilities included in Table 4.9.4–1.

TABLE 4.9.4–1.—*Estimated Existing Contaminated Space in LANL Facilities*

FACILITY	CONTAMINATED SPACE
TA–55	
Conveyor, Gloveboxes, Hoods, etc.	11,400 square feet (10,600 square meters)
Contaminated Ducts	1,100 cubic feet (30 cubic meters)
Laboratory Floor Space	59,600 square feet (5,550 square meters)
CMR Facility, TA–3	
Conveyor, Gloveboxes, Hoods, etc.	3,100 square feet (290 square meters)
Contaminated Ducts	760 cubic feet (20 cubic meters)
Hot Cell Floor Space	580 square feet (50 square meters)
Laboratory Floor Space	40,320 square feet (3750 square meters)
Radiochemistry Laboratory, TA–48	
Conveyor, Gloveboxes, Hoods, etc.	1,800 square feet (170 square meters)
Hot Cell Floor Space	17,060 square feet (1590 square meters)
Laboratory Floor Space	39,300 square feet (3650 square meters)
Tritium Facilities	
Weapons Engineering Tritium Facility (WETF) Process Room 14	1,460 square feet (140 square meters)
WETF Process Room 116	760 square feet (70 square meters)
WETF Process Room 120	1,300 square feet (120 square meters)
TA–33 (High Pressure Tritium Laboratory in Building 86)	7,500 cubic feet (210 cubic meters) of rubble (mostly cement)[a]
TA–21 Tritium System Test Assembly	8,000 square feet (740 square meters)
TA–21 Tritium Science and Fabrication Facility	750 square feet (70 square meters)
TA–18, Pajarito Site	< 500 square feet (47 square meters)
TA–50, RLWTF	37,000 square feet (3440 square meters)[b]
TA–53[c]	
Area A	178,000 cubic feet (4,980 cubic meters)
A-East Beam Stop	27,600 cubic feet (770 cubic meters)
Target Areas 5 and 6	9,000 cubic feet (250 cubic meters)
Lines B and C	100 cubic feet (3 cubic meters)
Lead Shielding	350 tons of lead shielding
Weapons Neutron Research and Proton Storage Ring	Unknown[d]

[a] This facility is being decommissioned, and the estimate made is for the concrete rubble that is projected to be generated for disposal from clean-up efforts.
[b] This facility processes liquid radioactive waste and includes large process areas, tanks, and a glovebox. Even though the entire facility is not contaminated, no method of estimated contaminated space for this facility was devised; the facility footprint is presented here.
[c] Contaminated space in these areas is typically materials in the target areas, which are best represented by material volumes.
[d] At the time these data were prepared, the Weapons Neutron Research and Proton Storage Ring were not available for experiments; it is not expected that experiments in these areas would result in large quantities of contaminated space/materials (as compared to the amounts noted for the other TA–53 facilities).
Source: Barr 1996

4.10 TRANSPORTATION

The primary methods and routes used to transport LANL-affiliated employees, commercial shipments, hazardous and radioactive material shipments, transportation packaging, transportation accidents, and on-site and off-site traffic volumes are presented in this subsection. Additional information on these subjects is included in volume III, appendix F.

4.10.1 Regional and Site Transportation Routes

Motor vehicles are the primary means of transportation to LANL. A public bus service located in Los Alamos operates within Los Alamos County. The Los Alamos bus system consists of seven buses that operate 5 days a week. The nearest commercial bus terminal is located in Santa Fe. The nearest commercial rail connection is at Lamy, New Mexico, 52 miles (83 kilometers) southeast of LANL. UC does not currently use rail for commercial shipments.

The primary commercial international airport in New Mexico is located in Albuquerque. The small Los Alamos County Airport is owned by the federal government, and the operations and maintenance are performed by the County of Los Alamos. The airport is located parallel to East Road at the southern edge of the Los Alamos community.

Constructed around 1943, the airport was opened to private pilot use in 1961. The airport has one runway running east-west at an elevation of 7,150 feet (2,180 meters). Takeoffs are predominantly from west to east, and all landings are from east to west. The airport is categorized as a private use facility; however, Federal Aviation Administration (FAA)-licensed pilots and pilots of transient aircraft may be issued permits to use the airport facilities. Until January 1996, the airport provided passenger and cargo service through specialized contract carriers such as Ross Aviation, which were under contract with DOE to provide passenger and cargo air service to Los Alamos County and LANL. Commercial air service, as provided by Ross Aviation, was discontinued in 1995. Peacock Air provided air service for part of 1996, and Mesa Airlines provided scheduled air carrier service briefly in 1997. DOE continues to negotiate with various companies to provide for service to the Los Alamos Airport (LAM 1996a and PC 1996q).

A Look Back in Time

The road was one of many challenges. The original laboratory buildings were located on Los Alamos mesa. Project managers refused to allow Sundt (Construction Company) to improve the Ranch School road; they did not want to draw attention to their activities! The narrow, unpaved road was unsuitable for heavy equipment. Trucks suffered numerous breakdowns, and parts were hard to replace in those days of wartime shortages.

It was not until massive equipment for the project began arriving that Sundt was allowed to straighten the road, and then crews could only work at night to avoid delaying daytime deliveries.

Source: Hoard nd

Northern New Mexico is bisected by I–25 in a generally northeast-southwest direction. This interstate highway connects Santa Fe with Albuquerque. The regional highway system and major roads in the LANL vicinity are illustrated in Figure 4.10.1–1. Regional transportation routes connecting LANL with Albuquerque and Santa Fe are I–25 to U.S. 84/285 to NM 502, with Española is NM 30 to NM 502, and with Jemez Springs and western communities is NM 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to NM 4 to

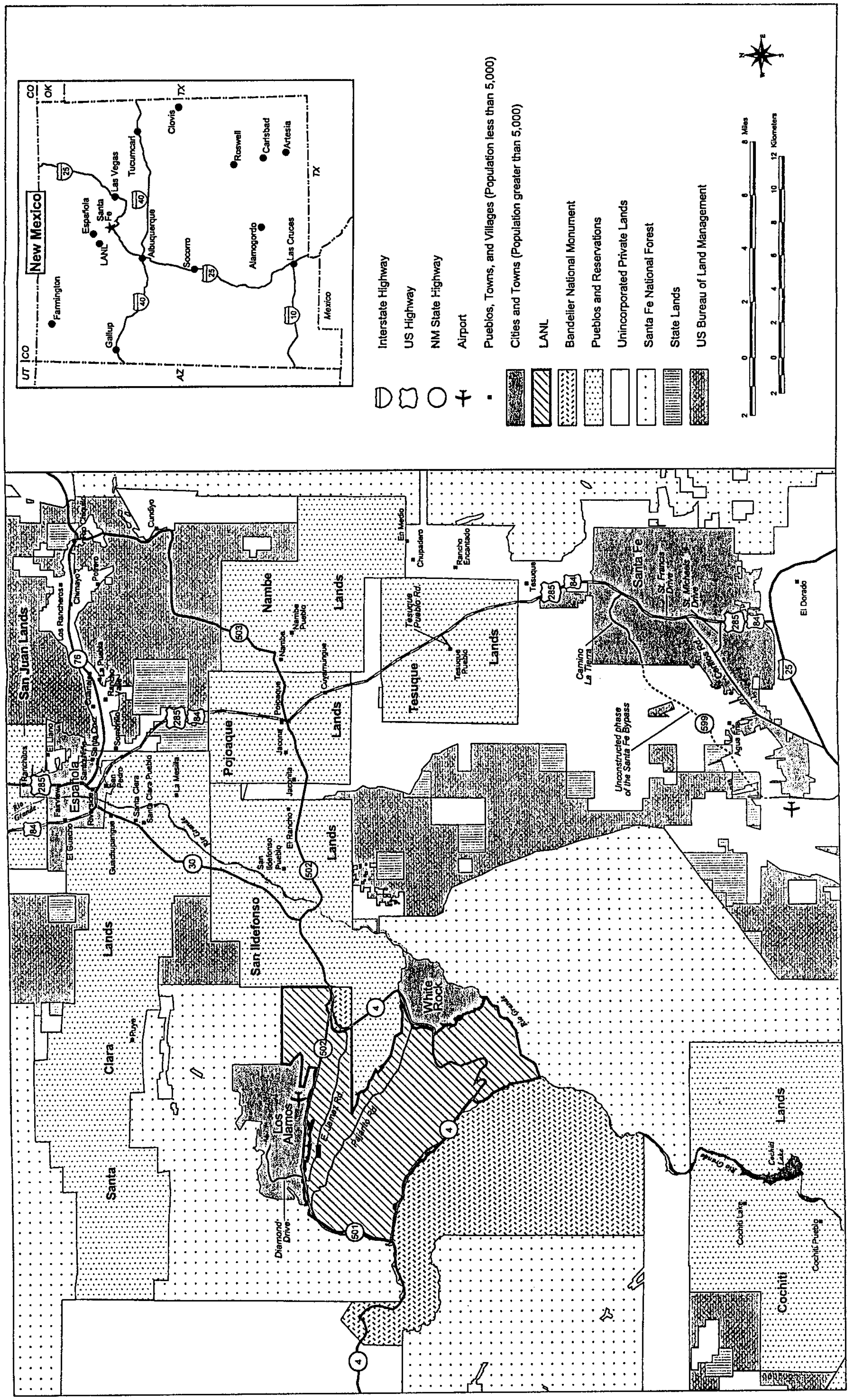

FIGURE 4.10.1–1.—*Regional Transportation Map.*

NM 502. East Jemez Road, as designated by the State of New Mexico and governed by 49 CFR 177.825, is the primary route for the transportation of hazardous and radioactive materials. The average daily traffic flow from 1990 through 1994 and estimated peak hourly traffic volumes for selected routes are presented in Table 4.10.1–1. Only two major roads, NM 502 and NM 4, access Los Alamos County. Los Alamos County traffic volume on these two segments of highway is primarily associated with LANL activities. Approximately 10,662 DOE and DOE contractor personnel administer and support LANL operations and activities (section 4.9, Socioeconomics). Most commuter traffic (approximately 63 percent) originates from Los Alamos County or east of Los Alamos County (Rio Grande Valley and Santa Fe, approximately 35 percent). Only 1 percent of LANL employees commute to LANL from the west along NM 4.

The primary route designated by the State of New Mexico to be used for radioactive and other hazardous material shipments to and from LANL is the approximately 40-mile (64-kilometer) corridor between LANL and I–25 at Santa Fe. This route passes through the Pueblos of San Ildefonso, Pojoaque, Nambe, and Tesuque and is adjacent to the northern segment of Bandelier National Monument. This primary transportation route also passes through residential and commercial segments of the city of Santa Fe for approximately 5 miles (9 kilometers) to I–25. There is a proposed Santa Fe bypass, leading from the northern edge of Santa Fe on U.S. 84/285 to I–25 west of Santa Fe. In the planning stages for over 12 years, this route is now under construction and is expected to be initially available for use later this year. The proposed alignment of the bypass is shown in Figure 4.10.1–1.

4.10.2 Transportation Accidents

Motor vehicle accidents in Los Alamos County from 1990 through 1994 are reported in Table 4.10.2–1.

From 1990 through 1994, there were 3,230 motor vehicle accidents on the regional transportation route between LANL and I–25 at Santa Fe. Heavy commercial vehicles (trucks) transporting materials to and from LANL accounted for less than 4 percent of accidents (Table 4.10.2–2).

4.10.3 LANL Shipments

Hazardous, radioactive, industrial, commercial, and recyclable materials, including wastes, are transported to, from, and on the LANL site during routine operations. Hazardous materials include commercial chemical products that are nonradioactive and are regulated and controlled based on whether they are listed materials, or if they exhibit the hazardous characteristics of ignitability, toxicity, corrosivity, or reactivity. Radioactive materials include SNMs (e.g., plutonium, enriched uranium), medical radioisotopes, and other miscellaneous radioactive materials. Off-site shipments, both to and from LANL, are carried by commercial carriers (including truck, air-freight, and government trucks), and by DOE safe secure transport (SST) trailers. Numerous regulations and requirements govern the transportation of hazardous and radioactive materials, including those of the U.S. Department of Transportation (DOT), NRC, DOE, FAA, International Air Traffic Association (IATA), and LANL.

4.10.3.1 *On-Site Shipments*

On-site hazardous material shipments are transported in conformance with DOT regulations. A shipment is considered an on-site shipment if both the origin and destination are at LANL. These shipments are transported in LANL-operated vehicles. Hazardous

TABLE 4.10.1–1.—*Traffic for Selected Highway Segments in the Vicinity of LANL*

HIGHWAY DESIGNATION	DESCRIPTION	HIGHWAY SEGMENT	SEGMENT LENGTH miles (kilometers)	AVERAGE DAILY TRAFFIC[a] 1994 (NO. OF VEHICLES)	PEAK HOURLY TRAFFIC[b] (NO. OF VEHICLES)
LANL SITE ROUTES					
NM 4	2-lane state highway	Intersection of NM 501 and NM 4 to Bandelier National Monument entrance	4 (6)	758	114
NM 4	2-lane state highway	Bandelier National Monument entrance to NM 502	9 (14)	1,029	154
NM 501	2-lane state highway	Intersection of NM 4 to Diamond Drive (West Jemez Road)	5 (8)	2,105	316
NM 501	4- to 6-lane state highway	Along Diamond Drive to NM 502	2 (3)	35,236	5,285
NM 502	2- to 4-lane state highway	Diamond Drive to the intersection of NM 4	6 (10)	16,286	2,443
East Jemez Road (truck route)	2-lane state highway	Intersection of NM 501 and Diamond Drive to NM 4	6 (10)	NA	NA
NM 502[c]	4-lane divided state highway with uphill truck lane	Intersection of NM 4 and NM 502 to NM 30	4 (6)	12,041	1,806
REGIONAL ROUTES					
NM 30	2- to 4-lane state highway	NM 502 to NM 201 in Española	8 (13)	6,371	956
NM 30	4-lane divided state highway	NM 201 to U.S. 84/285	1 (1.6)	12,003	1,801
NM 502[c]	4-lane divided state highway	NM 30 to U.S. 84/285	12 (19)	8,979	1,347
NM 4	2-lane state highway	San Ysidro to NM 485	10 (16)	2,535	380
U.S. 84/285[c]	4-lane divided U.S. highway	NM 502 to Tesuque Pueblo Road	7 (11)	29,333	4,400
U.S. 84/285[c]	4-lane divided U.S. highway	Tesuque Pueblo Road to Camino La Tierra (Santa Fe)	7 (11)	32,377	4,857
U.S. 84/285[c]	4- to 6-lane U.S. highway	Camino La Tierra to Cerrillos Road	3 (5)	37,957	5,694
U.S. 84/285[c]	4- to 6-lane U.S. highway	Cerrillos Road to St. Michael's Drive	1 (1.6)	47,124	7,069
U.S. 84/285[c]	4-lane U.S. highway	St. Michael's Drive to I–25	2 (3)	31,828	4,774

[a] Average daily traffic represents an annual average over a 7-day week.
[b] Peak hourly traffic is estimated as 15 percent of total daily traffic.
[c] Hazardous/radioactive material shipment route.
NA = Not available
Source: NMHTD 1995

TABLE 4.10.2–1.—*Accidents Within Los Alamos County (1990 Through 1994)*

YEAR	TOTAL NUMBER OF ACCIDENTS IN LOS ALAMOS COUNTY	PERCENT PRIVATELY OWNED VEHICLES	PERCENT LOS ALAMOS COUNTY VEHICLES	PERCENT DOE VEHICLES
1990	356	92	4	4
1991	358	89	5	6
1992	258	87	6	7
1993	325	88	8	4
1994	387	88	7	5

Source: PC ndb

TABLE 4.10.2–2.—*Truck Accident Rates in the Santa Fe to Los Alamos Area (1990 Through 1994)*

ROUTES[a]	TOTAL NUMBER OF ACCIDENTS	AVERAGE TRUCK TRAFFIC (VEHICLE/DAY)	PERCENT LANL VEHICLE/DOE VEHICLE
Through Santa Fe	97	2,104	3.7
U.S. 84/285	17	1,677	0.44
NM 502	5	462	0.49
NM 4	0	520	1.08
East Jemez Road	4	520	1.08

[a] Portion described in Table 4.10.1–1 as the Hazardous and Radioactive Material Route.

Sources: Fenner 1995, Fenner 1996, Vigil 1996 material shipments vary from bulk gases and liquids to small quantities of laboratory chemicals. Hazardous waste shipments are made to the hazardous waste storage facility at TA–50 and radioactive and hazardous waste shipments are made to the waste management area at TA–54. The number of LANL hazardous and radioactive material shipments made annually are presented in Table 4.10.3.1–1.

On-site radioactive material shipments are transported in conformance with DOT and NRC regulations or DOE requirements. A primary feature of these regulations is stringent packaging requirements governing shipments on public roads. In a few cases, it is not cost effective for LANL to meet these stringent packaging requirements. In such cases, roads are temporarily closed during the shipments; DOE safety requirements still apply in these cases. On-site radioactive shipments are made with LANL-operated vehicles. These vehicles vary depending on the quantity and radioactivity of the material shipped, from LANL-owned pick-up trucks to DOE-owned SSTs. Maintenance of these vehicles is closely monitored for physical performance as well as security.

4.10.3.2 *Off-Site Shipments*

LANL transports and receives radioactive and other hazardous materials shipments to and from other DOE facilities and commercial facilities nationwide. All shipments meet applicable DOT, NRC, and FAA regulations or DOE requirements, and most unclassified shipments are transported via commercial carriers. During 1990 through 1994, there were an average of 1,000 shipments per year (including waste shipments) according to the DOE database, which is called the Shipment Mobility/Accountability Collection (SMAC). These consisted, on average, of 800 shipments of hazardous materials and 200 shipments of radioactive materials. The difference between these totals and those listed in Table 4.10.3.1–1 is due to the classified shipments and other shipments for which transportation is not explicitly paid for by LANL; such shipments are not recorded in the SMAC database. The types of materials transported and the number of unclassified off-site radioactive and hazardous materials shipments are stated in Table 4.10.3.2–1. DOE regulations require an SST trailer be used for off-site shipments of special nuclear materials, weapons components, and explosive-like assemblies in DOE custody. SST trailers are similar in appearance to commercial tractor-trailers but are equipped with unique security and safeguard features that prevent unauthorized cargo removal and minimize the likelihood of an accidental radioactive materials release as a result of a vehicle accident. Classified shipments are made in an SST trailer. The designated hazardous materials route for Los Alamos County is East Jemez Road to NM 4 to NM 502.

TABLE 4.10.3.1–1.—*Annual LANL On-Site and Off-Site Shipments*

TYPE	NONHAZARDOUS	HAZARDOUS (NONRADIOACTIVE)	RADIOACTIVE
Off-Site	327,939	2,592	934
On-Site	Not Available	7,560	1,187

Source: Villa 1996

TABLE 4.10.3.2–1.—*Summary of Off-Site, Unclassified Radioactive and Hazardous Materials Shipments (1990 Through 1994)*

TRANSPORT MODE	MATERIAL CATEGORY	BOUNDING MATERIAL[a]	MAXIMUM SHIPPING QUANTITY[a]	NUMBER OF SMALL SHIPMENTS[b]	NUMBER OF LARGE SHIPMENTS[b]
Truck	Flammable	Hydrogen	50,000 ft^3	320	17
Truck	Toxic	Chlorine	2,000 lb	136	22
Truck	Radiological	Tritium	29,160 Ci	406	11
Truck	Explosive	HMX	13,801 lb	102	24
Air	Toxic	Chlorine	7 lb	160	15
Air	Explosive	HMX	195 lb	21	80
Air	Radiological	Tritium	970,000 Ci	1,185	1

Notes: SST trailer shipments not included. About 2,500 shipments screened due to low material toxicity. HMX is octahydro-1,3,5,7 tetranitro-1,3,5,7-tetrazocine. Large shipments are greater than 10 percent of the maximum shipping quantity.

[a] These columns reflect the material that bounds the risks associated with each material category and the maximum quantity of this material that has been shipped.

[b] These columns reflect the numbers of small and large shipments for each material in a particular material category; thus, these reflect the shipments of the bounding material and other materials in this category.

Source: SWEIS volume III, appendix F

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CHAPTER 5.0 ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential direct, indirect and cumulative environmental impacts, or changes, resulting from each of the reasonable alternatives for continuing the operation of LANL: the No Action Alternative, the Expanded Operations Alternative (DOE's Preferred Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year in the near term), the Reduced Operations Alternative, and the Greener Alternative. Environmental impacts are described and discussed across the various aspects of the affected environment or resource areas that are likely to change at a site-wide level.[1] Aspects of the environment that are not expected to change as a result of implementing any of the four alternatives analyzed are not discussed in detail.

The Region of Influence (ROI) varies across the resources as well as across the alternatives. Chapter 4, Affected Environment, describes the current environment in and around LANL for each of the resource areas (e.g., Land Resources, Air Quality, and Water Quality). The information presented in chapter 4 is the foundation for understanding and evaluating the environmental impacts associated with the four alternatives.

Chapter 5 includes six major sections. Section 5.1 presents the methodologies used for the impact analysis for each resource area. Sections 5.2, 5.3, 5.4, and 5.5 present the impacts associated with the No Action, Expanded Operations, Reduced Operations, and Greener Alternatives, respectively. Section 5.6 presents unavoidable adverse impacts, the relationship of short-term uses and long-term productivity of resources, the irreversible or irretrievable commitment of resources, and the cumulative impacts associated with the continued operation of LANL. Each section except 5.6 is formatted to follow the presentation of the affected environment or resource areas discussed in chapter 4 (e.g., section 5.2.1 presents the impacts of the No Action Alternative to Land Resources). The most detailed discussion is presented in section 5.2, and the impacts associated with each of the other alternatives are usually compared to the impacts of the No Action Alternative (in section 5.2) to minimize repetition. A discussion of bounding potential credible accidents for the four alternatives is presented near the end of each of these sections (i.e., sections 5.2.11, 5.3.11, 5.4.11, and 5.5.11). The discussions in this SWEIS, including discussions in this chapter, are augmented by a classified supplement to the SWEIS. This supplement contains certain classified information and data related to the activities at LANL that, though important to support understanding of certain details underlying the SWEIS and its analyses, must be protected in

1. The scope of the SWEIS was developed prior to issuance of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (SSM PEIS, DOE 1996d) Record of Decision (ROD). Thus, the Expanded Operations Alternative was originally defined to include the high explosives component production and the secondary assembly production mission elements, as discussed in chapter 1. Accordingly, the environmental consequences of the Expanded Operations Alternative (described in section 5.3) include the impacts associated with these mission elements. However, because these activities do not contribute substantially to air quality, water resource, land resource, socioeconomic, or other impacts projected regarding LANL operations, the environmental consequences of the Expanded Operations Alternative with or without these mission elements are substantially the same. Therefore, DOE determined that it was not cost effective to restructure and reanalyze the Expanded Operations Alternative. To the extent that this affects the impact analyses, the environmental consequences of the Expanded Operations Alternative can be expected to be somewhat less than identified in section 5.3.

accordance with the *Atomic Energy Act of 1954* (42 United States Code [U.S.C.] §2011). This information includes details associated with some operations, experiments, processes, or source terms. DOE presents as much information as possible in this unclassified document. Furthermore, the environmental impacts are fully contained in the results presented to the public in this unclassified document.

The major contributors to environmental impacts of operating LANL are wastewater discharges and radioactive air emissions.

- Historic discharges to Mortandad Canyon from the Radioactive Liquid Waste Treatment Facility (RLWTF) have resulted in above background residual radionuclide (americium, plutonium, strontium-90, and cesium-137) concentrations in alluvial groundwater and sediments.
- Plutonium deposits have been detected along the Rio Grande between Otowi and Cochiti Lake.
- The principal contributors to radioactive air emissions have been and continue to be the Los Alamos Neutron Science Center (LANSCE) and high explosives testing activities.

In addition, trace amounts of tritium have been detected in some samples from the main aquifer. (Isolated results have indicated the presence of other radionuclides. However, results have not been duplicated in previous or subsequent samples, making these results suspect.)

The analysis in the SWEIS indicates that there are very few differences in the site-wide environmental impacts among the alternatives analyzed. The major discriminators among alternatives are: collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, and electrical power demand. A summary of impacts is provided in section 3.6 in chapter 3. Tables 3.6.2–1 and 3.6.2–2 provide a direct comparison of expected consequences for each environmental factor across alternatives.

5.1 IMPACT ANALYSIS METHODOLOGIES

5.1.1 Land Resources Methodology

5.1.1.1 *Land Use*

The methodology used for assessing land use impacts is comparative in nature. The operations, facility construction and modification activities, and their predicted effects are compared against existing land use categories for the areas that could be influenced by such actions. In addition, the amounts of land disturbed or taken for construction are also identified. (This information is then used in the analysis of ecological and cultural resource impacts.)

5.1.1.2 *Visual Resources*

Visual impacts to the LANL viewshed depend on physical changes through development at the site, the ability for LANL structures to be seen by viewers because of changes in land cover, and the visibility of the area related to air or light pollution. Thus, this qualitative analysis addresses construction that may change the visibility of LANL structures or obscure views of the landscape, changes in land cover that may make LANL structures more or less visible, and changes in air or light pollution that could change visibility in the area.

5.1.1.3 *Noise*

Noise (unpleasant sounds), air blasts, and ground vibrations may be perceived both within and outside the LANL site boundaries due to the combined effect of the existing traffic, LANL high explosives research, and construction activities. The noise heard by people located outside the site boundaries may be very episodic (such as explosives testing) or may be long term in duration (such as traffic noise). This analysis examines projected activities with a focus on changes from existing noise conditions in the area, as well as the potential for noise impacts to workers and the public. Because noise and vibration impacts to cultural resources are addressed in the cultural resources impact analyses, such impacts are not discussed under land resources impacts.

5.1.2 Geology and Soils Methodology

The methodology used to assess potential impacts to geology and soils across the four alternatives was a two-step process. First, past LANL activities were evaluated to see how they had impacted the geology and soils in the Los Alamos area. The information from this study on the existing environment is presented in chapter 4 (section 4.2). Information from section 4.2 was then used as a basis for assessment of potential impacts that may result from implementing the four alternatives. The impact analysis focuses on any changes that have the potential for causing seismic events, slope instability, soils erosion, and changes to mineral resources. For example, observation and studies of the LANL site in the past have shown where slope stability problems are most likely to occur and under what circumstances. This type of information was then used to evaluate proposed activities to see if those same indicators leading to soil erosion were present in a new action or in a potential change to an existing activity. This manner of analysis is commensurate with the significance of the potential impact in this resource area.

Impacts to geology and soils are primarily associated with effects generated by proposed construction activities. However, for this SWEIS the majority of construction activities are within existing facilities. Where construction activities would occur outside of existing facilities (as in the expansion of Area G), they are explicitly addressed.

The effects on soil contamination from contaminants released to the atmosphere, either directly in gaseous effluents (e.g., air stack emissions) or indirectly from resuspension of on-site contamination (e.g., fugitive dust) were evaluated. As discussed in section 5.2.2, the information provided from the geology and soils sections directly relates to the analysis of several other sections within the SWEIS (such as cultural resources, human health, accidents, and ecological resources). For example, geologic hazards that are important components of accident scenarios are discussed in the accident sections, and the potential for human health and environmental impacts associated with soil contamination are discussed in the ecological and human health sections.

5.1.3 Water Resources Methodology

The primary differences in terms of water resources across the four alternatives are: (1) the change in flow from the permitted National Pollutant Discharge Elimination System (NPDES) outfalls and (2) the influences of water use to main aquifer.

The methodology used for assessing surface and groundwater impacts for the four alternatives was to first obtain index data on the NPDES outfalls (flow rates and analyte concentrations) and compare this information with projected NPDES flow rates and analyte concentrations for each of the alternatives. The majority of the changes, especially increases to NPDES flows for the alternatives, are contributed by the key facilities. Therefore, although index NPDES flows are discussed for the non-key facilities, flow projections for non-key facilities are assumed to be constant across the alternatives. If projections of NPDES outfall flows within each watershed vary within 5 percent of the index and historical NPDES outfall concentrations do not often exceed regulatory limits, effects are considered negligible. If projected NPDES outfall flow variations are greater than 5 percent of the index or historical NPDES outfall concentrations often exceed regulatory limits, consequences are evaluated qualitatively. This qualitative analysis includes evaluating the types of contamination that could originate from these outfalls and the potential for contamination in surface water, groundwater, and sediments to be transported off site. A qualitative analysis was done instead of a quantitative analysis because: (1) detailed information (i.e., distribution coefficient of radionuclides for soil, sediment, and alluvium; remaining sorption capacity of soil, sediment, and alluvium below outfall; vadose zone transport characteristics; moisture content; alluvial groundwater body lateral and vertical extent; alluvial groundwater flow rates alluvial recharge and discharge areas; recharge and discharge rates; stormwater and snowmelt runoff flow rates diluting the effluent; schedule of discharges relative to runoff event; and many others) is not available and (2) a reasonable qualitative assessment can be made. For stormwater runoff, the impact analysis focuses on changes across the alternatives that may have the potential for causing off-site migration of contaminants, such as new construction activities.

The water resources analysis was used as source information in several other sections within the SWEIS, such as ecological resources (i.e., potential effects of reduced flows to wetlands) and the human health and human and ecological risk (i.e., consumption of contaminated water and sediments).

The U.S. Geological Survey (USGS) MODFLOW model for north-central New Mexico (Frenzel 1995) was used to predict water level changes at the top of the main aquifer for the four alternatives. The model includes DOE supply wells, wells for the City of Santa Fe public water supply system, discharges from the Santa Fe sewage treatment plant, and 200 private and industrial wells in Santa Fe County. Water use projections for the purposes of modeling drawdown of the main aquifer and annual variations in LANL use were projected based on the alternative descriptions (particularly, the timing of construction projects and changes in operations). Projections for Los Alamos County and the National Park Service (NPS) were made also.

The Fenton Hill site (Technical Area [TA]–57), which was the location of LANL's Hot Dry Rock Geothermal Project and is still used for astrophysics research and experiments, is about 20 miles (32 kilometers) west of Los Alamos. The Hot Dry Rock Geothermal Project has been decommissioned and no further clean-up actions are anticipated. The NPDES permit was discontinued as of December 29, 1997, and during the time of operation there were no NPDES permit violations at the Fenton Hill site. For these reasons, there should be no impact to water resources from this facility, and this site is not discussed further in the SWEIS water resources impact analyses.

5.1.4 Air Quality Methodology

Radiological and nonradiological air pollutants are modeled differently, each with models most suitable for the purpose. Meteorological data sets also varied as was judged most appropriate given limitations on data, comparability of measurement points, and conventions typical for regulatory analyses. Details on these points are described below and in appendix B.

5.1.4.1 *Nonradiological Air Quality*

LANL has the potential to emit hundreds of air pollutants into the atmosphere from its laboratory operations (air toxic emissions) and fossil fuel-burning units (criteria pollutant emissions). An air quality assessment was conducted to estimate the potential impacts of the releases of these pollutants under each of the four alternatives identified for the SWEIS. Background information, including the methodology used for these analyses, is provided in this section.

In accordance with Title V of the *Clean Air Act*, as amended (42 U.S.C. §7401) and New Mexico Administrative Code (NMAC) 20 NMAC 2.70, the University of California (UC) submitted a *Clean Air Act* Operating Permit application to the New Mexico Environment Department (NMED) in December 1995 (20 NMAC 2.70, Operating Permit Application for LANL, LA-UR 95-4192).

In the operating permit application, LANL has voluntarily applied for plant-wide applicability limits (PALs) for nitrogen oxides (NOx), carbon monoxide, particulate matter (PM), sulfur dioxide, volatile organic compounds (VOCs), and hazardous air pollutants (HAPs) (as defined in *Clean Air Act Amendments of 1990* at Section 112[b]), while demonstrating compliance with the applicable standards. LANL has voluntarily proposed permit terms for relevant emission units in order to demonstrate the enforceability of the PALs. The purpose of setting a PAL is to keep emissions below levels that trigger more stringent regulatory requirements and to define LANL's potential to emit. These PALs are intended to demonstrate "minor" source status with respect to HAPs and the Prevention of Significant Deterioration (PSD) Program. The amount of HAPs modeled in the screening process for the impact analysis occurs at a level below the proposed voluntary permit limits.

Criteria Pollutants

Criteria pollutants released into the atmosphere from LANL operations are emitted primarily from combustion facilities such as boilers, emergency generators, and motor vehicles. The analysis of these pollutants was conducted for emissions estimated under actual peak and annual average operating conditions of each major combustion unit. With the existing emission data and stack parameter information (i.e., heights, diameters, flow rates) for the criteria pollutants known, these emissions were modeled using the EPA Industrial Source Complex Short Term (ISCST3) model and meteorological data collected at TA–6.

Short-term and long-term concentrations of these pollutants were estimated at the sensitive receptors and the results were compared with applicable air quality standards. Both time frames were analyzed to address the potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities.

Because the emissions rates for the Expanded Operations Alternative are the greatest of the emission rates across the alternatives, the initial analysis of potential impacts due to criteria pollutants was based on these "bounding" emissions. Ambient air quality standards are established at levels that ensure an ample margin of safety, based on health risk assessments. Therefore, in cases where results of the Expanded Operations Alternative analysis of criteria pollutants demonstrate that the highest estimated concentration of a pollutant are well below the appropriate ambient air quality standards, no further analysis was performed. In cases where this alternative threatens such exceedances, more detailed analysis for each alternative was performed.

No quantitative analysis of vehicle emissions was performed as part of this analysis. Although the operational alternatives may have different effects on the travel patterns in the study area as a result of changes in the number of LANL employees who would commute to Los Alamos, the future population of Los Alamos County is not expected to change substantially under any of the alternatives. Therefore, changes in regional emissions under any of the future alternatives are not expected to be more than a few (less than 5) percent. Vehicle emissions were included in the assumed background concentrations for each of the criteria pollutants in the analysis. Background concentrations were assumed to be 20 percent of the relevant standard, a conservative assumption. Because the study area is in attainment for the pollutants that are released primarily from motor vehicles (carbon monoxide and ozone) and because there are no nearby heavily congested traffic areas or major sources or ozone precursors (i.e., hydrocarbons and nitrogen oxides), no potentially significant air quality impacts are expected from the commuter traffic emissions. The transportation analyses for each alternative include emissions impact estimates from trucks (e.g., commercial transport) associated with LANL's operations across the U.S.

Toxic Air Pollutants

The pollutants and laboratory operations that may cause significant air quality impacts at LANL were identified through a progressive series of screening steps, each step involving fewer pollutants that were then screened by methods that involved more rigorous and realistic emission rates and modeling parameters than the step before. This approach, consistent with EPA guidance, focuses detailed analyses only on those chemicals that have a reasonable chance of being of concern. This approach is particularly useful for an installation such as LANL, where the research and development nature of the facility results in usage of a large number of chemicals, potentially released from hundreds of sources spread throughout a large geographic area, and at highly variable but relatively low usage rates.

The first screening step reduced a list of more than 2,000 chemicals purchased by LANL to a set of 382 on the basis of physical and chemical characteristics such as low vapor pressure or low toxicity, and small quantity. The second screening step involved a comparison of a calculated maximum rate derived from health-based standards to the potential emission rate from a TA. In this step, a screening level emission value (SLEV) was developed for each chemical and for each TA where that chemical was used. A SLEV is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year) period, would not exceed a health-based guideline value (GV) (Table 5.1.4.1–1). This SLEV was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at that TA over the course of 1 year were available to become airborne. Personnel knowledgeable of chemical usage and current and future operations reviewed these comparisons (put in the form of a ratio of SLEV to potential emission rate from the TA) and indicated whether or not it was possible that future chemical usage rates under any alternative could be increased by a factor indicated in these ratios. If there was an indication that usage could potentially be increased by that factor (a qualitative evaluation of whether chemical purchases could be increased by perhaps 10 times or 100 times over current rates), that chemical was referred to the next screening step.

The third step, performed for a set of 13 sources, some of which had multiple chemicals, involved a determination of more realistic emission rates based on actual knowledge of the process where the chemical was used and the modeling was conducted using actual stack parameters. If any chemical failed the screen at this point (a short- or long-term GV was exceeded), it was referred to the health and ecological risk assessment process of the SWEIS.

Additive effects of carcinogenic chemical emissions were also considered by calculating whether a GV could be exceeded in the case of emissions of the same chemical from multiple TAs, and whether a GV could be exceeded by adding the cancer risk from emissions of all carcinogenic chemicals from all TAs.

The EPA ISCST3 model was consistently used in this analysis, except for the third screening step in the case of modeling emissions from high explosives testing operations. In that case, a combination of the Hot Spot and the EPA ISCST3 models was more appropriate for modeling the emissions and conditions created by the detonation of explosives.

TABLE 5.1.4.1–1.—*Guideline Values Applied in the Nonradiological Air Quality Analysis*

Noncarcinogens Short-Term Guideline Values	While no national or State of New Mexico standards have been established for these pollutants, the NMED has developed GVs for determining whether a new or modified source emitting a toxic air pollutant would require a construction permit (20 NMAC 2.72, Subpart IV). These GVs are 8-hour concentrations that are 1/100 of the occupational exposure limits (OELs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the National Institute of Occupational Safety and Health (NIOSH).
Annual Average Guideline Values	The GVs used in this analysis are the inhalation reference concentrations (RfCs) from EPA's Integrated Risk Information System (IRIS). RfCs are daily exposure levels to the human population (including sensitive subgroups) during a lifetime (70 years) that could occur without appreciable risk of deleterious effects.
Carcinogens	The GVs used in this analysis to estimate potential impacts of carcinogenic toxic air pollutants from LANL operations are based on an incremental cancer risk of one in a million (1.0×10^{-6}) (i.e., one person in a million would develop cancer if exposed to this concentration over a lifetime)—a level of concern established in the *Clean Air Act*. The development of EPA risk estimates for exposure to carcinogens led to the concept of unit risk factors that are associated with exposure over a lifetime to annual average concentrations of chemicals. Therefore, only annual impact analyses of carcinogenic emissions were conducted. The impacts of the releases of carcinogenic toxic air pollutants were considered for more detailed analysis if the estimated combined incremental cancer risk associated with all of the carcinogenic pollutants emitted from LANL facilities at any location is greater than 1.0×10^{-6}. For the purpose of screening individual carcinogens, a cancer risk of 1.0×10^{-8} was established as the GV.

Two sets of receptors (i.e., locations where air quality levels were estimated) were considered for the methodology described above. The first set of receptors includes nearby identified actual locations of concentrated human activity that might be affected from the emissions from LANL facilities. These include: (1) schools, hospitals, parks, and playgrounds within Los Alamos; (2) residences (including those in trailer parks) in all directions surrounding all of LANL facilities in Los Alamos County; and (3) towns, cities, and sensitive national and cultural areas within approximately 50 miles (80 kilometers) of Los Alamos. These receptors are referred to as "sensitive receptors." The second set of receptors includes all of the fence line locations (in 10-degree increments) around each TA to which the public has access. These receptors are referred to as fence line receptors. Theoretical fence line receptors were considered in the comparison to short-term GVs; actual locations of receptors were considered in the comparison to long-term GVs (notably, carcinogens). Details on all aspects of this analysis may be found in appendix B (in volume III).

Of the 382 total pollutants, 35 carcinogenic pollutants were evaluated individually and were also considered in the additive impacts analysis of emissions from all of the TAs. A list of the toxic air pollutants evaluated is in attachment 2 to appendix B.

5.1.4.2 *Radiological Air Quality*

This section presents a discussion of the methods used to estimate the dose from radionuclide air emissions from LANL operations of selected modeled facilities. These methods were used for analysis of all alternatives; however, this information is not repeated in sections 5.2.4, 5.3.4, and 5.4.4. Prior to beginning the modeling of radionuclide air emissions under the SWEIS alternatives, historical data were reviewed for the index years 1990 through 1994. These data were used to verify that the modeled facilities under the SWEIS alternatives captured the majority of the emissions. The facilities listed in Table 5.1.4.2–1 were shown to represent over 99.7 percent of the dose to the LANL hypothetical maximally exposed individual (MEI) during the baseline years. Other facility emissions were not modeled due to their small contributions to the total. Additional information is presented in appendix B.

Air emission modeling and dose calculations were then performed for each facility listed in Table 5.1.4.2–1. The results of this modeling are presented for each of the four SWEIS

TABLE 5.1.4.2–1.—*Facilities Modeled for Radionuclide Air Emissions*

FACILITY	TYPE OF EMISSIONS
TA–3–29 (Chemistry and Metallurgy Research)	Point Emissions
TA–3–66 (Sigma Building)	Point Emissions
TA–3–102 (Machine Shops)	Point Emissions
TA–11 (High Explosives Testing)	Diffuse Emissions
TA–15/36 (Firing Sites)	Diffuse Emissions
TA–16 (Weapons Engineering Tritium Facility)	Point Emissions
TA–18 (Pajarito Site: Los Alamos Critical Experiments Facility)	Diffuse Emissions
TA–21 (TSTA and TSFF)[a]	Point Emissions
TA–48 (Radiochemistry Laboratory)	Point Emissions
TA–53 (LANSCE)[b]	Point and Diffuse Emissions
TA–54 (Area G)	Diffuse Emissions
TA–55 (Plutonium Facility)	Point Emissions

[a] Tritium System Test Assembly and Tritium Science and Fabrication Facility
[b] Five specific sources were modeled from TA–53 (Los Alamos Neutron Science Center). These include the TA–53 Exhaust Stack-2 (ES–2), Exhaust Stack-3 (ES–3), Isotope Production Facility, Low-Energy Demonstration Accelerator, and combined diffuse emissions.

alternatives. For each alternative analyzed, dose estimates were made to three specific receptors. These three receptors include the:

- *Facility-Specific Maximally Exposed Individual (FS MEI)*—Due to the distance between facilities across the LANL, each modeled facility was modeled independently. The FS MEI represents the location corresponding to a specific facility where the modeled dose was greatest. The location of the FS MEI was determined based on distance, direction, and meteorological data for each site. The dose commitments were then calculated at this location from all other modeled facilities; thus, the FS MEI represents the estimated dose to an individual from the specific facility and all other modeled facilities.
- *Site-Wide Maximally Exposed Individual (LANL MEI)*—The LANL MEI is the single highest FS MEI derived as described above. The LANL MEI was shown to be the same as the LANSCE FS MEI under all alternatives. The LANL MEI dose by alternative is presented in the air quality analyses, and the resultant human health risk effects due to these doses are presented in the human health analyses for each alternative.
- *Population Dose Within 50 miles (80 kilometers)*—Population dose estimates were made for the entire population within a 50-mile (80-kilometer) radius of LANL (i.e., the summation of all doses to all people within that radius). The population dose from each facility was modeled independently for each alternative. The total from all facilities for one alternative represents the population dose from that alternative. Dose estimates to the population were derived from both point source and diffuse emissions. The expected excess latent cancer fatalities (LCFs) for the exposed populations are presented in the human health analyses for each alternative.

  Using a composite of all modeled data, maps were developed showing estimated isodose lines (lines of equal dose) for each alternative. Estimates of dose at particular locations can be identified from these maps.

The results of this modeling were used to support human health impact analyses.

There are two general mechanisms in which radionuclides are dispersed into the ambient air from LANL operations. The first is through forced ventilation systems with pollution control devices through a stack or vent. The second is from diffuse or nonpoint source emissions. Diffuse emissions occur in areas such as firing sites, landfills, unvented buildings, and solid waste management units.

To estimate the dose impact from LANL operations, the facilities that emit the majority of radioactive materials to the air were identified. Twelve facilities were modeled within ten TAs. These facilities and types of radionuclide air emissions are listed in Table 5.1.4.2–1.

Radionuclide emission projections were made by LANL staff based on historical activity levels and corresponding emissions for each of the four alternatives. These emissions were used to model the doses and develop the isodose maps.

Individual and population dose estimates were calculated through the use of air dispersion modeling, which predicts the dispersion and dilution of radionuclide emissions at various locations. Following the release to the atmosphere, a radionuclide concentration at a given location is influenced by many variables including distance, direction, wind speed, wind direction, and others. Once the quantity of a radionuclide a person either ingests, inhales, or is otherwise exposed to is determined, the effective dose equivalent (EDE) is estimated by applying appropriate dose conversion factors for each radionuclide.

The air dispersion model used for these calculations was the *Clean Air Act* Assessment Package for 1988 (CAP–88). CAP–88 contains a modified Gaussian plume model that estimates the average dispersion of radionuclides released from up to six sources simultaneously. The model may be run on individual sources as well. The sources may be elevated stacks or uniform area (diffuse) sources. The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food, and intake rates to people from ingestion of food produced in the assessment area. The model calculates the committed effective dose equivalent (CEDE).

This model is approved by the EPA for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61, Subpart H). This standard states: "Emissions of radionuclides to the ambient air from any DOE contiguous site shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 millirem" (40 Code of Federal Regulations [CFR] 61.92). Modeling of the dose to a hypothetical MEI was used to show that facility emissions would not exceed this standard under any of the alternatives.

The locations of the maximum dose estimates from each of the individual facilities emitting radionuclides were identified using estimated emissions and local meteorological conditions. This location is used as the FS MEI, and the dose is calculated from all air exposure pathways. The distance and direction to this location from all emissions points can then be calculated.

Each facility's emissions impacts on other facilities' MEIs were determined. The location of the maximum dose considering all emissions from all facilities, is designated as the LANL MEI.

Population dose estimates to a 50-mile (80-kilometer) radius were generated by CAP–88 using current population data. Composite maps of these calculations were also developed as mentioned. The health effects, predicted as a consequence of the radiological doses to off-site residents and recreational users, as well as those predicted from the population doses, are evaluated in the human health analyses in this chapter.

5.1.5 Ecological Resources, Biodiversity, and Ecological Risk Methodology

The conceptual scope of this impact analysis is the larger regional ecosystem in which the approximately 43-square-mile (111-square-kilometer) LANL site is immersed. LANL facilities, infrastructure, operations, and impacts—positive, negative, and undetermined—are an integral part of the patterns and processes of a complex regional landscape. Weather, topography, soils, plant and animal communities, and canyon systems carrying water from the Jemez Mountains east to the Rio Grande are continuous across the administrative boundaries of LANL, the NPS, U.S. Forest Service (USFS), regional Pueblos, and other regional land stewards. This ecological context has both spatial and temporal dimensions.

The spatial scope of effects analysis is defined by prominent landscape features in the larger region surrounding LANL that approximate ecological boundaries in terms of many processes important to ecosystem function. These geographical boundaries were determined from input from regional land and resource managers and consultants, review of the technical literature, and knowledge and experience of LANL biological science experts. This information was combined with environmental data from LANL, the State of New Mexico, and federal and private research to define an area that simultaneously includes a reasonably complete suite of representative ecological components as well as conditions that would bound impacts resulting from ongoing LANL operations and evaluated alternatives.

The temporal basis for this analysis extends from about the year 1850 to the present (as described in section 4.5), which captures the genesis and development of current dynamic processes operating in the regional ecosystem. This dimension provides the context necessary for identifying and analyzing impacts in the future.

Effects analysis is based primarily on two measurements of ecological organization: watershed units and major vegetation zones. The identified 14 regional watersheds plus the White Rock Canyon section of the Rio Grande and Cochiti Lake were delineated for effects assessment. Six major plant communities within five elevation-defined vegetation bands across the Pajarito Plateau were defined. Watersheds were overlain with community types to form a landscape grid that facilitated the description and analysis of vegetation and wildlife distributions. This analysis encompasses specific elements of ecosystem composition, structure, and function at the species, local, and regional ecosystem levels.

Biodiversity considerations form an important part of ecological impact assessment. Simply defined as "the variety of life and its processes," components of biodiversity analyzed consist of regional ecosystem diversity, local ecosystem or community diversity, and species diversity. These components are analyzed as part of the analysis of the following major factors contributing to the decline or loss of biodiversity as identified by the Council on Environmental Quality (CEQ 1993):

- Physical alteration of the landscape
- Over harvesting
- Disruption of natural processes
- Introduction of exotic species
- Pollution

Ecological risk is the likelihood that adverse effects may occur or are occurring as a result of exposure to one or more physical, chemical, or biological stressors (EPA 1992). Environmental pollution generated from past and present LANL operations and projected discharges from the four alternatives identified for continued operation of LANL could potentially pose a risk to biotic communities and ecological processes. Qualitative assessments of ecological risk from the four alternatives were based on findings of the Environmental Surveillance Monitoring Program, quantitative risk assessments of three threatened and two endangered species at LANL, and ongoing programs and plans that address mitigation of legacy and operational contaminants.

The impact analysis considered the potential for each alternative to affect habitats, ecological processes, biodiversity, and exposures to toxic chemicals and radionuclides.

5.1.6 Human Health Methodology

The detailed methodology used in evaluating potential consequences of continued operations of LANL on human health (the public and LANL workers) is described in volume III, appendixes B and D, sections B.1.1, B.2.1, and D.2. Estimates were made of the amount of radioactive or hazardous materials to which workers or the public could be exposed based on both site-wide and facility-specific estimates of emissions and effluents. Additionally, information from other resource area analyses (water resources, air quality, geology and soils, and ecological resources) are inputs for the human health analyses. Finally, recent information regarding LANL worker health incidents was used in predicting similar events over the next 10 years.

The radiation dose (for radioactive emissions) to the public and concentrations at receptor locations (for hazardous chemical emissions) from atmospheric emissions are calculated in appendix B, Air Quality (in volume III). The human health analysis translates these doses to their effects on human health. There are other potential exposures from liquid releases through the soil and aquatic pathways. However, the lesser contributions of current and projected LANL operations through environmental contamination in soil, sediment, surface water, and groundwater are so low that they cannot be partitioned from the existing contamination. The existing contamination is highly variable and much larger than annual incremental LANL contributions. This existing contamination consists of naturally occurring radionuclides and metals, weapons testing fallout, and contamination remaining from past operations. The decision was made to calculate the combined risk from the continued operation, plus the existing contamination. This exposure is almost entirely through ingestion of water, soil and sediment, and food. Estimates also were made of the inhalation and direct radiation exposure that can occur from being in the vicinity of radioactively contaminated soil.

Exposures for members of the public and for LANL workers were estimated for all alternatives. Estimates of risk were based on inhalation, ingestion, and dermal absorption pathways. For an individual, the risk value (in terms of excess LCFs) is the increased probability for that individual. Exposure and risk evaluations include individuals who are:

- Workers, site-wide or in a specific facility or specific job classification
- The LANL MEI located north-northeast of the LANSCE facility (TA–53); FS MEIs were also analyzed for the key facilities (appendix B, section B.1.1)
- Off-site residents near LANL (Los Alamos County and non-Los Alamos County residents)
- Resident and nonresident recreational users of the lands within LANL
- Individuals who may receive exposures via special pathways (e.g., smoking locally grown herbs or drinking these in teas, or increased intake of local fishes, or use of contaminated soil/clays in arts and crafts)

The last three of these were evaluated based on exposure scenarios for each of five receptors (Los Alamos County and non-Los Alamos County off-site residents, resident and nonresident recreational users, and individuals exposed through special pathways). In addition, the total inhalation dose and risk to the population within 50 miles (80 kilometers) of LANL were estimated. This risk is presented as the added number of cancer deaths (excess LCFs due to the dose estimated) from LANL operations.

Consequences were estimated by calculating the changes in risk to members of the public or to workers based on risk factors and reference values developed by the International Commission on Radiological Protection (ICRP), EPA, or other authoritative organizations. An estimate of the lifetime risk of dying from cancer due to chronic exposure to radionuclides or chemicals was made to determine human health consequence—that is, it was assumed that an individual received this dose every year for a 72-year lifetime.

An example of how consequence is estimated for radiation exposure would be estimating the excess LCFs over their lifetimes in a worker population as a function of the radiation dose estimated to be received by that population. The LCF is the product of the dose and the risk factor (0.0005 LCF per person-rem for the public and 0.0004 LCF per person-rem for workers) (discussed in appendix D, section D.1, Table D.1.1.2–1). The reader should recognize that these estimates are intended to provide a conservative measure of the potential impacts to be used in the decision-making process, and do not necessarily portray an accurate representation of actual anticipated fatalities. In other words, one could expect that the stated impacts form an upper bound, and that actual consequences could be less, but probably would not be worse. This is discussed in the primer on the effects of radiation in appendix D, section D.1.1.

For consequence to the public, conservative estimates of potential exposures were made using environmental surveillance data (typically from 1991 to 1996), data from specific contaminated sites, and estimates of operations releases (effluents and emissions) associated with each alternative. The total risk to the public from LANL operations is proportional to the collective dose within the 50-mile (80-kilometer) radius from LANL (that is, to the sum of all the doses to individuals in that population). However, questions may arise about the range of exposures within that population. The most likely exposure to individual members of the public is typically near zero. The upper bound for individual exposure is expressed as the potential dose to the hypothetical MEI. The MEI is assumed to remain in place outdoors without shelter and without taking any protective action for the entire period of exposure. This may be for days during accidents and as long as an entire year for routine operations. In reality, no one would receive a dose approaching that of an MEI, but the concept is useful as an expression of the upper bound of any possible dose to an individual. The ICRP and federal guidance recognize that through limiting the dose to all individual members of the population, the entire population is protected (because the average dose is much less than the maximum dose) (ICRP 1977 and EPA 1987). The EPA uses the concept of MEI to ensure that no member of the public has exceeded specified dose limits. The methodology used to evaluate radiological air doses and chemical exposures from airborne emissions to the public is detailed in chapter 5, section 5.1.4. Also, appendix D (section D.2.) presents a more detailed discussion of methodologies used for estimating human health consequences.

The ingestion of radionuclides, chemicals, and metals was calculated for the total concentrations that exist in the environment, regardless of origin. The concentrations in the environment include naturally occurring radionuclides and chemicals, residual contamination from worldwide fallout and earlier LANL operations, and small quantities of contamination from more recent and ongoing operations. Because it is impractical to impossible to differentiate among these sources for most materials, this SWEIS analysis calculates the total risk from all these sources. This total risk would be affected by the alternatives only to the extent that additional operational and accidental emissions may occur.

The exposures through ingestion were calculated using the 95 percentile upper confidence limit (UCL) concentrations. In calculating the UCL, all samples of zero, negative value, or less than the detection limit were rejected. This significantly increases the average value and the UCL, and especially so when a large fraction of the samples show no detectable contamination.

Estimates of ingestion risk were based on standard assumptions from ICRP and/or EPA. Estimates were made of annual exposures (cancer rates are presumed to depend upon integrated exposure and to be independent of exposure rate). Concentrations of radionuclides and chemicals in environmental media were from the LANL environmental surveillance monitoring data collected from 1991 to 1996 (e.g., LANL 1997d). Background concentrations of radionuclides and chemicals in the soils and sediments and waters in the region around LANL were used to compare to LANL emissions/effluents and contaminated media on site.

Worker consequences were evaluated by estimating the changes that would occur in a specific alternative and determining the increment from actual exposure records at LANL for the base period (1991 through 1995). For example, for worker exposures to chemicals and to nonionizing radiation, and for the consequences of physical hazards (such as electrical hazards), the historical occupational record at LANL was examined and consequences were estimated by alternative, based on changes in the workforce associated with the alternative. No credit was taken for increased safety performance by LANL over that experienced during the base period.

Many of the estimates of consequence (such as risk of excess LCFs) were calculated using mathematical modeling. These results are estimates based on multiple assumptions about toxicity, exposure route, human behavior, and the movement of materials through the environment. Therefore, there are substantial uncertainties inherent in the human health evaluations presented in this chapter. These uncertainties include: model simplification of the actual process by which exposure occurs; the variance associated with sampling and measurements of concentration of chemicals and radionuclides in the environment; the simplifying and conservative assumptions made regarding the receptor location, age, and length of time in the area; and behavioral risk factors. Uncertainty also increases in areas having higher naturally occurring concentrations of some radionuclides and soil metals; the area around LANL has relatively high and extremely variable concentrations of natural uranium and many metal ores. A discussion of uncertainties and their impacts on the use of model results to evaluate consequences is given in appendix D, section D.2.

5.1.7 Environmental Justice Methodology

Because most of the topical analyses in the SWEIS considered potential impacts within a 50-mile (80-kilometer) radius of LANL, that distance was also considered for the environmental justice analysis. The presence of minority and low-income communities within that radius is described in chapter 4 (section 4.7), as is the methodology used to identify these communities. Figures 4.7.1–1 and 4.7.1–2 in chapter 4 illustrate how the area within a 50-mile (80-kilometer) radius was divided into sectors for the environmental justice analysis. It is noteworthy that the majority of the sectors reflect a substantial presence of minority and/or low-income populations. (For the purposes of the SWEIS, a substantial presence means greater than 25 percent of the population is considered to be minority or below the poverty level.) The impacts for each of the individual topical areas are, in essence, overlaid onto this figure to assess the impacts.

The environmental justice analysis is a comparative analysis. In order to determine whether impacts are disproportionate, the impacts in sectors with a substantial presence of minority or low-income populations are compared to the sectors that do not have a substantial presence of these populations. In this case, sectors 1–3 and 6–16, all within a 10-mile (16-kilometer) radius of LANL, do not have a substantial presence of minority or low-income populations and are used for this comparison.

It is presumed that the minority populations have traditional or cultural practices that include subsistence materials different than those of other populations in the area. There is little information regarding such materials and quantities used, but assumptions are made for the purposes of the human health analyses. These analyses are referred to as special pathways analyses. Because the special pathways may be more viable or important to minority populations, they are of interest in the analyses under Environmental Justice. Thus, this impact area analysis explicitly addresses the potential human health risks due to these special pathways.

5.1.8 Cultural Resources Methodology

For the purposes of impact assessment, cultural resources were grouped into three broad categories: prehistoric archaeological sites, historic resources, and traditional cultural properties (TCPs). Within these three categories, cultural resources were grouped into general types or classes for impact analysis as opposed to analyzing individual resources (e.g., simple and complex Pueblos, scientific laboratories, and ceremonial sites). More detailed information on these resources is included in volume III, appendix E. Data and impact levels occurring from LANL operations during the period of 1991 through 1995 were used as the background or baseline standard to compare any changes resulting from implementation of the four alternatives.

Sources of information used for impacts assessment included systematic archeological surveys of cultural resources present on LANL and recorded in the LANL cultural resource database; consultations with the LANL Cultural Resources Management Team, 23 Native American tribal governments, Hispanic communities, and the State Historic Preservation Office(r) (SHPO); and literature reviews of Native American and Hispanic TCPs. Also, results of the consequence analysis for air quality, surface and groundwater, human health risk, and noise and vibration were used to evaluate impacts to human users of TCPs and other potential impacts to cultural resources.

Impact assessment is based on general sources of effects or types of actions. These consist of the following:

- New construction
- Increased vibrations (from traffic, explosives testing, etc.)
- Increased erosion or siltation
- Shrapnel scatter from firing points
- Explosives (direct hits)
- Radiation hazards (from airborne or waterborne contamination)
- Hazardous material (nonradiological from airborne or waterborne contamination)
- Noise
- Security changes
- Hydrogeologic changes
- Maintenance changes

Impacts were evaluated according to four broad categories that reflect the criteria of effect (36 CFR 800.9) under the *National Historic Preservation Act* (16 U.S.C. §470). These categories consist of destruction/alteration; isolation and restriction of access; introduction of visual, audible, or atmospheric elements out of character with the resource; and neglect leading to deterioration and vandalism. Not all classes of cultural resources would be affected by every category of effect.

Effects to resource categories were evaluated for each of the four alternatives by means of a data matrix. Geographic overlay analysis and detailed project descriptions were used to assist in identifying the numbers and types of cultural resources that might be affected by the alternatives.

5.1.9 SOCIOECONOMICS, INFRASTRUCTURE, AND WASTE MANAGEMENT METHODOLOGY

5.1.9.1 *Socioeconomics*

Employment, Salaries, and Procurement

The primary (direct) and the secondary (indirect) impacts of LANL activities on employment, salaries, and procurement are analyzed in the SWEIS. The primary impacts are projected based on the changes in employment (in terms of full-time equivalents and procurement at LANL, including the full-time, part-time, and temporary employees of UC, Johnson Controls, Inc., Protection Technology of Los Alamos, and technical subcontractors. Changes in employment were projected by subject matter experts for each of the key facilities, and employment for the rest of LANL was assumed to remain the same. The changes in employment are associated with full implementation of each alternative. Although these changes are likely to happen over a few years, the analysis assumes that they occur within a year of the ROD for the SWEIS. The employment projections were made by job category, and the 1996 average annual salary for each job category was used to project annual salaries (LANL 1996a). The LANL annual procurement projections were made based upon historical procurement and the changes in activity levels and employment across alternatives (LANL 1995b, LANL 1996a, and LANL 1997a). Future procurement was distributed among the Tri-County Area (the three counties closest to LANL: Los Alamos County, Rio Arriba County, and Santa Fe County), the remaining New Mexico counties, and areas outside of New Mexico based on the historical distribution of procurement.

Changes in employment and procurement at LANL are expected to result in additional, secondary, changes in employment, salaries, and expenditures in the area, as well as changes in the demands on social services. These secondary impacts occur within a regional economy because jobs added in a primary industry such as LANL create local opportunities for new employment in supporting industries. Analysis of these secondary economic and social impacts of LANL activities across the alternatives utilizes multipliers derived from a 1996 DOE/New Mexico State University study (Lansford et al. 1996). These multipliers are:

- Employment: 2.71
- Salaries: 1.95
- Expenditures/Business Activity: 2.89

These multipliers are used to predict the total LANL socioeconomic impacts in the area. For example, if LANL were to expand employment by 100 full-time workers who would reside in the Tri-County area, the secondary effect of that action would be the addition of 171 new secondary jobs in the Tri-County labor market. On the other hand, if LANL were to reduce employment by 100 full-time workers, the reverberating effect across the Tri-County economy would be the loss of 171 other jobs.

The employment changes result in population changes in the Tri-County region. It should be noted that the 1996 report (reflecting 1995 data) has been updated since this SWEIS analysis was performed. The latest of this series of DOE/ New Mexico State University reports was issued in May 1998 (reflecting 1997 data). The regional multipliers reflected in that recent report are about 5 percent greater than those reflected above. Because these multipliers are used only to determine the secondary socioeconomic impacts and because these changes are relatively small, the impact analyses influenced by these changes were not updated for the issuance of the final SWEIS. If these updated numbers were applied, population increases, housing demand, regional employment, local government finance, and services values would be slightly higher than presented in the final SWEIS. The DOE does not consider such slight changes to be substantial for the purposes of the SWEIS.

Only LANL changes in employment, incomes, and expenditures were used for this analysis. For example, changes because of tourist and skier visitation to the region were ignored, as were changes in non-LANL construction and retail sales.

Housing

The projections of housing distribution for the four alternatives were made by:

- Determining the potential housing growth for LANL employees in Los Alamos County by adding the county's housing units now under construction, potential housing conversions, and the buildable, vacant, single-family lots (PC 1996a and PC 1997c).
- Distributing the remaining housing growth for LANL employees between Santa Fe and Rio Arriba Counties, based on the availability of buildable land, the presence of utilities, and the presence of developer capital (PC 1996a and PC 1997c).

For analysis of housing, it was assumed that one unit of housing demand would be created for every 2.39 (the average household size) net additions to the area population. This algorithm is based on the relationship of housing units to population for the Tri-County region shown in the 1990 U.S. Census (DOC 1993b). Population projections were based on the 1990 U.S. Census information (DOC 1992 and DOC 1993a), New Mexico Department of Labor information (NMDL 1996), and on a 1994 study done by the University of New Mexico (UNM 1994).

Construction

Construction projects included in each of the SWEIS alternatives are detailed in chapter 3. The employment and salaries associated with LANL construction activities were projected separate from those for LANL operations. On average, field construction labor (the basis for construction employment and salaries) is about 24 percent of the total project cost. Although this percentage can vary substantially from project to project, this average percentage was used for the SWEIS analyses. The total project costs and the salaries estimates are in 1996 constant dollars and are subject to congressional appropriations. The average annual wage for construction workers in northern New Mexico, including supervisory personnel, is $35,000, which is the annual wage assumed for these analyses.

Total project costs were determined based upon the 1997 and 1998 Capital Asset Management Process (CAMP) reports (LANL 1997c) and other NEPA documents that discuss construction projects at LANL. Application of labor expenditures as a percentage of total project cost (24 percent) is the total construction salaries for each alternative. The total construction salary divided by $35,000, produced an estimate of the number of employees who would be engaged in construction at LANL each year for the period 1997 through 2006 for each alternative.

Local Government Finance

Changes in gross receipts tax yields, the key LANL-dependent local government tax revenue, were determined by dividing the 1995 gross receipts tax yields for Los Alamos, Rio Arriba, and Santa Fe Counties and the cities of Santa Fe and Española (NMDFA 1996, NMTR 1995, and NMTR 1996) by population, and multiplying that product by the changes in population (due to both primary and secondary employment changes) resulting from changes in LANL activities across the alternatives.

Services

Education finance impacts across the alternatives were based on calculating enrollment changes induced by LANL activities on total budget requirements. Thus, population changes were converted to school enrollment changes that were then multiplied by $4,009, which is the average New Mexico annual operating cost per public school student (NMDE 1995).

Impacts presented for other services (e.g., police, fire) are qualitative and were based on field interviews and the knowledge of subject matter experts (PC 1996b, PC 1997d, and BH&A 1995).

5.1.9.2 *Infrastructure*

Utilities

LANL annual requirements for electricity and water are projected by alternative based on historical use and on projected activity levels. These projections are considered maximum annual demands. Because most LANL facilities are not individually metered for utility usage (none of these facilities are individually metered for natural gas usage), useful projections could not be made on a facility-by-facility basis. However, the TA–53 facilities and operations discussed in chapter 3 (section 3.5.11) are substantial users of these utilities, and TA–53 is individually metered for electricity and water use. For this reason, electricity and water usage by alternative is projected for LANSCE separate from the rest of LANL facilities. Except for LANSCE electricity and water usage, LANL's utilities usage is not expected to change substantially from the baseline usage described in chapter 4 (section 4.9). Natural gas use is projected to continue at the baseline usage rate, which is the maximum amount used in recent years.

5.1.9.3 *Waste Management*

Radioactive and Hazardous Waste Generation

The generation of waste places a burden on the LANL waste treatment, storage, and disposal infrastructure. For this reason, LANL waste generation by alternative is presented in this section. The waste treatment, storage, and disposal activities could have impacts; those impacts are included in the other sections of this chapter (e.g., radioactive air emissions include those attributable to waste operations). Waste generation projections were based on projected operations as compared to the baseline waste generation. These projections take credit for fully developed and implemented waste minimization/pollution prevention measures, but do not assume implementation of actions that are currently in development or may occur in the future. Every indication is that the waste minimization/pollution prevention program at LANL will continue to reduce the waste that must be managed, so the projections made by alternative are considered conservative.

The report *Waste Management Strategies for LANL* (LANL 1998a) reflects the treatment and disposal of waste at LANL, as well as more detailed information regarding the waste types and applicable treatment processes.

5.1.9.4 *Contaminated Space*

The contamination of space and equipment places a burden on the LANL infrastructure for eventual cleanup, waste handling, and decontamination and decommissioning efforts (at additional cost, as compared to these actions for uncontaminated space and equipment). During the scoping activities for the SWEIS, members of the public suggested that DOE decision-making should consider this burden and requested that changes in contaminated space and equipment by alternative be presented in the SWEIS. For these reasons, the SWEIS includes estimates of changes in contaminated space and equipment by alternative, as compared to the baseline contaminated space presented in chapter 4 (section 4.9).

In general, the estimation of contaminated spaces was made within plutonium facilities, hot cells, process gloveboxes, and general laboratory areas on a foot print (square footage) basis, and was made by subject matter experts. Future clean-up costs or environmental impacts associated with eventual cleanup of LANL are dependent on the regulations and facility conditions at the time of the cleanup and cannot be predicted; thus, no attempt is made in the SWEIS to translate the contaminated space projections into a cost liability or into eventual cleanup actions and impacts. It is anticipated that such assessments will be made at the time DOE plans for such actions (presumed to be well beyond the 10-year time frame of the SWEIS).

5.1.10 Transportation Methodology

The methods and assumptions described in this analysis were selected to ensure meaningful comparisons among the SWEIS alternatives. In general, assumptions used in this analysis are intended to be conservative enough to ensure that the results do not underestimate the level of transportation risk, but not so conservative that the risk calculation is knowingly orders of magnitude too conservative or such that any differences between alternatives are obscured.

The analyses of both radioactive and hazardous material risks are largely accomplished with standard computer codes; the methodology is documented in more detail in volume III, appendix F. Figure 5.1.10–1 illustrates the basic transportation risk analysis methodology. As indicated in the figure, the overall transportation analysis was approached in two major segments:

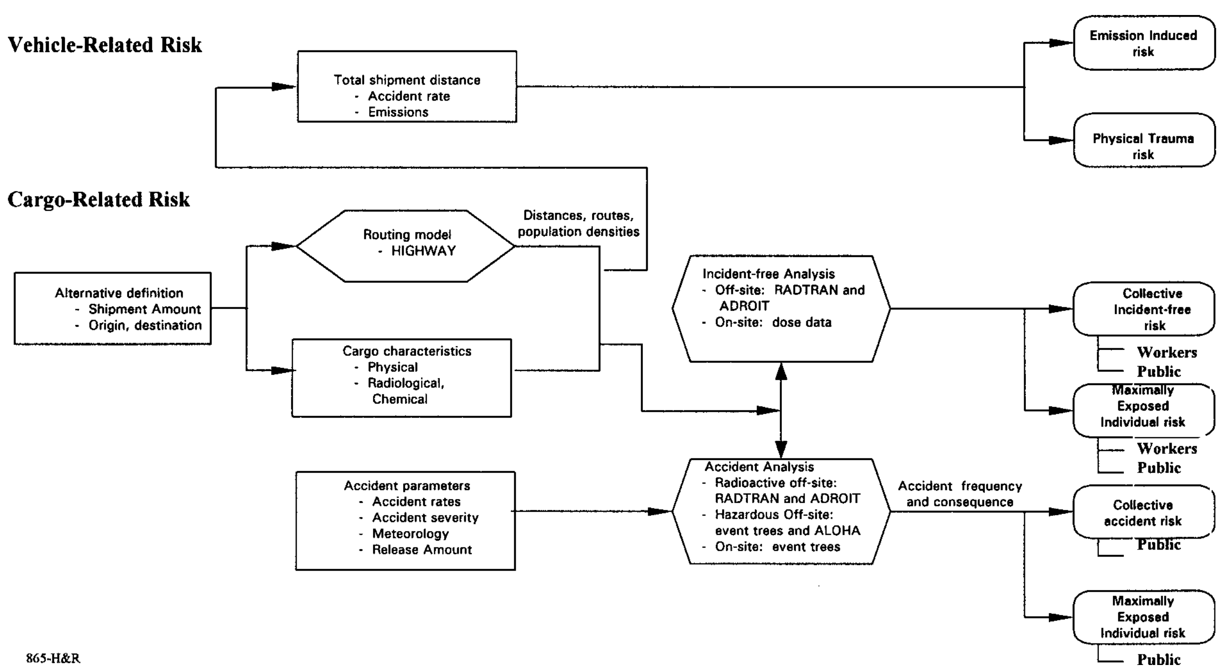


FIGURE 5.1.10–1.—*Transportation Risk Analysis Methodology.*

- Vehicle-related risk includes truck emissions and vehicle accidents (no release of cargo).
- Cargo-related risk includes both incident-free radiation exposure and accidents that could release radioactive or hazardous cargo.

5.1.10.1 *Determination of Shipment Amounts, Materials, and Physical Forms*

The determination of annual radioactive and hazardous chemical shipment amounts, materials, and physical forms, by SWEIS alternative, was intended to ensure that shipments that could contribute significantly to accident risk were projected and analyzed. Shipments of relatively small quantities and of materials that present substantially lesser hazards were not considered in as much detail. Shipments of waste are included in the SWEIS transportation analyses and are also discussed in section F.6.6 in appendix F.

The radioactive material shipment projections by alternative were determined by interviewing DOE and LANL subject matter experts. Historical shipment data, on site and off site, were used to help ensure completeness. On-site shipments of special nuclear material (SNM) at the gram level were not accounted for because their contribution to risk would be minor. The off-site and on-site radioactive material shipments for each SWEIS alternative are listed in appendix F.

The historical hazardous chemical shipments were determined primarily by using existing LANL databases, as well as by using DOE shipment mobility/accountability collection (SMAC) data. Large inventories and bulk shipments were identified from these databases. Through this process and through interviews with subject matter experts, bounding historical material types and quantities were identified. Where possible, future hazardous chemical shipment projections were made by subject matter experts (e.g., future explosive shipments are explicitly related to the alternative descriptions). In many cases, hazardous chemical shipment projections could not be explicitly determined in this manner because many chemicals are purchased in large quantities but are actually used in small quantities over long periods and across the entire site. In such cases, chemical shipment projections were made based on the ratios of projected shipments to historical shipments for materials that were explicitly related to alternative descriptions. This process and the bounding chemical shipments, on site and off site, by alternative are described in detail in appendix F (in volume III).

5.1.10.2 *Shipment Routes and Distances*

LANL shipments projected for each of the SWEIS alternatives include shipments to and from other DOE sites as well as to and from numerous non-DOE (e.g., commercial) sites. Subject matter experts identified DOE sites involved in such shipments. For shipments to sites other than DOE sites, five geographical areas are defined for radioactive material shipments: northeast, southeast, northwest, southwest, and New Mexico. The cities selected as representative of each area are Concord, Massachusetts; Aiken, South Carolina; Richland, Washington; Berkeley, California; and Albuquerque, New Mexico. These cities were chosen as conservatively representative (on the basis of the number of shipments) of the various shipment locations in the geographic area in the 1990 through 1994 baseline. Cargo air shipments are also made to and from the LANL site. Air shipments arrive at the Albuquerque International Airport and are transported by truck or van to LANL or vice versa.

In general, the transportation impacts presented in the SWEIS are reflected on an annual basis for each of four route segments: from LANL to U.S. 84/285; from U.S. 84/285 to I–25, remainder of New Mexico (all other transportation in the state), and outside New Mexico. Based on the routes established for this analysis, shipment mileage was calculated, and the population density along the route was estimated. The HIGHWAY code (Johnson et al. 1993) was used to determine the distance traveled for each off-site shipment route.

All routes for shipment of radioactive or hazardous material into or out of LANL are conservatively assumed to pass through Santa Fe. The Santa Fe Relief Route (currently being constructed) would replace 6.5 miles (10.5 kilometers) on U.S. 84/285 through Santa Fe to I–25, with 13.8 miles (22.2 kilometers) starting from U.S. 84/285 north of Santa Fe to exit number 276 of I–25, south of Santa Fe. Because of the location where the Relief Route meets I–25, travel on I–25 south of Santa Fe would be reduced by 6 miles (___ kilometers) of highway travel, and travel on I–25 north of Santa Fe would be increased by 6 miles (___ kilometers) of highway travel if the Relief Route were used. The Santa Fe Relief Route between I–25 and the junction of U.S. 84/285 with NM 502 consists of 1.2 miles (1.9 kilometers) of urban highway, 3.9 miles (1.9 kilometers) of suburban highway, and 14.9 miles (24 kilometers) of rural highway. Appendix F (in volume III) includes a detailed comparison of impacts between transportation through Santa Fe and using the proposed Santa Fe Relief Route. (The segments from U.S. 84/285 I–25 and the remainder of New Mexico are the only ones that would potentially be affected.) In most of the analyses, the differences are very small; these differences are discussed in the discussion of each type of transportation impact and are presented in more detail in appendix F (section F.7).

5.1.10.3 *Vehicle-Related Risks*

Truck traffic on public highways presents two types of health risks independent of the nature of the cargo: the health effect of air pollutants (primarily diesel fuel combustion products) and the injuries and fatalities caused by truck accidents. Aircraft accidents could also contribute to injuries and fatalities. Because there is no rail service to LANL, rail transport is not addressed.

As described in Figure 5.1.10–1, once the routes, distances, and population densities are determined (as described above), truck emissions and vehicle accident rates must be determined to calculate the vehicle-related risks. These factors are discussed further below.

Truck Emissions

Truck traffic produces air pollution from diesel engine exhaust, fugitive dust generated by the vehicle wake on the highway surface and shoulders, and particulates from tire wear on the paved surface. The primary health effect of diesel fuel combustion is caused by sulfur oxides and particulates, although nitrogen oxides and hydrocarbons are also produced. The health effect of these pollutants is increased sickness (morbidity) and death, generally occurring after a latency period of some years. No analysis was made for increased sickness because no data were available. The health effect has been evaluated by Rao et al. (1982) as 1.6×10^{-7} excess LCFs per truck mile (1.0×10^{-7} fatalities per truck kilometer) in urban areas. The result is limited to urban areas because the available air pollution mortality data were limited to metropolitan population subgroups.

The total number of radioactive and hazardous material shipments made annually under each alternative (detailed in appendix F, section F.5) and the urban mileage per shipment are used to determine the total annual urban mileage for all shipments. This mileage is converted to excess LCFs per year using the conversion factor from Rao et al. 1982, as noted above.

Truck Accidents

Four sets of truck accident rates are used in the analysis: state-specific; route-specific, between I–25 and the LANL site; on-site roads with and without road closure; and the safe secure transport (SST) trailer. To the extent possible, each of these sets of accident rates was determined based on existing accident rate data available from the U.S. Department of Transportation (DOT), the State of New Mexico, and previous on-site transportation risk analyses at LANL. The truck accident rate for closed roads was determined to be 1.44 x 10^{-8} accidents per mile (8.95 x 10^{-9} accidents per kilometer) based on an analysis of the types of truck accidents and the LANL site administrative controls (Rhyne 1994b). The accident rate for SST shipments was determined based on the actual SST accident rate for the 9-year period between 1988 and 1996 (7.7 x 10^{-8} accidents per mile [4.8 x 10^{-8} accidents per kilometer]) by extrapolating data for varying operating environments of five-axle vans in the appropriate weight range in commercial service (Phillips et al. 1994). The determination of these accident rates and the accident rates used for this analysis are discussed further in volume III, appendix F.

Aircraft Accidents

Air transport associated with shipments to and from LANL is assumed to be by commercial air-cargo carriers (such as Federal Express) to and from the Albuquerque International Airport. (Transport between this airport and LANL is by truck or van.) Shipments are picked up in the carrier’s van and taken to an airport, flown to the destination city, and taken to the final destination by the carrier’s van. Commercial air-cargo carriers are categorized as large certified air carriers and are assumed to fall in the subcategory of “large nonscheduled service” for which the 1992 accident rate was 7.9 x 10^{-9} accidents per mile (DOT 1992). Because the accident rate for similar shipments by truck is much greater (by two orders of magnitude) and this difference is not offset by a comparable difference in the consequences of these accidents, aircraft accidents were screened from further analysis.

5.1.10.4 *Cargo-Related Risks*

In addition to the vehicle-related risks, cargo-related risks are also analyzed in this section. These risks include incident-free radiation exposure, and exposure to radioactive or other hazardous materials due to an accidental release. The estimates of material amounts, physical forms, routing, and population densities along these routes that were described earlier in this section are used in these analyses. The following information presents the methods used to estimate cargo-related risks.

RADTRAN and ADROIT Analyses for Radioactive Materials

Two of the four risk measures illustrated in Figure 5.1.10–1 are modeled by RADTRAN or ADROIT. (These are discussed further in appendix F, section F.4.4.) The RADTRAN code is designed to produce conservative estimates of the radiological dose to workers and the public during incident-free transportation, as well as the radiological risks from potential accidents. RADTRAN is widely accepted and used both in the U.S. and internationally.

The ADROIT code was developed to replicate the RADTRAN incident-free and accident estimates specific to transport using DOE SST trailers. ADROIT end results are very similar to RADTRAN. These codes were applied to the impact analyses for off-site shipments of radioactive materials.

Incident-Free Radiation Exposure. The most important parameter for evaluation of incident-free radiation exposure is the package exterior radiation level. The transport index (TI) is used in RADTRAN to characterize the exterior radiation field. The TI is defined in 49 CFR 73.403 as "the exposure rate in millirems per hour at a distance of 3 feet (1 meter) from the surface of the package," and DOT regulations limit the value of TI to 10 or less for general commerce shipments. The TIs for LANL's on-site shipments are based on historical measurements. The average truck shipment TI is less than 2, and the average air shipment TI is approximately 0.1.

Annual radiation doses and excess LCFs are calculated for members of the public along the truck route, members of the public traveling on the truck route, members of the public at truck stops, truck and air crew members, and MEIs. All trucks are assumed to pass a residence 98 feet (30 meters) from the highway at a speed of 15 miles (24 kilometers) per hour.

Accidental Release of Radioactive Materials. Radioactive material shipments were evaluated to determine those that would likely present the largest calculated consequence (see appendix F). These are referred to as the bounding material shipments. The bounding radioactive material shipments included in the SWEIS transportation analyses are:

- Off-site shipment of plutonium-238 oxide powder in an SST
- Off-site shipment of americium-241 standards
- On-site shipment of plutonium-238 solution samples (performed with road closures)
- On-site shipment of irradiated targets (performed with road closures)

In addition to these shipments, off-site shipments of contact-handled transuranic (CH TRU) waste, remote-handled transuranic (RH TRU) waste, and plutonium weapon components (pits) are analyzed due to the level of public interest in such shipments that was expressed during scoping for the SWEIS.

In order to determine the frequency terms for these analyses, the frequencies of the shipments listed above were supplemented with the frequencies of other large shipments of similar materials. For example, the number of on-site plutonium-238 solution shipments was increased for analysis by the number of on-site weapons-grade plutonium solution shipments (see volume III, appendix F). Thus, the frequency term includes both plutonium-238 and weapons-grade plutonium shipments.

The impacts of an accidental release of radioactive materials from shipments are based on the accident scenario (and the associated forces on the packages), the fraction of the radioactive material in a package that could be released during an accident of a certain severity, and the fraction of material released that would be dispersed as an aerosol that could be inhaled into the respiratory tract. This information is used to determine the radiation dose that would result from the accident to exposed individuals.

The fraction of the radioactive material in a package that could be released during an accident is referred to as the release fraction. Release fractions vary according to the package type and the accident severity. Type B packages are designed to withstand the forces of severe accidents and, therefore, have smaller release fractions than Type A packaging (see appendix F for more information on packaging). Plutonium packages are designed to even higher standards. The RADTRAN and ADROIT models include the accident severity and the shipment packaging in consequence analyses.

Subsequent to release, dispersion of the material into the atmosphere as an aerosol and, in most cases of interest, inhalation into the respiratory tract (respirable aerosols only) would be required to produce a significant exposure to members of the public. Most solid materials are relatively nondispersible. Conversely, gaseous materials are easily dispersed. Liquid dispersibility depends on the liquid volatility. The aerosolization and respirable fractions depend on the physical form of the material. RADTRAN and ADROIT include all of these factors to determine respirable release fractions in calculating the accident consequences.

Health Risk Conversion Factors. The health risk conversion factors used throughout this analysis (as in the accident and human health analyses) to estimate the number of expected excess cancer-caused fatalities, from radiological exposures are 0.0005 cases of excess fatal cancer per person-rem for members of the public, and 0.0004 cases per person-rem for workers (ICRP 1991). Cancer-caused fatalities are determined over the lifetimes of exposed populations.

Event Tree Analyses for On-Site Radioactive and All Hazardous Chemical Accidents

Event trees are used for the analyses of on-site and off-site transportation accidents involving hazardous chemical inventories and on-site transportation accidents involving radioactive materials. An event tree is a graphical model for identifying and evaluating potential outcomes from a specific initiating event. The event tree depicts the chronological sequence of events (the accident scenario) that could result from the initiating event. In addition to identifying the accident scenarios, an event tree can also be used to quantify the frequencies of each scenario. The use of event trees for these analyses is explained further in appendix F.

The consequences of hazardous chemical accidents are determined using the Areal Locations of Hazardous Atmospheres (ALOHA™) computer model (NSC 1995), the dense gas dispersion (DEGADIS) model (Havens and Spicer 1985), and hand calculations, depending on the characteristics of the material and release mechanism. The consequences are presented in terms of numbers of fatalities, number of injuries, and impact to the MEI.

Hazardous material shipments were evaluated to determine those that would likely present the largest calculated consequence (see appendix F). These are referred to as the bounding material shipments. The bounding hazardous material shipments included in the SWEIS transportation analyses are:

- Off-site shipment of chlorine
- Off-site shipment of explosives
- Off-site shipment of propane

An examination of historical on-site shipments did not identify any unique materials or shipment risks. The off-site shipments identified above bound the accident risk both on site and off site.

Consequences of on-site radioactive material accidents were analyzed using hand calculations, based on the material and the accident scenario involved.

5.1.11 Accident Analysis Methodology

5.1.11.1 *Introduction*

Accidents are defined as unexpected or undesirable events that lead to the release of hazardous material within a facility or into the environment, exposing workers and the public to hazardous materials or radiation. Any activity therefore poses a certain amount of risk to the adjacent environment and human populations. The objective of this analysis is to characterize the overall risk posed by the operation, creating a context for the decision maker and putting the site in perspective for the public. Secondly, it quantifies the increment in risk among the alternatives, as an input to the decision. Table 5.1.11.1–1 lists the facilities by TA and/or building that were considered in the accident analysis.

TABLE 5.1.11.1–1.—*SWEIS Accident Analysis Facility Listing*

TECHNICAL AREA AND BUILDING NUMBER	FACILITY NAME
TA–0–1109	Potable Water Chlorinator
TA–0–1110	Potable Water Chlorinator
TA–3–29	Chemistry and Metallurgy Research (CMR) Facility
TA–3–66	Sigma Facility
TA–3–476	Toxic Gas Storage Shed
TA–9–21	Analytical Chemistry Building (worker hazard only)
TA–15–312	Dual Axis Radiographic Hydrodyamic Test (DARHT) Facility
TA–16–205	Weapons Engineering Tritium Facility (WETF)
TA–16–411	Assembly Building
TA–18–23	Pajarito Site Kiva #1 (seismic only)
TA–18–32	Pajarito Site Kiva #2 (seismic only)
TA–18–116	Pajarito Site Kiva #3
TA–18–169	Pajarito Site Solution High-Energy Burst Assembly (SHEBA) Building (seismic only)
TA–21–155	Tritium Systems Test Assembly (TSTA)
TA–21–209	Tritium Science and Fabrication Facility (TSFF)
TA–43–1	Health Research Laboratory (HRL) (seismic only)
TA–46–340	Waste Water Treatment Facility (WWTF)
TA–48–1	Radiochemistry Laboratory[a]
TA–50–1	Radioactive Liquid Waste Treatment Facility (seismic only)
TA–50–37	Radioactive Materials Research, Operations, and Demonstration (RAMROD) Facility
TA–50–69	Waste Characterization, Reduction, and Repackaging (WCRR) Facility
TA–54–G	Transuranic Waste Inspectable Storage Project (TWISP) (TA–54–229, TA–54–230, TA–54–231, and TA–54–232); Transuranic Waste Storage Domes (TA–54–48, TA–54–153, TA–54–224, TA–54–226, and TA–54–283); Tritium Waste Sheds (TA–54–1027, TA–54–1028, TA–54–1029, and TA–54–1041)
TA–54–38	Radioactive Assay and Nondestructive Testing (RANT) Facility
TA–54–39	Polychlorinated Biphenyl (PCB) Waste Storage Facility
TA–54–216	Legacy Toxic Gas Storage Facility
TA–55–4	Plutonium Facility
TA–55–185	Transuranic Waste Drum Staging Building
TA–59–1	Occupational Health Laboratory (worker hazard only)

[a] Table G.5.4.4–3 in volume III, appendix G, lists all facilities found to have a moderate or higher vulnerability to wildfire, and therefore, were considered in the site-wide wildfire analysis.

5.1.11.2 *Meaning of Risk and Frequency as Used in This SWEIS*

The word "risk" is defined in the dictionary as the probability that a specific loss or injury will occur. In this SWEIS, DOE couples the consequence of an event with the probability that it will occur, and calls this combination the risk. Note that a high consequence event would not necessarily have significant risk if its probability is very low.

The probability of the accident is typically expressed as a frequency; that is, an accident with a frequency of 0.001 per year has a probability of occurring once in 1,000 years and twice in 2,000 years. This is only another way of saying that the probability of the accident occurring in any particular year is 1 in 1,000.

For many events, the risk can be expressed mathematically as the product of the consequence and its probability. In illustration, if the expected public consequence of an accident at a particular facility is one cancer per accident, and if the accident has a probability of occurring once in 1,000 years, then the continuing risk presented by that accident is (1 x 1/1000) or 0.001 cancer per year. This product of consequence and probability is called "societal risk" in this SWEIS. It permits the ready comparison of accidents and alternatives without the burden of the details. The details of the analyses are presented in volume III, appendix G.

5.1.11.3 *Characterization of the Risk from Accidents*

Characterization includes a consideration of the type of the accident (e.g., fire, explosion, spill, leak, depressurization, criticality, etc.), the initiator (e.g., human error, chemical reaction, earthquake, strong wind, flood, vehicle accident, mechanical failure, etc.), and the material-at-risk (MAR) (e.g., plutonium, tritium, toxic chemical, explosives, inflammable gas, etc.). Characterization also considers the type of consequences of the accident (e.g., immediate fatalities, prompt reversible and irreversible health effects, latent cancers—some of which lead to eventual death and are referred to as fatal) and the magnitude of the consequences (e.g., to workers only, to hypothetical members of the public, to a few, some or many real individuals off site). Finally, characterization considers the likelihood that an accident will occur.

LANL is a complex and diverse site, and there is a wide range of accident scenarios that can be hypothesized, with a wide range of likelihoods and a wide range of realistic and imagined consequences. To characterize the accident risk at LANL, this analysis has deliberately chosen a range of types of accidents and a range of consequences, including accidents involving materials for which the public has shown concern. This analysis does not attempt to identify every possible accident, but instead selects accidents that characterize or dominate the risk to the public and workers from site operations. It thereby provides an objective context for the public to evaluate the risk posed by site operations, and a context for the decision among alternatives. It also allows the decision maker to consider whether mitigation measures are needed to reduce risk.

By identifying the locations of appreciable quantities of hazardous material, the accidents associated with these materials can be assessed. By grouping these accidents according to their likelihood or frequency, and the magnitude of their consequences, it is possible to select accidents for further characterization and qualitatively portray their relative risk. The accidents selected for this detailed analysis are those with bounding consequences as well as those that characterize the risk of operating LANL.

5.1.11.4 *Determining the Increment in Risk Among Alternatives*

If an accident is not reasonably foreseeable—that is, it is incredible—DOE does not consider that it contributes substantially to the risk of operating LANL (DOE 1993). If, on the other hand, a hazardous material has a reasonable chance of being involved in an accident, then the consequences and the likelihood of the accident are considered.

Specific accidents that contribute substantially to, or envelop the risk, are considered risk-dominant accidents or bounding accidents. They are not exceeded by other accidents analyzed or believed to be possible that involve that inventory. For instance, there may be a number of accidents that could disperse plutonium, with different initiators or different mitigation, but they are represented by the risk-dominant accident involving plutonium dispersal. This accident also may bound the consequences for other facilities that may have more sensitive site characteristics (such as larger populations), but have lesser inventories than those addressed by the analyses.

This suite of accidents was derived from consideration of the current operations plus currently planned changes. These constitute the baseline (No Action Alternative) condition that serves as a reference from which to evaluate the alternatives. Changes in locations, changes in MAR, and changes in types of operations were considered among the alternatives. These differences were then used to determine the changes to the probability and consequences of the accidents. In each of the sections discussing the impacts of the alternatives, the risk, as well as the change in risk from the No Action Alternative, is given in the summary tables.

5.1.11.5 *Methodology for Selection of Accidents for Analysis*

The analysis began with the establishment of the baseline risk from current operations, plus planned activities, that together constitute the No Action Alternative. The baseline was established by a process of safety documentation review, interviews with facility management, physical inspections ("walkdowns") of facilities, and discussions with facility management. Changes in the baseline risk were estimated for the Expanded Operations Alternative, the Reduced Operations Alternative, and the Greener Alternative to ascertain the human health impacts of the alternatives.

Assessing the human health consequences of accidents for the alternatives is a four-step process. The first step was to identify a broad spectrum of potential accident scenarios. These scenarios were obtained from available site-specific safety and environmental documents, from programmatic documents, from discussions with facility management, and from physical inspections (walkdowns) of the facilities.

The second step in the process used screening techniques to identify the specific scenarios that contribute significantly to risk (i.e., the scenarios that contribute an appreciable fraction of the total risk). Due to the large number of potential accident scenarios that could impact human health, it is impractical to evaluate them all in detail. This is a common problem encountered in risk assessments, and the standard approach (which was adopted here) is to apply rough bounding calculations during the screening steps. The calculations are performed to progressively greater degrees of detail until it becomes clear that the accident is either not risk-significant or requires a detailed analysis in order to determine the frequency and consequences of the accident (i.e., its risk).

Rigorous evaluations (the third step in the process) were only performed for the potentially risk-dominant scenarios identified in step two—that is, those which had a frequency of 10^{-6} or above and led to off-site consequences beyond insignificant.

The fourth step in assessing the human health impact of accidents for the alternatives was to carefully evaluate the effect of the alternatives on the accident scenarios. The important considerations involved in this evaluation were whether the alternative would result in the elimination of some accidents and the addition of others, whether the alternative would result in an increase or decrease in the frequency of some accidents, and whether the alternative would result in an increase or decrease in the amount of hazardous materials released. The results of the analysis indicate that, while a number of accidents are potentially affected by the alternatives, few of them are significant to public or worker risk.

It is important to recognize that as a result of several factors (the nature of the activities performed, the design features of the facilities at which the activities are performed, the conditions under which the activities are performed, and the location of the facility vis a vis the public), accidents are more likely to impact facility workers than they are to impact the public. This is true even though at LANL the public has access to many areas of the laboratory via roadway. Even for facility workers, the consequences in many cases would be dependent on the use by facility workers of personal protective equipment (PPE) and on the effectiveness of emergency response and mitigation actions taken to limit consequences (e.g., the timeliness of evacuation from the facility).

5.1.11.6 *Conservatism in the Analyses*

At all steps, when faced with uncertainties, the analysts selected the most probable or conservative value for accident probability and the quantity of hazardous materials released. Accepted models and expected atmospheric dispersion parameters were used in the modeling. Exposure conditions (location, time in the plume) were used that would maximize exposure of the total population and of individuals. Concentration planning guidelines appropriate to the public were used to evaluate impacts from chemical accidents. A conservative risk factor for excess LCFs was used to calculate radiological health effects; whereas, the true risk factor may be considerably less, as described in appendix D, section D.1 (in volume III). The resulting estimates of risks are quite conservative.

Despite the conservatism, some accident scenarios originally thought plausible were found by analysis to have a probability of less than 10^{-6} per year, (i.e., to be incredible). These accidents are retained in the appendix to preserve the information they contain, in illustration of the range of the analyses, and in demonstration of the conservativeness of the screening.

5.1.11.7 *Accident Scenario Screening and Selection*

Spectrum of Potential Accidents

Potential accident scenarios were first selected based on facility safety documentation review. Facility walkdowns and discussions with operations personnel also were undertaken to ensure a comprehensive look at the possible accidents. In this manner, scenarios from the safety documentation were validated and other scenarios added to make a comprehensive list.

For the facility walkdowns, a pre-visit facility walkdown/interview data collection form was prepared for each facility to facilitate the collection of a consistent set of facility data and transmitted to facility representatives. Preparation of the forms benefited from the experience of previous accident evaluations (including safety analyses, probabilistic risk assessments, and process hazard analyses). In addition, relevant DOE handbooks and standards were considered, as described in volume III, appendix G.

During and subsequent to the walkdowns, revised safety documentation was provided by the facility representatives. This documentation was subsequently reviewed, and a draft data collection document was prepared for each facility.

Identification of Accident Scenarios

Two primary types of data sources were used for radiological accident analysis: (1) safety documentation, including safety assessments (SAs), hazard analyses (HAs), process hazard analyses (PrHAs), probabilistic risk assessments (PRAs), and safety analysis reports (SARs); and (2) facility walkdown/interview data collection forms.

Where a facility had current safety documentation, that documentation was used to define accident scenarios. Owing to differences in scope between safety documentation and NEPA accident analyses, some supplementation of the safety documentation was necessary in a few instances in order to provide the required NEPA coverage (this was especially true in the area of seismically initiated sequences). The facility walkdowns were used to further evaluate the accident scenarios identified in the safety documentation, to evaluate whether additional accident scenarios were possible that were not included in the safety documentation, to evaluate whether there were accident frequency or accident consequence mitigation capabilities present that were not credited in the safety documentation, and to assess the impacts of the SWEIS alternatives on the accident scenarios. This latter consideration included whether accident frequencies or MAR could increase or decrease across the alternatives, and whether any accident scenario existed in one or some but not in all alternatives.

Documentation relied upon for the radiological facility accident analysis included the following:

- The LANL seismic hazard evaluation (Wong et al. 1995) and the LANL aircraft crash hazard evaluation (LANL 1996d)
- Basis for Interim Operation (BIO)
- Operational safety requirements
- Technical safety requirements
  Environmental assessments (EAs)
- EISs
- Facility descriptions (LANL 1998b)

Based on the results of the review of facility safety documentation and the facility walkdown/interview data collection process, a large suite of accident scenarios was identified and grouped by MAR (e.g., weapons-grade plutonium, source material plutonium, tritium, highly enriched uranium [HEU], depleted uranium (DU), etc.) for further consideration.

Accident Initiator Screening

Section G.3 in appendix G (in volume III) describes the comprehensive screening and evaluation of various accident types and initiators.

Accident types and accident initiators that could produce an accident with a frequency in excess of 10^{-7} per year when realistically estimated, or a frequency in excess of 10^{-6} per year when conservatively estimated, were treated as "credible" and "reasonably foreseeable." Of course, accidents with frequencies less than this were not dismissed without considering whether they were capable of producing worse consequences than credible earthquakes, which affect the entire LANL site. It is also not plausible that many individual, but unlikely, accidents could rival earthquakes in risk, and so such accidents were not retained for detailed analysis.

Summary of Consequence Screening for Chemical Accidents

Thirty-seven chemicals were identified in the 1992 LANL database that met the following criteria:

- Has a time-weighted-average (TWA) less than 2 parts per million
- Is found in readily dispersible form (i.e., a gas or liquid)
- Has a boiling point less than 212 degrees Fahrenheit (°F) (100 degrees Celsius [°C]) and a vapor pressure greater than 0.5 millimeter mercury

These 37 chemicals were modeled for release of their largest 1992 inventory, using adverse dispersion conditions and the ALOHA™ code, which is described in appendix G, section G.2.3. The 10 releases that exceeded the Emergency Response Planning Guideline (ERPG)–3 at 328 feet (100 meters) distance were retained for further analysis. To these were added another eight chemicals of interest.

Releases of the actual inventories of these 18 chemicals at 78 locations were then modeled to see which would exceed the ERPG–3 concentration under conservative daytime dispersion conditions. In this modeling:

- Release was at surface level.
- Gases were released over 10 minutes.
- Liquids were spilled instantaneously and then evaporated from a puddle 0.4 inch (1 centimeter) deep.

The releases that exceeded the ERPG–3 concentration were examined with consideration of:

- Whether there is a large work force nearby or there is public exposure
- If a heavy gas, whether the public is protected by intervening canyons
- Whether the consequences are less than a release of the chemical from a different facility
- Whether the consequences are less than those of another chemical released from the same facility

With these considerations, a number of releases were selected and retained for detailed analysis. Formaldehyde was also retained as it represents the largest LANL inventory of a readily dispersible chemical carcinogen. These final selections are shown in Table 5.1.11.7–1.

Summary of Consequence Screening for Radiological Accidents

To facilitate radiological facility accident screening, integrated population exposure was established as an evaluation criterion. Consequences were calculated for the release of a unit of material and multiplied by the source term magnitude to obtain approximate consequences for screening. The calculations were performed with the Melcor Accident Consequence Code System (MACCS) 2 (as described in appendix G, section G.2.4), for both ground level releases and elevated releases.

Population distributions for the screening and detailed analysis calculations were created from the 1990 Census data for residential populations, and 1996 LANL workforce populations by TA. LANL workforce populations were included by centering the total TA population in the direction where there is the largest concentration of that TA's population. This is a conservative and approximate method because it results in some double counting of facility workers who have residences within the 50-mile (80-kilometer) radius of LANL.

With these releases and frequency estimates, a number of scenarios were selected and retained for further detailed analysis, as listed in Table 5.1.11.7–1. Several accidents scenarios that might or should have been screened out are listed in Table 5.1.11.7–2. They were, at first,

TABLE 5.1.11.7–1.—*Dominant Accidents at LANL*

PROCESS HAZARD ACCIDENTS	
CHLORINE RELEASES	
CHEM–01	Single cylinder release of chlorine (150 pounds) from a potable water chlorinator (TA–00–1109, bounding) due to equipment failure or human error during chlorine cylinder replacement or maintenance activities.
CHEM–03	Single cylinder release of chlorine (150 pounds) from toxic gas cylinder storage facility (TA–3–476) due human error during cylinder handling or cylinder deterioration due to unintended long-term exposure to weather.
CHEM–06	Chlorine gas release (150 pounds) from a process line at the Plutonium Facility (TA–55–4) due to mechanical damage to a supply manifold.
HIGHLY ENRICHED URANIUM RELEASE	
RAD–03	Reactivity excursion accident at Pajarito Site Kiva #3 (TA–18–116) with Godiva-IV outside the kiva, vaporizing part of the HEU fuel and melting the remainder.
PLUTONIUM RELEASES	
RAD–09	TRU waste drum failure or puncture at TA–54, Area G (bounding).
RAD–13	Plutonium melting and release accident at Pajarito Site Kiva #3 (TA–18–116).
RAD–15	Plutonium release from a laboratory and wing fire at the CMR Building.
MANMADE HAZARD ACCIDENTS	
CHLORINE RELEASE	
CHEM–02	Multiple-cylinder chlorine release (1,500 pounds) due to explosion or unsuppressed fire affecting a toxic gas storage facility (TA–3–476).
SELENIUM HEXAFLUORIDE AND SULFUR DIOXIDE RELEASE	
CHEM–04	Single cylinder release of toxic gas (selenium hexafluoride, historical bounding chemical) from the legacy toxic gas storage facility (TA–54–216) due to random cylinder failure or a forklift accident.
CHEM–05	Multiple cylinder release of toxic gas (sulfur dioxide, historical bounding chemical) from the legacy toxic gas storage facility (TA–54–216) due to a fire, a propane tank BLEVE, or a propagating random failure.
TRITIUM RELEASE	
RAD–05	Aircraft crash with explosion and/or fire at TA–21 resulting in a tritium oxide release.
PLUTONIUM RELEASE	
RAD–01	Plutonium release due to container storage area fire involving TRU waste drums (TA–54–38).
RAD–07	Plutonium release due to container storage area fire involving TRU waste drums (TA–50–69).
RAD–08	Aircraft crash with explosion and/or fire at the TRU waste dome area at TA–54 (TA–54–229, TA–54–230, TA–54–231, and TA–54–232).
RAD–16	Aircraft crash with explosion and/or fire at CMR Building resulting in a plutonium release.

TABLE 5.1.11.7–1.—*Dominant Accidents at LANL*-Continued

NATURAL PHENOMENA HAZARD ACCIDENTS	
MULTIPLE RELEASES OF HAZARDOUS MATERIAL	
SITE–01	Site-wide earthquake, resulting in damage to low capacity structure or internal components at multiple facilities.
SITE–02	Site-wide earthquake, resulting in damage to moderate capacity structures or internal components at multiple facilities.
SITE–03	Site-wide earthquake, resulting in structural damage or collapse to all facilities.
SITE–04	Site-wide wildfire, consuming combustible structures and vegetation.
RAD–12	Plutonium release from a seismically initiated event.

TABLE 5.1.11.7–2.—*Incredible Accidents That Were Analyzed*

PROCESS HAZARD ACCIDENTS	
RAD–04	Inadvertent detonation of a plutonium-containing assembly at or near the DARHT Facility firing point, resulting in an elevated, explosive-driven release of plutonium (TA–15).
RAD–10	Plutonium release from a degraded storage container in the Plutonium Facility (TA–55–4) vault during container retrieval.
RAD–11	Catastrophic containment failure after detonation of a plutonium-containing assembly at the DARHT firing point (TA–15), resulting in a ground-level release of plutonium.
RAD–14	Plutonium release from ion exchange column thermal excursion at TA–55–4 (the screening process identified this as the most likely initiator of a glovebox fire).
MANMADE HAZARD ACCIDENTS	
RAD–02	Plutonium release due to natural gas pipeline failure near TA–3–29, with no immediate ignition, ingestion of gas into facility, followed by explosion and fire.
RAD–06	Aircraft crash with explosion and/or fire at TA–50–37, resulting in a plutonium release from TRU waste drums.

considered credible accidents because of the conservatism applied in the original estimates of event frequency. However, after a more detailed evaluation of the accident progression, the events were found to be incredible. These scenarios are retained in appendix G for the information they contain.

Addition of Site-Wide Wildfire to the Accident Scenarios

Site-wide wildfires escaped consideration in the draft SWEIS. At the same time, there was a general recognition of the threat to LANL, as evidenced by the multiple agency cooperation in an ongoing fuel reduction effort. This oversight was brought to DOE's attention during the public hearings on the draft SWEIS, and an analysis began with input from the Española District of the Santa Fe National Forest (SFNF), the Bandelier National Monument (BNM) of the NPS, the Los Alamos Fire Department, and LANL departments and personnel. The final analysis appears as SITE–04.

The frequency of a large wildfire moving onto the LANL site was estimated to be 0.1, or one chance in 10 years. The extent of the subsequent fire and its consequences can vary widely according to the ensuing meteorological conditions. The SITE–04 analysis conservatively assumes that all combustible structures and vegetation over the western part of LANL are burned. The resulting public exposures were estimated for each facility, using (when available) existing calculations of public exposure from fire at that facility. Although the summed exposures from all buildings is modest, the frequency of the accident is high; as a result, the public risk places this accident in Table 5.1.11.7–1, "Dominant Accidents at LANL."

5.1.11.8 *Detailed Accident Evaluations*

The probability of a release (expressed as an annual frequency) of the hazardous material was calculated from the accident progressions in each of the scenarios retained for detailed analysis. The accident analysis included a step-by-step analysis of the initiating events and of the barriers that need to fail before a substantial amount of material can be made available for atmospheric transport to downwind receptors. The details are provided in volume III, appendix G.

Toxic chemical source terms were evaluated by looking at the release mechanisms to determine the amount and rates of material released, release heights, and other source term parameters for input to calculations of the atmospheric concentrations.

For radiological accidents, there are two source terms: the initial (prompt) source term and the subsequent, continuing suspension source term. The initial source term is the radioactive material driven airborne at the time of the accident. The suspension source term is the radioactive material that becomes airborne subsequent to the accident as a result of evaporation, winds, or other processes. For both of these terms, the characteristics of the release were evaluated to determine the amount of material available for atmospheric transport and the parameters that influence its dispersion. For most DOE nonreactor facilities, the dose from inhalation exposure dominates the overall dose from accidents.

DOE Handbook 3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vols. I & II, December 1994 (DOE 1994), was used as the primary reference for calculation of radiological source terms. To maintain consistency across the accident analyses, DOE Handbook 3010-94 source term methodology has been applied to the aircraft crash accidents, although there is a separate DOE Standard 3014-96 that covers aircraft crashes (DOE 1996b).

Human Health Impact of Accidents

The final step in the process is the determination of human health impacts resulting through exposures. For chemical accidents, the concentrations of chemicals at various distances were made with ALOHA™, as described in appendix G, section G.2.1, and compared to the ERPGs. Once concentrations were determined using the ALOHA™ code, demographic data were used to determine the number of people exposed above each ERPG level. ERPGs are concentrations associated with different levels of reversible and serious health effects.

For radiological accidents, the effects on the surrounding populations were calculated using the MACCS2, as described in appendix G, section G.2.4. MACCS2 determines the expected collective doses to the population within a 50-mile (80-kilometer) radius of the accident, and then computes the acute fatalities and excess LCFs for this population. MACCS2 uses risk factors of about 0.0005 excess LCF per person-rem for the general population. Doses to the MEIs at specific off-site locations are used to characterize the maximum possible risk to an individual member of the public.

The resulting human health impacts are described in the following sections.

- No Action Alternative, section 5.2.11
- Expanded Operations Alternative, section 5.3.11
- Reduced Operations Alternative, section 5.4.11
- Greener Alternative, section 5.5.11

5.1.11.9 *Worker Accident Screening*

Analysis of worker accidents (other than the transportation and physical safety hazards discussed in the SWEIS transportation risk and human health analyses, respectively) was performed to provide estimates of potential health effects from chemical and radiological exposure for involved workers. (For purposes of this SWEIS, workers within the TA where the accident occurs are defined as "involved workers," and other on site LANL employees are defined as "noninvolved workers.") Worker accident analysis need not be either as extensive or detailed as the public accident analysis because worker health risk from industrial accidents (falls, electrical shock, crushing, etc.) dominates over worker health risk from exposure in radiological and chemical accidents.

Worker accidents were reviewed qualitatively in order to arrive at a list of accidents that is representative of the accident potential at LANL under the four alternatives. The process used was similar to the analysis of accidents with public impact. The purpose of the separate worker accident screening was to identify whether there are accident scenarios that could have greater consequence to workers than the worker consequences associated with the public accident scenarios.

Data to support the accident analysis were obtained from a variety of sources, both facility- and site-specific, as well as from industrial and nuclear generic databases and compilations. Data sources, detailed in appendix G, included safety and hazard analysis documentation, data forms generated during the facility walkdowns, LANL SWEIS alternatives documentation, and Occupational Safety and Health Administration (OSHA) Form 200 Injury/Illness Reports for LANL and other DOE facilities.

The summary listing identified over 600 potential worker accident scenarios. Potential worker accident scenarios were then sorted by material hazard and initiators and ranked according to relative risk. Risk was qualitatively assigned on the basis of the frequency and consequence ranking matrix for hazard evaluation described in section G.1 of appendix G. The array of worker accidents was not dissimilar from the array of accidents with public impact, so that the worker accident component of the selected public accidents also provides a representative picture of the worker accident potential. There are, however, some accidents that pose a risk to workers but not to the public. An example is the medical research at TA–43–1, field work on small mammal capture and blood sampling, where the exposures to workers are localized and the exposure to the population from a release would be mitigated by environmental attenuation. Another exception is energetic hazards, where potential hazardous sources do not involve the public.

The ranked worker accident scenarios were then compared to the public impact accidents with comparable risk rankings. From the review of the chemical and radiological accidents selected for detailed quantification of public risk and a screen of these accidents against the worker accidents, the following worker accidents were selected for more detailed evaluation (also listed in Table 5.1.11.9–1).

- Inadvertent high explosives detonation
- Biohazard contamination of a single worker
- Inadvertent criticality event
- Inadvertent exposure to electromagnetic radiation (x-rays, accelerator beam, laser, or radiofrequency [RF] source)

5.1.11.10 *Detailed Worker Accident Evaluations*

The worker accidents were qualitatively assessed because exposure can vary widely based on the exact sequence of the accident. One of the bounding parameters is the length of time that a worker is exposed to a hazardous material. Rapid evacuation, sheltering, and donning of protective equipment can greatly reduce a worker's exposure. Prompt medical treatment can also reduce the consequences. Therefore, worker accidents can be only qualitatively assessed for both the likelihood of the accident and its impact on individual workers. The human health results for the workers are provided in the following sections.

- No Action Alternative, section 5.2.11
- Expanded Operations Alternative, section 5.3.11
- Reduced Operations Alternative, section 5.4.11
- Greener Alternative, section 5.5.11

5.1.11.11 *Uncertainties and Sensitivities*

In principle, one could estimate the uncertainty associated with each step of the analysis for each accident scenario, and predict the uncertainty in the results (frequency, source term, consequences, risk, etc.). However,

TABLE 5.1.11.9–1.—*Dominant Worker Accidents at LANL*

PROCESS HAZARD ACCIDENTS	
WORK–01	Worker fatality due to inadvertent high explosives detonation.
WORK–02	Worker illness or fatality due to inadvertent biohazard contamination.
WORK–03	Multiple worker fatality due to inadvertent nuclear criticality event.
WORK–04	Worker injury or fatality due to inadvertent electronic radiation exposure (x-ray, accelerator beam, laser, or radiofrequency source exposure).
WORK–05	Worker exposure to plutonium released from a degraded storage container in the plutonium (TA–55–4) vault during container retrieval.

conducting such a full-scale quantitative uncertainty analysis is neither practical nor a standard practice for a study of this type. Instead, the analysis is intended to ensure, through judicious selection of release scenarios, models, and parameters, that the results represent and give a reasonable estimate of the actual risks.

This is accomplished by making conservative assumptions at each step of the calculations. The models, model parameters, and release scenarios are selected in such a way that most intermediate results and the final estimate of impacts are almost certainly greater than what would be expected should the events actually occur. That is, there is a small chance that the actual risk is greater than presented, but a very large chance that the actual risk is less.

Often, there are no differences between accident impacts among the alternatives, largely as a result of conservative approaches used in accident frequency and public consequence. The inventories used in the analyses are typically those of permitted or administrative limits (i.e., controls on the maximum amounts of material that can be processed at one time and/or in storage), rather than operational values (i.e., the actual amount of material needed to perform the task). The operational values would be more likely to change among the alternatives. The administrative limits or inventories are selected so that the analyses are sufficiently conservative and bounding to cover maximum possible operational values. The accident frequencies depend upon the accident initiators, such as an aircraft crash, earthquake, or wildfire. These particular initiators are independent of the operations and of inventory; therefore, the frequency or likelihood of such an event remains constant among the alternatives. In the few cases of accidents in which the frequency depends upon operations, the variation in frequency among the alternatives does not necessarily translate into a significant change in the risk of an environmental release to the public because the value of a release is very small. Likewise, the risk to workers is affected by the change in frequency of the operations; but, the consequence of a single accident remains the same. These details for specific accidents appear in volume III, appendix G.

5.1.11.12 Summary of Methodology for Supplement Analysis, SSM PEIS

The DOE is preparing a Supplement Analysis for the SSM PEIS (DOE 1996d) in accordance with an order issued by the U.S. District Court for the District of Columbia, resulting from a lawsuit filed against the DOE (chapter 1, section 1.5.2). The Supplement Analysis will: (1) assess the significance of recent seismic studies at LANL and (2) re-examine the plausibility of a building-wide fire at TA–55. With respect to the seismic analyses, the Supplemental Analysis will reflect the differences between DOE's understanding of seismic risk at the time the SSM PEIS and its ROD were prepared and the understanding of seismic risk at the completion of recent seismic studies (the last studies are expected to be finalized in March 1999). This analysis will reflect the difference, if any, in terms of both the frequency of the bounding seismically induced accident and the consequences of such an accident. This difference will then be examined for significance with respect to DOE's assignment of the pit production mission to LANL, as reflected in the SSM PEIS ROD.

With respect to the building-wide fire analyses, two types of accident scenarios will be considered: process and natural phenomena events. In addition, an analysis of the plausibility of a building-wide fire due to sabotage will be included in the Supplement Analysis. The process events will look at various classes of fire initiation (e.g., flammable material, electrical fires, equipment malfunctions, etc.). These process scenarios will be compared to historical data for glovebox and laboratory fires from the DOE complex, as well as from industry data to ensure a complete understanding of possible ways that fires could start at TA–55. These fires then will be analyzed for ways in which they could propagate throughout the Plutonium Facility (PF)–4 complex (including analyses for potential failure of the various barriers to fire propagation). These considerations of how and where a fire could start and then spread to envelop the entire PF–4 facility will be developed into an analysis of a building-wide fire at the LANL Plutonium Facility (PF–4 at TA–55).

The natural phenomena event that will be considered as part of the Supplement Analysis will be the seismically induced fire at TA–55. This analysis will look at the fragility of gloveboxes, cable trays, flammable gas cabinets, etc., in order to compare to postulated ground accelerations. Essentially, the analysis will examine the means to start fire in TA–55 through the seismically induced damage of material or equipment in the building. The analysis then will consider the spread of the fire throughout the building because of damaged fire barriers or the presence of material that is no longer contained because of damage from ground accelerations.

The plausibility of a building-wide fire due to sabotage will be examined, consistent with existing DOE threat guidance regarding sabotage and the tools and analyses routinely used to assess vulnerability to sabotage events. The nature of such analyses is that the result will be presented in terms of the potential that the attempted sabotage would be defeated; that is, the potential for the attempt to be detected and prevented or controlled prior to the saboteur's objective being met. This analysis is likely to be classified, in accordance with U.S. laws, due to the highly sensitive nature of information regarding LANL security features and their performance.

5.2 IMPACTS OF THE NO ACTION ALTERNATIVE

5.2.1 Land Resources

5.2.1.1 *Land Use*

Common to all four alternatives are ongoing environmental restoration activities. These include the decontamination and demolition of facilities and cleanup of land disposal sites located across LANL. Upon completion of restoration activities, these individual sites could be made available for different uses. It is currently estimated that these restoration actions would be ongoing over most of LANL for about the next 10 years. As sites are remediated, it is currently planned that the newly available site land uses would revert to the current land use category of the surrounding TA location. In the case of environmental restoration sites, this would change these areas back to Research and Development or Explosives land use categories from the Waste Disposal land use category designation. Because most of the sites are relatively small in size, this reversion will not result in significant land use acreage changes overall within the different categories of use. In the case of those TAs located next to the Los Alamos townsite, current evaluation of these areas reveals that they are not likely to undergo total decontamination or demolition and evacuation within the foreseeable future, so, accordingly, their land use category designations would not be expected to change within that time frame.

No changes to land use categories are anticipated from activities that are unique to this alternative. Activities identified for the key facilities under this alternative would occur primarily within existing facilities or within near proximity to them in disturbed areas and within the same type of land use category.

5.2.1.2 *Visual Resources*

Common to all four alternatives analyzed are environmental restoration activities that include the decontamination and demolition of facilities and cleanup of land disposal sites located across LANL. Upon completion of restoration activities, these sites will undergo soil stabilization through such efforts as vegetation reseeding or the installation of a site covering such as asphalt or concrete, dependent upon the identified future site uses. There will be a time period from the onset of site remediation through final site restoration when the viewshed will be minimally altered by the introduction of heavy equipment and vehicles and by any subsequent areas left bare of vegetation. Although some sites could be bare of vegetation or only sparsely covered for several subsequent growing seasons, this effect would be temporary and minor overall in nature. These sites are usually rather small in size and some may already be within developed, disturbed, or cleared areas.

No major changes to visual resources are anticipated from activities that are unique to the No Action Alternative. Construction activities identified for the key facilities under this alternative would occur within near proximity to existing buildings and parking areas in already disturbed locations. There would be a minimum of clearing activities required and these would be limited to a few acres. Fugitive dust generation during construction would be minimal and temporary. It would not be expected to change the overall air quality, nor would the ongoing operations at these facilities once they were initiated. There could be some changes at LANL's key facilities under this alternative that add to use of artificial nighttime personnel safety lighting around buildings and parking lots. These light sources would usually shed areas of localized light within the immediate vicinity of the building area and would not be expected to pose an adverse effect to wildlife in the area. Use of these additional light fixtures could result in an extremely slight increase in overall LANL area levels of light pollution that is unlikely to result in an expanded visibility of LANL by nighttime viewers located across the Rio Grande Valley.

5.2.1.3 *Noise*

Common to all four alternatives is LANL's continued contribution to the background noise generation with the Los Alamos County area. This background noise level is expected to remain at or near current levels for most of the foreseeable future regardless of the alternative that is implemented. There is no single representative measurement of ambient noise available for the LANL site. The upper regulatory limit for levels of noise experienced over a 16-hour period for workers is 80 decibels (dB) on the A-weighted frequency scale (dBA) (29 CFR 1910.95). Adverse permanent health effects are not expected to occur with levels of sound occurring constantly for up to 16 hours that are lower than that upper bounding regulatory limit. It is not anticipated that the background levels of noise associated with LANL activities under any of the four alternatives would approach this upper limit sound level based upon estimates of potential levels of site activities associated with each alternative relative to the existing environment.

The levels of noise and short-range ground vibrations generated by environmental restoration activities are consistent with those produced by most construction activities. Heavy equipment use, such as the operation of bulldozers, loaders, backhoes, and portable generators, typically produces noise with mean levels ranging from 81 to 85 dBA. For a comparison with these noise levels, normal conversation is usually conducted at a sound level of about 60 dBA (DOE 1995a). If heavy machinery were to be operated over a 16-hour period so that it produced noise at levels above 80 dBA constantly, it would be considered to be unsafe for workers. However, these noises are generally produced for short time periods or even sporadically. While occasional short spurts of site activities may result in noise levels in excess of 80 dBA, these are expected to be well within the levels of noise considered to be safe for likely exposure time durations of one-half hour (100 dBA) to one hour (96 dBA). Hearing protection is provided and worn by workers, as appropriate according to their standard operating procedures to afford them greater hearing protection. Additionally, some minor interior and outdoor construction activities are common across all alternatives. Noise produced by these activities would be mostly noticed by LANL workers at the site performing those activities; these workers would also be provided with hearing protection as part of their standard operating procedures.

Noise from these LANL construction-type activities may be somewhat noticeable to nearby members of the public, especially in the case of off-site environmental restoration activities. Because these activities are conducted during the daytime hours for short continuous durations, it is unlikely that the noise levels and ground vibrations produced by these activities would be sufficient to result in an adverse impact to the public. Nor are the noise levels likely to adversely affect sensitive wildlife receptors or their habitat. If certain sensitive wildlife species are found to occupy habitat areas near locations where these types of activities need to occur, or if the occupancy status of these habitat areas is unknown, it may be necessary to plan these activities so that they take place outside of the species' breeding seasons or else other special protective measures would need to be planned and implemented (e.g., hand digging).

Similarly, it is unlikely that workers, the public, or sensitive wildlife receptors would be adversely impacted by explosives testing that is common to some degree over the four alternatives. Workers are allowed to experience up to 100 impulsive/impact noise events at a maximum of 140 dBA per day and are kept away from harmful noise levels and air blasts by gated exclusion zones that control their entry into explosives firing site detonation points. The public is not allowed within the fenced TAs that have firing sites, and as mentioned in chapter 4 (section 4.1), noise levels produced by explosives tests are sufficiently reduced at locations where the public would be present to preclude hearing damages. Various studies are currently underway to gain an understanding of the effect of noises on sensitive wildlife species. The continued well-being of LANL's resident and long-term migratory populations of these sensitive species indicates that the level of noise generated by explosives testing under the No Action Alternative would at least be tolerated by these particular species.

Implementing the No Action Alternative would be expected to result in the previously discussed effects common to all alternatives. There would be no other anticipated effects unique to this alternative.

5.2.2 Geology and Soils

The information provided from the geology and soils sections feeds into several other sections within the SWEIS, such as human health, accidents, and ecological risk.

5.2.2.1 *Seismic Events or Volcanic Eruptions*

LANL operations under the No Action Alternative do not include activities that could trigger seismic events or volcanic eruptions (e.g., underground nuclear tests, operation of injection wells). Therefore, it is unlikely that operations under the No Action Alternative will have any geological impacts. Geologic hazards that are important components of accident scenarios are discussed in section 5.1.11.

5.2.2.2 *Slope Stability/Soil Erosion*

LANL operations under the No Action Alternative do not include any new activities that would result in any additional slope stability impacts. As discussed in section 4.2, the potential for rockfall and landslides and the historic downward cutting or erosion of surface water streams in the LANL regions, which results in steep canyon walls, will continue over time. These processes may destabilize supporting rocks. These processes will continue under the No Action Alternative; however, no new facilities near the canyon walls are planned. New rock catchers similar to those installed at TA–2 for the Omega West reactor should not be necessary under the No Action Alternative. All new activities that will disturb soils, such as environmental restoration activities, will continue to use mitigative measures (e.g., plastic lined trenches and the construction of flow barriers) to minimize the effect of surface runoff and soil erosion.

5.2.2.3 *Soils*

Soils in the area around LANL contain chemicals and radioactive materials, including those that are naturally occurring as well as those due to past LANL activities and worldwide fallout. These have the potential to affect human health and the environment. Most of the soil contamination due to LANL operations occurred as a result of past practices. (This contamination is referred to as "legacy contamination.") These past practices were associated with surface impoundments and disposal areas; experimental reactors; inactive firing sites; aboveground and underground storage tanks; PCB transformers; incinerators; chemical processing; shop machining that resulted in radioactive waste; and operations to develop, fabricate, and test explosive components for nuclear weapons. Although most of these activities are still ongoing at LANL, with the exception of underground testing, environmental regulations have become more stringent, and management of LANL operations is more proactive in minimizing such contamination.

Under the No Action Alternative, as sites are remediated, legacy soil contamination will be reduced. Legacy contamination is being addressed by the LANL Environmental Restoration (ER) Project, which is described in chapter 2 (section 2.1.2.5) of the SWEIS. In the future, consistent with the trend analyses discussed in chapter 4 (section 4.2.3.1), most radionuclides in soils, particularly tritium and uranium, from both on-site and off-site areas should continue to decrease. Contaminants such as DU, beryllium, lead, copper, and others are produced at firing sites and are of potential concern for deposition in sediments and soils. ER data to date show no appreciable difference between sediment samples and off-site samples (volume III, appendix D, Table D.3.4–1). Although a similar study is not available for soils because sediments are narrow bands of canyon bottom deposits that can be transported by surface water, this indicates that off-site deposition from runoff resulting from past firing site activities is minimal. Section 4.3.1.4 presents more information on sediments. When comparing LANL historical levels of firing sites activities with the No Action Alternative, historical levels during the time of peak activity (1980 to 1985) were approximately 2.8 times greater than proposed for the No Action Alternative (LANL 1995d). As a result, ongoing operations under the No Action Alternative should have little potential to contribute substantially to soil contamination, and as more remedial actions projects are completed, the overall levels of soil contamination will be reduced.

5.2.2.4 *Mineral Resources*

Although there is the potential that sand, gravel, and pumice deposits may exist within the LANL boundaries as discussed in section 4.2.4, the No Action Alternative will not affect the availability of these materials for mining purposes. The disturbed area for new construction activities associated with the new facilities or environmental restoration are small in comparison to the overall 43 square miles (111 square kilometers) of land that LANL occupies and, as discussed in section 5.1.1, are not in land use areas designated for mining activities.

5.2.3 Water Resources

5.2.3.1 *Surface Water*

The primary sources of potential impacts to surface water at LANL are the NPDES outfalls and transport of sediments contaminated from historic LANL activities. For the No Action Alternative, there are no new activities that will result in changes in stormwater runoff.

The volumes of effluent discharged into each watershed for the No Action Alternative are given in Table 5.2.3.1–1. In volume III, appendix A, Table A.1–1 presents a more detailed table of the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. In all of the alternatives there are no outfall discharges into the Barrancas, Bayo, Potrillo, Frijoles, Ancho, and Chaquehui watersheds. Ancho and Chaquehui canyons have baseline flows but no projected flows for the alternatives. Pueblo and Guaje watersheds have 1 million gallons (3.8 million liters) or less per year. For the No Action Alternative, 55 outfalls from key and non-key facilities discharge into eight separate watersheds. The estimated total discharge into all watersheds under the No Action Alternative is 261 million gallons (988 million liters) per year. This is an increase from the index effluent volume of 233 million gallons (882 million liters) discharged, as reflected in section 4.3. The number of outfalls remains constant across the alternatives.

TABLE 5.2.3.1–1.—*NPDES Discharges by Watershed Under the No Action Alternative*[a]

WATERSHED	#OUTFALLS		DISCHARGE, MGY					
			KEY FACILITIES		NON-KEY		TOTALS	
	INDEX	NA	INDEX	NA	INDEX	NA	INDEX	NA
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	30.6	0.5	0.2	19.7	30.8
Mortandad	12	7	42.0	29.6	10.9	5.1	52.9	34.7
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	42.7	103.5	127.9	107.9	170.6
Water	21	10	29.5	14.1	0.0	0.0	29.5	14.1
Totals	87	55	103.6	118.8	129.6	142.0	233.2	260.9

MGY = millions of gallons per year, NA = No Action Alternative

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future, as discussed in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

NPDES outfall effluent quality during the 10-year period analyzed (1997 through 2006) is expected to be similar to or improved over the effluent quality discharged during the period 1991 through 1995. LANL actions to improve compliance with permit conditions are continually being taken, including elimination of outfalls, improvements and corrective actions at specific outfalls, and implementation and completion of the Waste Stream Characterization Program and Corrections Project. Furthermore, several of the outfalls contain stormwater only; the cleanups at ER Project sites that will occur during the period of the SWEIS may result in improvement in the quality of the effluent in outfalls containing stormwater. As can be seen from Table 5.2.3.1–1, as of November 1997, 32 of the 87 index NPDES outfalls will be reduced to zero flow, resulting in 55 outfalls for the No Action Alternative (this is the case for all the alternatives). As the LANL outfall reduction program continues, it is anticipated that even more outfalls will be eliminated. No new outfalls are anticipated under any of the alternatives.

Another improvement to outfall effluent quality (in relation to the period 1991 through 1995) has occurred as a result of the improvements made at the High Explosives Wastewater Treatment Facility (HEWTF) (DOE 1995b). The new HEWTF, completed in October 1997, came on-line in February 1998 and will minimize the use of water in high explosives processes and will treat all remaining high explosives-contaminated wastewater at the new treatment facility. These changes will improve the quality of effluent from the HEWTF outfalls across the alternatives.

Improvements are also planned for outfall 051 at the TA–50 RLWTF. The effluent from the RLWTF have exceeded the DOE-Derived

Concentration Guide (DCG) for the public for the radionuclides americium-241, cesium-137, tritium, plutonium-238 and plutonium-239, and strontium-90 during the period 1990 through 1995 (LANL 1992, LANL 1993, LANL 1994, LANL 1995c, LANL 1996b, and LANL 1996c). A treatment system will be operational by early 1999 that will reduce concentrations of all of the above radionuclides, except tritium. Table 5.2.3.1–2 lists, for the above radionuclides, the average concentrations from 1990 through 1995 effluent, the predicted concentrations following treatment upgrades, and the DOE-DCGs for the public. The newly installed treatment system will result in concentrations of these radionuclides in effluent that will meet the DOE-DCGs for the public.

For liquid radioactive effluents, the "as low as reasonably achievable" (ALARA) and "best available technology" (BAT) processes are adopted, to determine the appropriate level of treatment. If discharges are below the DCGs reference values at the point of discharge to a surface waterway, generally no further treatment is required due to cost benefit considerations. Because the average tritium concentration (311,203 picocuries per liter) is well below the DOE-DCG (2,000,000 picocuries per liter), no further treatment of tritium was considered necessary. In addition, there is currently no practical treatment technology for tritium removal from the dilute concentrations present in the RLWTF effluent.

The effluent from the RLWTF has also exceeded the New Mexico Water Quality Control Commission (NMWQCC) standard for nitrate as nitrogen of 10 milligrams per liter. A nitrates removal system is being installed as part of the RLWTF improvements that will be operational by mid 1999. This new system will reduce the nitrates concentration levels below the NMWQCC standard.

As discussed in chapter 4 (section 4.3.1.2), LANL conducts a variety of construction, maintenance, and environmental activities that result in excavation or fill within water courses, which are waters of the U.S. under Section 404 of the *Clean Water Act*. These activities are done pursuant to 404 permits issued by the Army Corps of Engineers and certified per Section 401 by NMED. Each permit is issued pursuant to one or more specific nationwide permits. These include relevant permit conditions to protect water quality and wildlife that must be complied with by LANL and its construction contractors. The NMED also adds conditions as a part of its Section 401 certification that require application of "best management practices" to ensure satisfaction of New Mexico stream standards. Under the No

TABLE 5.2.3.1–2.—*TA–50 Radionuclide Summary*

RADIONUCLIDE	AVERAGE CONCENTRATIONS 1990 TO 1995[a]	PREDICTED CONCENTRATION AFTER TREATMENT[b]	DOE-DCG (PUBLIC)
Americium-241	155	25	30
Cesium-137	804	80	3,000
Tritium	311,203	311,203	2×10^6
Plutonium-238	66	17	40
Plutonium-239	28	27	30
Strontium-90	659	66	1,000

Note: All results are given in picocuries per liter.
Sources: [a] LANL 1992, LANL 1993, LANL 1994, LANL 1995c, LANL 1996b, and LANL 1996c; [b]Vance et al., 1996

Action Alternative, LANL will continue to comply with these permit requirements and use "best management practices" to ensure satisfaction of New Mexico stream standards.

As discussed under section 5.1.2, Water Resources Methodology, only the canyons with increased flows over the index are discussed in detail. It is assumed that for canyons with NPDES flows that are the same or reduced from the index flows, the impact will be negligible. Canyons that have an increase in outfall flows over the index are Los Alamos and Sandia Canyons. In Los Alamos Canyon the overall increase in flow of 11 million gallons (42 million liters) per year from the index is from the outfalls associated with the LANSCE Facility. In order to assess potential impacts, one needs to identify the types of contaminants that could originate from these outfalls and what type of contaminants may be transported off the site. The LANSCE outfalls with increased flow are 03A–047, 03A–048, and 03A–049. These outfalls are of the type containing cooling tower blowdown, evaporative coolers, chillers, condenser and air washer blowdown (Table 4.3.1.3–2 and Figure 4.3.1.3–1 in chapter 4 [legend numbers 18, 19, and 20] provide information regarding type and location, respectively). The primary noncompliance issues associated with these outfalls are for arsenic. LANL is in the process of designing a long-term corrective action that should help to eliminate future exceedances of arsenic. Corrective actions being evaluated include use of nontreated redwood and replacement of the wooden cooling towers with new units constructed of steel, fiberglass, and plastic. In 1996, outfalls 03A–048 and 03A–049 had a total of six arsenic exceedances; however, 1996 surface water monitoring stations for Los Alamos Canyon show levels of arsenic of less than 3 micrograms per liter, which is substantially less than the EPA drinking water standard of 50 micrograms per liter.

Elevated concentrations of tritium and other radionuclides have been detected in surface water samples in Los Alamos Canyon since the beginning of surveillance measurements in the mid 1960's. An industrial liquid waste treatment plant at TA–21 discharged effluent containing radionuclides into DP canyon, a tributary to Los Alamos Canyon, from 1952 to 1986. After 1986, the treated effluent was diverted to the TA–50 RLWTF. Up until 1989, Los Alamos Canyon received discharges containing radionuclides from the LANSCE Facility. In 1993, a cooling water leak was discovered at the Omega West Reactor (OWR). The OWR was shut down in 1992. The leak may have been occurring since beginning operation in 1956. The leak was repaired in 1993 soon after being discovered (LANL 1995c). However, the 1996 radiochemical analyses of runoff from Los Alamos Canyon (LANL 1997d) were well below the DOE-DCGs for the public. Within Los Alamos Canyon there are some relatively small areas that are being evaluated by the ER Project (chapter 2, section 2.1.2.5), where sediments may contain contaminants such as radionuclides, chemicals, and metals that are at higher levels than the LANL screening action levels (SALs). SALs are a benchmark for the potential for human health risk and are derived from toxicity data using a risk assessment approach (section 4.2.3.1). The ER Project plans to either remediate these areas or temporarily stabilize them until remediation, or permanently stabilize them such that potential transport of these contaminated sediments would be minimal. The reach in the vicinity of the LANSCE outfalls 03A–047, 03A–048, and 03A–49, is ephemeral and intermittent.

Table 4.3.1.1–1 in chapter 4 shows that the total volume of water at station E030, which is in the vicinity of these outfalls, was 160 million gallons (606 million liters) per water year in 1995. This is large in comparison to the additional 11 million gallons (42 million liters) identified in the No Action Alternative. Based on surface water monitoring results, particularly for arsenic and radiochemical analysis, and the relatively small increases in flow in Los Alamos Canyon as compared to the naturally occurring flows, the impacts to surface water from the increased flow in Los Alamos Canyon should be negligible.

Sandia Canyon has a small drainage area that heads at TA–3. Currently, under baseline conditions, the canyon primarily receives water from the cooling tower at the TA–3 power plant. These effluents support a continuous flow in a short reach of the upper part of the canyon (Figure 4.3.1.3–1); but, only during summer thundershowers does stream flow reach the LANL boundary at State Road 4, and only during periods of heavy thunderstorms or snowmelt does surface flow from Sandia Canyon extend beyond the LANL boundary.

In Sandia Canyon for the No Action Alternative, out of the total 63 million gallons per year (238 million liters) increase from the index, approximately 24 million gallons (91 million liters) per year are associated with outfalls from the cooling tower at TA–3, particularly outfall 01A–001, identified as 27 in Figure 4.3.1.3–1. All effluent from the TA–46 Sanitary Wastewater Systems Consolidation (SWSC) Facility is pumped to a reuse tank adjacent to the TA–3 power plant. When the power plant is in operation, water is drawn from the tank as makeup for the power plant cooling towers, where it is either lost to the air through evaporation or discharged to Sandia Canyon via the power plant outfall 01A–001. Outfall 13S, the original outfall for the TA–46 SWSC Facility, is located at the TA–46 SWSC Facility but is not used. However, the SWSC effluent, prior to being pumped over to TA–3, must meet the NPDES discharge limits for 05S (Table 4.3.1.3–2 shows NPDES effluent limits). The additional 24 million gallons (91 million liters) per year flow at TA–3 includes the increase flow projected from the SWSC plant. The additional outfall flow at TA–3 will support the continuous flow in the upper part of the canyon. The remaining 39 million gallons (148 million liters) per year increase in flow is from another LANSCE outfall, 03A–113 at TA–53, identified as 21 in Figure 4.3.1.3–1. The effluent water quality from both outfalls 01A–001 and 03A–113 is similar to the outfalls discussed previously for cooling towers. In 1996, both outfalls 01A–001 and 03A–113 were in compliance with the NPDES permit, and the radiochemical results of runoff from Sandia Canyon were well below the DOE-DCG for the public. Within Sandia Canyon, there are some relatively small areas that are being evaluated by the ER Project (chapter 2, section 2.1.2.5) where sediments may contain contaminants such as radionuclides, chemicals, and metals that are at higher levels than the LANL SALs. The ER Project plans to either remediate these areas or stabilize them such that potential transport of these contaminated sediments should be minimal.

Figure 4.3.1.3–1 in chapter 4 shows that the flow in Sandia Canyon is ephemeral and intermittent in the vicinity of outfall 03A–113, and Table 4.3.1.1–1 shows that the total volume of water at perimeter downstream station E–125 in Sandia Canyon was less than 2 million gallons (4 million liters) per year. Increased flow from outfall 03A–113 of 39 million gallons (148 million liters) per year may be sufficient to support a continuous flow for a short reach in the vicinity of the outfall. However, transport of contaminants off the site should be negligible.

For additional information on changes in NPDES outfall flows for each outfall for all the alternatives see volume III, appendix A.

5.2.3.2 *Groundwater*

Groundwater quantity and quality impacts to the three areas of groundwater under the Pajarito Plateau (alluvial, intermediate perched, and main aquifer) that may result from implementing the alternatives over the next

10 years were evaluated. As discussed under section 5.1.2, Water Resources Methodology, only the canyons with increased flows over the index are discussed in detail. It is assumed that for canyons with NPDES flows that are the same or reduced from the index flows, the impact will be negligible.

In order to better understand the extent of the effects of LANL activities on groundwater, more monitoring wells are being installed. Once constructed, the new monitoring wells should provide data for researchers to gain better understanding of how contaminants are transported from discharge sites. Because of the many questions concerning the hydraulic characterization of the Pajarito Plateau, such as recharge mechanisms for the main aquifer and the lack of hydrogeologic detail, LANL personnel prepared a Hydrogeologic Workplan that was approved by NMED in 1998 (LANL 1998d). The first of these wells to be installed is R-9 located in lower Los Alamos Canyon near the intersection of NM 501 and NM 4. On December 10, 1997, LANL personnel found preliminary indications of low levels of tritium in two perched groundwater zones. The water in which the tritium contamination was detected lies several hundred feet above the main aquifer, and the tritium levels were below the Safe Drinking Water Standards established by the EPA. LANL has previously detected extremely low level of tritium in the deep aquifer at several existing wells. Potential impacts to groundwater for the No Action Alternative are based on the most current information available.

Alluvial Groundwater

Alluvial groundwater aquifers may vary in size, dry out, or develop in locations where they previously did not exist in response to variations in seasonal snowmelt and thunderstorm runoff and LANL NPDES-permitted discharges into the canyons (LANL 1994). Of all LANL operational factors that may affect shallow groundwater quality and quantity, variations in NPDES discharges are the most significant. The canyons that may have an overall increase in alluvial groundwater volumes as a direct result of increased NPDES outfall volumes are Los Alamos and Sandia Canyons. Quantification of alluvial groundwater volume changes is not possible due to the high degree of uncertainty in many parameters (e.g., snowmelt, rainfall, infiltration rates, evaporation rates, canyon dimensions, storage capacity of alluvium). However, increases or decreases in discharges should result in similar changes in groundwater volumes.

In terms of changes in specific outfalls, the outfalls at the TA–50 RLWFT and the TA–16 HELWTF are worthy of further discussion and are described below.

Technical Area–50 Radioactive Liquid Waste Treatment Facility. The TA–50 RLWTF, which discharges into Mortandad Canyon will have several improvements over the next 10 years. Although historic discharges have been in compliance with existing NPDES permit requirements agreed upon by the EPA and LANL, improvements in discharge quality are necessary to meet more stringent requirements coming into effect over the next several years. Improvements in treatment technology (ultrafiltration/reverse osmosis) should allow compliance with the DOE-DCGs for the public for radionuclides by early 1999. Compliance for nitrate to within the new groundwater discharge limits established by NMED will be operational by mid 1999. Tritium activity in the discharge from the RLWTF will not be affected by the improved treatment technologies (section 5.2.3.1).

LANL projections for discharges from the RLWTF into Mortandad Canyon under the No Action Alternative are 6.6 million gallons (25 million liters) per year, as compared to the RLWTF index volume of 5.5 million gallons (21 million liters) per year. This flow rate is similar to that experienced in previous years, and no substantial changes to the volume of groundwater stored in the alluvium are anticipated.

Technical Area–16 S-Site Springs. The new HELWTF will be fully operational in mid 1998, resulting in a reduction in NPDES discharges of approximately 16 million gallons (61 million liters) per year into Canyon de Valle, a tributary to Water Canyon. This may reduce or eliminate flow in springs at S-Site.

The water quality discharging from the S-Site springs, some of which may have been contaminated by high explosives compounds and VOCs from past NPDES discharges, will likely improve due to the new HELWTF. The new plant will reduce the amount of water used in high explosives processing by 99 percent, and solvents will be extracted prior to high explosives processing rather than being discharged into Canyon de Valle.

Perched Groundwater

The Water Canyon Gallery has not been used as a source of potable water since 1991 and has not been used for boiler makeup water at TA–16 since 1994. LANL does not plan to use Water Canyon Gallery as a potable or industrial source over the next 10 years under any of the alternatives. The Water Canyon Gallery is on USFS land, and it is expected that it would only be used for wildlife watering.

Evaluations of impacts to intermediate perched groundwater quantity and quality resulting from operation changes under the alternatives are qualitative, because groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. Chemical radionuclides in the vicinity of the outfalls with increased flow under the No Action Alternative are minimal. The type of outfalls that have increased flow are primarily from cooling tower blowdown, evaporative coolers, etc. The impacts to perched groundwater should be negligible. However, it is possible that NPDES discharges to Los Alamos and Sandia Canyons contribute to recharge to the intermediate perched groundwater and contaminant transport beneath Los Alamos and Sandia Canyons. The increase NPDES discharges to Los Alamos and Sandia Canyons may contribute to the transport of contaminants off the site. Environmental monitoring of the perched groundwater will continue, and as new wells are installed the information obtained will be used to better understand the effects of LANL on groundwater quality.

Main Aquifer Water Quality

As mentioned at the beginning of this section, new wells are being installed to better understand recharge to the main aquifer. Extremely low levels of tritium have been detected in the main aquifer (chapter 4, sections 4.3.2.2 and 4.3.2.3) and this trend will most likely continue under the No Action Alternative. Environmental monitoring of the main aquifer will continue, and as new wells are installed the information will be used to better understand the effects of LANL on groundwater quality in the main aquifer. The impacts resulting from the increased NPDES outfall flows, under the No Action Alternative, to the main aquifer water quality should be negligible.

Public Water Supply

DOE has groundwater rights to about 1,805 million gallons (6,830 million liters) per year from the main aquifer. These rights provide water, including drinking water, to LANL, Los Alamos County, and the NPS (for BNM). A conservative projection of maximum LANL water use under the No Action Alternative is 712 million gallons (2,695 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the county used about 958 million gallons (3,626 million liters) from this water right, and the NPS used about 5 millions gallons

(19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer.

For the purposes of modeling drawdown of the main aquifer, water usage was projected annually. The total water usage from DOE water rights was projected to average 1,593 million gallons (6,030 million liters) per year under the No Action Alternative, with a maximum annual use of 1,620 million gallons (6,130 million liters) and a minimum annual use of 1,534 million gallons (5,880 million liters).

The USGS MODFLOW model for north-central New Mexico (Frenzel 1995) was used to predict water level changes at the top of the main aquifer for the alternatives. The model includes DOE supply wells, wells for the city of Santa Fe public supply system, discharges from the Santa Fe sewage treatment plant, and 200 private and industrial wells in Santa Fe County. Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.2.3.1–3 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the No Action Alternative. These changes are not all due to LANL operations; the changes for the on-site well fields and the Guaje well field are largely attributable to LANL operations and Los Alamos County. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. Springs in White Rock Canyon in the vicinity of the Buckman well field may actually increase in flow due to rising groundwater levels (from 0.1 to 3.8 feet [.03 to 1.2 meters]). The rising water levels result from the continuing recovery

TABLE 5.2.3.1–3.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the No Action Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-13.2
Otowi Well Field (Well 0-4)	-12.9
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-8.7
Santa Fe Water Supply	
Buckman Well Field	+21.6
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande:	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande:	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.
[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid-cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite difference from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and not be considered as finite changes.

in the vicinity of the Los Alamos well field, which was shut down in 1992, and recovery in the vicinity of Santa Fe's Buckman well field, which will be shut down in 1999. Operations of both well fields are independent of the alternatives and significantly affect water levels in the main aquifer in the vicinity of the Rio Grande. Therefore, the water level changes and the resulting impacts to White Rock Canyon Springs are identical across the alternatives.

In comparison to the thicknesses of the eight model layers (total = 5,600 feet [1,707 meters]), the maximum drawdown predicted for DOE well fields represents a reduction of main aquifer saturated thickness of less than 1 percent. Water use projections indicate that the total volume of water to be withdrawn from DOE well fields from 1997 through 2006 is less than 0.1 percent of the main aquifer volume (22 trillion gallons [83 trillion liters]) of water in storage beneath the Pajarito Plateau. In summary, the drawdowns in DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage.

5.2.4 Air Quality

This section describes the estimated air quality impacts from LANL operations under the No Action Alternative. The discussion includes estimated impacts from nonradiological and radiological air emissions. Additional detail and information on the material in this section is included in volume III, appendix B.

5.2.4.1 *Nonradiological Air Quality Impacts*

The results of the Expanded Operations Alternative analysis of criteria pollutants demonstrate that the highest estimated concentration of each pollutant would be below the standards established to protect human health with an ample margin of safety. For criteria pollutants, the No Action Alternative emission rates are lower than those under the Expanded Operations Alternative. Therefore, criteria pollutant emissions under the No Action Alternative are also expected to be below these levels.

For toxic air pollutants, the bounding analyses (based on the emission rates under the Expanded Operations Alternative) indicate that the only pollutant emissions with the potential to exceed the guideline values under any SWEIS alternative are the emissions from High Explosives Firing Site (HEFS) operations and the additive risk from all the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. Emissions from the firing site operations under the No Action Alternative are projected to be one-third the emissions projected under the Expanded Operations Alternative. Linear extrapolation of pollutant concentrations based on this difference in emissions results in concentrations that are below the GVs. Therefore, the pollutants released from LANL firing site operations under the No Action Alternative are not expected to cause air quality impacts that would affect human health.

As discussed in section 5.3.4.1, the combined cancer risk due to all carcinogenic pollutants from all TAs is dominated by the chloroform emissions from the HRL. Under the No Action Alternative, chloroform use is projected to be similar to current usage (about 55 pounds per year [17 liters per year], or about 15 percent less than projected under the Expanded Operations Alternative). Assuming that 100 percent of the chloroform used is emitted (and assuming no change in other carcinogenic pollutant emissions as compared to those under the Expanded Operations Alternative), the estimated combined incremental cancer risk at the Los Alamos Medical Center is slightly above the guideline value of 1.0×10^{-6}. Because it is known that less than 100 percent of the chloroform used is emitted (as much as 25 pounds per year [8 liters per year] are disposed of as liquid chemical waste), the incremental cancer risk under the No Action Alternative would be less than the GV.

Based on the information discussed above, pollutants released under the No Action Alternative are not expected to cause air quality impacts that would affect human health and the environment.

5.2.4.2 *Radiological Air Quality Impacts*

Facility-Specific Maximally Exposed Individual

Table 5.2.4.2–1 shows the distance and direction and estimated dose to each FS MEI under the No Action Alternative. The highest FS MEI dose under this alternative was calculated to be 3.11 millirem per year, which is 31.1 percent of the regulatory limit (which is 10 millirem per year for the air pathway).

LANL Maximally Exposed Individual

The location of the highest dose from all facility emissions was 2,625 feet (approximately

TABLE 5.2.4.2–1.—*Facility-Specific Maximally Exposed Individual Information—No Action Alternative*

FACILITY	MEI DISTANCE feet (meters)	DIRECTION	DOSE[a] (mrem/yr)
TA–3–29 (CMR Building)	3,576 (1,090)	North	0.43
TA–3–66 (Sigma Building)	3,560 (1,085)	North	0.43
TA–3–102 (Machine Shops)	3,379 (1,030)	North	0.34
TA–11 (High Explosive Testing)	4,298 (1,310)	South	0.31
TA–15/36 (Firing Sites)	7,415 (2,260)	Northeast	2.26
TA–16 (WETF)	2,886 (880)	South-Southeast	0.31
TA–18 (Pajarito Site: LACEF)	2,821 (860)	Northeast	1.73
TA–21 (TSTA and TSFF)	1,050 (320)	North	1.41
TA–48 (Radiochemistry Laboratory)	2,920 (890)	North-Northeast	1.66
TA–53 (LANSCE)[b]	2,625 (800)	North-Northeast	3.11
TA–54 (Area G)[c]	1,197 (365)	Northeast - LANL Boundary	0.75
	5,331 (1,625)	Southeast - White Rock	0.43
TA–55 (Plutonium Facility)	3,691 (1,125)	North	1.66

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. Note that an MEI is assumed not to leave or to take protective measures.
[b] This is also the location of the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES–2, ES–3, IPF, LEDA and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54, because Area G borders San Ildefonso Pueblo land. The first is an MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

800 meters) north-northeast of LANSCE. This location defines the LANL MEI. The dose to this location from all facility emissions was calculated to be 3.11 millirem per year.

Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated for emissions from all facilities and found to be 13.59 person-rem per year. The values reported for population doses for this alternative, as well as the other alternatives, are higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. (For example, LANSCE and firing site operations currently planned are higher than achieved in recent years.) The material throughput at the different facilities under the various alternatives is presented in chapter 3 (section 3.6).

An examination of the detailed data contained in appendix B (volume III) reveals that most (52 percent) of the collective population dose comes from emissions from the TA–15/36 firing sites. This is in contrast to the dose delivered to the LANL MEI, most of whose dose comes from LANSCE. The reason is that the firing site emits long-lived uranium isotopes; whereas, the LANSCE facility emits short-lived air activation products that decay quickly. Collectively, diffuse emissions (including those from TA–15/36) account for 52.8 percent of the population dose under the No Action Alternative.

Isodose Maps

Isodose maps present the estimated doses within a 50-mile (80-kilometer) radius from LANL. These isodose maps are shown in Figures 5.2.4.2–1 and 5.2.4.2–2. The isodose lines represent the summation of all modeled emissions and their subsequent estimated annual doses. Due to the summation, the resulting lines do not necessarily match individual wind rose patterns. This is due to the multiple facilities that contribute to the summed doses, as well as the distances displayed in the figure. To determine the dose at a specific location, individuals need only find the location on these maps and interpolate between the isopleths.

5.2.5 Ecological Resources, Biodiversity, and Ecological Risk

This section discusses potential impacts to ecological resources (including wetlands), biodiversity, and ecological risk. Under the No Action Alternative, LANL operations would continue at their currently planned level. Construction activities would be limited largely to those required to maintain facilities for currently authorized activities. Because of this continuation of current operational levels, there would not be any appreciable change to landscape features.

Ecological Resources and Biodiversity

A continuation of the current LANL facility operation and planned actions as reflected in DOE management plans that implement currently assigned programs would enhance present biological resources (including protected and sensitive species), ecological processes, and biodiversity. This enhancement would result largely from ongoing actions and plans whose objectives are to eliminate or reduce pollutants that could potentially pose a risk to biological systems, and biological management plans that would be incorporated into existing LANL operations to protect and enhance its biological resources. Key actions and plans and their objectives are briefly stated as follows:

- *Environmental Restoration Project.* Objectives are to remediate potentially contaminated sites resulting from historic

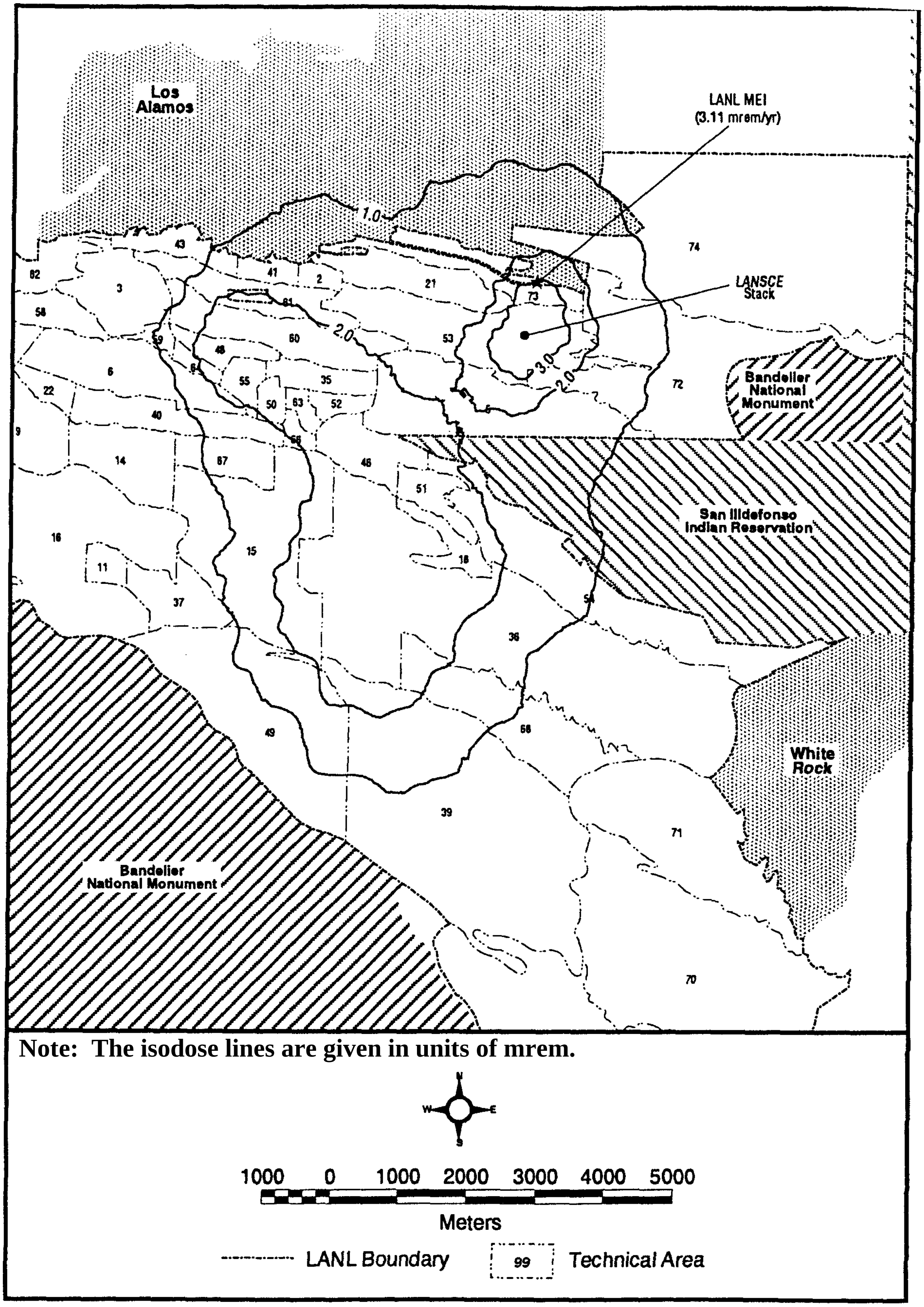
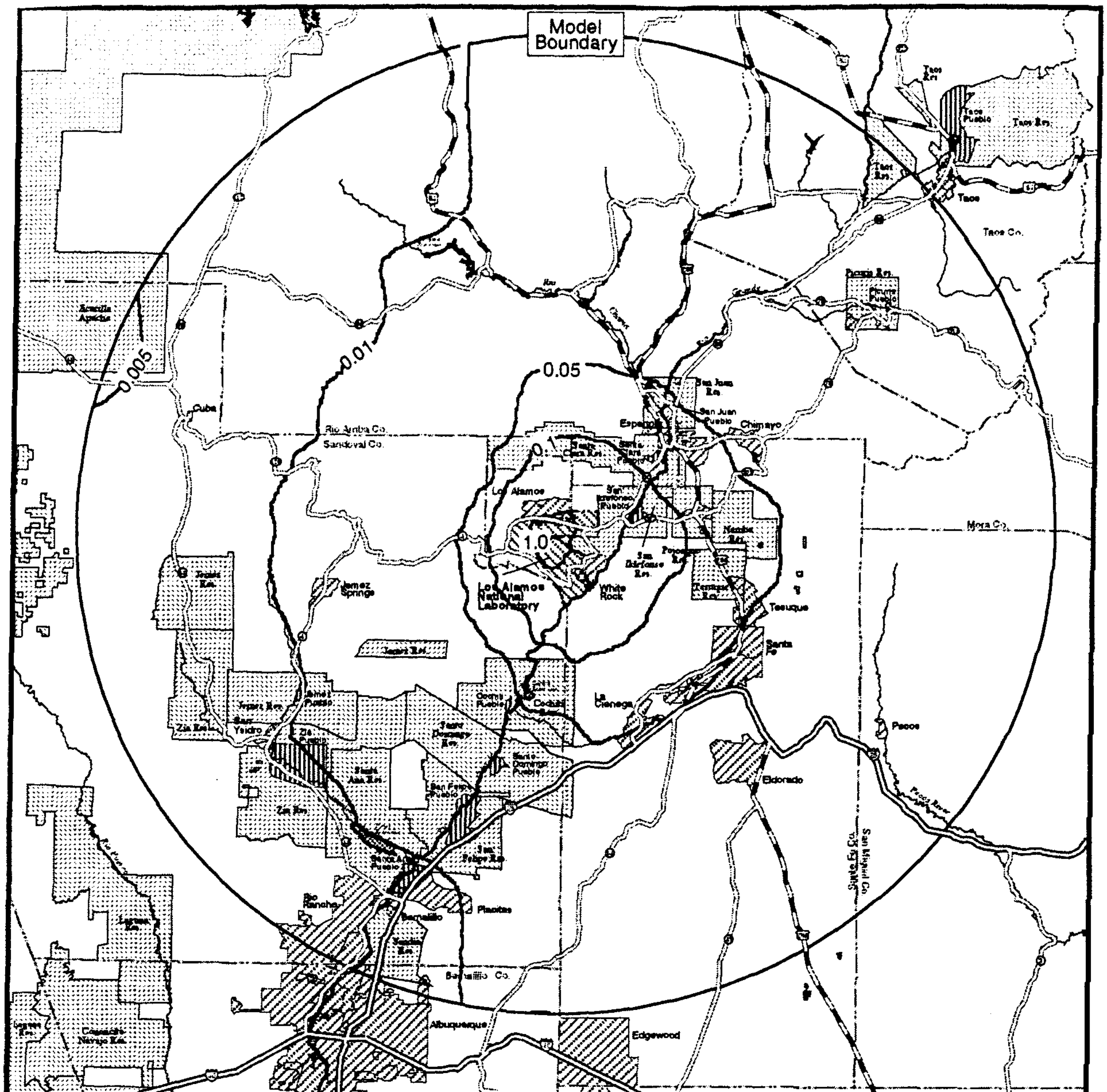


FIGURE 5.2.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the No Action Alternative*.



Note: The isodose lines are given in units of mrem.

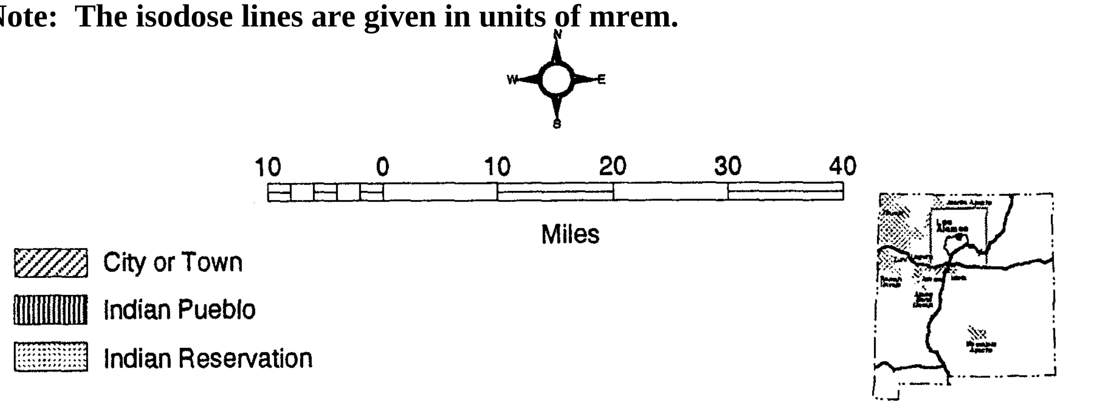


FIGURE 5.2.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the No Action Alternative.*

treatment, storage, and disposal practices at LANL; meet the environmental clean-up requirements of the *Resource Conservation and Recovery Act* (RCRA) (42 U.S.C. §6901); and decontaminate and decommission facilities previously contaminated by radioactive and hazardous materials, such restorations can result in ecological disturbance during individual actions.

- *Waste Stream Characterization Program and Outfall Reduction Program.* Objectives are to reduce the possibility that LANL activities could produce wastewater discharges into the ecosystem.
- *Construction of a New High Explosives Wastewater Treatment Facility.* Objectives are to further improve outfall effluent quality by reducing the amount of water used in high explosives (HE) processing, eliminating non-HE industrial wastewater, preventing contamination of stormwater, and treating all HE-contaminated wastewater.
- *Completion of New Wastewater Treatment System at the TA–50 RWLTF.* Objective is to reduce radionuclide and nitrate concentrations in the treatment plant effluent.
- *Threatened and Endangered Species Habitat Management Plan.* Objectives are to identify the combined effects of many LANL projects on threatened, endangered, or sensitive species; provide long-range planning information for all future LANL projects; and develop long-range management measures to protect habitat for these species (see chapter 4, section 4.5.1.6).
- *Initiate Natural Resources Management Plan.* Objectives will be to determine conditions and to recommend management measures that will restore, sustain, and enhance the biological quality and ecosystem integrity at LANL within the context of a dynamic Pajarito Plateau ecosystem (see section 4.5.1.6).

In addition to these continuing actions and plans, studies are underway to make a more quantitative assessment of trophic level transport of radionuclides of interest. These assessments would refine measures being taken for protection of biological resources should any concerns arise.

These ongoing programs and planning actions would not only benefit resources on LANL but would contribute to a more regionalized management strategy, thereby improving the current fragmented and compartmentalized management by five or more agencies. A regionalized management strategy would significantly lessen the decline or loss of regional biological diversity resulting from anthropogenic disturbances (e.g., risk of catastrophic wildfire, erosion, elk overpopulation, and habitat loss and fragmentation). The roots of these environmental issues predate LANL, yet are common to (or sensitive to) all alternatives evaluated in the SWEIS. Their resolution is to be found through a philosophy of environmental stewardship, permanent interagency coordination, and development of a joint planning and management program.

The presence of LANL, with its highly restricted access and limited planned land disturbing activities, would continue to provide habitat and protection for a rich diversity of plants and animals, including an appreciable number of threatened, endangered, and other sensitive species. The presence of measures to protect threatened and endangered species (e.g., habitat protection, access and activity restrictions, and noise and light restrictions), combined with surveys and studies associated with the stated Threatened and Endangered Species Management Plan, would continue to protect and conserve these protected species.

Terrestrial and Wetland Habitat

Common to the No Action, Reduced Operations, and Greener Alternatives, is the absence of activities that would result in the loss of terrestrial habitat. Further, a reduction in the number of wetlands as a consequence of outfall reduction would reduce wetland habitat under all four SWEIS alternatives.

As demonstrated in Table 5.2.3.1–1 of section 5.2.3, Water Resources, there would be a reduction in the number of outfalls over the index period and an increase in the volume of effluent discharged by some remaining outfalls. This reduction includes many of the 27 outfalls proposed for closure and evaluated in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several others that have been closed as part of LANL's Outfall Reduction Program. While it is possible that not all 27 closures discussed under effluent reduction may be realized, this is the planned reduction, as reflected in the *Environmental Assessment for Effluent Reduction*. Thus, the elimination of 27 outfalls is used as the bounding case for the purposes of this SWEIS. The number of outfalls remains constant across all four alternatives.

The elimination of industrial effluent from up to 27 outfalls could result in a decrease of approximately 8.6 acres (3.5 hectares) of wetlands. Most of these are linear riparian wetlands that vary in size from 0.001 acre (0.0004 hectares) to 4.4 acres (1.8 hectares). Many wetlands associated with outfalls have other water sources that have contributed to the establishment and maintenance of the wetlands. Consequently, some outfalls would continue to have the same plant species in about the same proportions as they do now. Other outfall wetlands would experience a moderate amount of replacement of vegetation with species that require less water. Still, many would undergo a more pronounced change in character, with a high degree of replacement by other species requiring less water. The reduction would result in a localized die-off of aquatic invertebrates and possibly some small numbers of small mammals and amphibians with limited ranges. These species would be replaced with those characteristic of drier habitats. There would be very localized decrease in biodiversity. Cessation of some watering sources may cause some localized displacement of large- and medium-sized animals. However, because larger mammals can travel to other available water sources, daily and seasonal movement may only change slightly.

The possible loss of up to 8.6 acres (3.5 hectares) of wetlands associated with the elimination of industrial effluent from up to 27 outfalls, combined with about 5 acres (2 hectares) from past and planned LANL actions could result in the cumulative loss of about 13.6 acres (5.5 hectares). Because there are about 161 wetlands covering about 50 acres (20 hectares) within LANL boundaries, about 36.4 acres (14.7 hectares) or 73 percent of all wetlands would still remain available for wildlife use. The cumulative effect of these actions on large mammals, such as deer and elk, would be changes in animal distribution and patterns of movement. As industrial effluent from outfalls continues to be eliminated over the next 3 to 5 years, these large mammals would adapt and utilize other available water sources, both natural and human caused. Any measurable effects of a continuing reduction in outfalls could be a local reduction in elk density at LANL, but this would not likely alter the overall pattern of elk movement, use, and numbers in the Jemez Mountains.

An increase in the quantity of discharge from remaining outfalls under the No Action Alternative, specifically in Sandia and Los Alamos Canyons, is within historic fluctuations, which are governed by project types and operational levels. This increase would not be expected to significantly affect channel morphology nor associated biological features. An increase in flow holds the potential for the expansion of existing wetlands. However, because of the narrow canyon floors and steep canyon sides, this potential may be only marginal. There could be a small increase in opportunity for wildlife watering.

The biological and ecological consequences of a wildfire on LANL are potentially significant. LANL and surrounding lands are generally forested areas with high fuel loading. Although fire is a natural part of biological systems, anthropogenic influences such as grazing, logging, and fire suppression have produced conditions that can have pronouced adverse effects on forest ecosystems. Natural high-frequency, low-intensity fire regimes have been replaced with low-frequency, high-intensity fires that consume a higher percentage of vegetation. As reflected in other nearby areas that have experienced severe wildfires in the past (e.g., the Water Canyon, La Mesa, Dome, and Oso Complex fires), the potential for wildfires encroaching on LANL exists. Biological and ecological consequences of a severe wildfire involving LANL would result from loss of habitat soil erosion, sedimentation, and increased risk from contaminants. The loss of forest or woodland habitat would result in a temporary loss of habitat for a broad spectrum of animals. As vegetation is re-established, an altered community of animal species would follow, its composition changing with the evolution of the plant community. The pattern of burned vegetation will play a significant role in renewed wildlife use. Early plant communities of grasses and herbaceous growth can have a high biomass and species diversity, as exhibited by nearby areas affected by recent wildfires. This expansion of grass and herbaceous growth could provide additional forage for the large elk population in and around LANL and contribute to existing management concerns.

Impacts to threatened and endangered species (e.g., the Mexican spotted owl) from a wildfire would depend on several factors such as the burn pattern, the time of day that the burn occurs, the type of fire, topography, and if nesting is occurring. Threatened and endangered species have remained or returned to nearby areas that have experienced recent burns. Some species, such as the peregrine falcon, could benefit through improved foraging habitat. Perhaps the most significant impact to threatened and endangered species that could be precipitated by a wildfire is the general disturbance caused by the fire-fighting effort itself (e.g., fire-fighting crews, aircraft, and vehicular traffic).

Increased runoff resulting from the burning of vegetation cover would result in a commensurate increase in water channel scouring, enlargement, and headcutting. This process and any accompanying sedimentation would have the potential to degrade or remove the limited riparian vegetation on LANL. Wetlands associated with water courses could also be affected, and perhaps several would be removed for a period of time because of changes in channel morphology. With the degradation of riparian vegetation and wetlands would be an associated reduction or loss of habitat for a variety of invertebrates, small and large mammals, amphibians, reptiles, and a diversity of birds.

Any impact of legacy contaminants transported to downstream riverine and lake ecosystems is unknown, but there could potentially be an increase in ecological risk. A more extensive discussion of the biological effects of a wildfire at LANL can be found in volume III, appendix G, Accident Analysis.

Ecological Risk

As stated (in sections 5.2.2.3, 5.2.3.1, 5.2.4.1, and 5.2.4.2), ongoing operations under the No Action Alternative have little potential to contribute substantially to soil, water, and air contamination. Contaminants such as DU, beryllium, lead, copper, and others are produced at firing sites and are of potential concern for conveyance in sediments. However, the estimated soil concentrations from future air concentrations at the firing sites would be at orders of magnitude less than those in the average background or maximum legacy contamination. Also, as more remedial action projects are completed, the overall levels of soil and water contamination would be reduced.

Because of the absence of increased levels of contamination, there would not be an incremental change in ecological risk. There are no projected differences in firing site emissions among the No Action, Reduced Operations, and Greener Alternatives.

5.2.6 Human Health

The consequences of implementing the No Action Alternative on public health and worker health are presented below. The methodologies used to evaluate consequences are summarized in section 5.1.6 and detailed in appendix D, section D.2. Detailed discussions of the results are presented in appendix D, sections D.3 and D.4. There is a discussion of the terminology used in the human health evaluation presented in appendix D, section D.1. "Risk," as used in the Human Health Consequences section, refers to the probability of toxic or cancer mortality consequences under the specific exposure scenarios analyzed.

5.2.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the No Action Alternative are presented below. The evaluation is presented in four topics: (1) the consequences of external radiation and airborne radioactivity from LANL operations; (2) consequences of chemical emissions from LANL facilities; (3) consequences of ingestion of local foodstuffs, water, and incidental intake of soils and sediments to residents, to recreational users of the canyon lands on or near LANL, and to special receptors (traditional Native American and Hispanic life styles) and; (4) a summary of consequences to the public along transportation routes (summarized from the analyses in section 5.2.10). (Risks from accidents are discussed in section 5.2.1.1.)

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

As shown in section 5.2.4.2, the doses from airborne radioactive emissions from LANL were estimated to a 50-mile (80-kilometer) radius from LANSCE (the central point assumed for LANL emissions). Both facility-specific and site-wide doses were calculated (volume III, appendix B).

The location of the highest potential dose from all emissions, called the LANL MEI, was estimated to be 2,625 feet (approximately 800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose to the MEI at this location is estimated to be 3.11 millirem per year, which is 0.9 percent of the backgound dose (about 360 millirem per year). This location borders the Los Alamos townsite and is a conservative estimate for a MEI from LANL-wide emissions.

Table 5.2.6.1–1 summarizes the LANL MEI dose and presents the corresponding risk of excess LCF to the MEI. These risks are presented on a lifetime basis, assuming that the LANL MEI received the estimated dose of 3.11 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.0001 over a lifetime.

The isodose maps showing both the estimated dose near LANL and to a 50-mile (80-kilometer) radius of LANL are provided as Figures 5.2.4.2–1 and 5.2.4.2–2. The collective dose to the population that lives within the 50-mile (80-kilometer) radius is given in Table 5.2.6.1–1, estimated to be 13.6 person-rem per year of operation with an estimated lifetime excess LCF risk of about 0.0068 per year of operation. (As summarized in appendix D, the lifetime risk of dying from cancer in the U.S. is more than 23 percent for men and more than 20 percent for women. Based on this rate, approximately 40,000 people

TABLE 5.2.6.1–1.—*Estimated Public Health Consequences for LANL Maximally Exposed Individual and the Population Within 50-Mile (80-Kilometer) Radius of LANL for the No Action Alternative*

PARAMETER	LANL MEI	50-MILE RADIUS POPULATION
Dose	3.11 millirem per year	13.59 person-rem per year
Excess LCF	0.00011 per lifetime (72 year)	0.0068 per year of operation

within the 50-mile [80-kilometer] radius of LANL would be expected to die from cancer.)

A level of 1 millirem per year is a benchmark used as a screen for negligible individual consequences (NCRP 1993). In the No Action Alternative, there are six facilities with FS MEIs estimated to receive at least a 1 millirem per year dose, based on contributions from all facilities to these locations (volume III, appendix B):

- LANSCE, 3.11 millirem per year to the FS MEI
- HE Testing Sites (TA–15 and TA–36), 2.26 millirem
- Pajarito Site (TA–18), 1.73 millirem
- Radiochemistry Laboratory (TA–48), 1.66 millirem
- Plutonium Facility (TA–55), 1.66 millirem
- Tritium System Test Assembly (TSTA) and Tritium Science and Fabrication Facility (TSFF) (TA–21), 1.41 millirem

External Radiation: Two Special Cases

One contribution to public dose results from jogging or hiking the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA in Area F (LANL 1997d). The MEI dose is not expected to change from that currently estimated as an EDE of 2.9 millirem per year (chapter 4, section 4.6). For this MEI, the excess LCF risk over a lifetime from that dose would be about 1.4×10^{-6} per year of operation, assuming that the MEI exposure was equivalent to about 24, 4-hour days per year, a very conservative estimate.

Another contribution to public dose would result from TA–18 “road-open” operations (that is, undertaken at TA–18 for which roads are not closed). About four exposures per year would be expected for the MEI (who is assumed to be passing TA–18 on Pajarito Road at the time of maximum radiation flux during an experiment) out of the 100 operations per year at TA–18. The maximum dose to the MEI per operational event was estimated 4.75 millirem. Assuming that a maximum of four events would contribute to the MEI, the annual projected MEI EDE dose would be 19 millirem per year. This would result in a lifetime excess LCF risk of about 9.5×10^{-6} per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. It is extremely unlikely that a member of the public would be exposed to this source. However, the consequence of a 1-second exposure at the shortest distance a person could get to the transmitter was examined (volume III, appendix D, section D.2.2.2). The consequence to a person exposed at 1,640 feet (500 meters) is negligible, elevating body temperature approximately 0.04°F (0.02°C) and not affecting biochemical processes.

Consequences of Airborne Chemical Emissions

For the nonradiological (chemical) air quality analysis, a screening was conducted for each TA within LANL to identify potential chemical emissions under normal operations of the four alternatives that would need to be assessed for public health consequences. In the analysis of the Expanded Operations Alternative (which had the greatest emissions out of the four alternatives), four TAs involved in HE testing were identified (TA–14, TA–15, TA–26, and TA–39) for public health consequence analysis for three specific chemicals (beryllium, lead, and DU). While these operations result in emissions of other chemicals as well (aluminum, copper, iron, tantalum, and tungsten), the health effects of these other emissions were not analyzed in detail because their toxicity reference doses and estimated concentrations in air are relatively low. The emissions of the three chemicals analyzed were evaluated for potential human health effects under each of the SWEIS alternatives. (Sections 5.1.4 and 5.2.4, and appendix B, section B.2.3, include additional information regarding nonradiological air emissions screening and analysis.)

Hazard indices (HIs) were calculated for two of the three metals evaluated quantitatively (lead and uranium). An HI equal to or above 1 is considered consequential from a human toxicity standpoint. For the No Action Alternative, the worst-case HI for lead did not exceed one in a million (10^{-6}). For DU, the worst-case HI did not exceed 1 in 100,000 (10^{-5}).

Beryllium has no established EPA reference concentration for inhalation from which to calculate the HI. Beryllium was evaluated as a carcinogen, however. The excess LCF rate for beryllium under the No Action Alternative was estimated to be less than 3.6 x 10^{-7} per year; that is, none.

Carcinogenic Risk from Air Emissions

The screening process described in volume III, appendix B, identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs (appendix B, attachment 6).

This was found to be less than 1 in 1 million for the No Action Alternative because projected emissions for this alternative are far less than those analyzed for the Expanded Operations Alternative (which was only slightly above the screening GV of 1 x 10^{-6}). Thus, it is expected that a negligible increase in incremental combined cancer risk will result from the No Action Alternative.

Consequences of Ingestion to Residents, Recreational Users, and Special Pathways Receptors

The risk to public health from ingestion of water, foodstuffs, and from incidental ingestion of soils and sediments was estimated from environmental surveillance data within and surrounding LANL. The risk of toxicity and carcinogenicity will continue to be dominated by existing concentrations of radionuclides and chemicals in environmental media due to naturally occurring materials, fallout and other anthropogenic sources affecting the region, and historical operations (including emissions/ effluents, and accidental spills and releases). In addition, the potential for short-term exposures to contaminated sites at LANL, identified in the LANL ER Project, was evaluated using the ER database from LANL (appendix D, section D.3.5, Tables D.3.5–5 and D.3.5–6).

The consequences of ingestion were estimated for hypothetical individuals based on five exposure scenarios (as discussed in 5.1.6). The consequences estimated are based on

95th percentile values of detected analytes for the periods of environmental surveillance data sets available for the 1990's. The estimates were also made using the worst-case (95th percentile) uptake rates for the specific food components.

The LANL-wide maximum hypothetical risk from ingestion is the non-Los Alamos County resident who is also a resident recreational user of LANL lands and is also subject to the exposures in the special pathways analyzed. This composite hypothetical risk was used to represent the LANL-wide MEI dose from ingestion because it contains the maximum number of potential pathways for ingestion risk.

Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6×10^{-6} per year of exposure and 9.1×10^{-7} per year of exposure for the individual who is also an avid recreational user. The worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in appendix D, section D.3.3.

Estimates were made of the potential risk from metals exposure to public health using environmental surveillance data in the mid 1990's monitoring of metals in groundwater, surface water, soils and sediments, vegetables, fruit (Los Alamos County only) and fish (appendix D, section D.3.3 and associated tables). Table 5.2.6.1–4 identifies HI values of 1 for any of the MEIs, and excess LCF risks exceeding 10^{-6} to these MEIs via ingestion pathways.

Arsenic was identified as having an HI greater than 1 in groundwater within the water supplies of Los Alamos County and San Ildefonso Pueblo. Excess LCF risks are elevated also (Table 5.2.6.1–4). Elevated excess LCF risk from arsenic was estimated for worst-case consumption of incidental soils, sediments, surface water, and NPDES discharges by some residents and recreational users of LANL. While the risk associated with arsenic ingestion is greater than 10^{-6} per year in many pathways, the arsenic is not associated with LANL discharges. Arsenic is endemically present in the geology and soils and groundwaters and surface waters of the region in which New Mexico is located (volume III, appendix D, section D.3.4).

Beryllium has no HI for ingestion exceeding 1. However, the excess LCF rate estimated from worst-case ingestion of waters and soils is elevated (Table 5.2.6.1–4). While the risk associated with beryllium ingestion is greater than 10^{-6} in several pathways, the beryllium concentrations in waters, soils, and sediments are typical of those in background in the northern New Mexico region. Based on the environmental surveillance data from LANL, the portion of beryllium associated with LANL operations is not a significant contributor to

TABLE 5.2.6.1–2.—*Average Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f]

EXPOSURE PATHWAY	RECEPTOR[a]									
	OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NONRESIDENT RECREATIONAL USER[b]		RESIDENT RECREATIONAL USER[b]		SPECIAL PATHWAYS RECEPTORS[c]	
	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr
Produce										
• Fruit	0.00064	3.2×10^{-7}	0.00046	2.3×10^{-7}	--	--	--	--	--	--
• Vegetables	0.00098	4.9×10^{-7}	0.0013	6.7×10^{-7}						
Meat (Cattle: Free Ranging Steer)	--	--	0.00027	1.4×10^{-7}	--	--	--	--	--	--
Milk	0.000073	3.7×10^{-8}	0.00005	2.5×10^{-8}	--	--	--	--	--	--
Fish	--	--	0.000054	2.7×10^{-8}	--	--	--	--	0.00019	9.4×10^{-8}
Honey	7.4×10^{-7}	3.7×10^{-10}	1.3×10^{-8}	6.3×10^{-12}	--	--	--	--	--	--
Elk	0.000077[d]	3.9×10^{-8}	0.00005[d]	2.6×10^{-8}	--	--	--	--	0.000034[e]	1.7×10^{-8}
Deer	0.000018	9.0×10^{-9}	0.00038	1.9×10^{-7}	--	--	--	--	--	--
Pinyon Nuts	--	--	0.000016	7.7×10^{-9}	--	--	--	--	0.00013	6.5×10^{-8}
Indian Tea (Cota)	--	--	--	--	--	--	--	--	0.00075	3.8×10^{-7}
Groundwater	0.0014	7.2×10^{-7}	0.0042	2.1×10^{-6}	--	--	--	--	--	--
Surface Water										
• Creeks	--	--	--	--	0.00017	8.6×10^{-8}	0.00046	2.3×10^{-7}	--	--
• NPDES Discharge					0.000022	1.1×10^{-8}	0.000059	3.0×10^{-8}		
Soils	0.000078	3.9×10^{-8}	0.000078	3.9×10^{-8}	1.2×10^{-6}	5.9×10^{-10}	3.1×10^{-6}	1.6×10^{-9}	--	--
Sediments	0.00065	3.3×10^{-7}	0.00065	3.3×10^{-7}	0.000016	8.3×10^{-9}	0.000044	2.2×10^{-8}	--	--
Sum Ingestion Dose/Risk	0.0039	2.0×10^{-6}	0.0075	3.8×10^{-6}	0.00021	1.0×10^{-7}	0.00057	2.8×10^{-7}		

TABLE 5.2.6.1–2.—*Average Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f] -Continued

[a] Receptor is a hypothetical person who has an average (50^{th} percentile) intake of the 95^{th} UCL concentration in every medium.
[b] The nonresident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 12 visits per year for 6 hours per visit. The resident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 24 visits per year of 8 hours per visit.
[c] Special pathways receptors are those with traditional Native American or Hispanic lifestyles. See text.
[d] Elk muscle.
[e] Elk heart and liver.
[f] Because almost all public ingestion is from naturally occurring radionuclides, weapons testing fallout, and contamination from past operations, the ingestion dose is not affected by the alternatives. See section 5.1.6.

TABLE 5.2.6.1–3.—*Worst-Case Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives* [f]

EXPOSURE PATHWAY	RECEPTOR[a]									
	OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NONRESIDENT RECREATIONAL USER[b]		RESIDENT RECREATIONAL USER[b]		SPECIAL PATHWAYS RECEPTORS[c]	
	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr	DOSE (rem/yr)	EXCESS LCF/yr
Produce • Fruit • Vegetables	0.0026 0.0027	1.3×10^{-6} 1.3×10^{-6}	0.0016 0.004	8.2×10^{-7} 2.0×10^{-6}	--	--	--	--	--	--
Meat (Cattle: Free Ranging Steer)	--	--	0.00067	3.4×10^{-7}	--	--	--	--	--	--
Milk	0.0002	9.8×10^{-8}	0.00014	6.8×10^{-8}	--	--	--	--	--	--
Fish	--	--	0.00017	8.5×10^{-8}	--	--	--	--	0.00046	2.3×10^{-7}
Honey	2.6×10^{-6}	1.3×10^{-9}	4.5×10^{-8}	2.2×10^{-11}	--	--	--	--	--	--
Elk	0.00019[d]	9.4×10^{-8}	0.00013[d]	6.4×10^{-8}	--	--	--	--	0.000034[e]	1.7×10^{-8}
Deer	0.000044	2.2×10^{-8}	0.00091	4.5×10^{-7}	--	--	--	--	--	--
Pinyon Nuts	--	--	0.000016	7.7×10^{-9}	--	--	--	--	0.00013	6.5×10^{-8}
Indian Tea (Cota)	--	--	--	--	--	--	--	--	0.0026	1.3×10^{-6}
Groundwater	0.0023	1.2×10^{-6}	0.0067	3.4×10^{-6}	--	--	--	--	--	--
Surface Water • Creeks • NPDES Discharge	--	--	--	--	0.00028 0.000036	1.4×10^{-7} 1.8×10^{-8}	0.00074 0.000096	3.7×10^{-7} 4.8×10^{-8}	--	--
Soils	0.00031	1.6×10^{-7}	0.00031	1.6×10^{-7}	4.7×10^{-6}	2.4×10^{-9}	0.000012	6.3×10^{-9}	--	--
Sediments	0.0026	1.3×10^{-6}	0.0026	1.3×10^{-6}	0.000066	3.3×10^{-8}	0.00018	8.8×10^{-8}	--	--
Sum Ingestion Dose/Risk	0.011	5.5×10^{-6}	0.017	8.6×10^{-6}	0.00039	1.9×10^{-7}	0.0010	5.1×10^{-7}		

TABLE 5.2.6.1–3.—*Worst-Case Public Radiological Dose and Potential Consequences by Ingestion Pathways, All Alternatives*[f] -Continued

[a] Receptor is a hypothetical person who has a worst-case (95^{th} percentile) intake of the 95^{th} UCL concentration in every medium.
[b] The nonresident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 12 visits per year for about 6 hours per visit. The resident recreational user lives in Los Alamos County or a neighboring county, and is in the Los Alamos canyons 24 visits per year of 8 hours per visit.
[c] Special pathways receptors are those with traditional Native American or Hispanic lifestyles. See text.
[d] Elk muscle.
[e] Elk heart and liver.
[f] Because almost all public ingestion is from naturally occurring radionuclides, weapons testing fallout, and contamination from past operations, the ingestion dose is not affected by the alternatives. See section 5.1.6.

TABLE 5.2.6.1–4.—*Metals Exposure and Risk via Ingestion Pathways and Hypothetical Receptors Used to Evaluate Potential Public Health Consequence, All Alternatives*

EXPOSURE PATHWAY		RECEPTOR									
		OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NON-RESIDENT RECREATIONAL USER		RESIDENT RECREATIONAL USER		SPECIAL PATHWAYS RECEPTORS[c]	
	CHEMICAL	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr
Produce											
• Fruit[a]	Arsenic	< 1	0.000084	NA	NA	NA	NA	NA	NA	NA[c]	NA[c]
	Beryllium	< 1	0.00014								
	Lead	1.5	b								
• Vegetables	Arsenic	2.2	0.00099								
	Beryllium	< 1	0.00023								
	Lead	18	b								
Fish	Arsenic			< 1	0.00033					3.2	0.0014
	Beryllium	NA	NA	< 1	0.0002	NA	NA	NA	NA	< 1	0.013
	Lead			< 1	b					6.8	b
	Cadmium			< 1	< 10^{-6}					1.4	1.3×10^{-6}
Groundwater	Arsenic	4.5	0.002	2.5	0. 0011	NA		NA		NA[c]	
	Beryllium	< 1	0.00036	< 1	0.003						
Surface Water	Arsenic	NA	NA	NA	NA	< 1	1.9×10^{-6}	< 1	5.0×10^{-6}	NA[c]	NA[c]
	Beryllium					< 1	0.000045	< 1	0.00012		
NPDES Discharge	Arsenic					< 1	4.8×10^{-6}	< 1	0.000013		
Soils	Arsenic	< 1	0.000033	< 1	0.000033	< 1	< 10^{-6}	< 1	< 10^{-6}	NA[c]	NA[c]
	Beryllium	< 1	0.000024	< 1	0.000024	< 1	< 10^{-6}	< 1	< 10^{-6}		

TABLE 5.2.6.1–4.—*Metals Exposure and Risk via Ingestion Pathways and Hypothetical Receptors Used to Evaluate Potential Public Health Consequence, All Alternatives*-Continued

EXPOSURE PATHWAY		RECEPTOR									
		OFF-SITE RESIDENT LOS ALAMOS COUNTY		OFF-SITE RESIDENT NON-LOS ALAMOS COUNTY		NON-RESIDENT RECREATIONAL USER		RESIDENT RECREATIONAL USER		SPECIAL PATHWAYS RECEPTORS[c]	
	CHEMICAL	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr	HI*	EXCESS LCF/yr
Sediments	Arsenic	< 1	0.00013	< 1	0.00013	< 1	$< 10^{-6}$	< 1	$< 10^{-6}$	NA[c]	NA[c]
	Beryllium	< 1	0.000026	< 1	0.000026	< 1	$< 10^{-6}$	< 1	1.2×10^{-6}		

[a] No data were available on regional metals concentrations in store bought fruit. Metals data are provided for homegrown fruit in Los Alamos County only. There were data for fruits raised within the LANL reservation, although there are no receptors affected because these fruits are not used as food sources.

[b] Lead is considered a potential human carcinogen but no slope factor has been established by EPA to estimate carcinogenic risk because there are so few data supporting its development. Many studies indicate a link between lead uptake in children and elevated blood lead levels in children associated with learning disabilities and other physiological impacts. The estimate of HI presented here was made for a standard adult male (approximately 71.8 kilograms).

[c] Special pathways receptors are those who have additional risk because of traditional Native American or Hispanic lifestyles. There are no receptors for pinto beans, sweet corn, and zucchini grown in an environmental restoration study site in Los Alamos County.

NA = Not applicable

beryllium concentrations in the immediate area of LANL (appendix D, section D.3.4).

Dose from Ingestion of Water from Supply Wells

The radiation doses from ingestion of water from supply wells for off-site Los Alamos County residents (Table D.3.3–1) and San Ildefonso (Table D.3.3–5) run from about 1 to 7 millirem per year, mostly due to naturally occurring uranium. (The concentrations used in these analyses include contribution from background.)

Consequences to the Public Along Transportation Routes

Section 5.2.10 details the analysis of transportation consequences. Public health consequences include the dose and excess LCF risk associated with routine, accident-free transportation. Table 5.2.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments throughout the U.S. The population dose and excess LCF associated with exposures occurring during stops for transportation segments near LANL are provided in Table 5.2.6.1–5. Doses associated with living along and sharing routes with these shipments are detailed in Table 5.2.10–2, and are less than those associated with stops. Risks associated with accidents during transportation are also discussed in section 5.2.10.

5.2.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological (ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the No Action Alternative are given below and detailed in appendix D, section D.2.2.

TABLE 5.2.6.1–5.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials from LANL*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	3.2	0.0016
U.S. 84/285	3.3	0.0016

Radiological Consequences

Ionizing Radiation Consequences. Table 5.2.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the No Action Alternative for continued operations of LANL.

The collective worker dose under the No Action Alternative is conservatively projected to be approximately twice that measured in 1993 to 1995. In terms of the average non-zero dose to an individual worker, the No Action Alternative is conservatively projected to result in 0.14 rem per year, as compared with 0.097 rem per year, 1993 to 1995 (chapter 4, section 4.6.2.2). The estimated excess LCF risk over a lifetime is 0.000054 per year of operation.

Nonionizing Radiation Consequences. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (See volume III, appendix D, section D.2.2.2 for methodology used to estimate nonionizing radiation from LANL operations to humans and wildlife and for the estimated results.)

TABLE 5.2.6.2–1.—*Worker Ionizing Radiation Annual Doses and Associated Lifetime Excess LCF Risks Under the No Action Alternative*

LANL Collective Worker Dose (person-rem per year)	446
Estimated Excess LCF Risk (across the worker population) per year of operation	0.18
Average Non-Zero Worker Dose (rem per year)	0.14
Estimated Excess LCF Risk (average worker > 0 dose)	0.000054

Chemical Exposure Consequences

There have been no chemical exposures resulting in hospitalization or extended medical care at LANL in the 1990's (section 4.6.2.1). This section examines the occasional reportable, but minor, chemical exposure likely during normal operations at LANL. Because beryllium operations in support of DOE missions are being concentrated at LANL, the consequences to workers are discussed as a special case below.

It is anticipated that there will continue to be a few chemical exposures annually, such as to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

Based on the performance for the index period (1990 to 1996), there would be expected to be a reportable chemical exposures of one to three incidents per year at LANL, using the current worker population of approximately 9,000 individuals.

Under the No Action Alternative, it is expected that there will be a worker population of approximately 10,000 individuals, approximately 10 percent higher than index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the Chemical Hygiene Program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures from continued operations would continue at a rate of one to three injuries per year over the next 10 years.

Beryllium Processing Consequences. Beryllium exposure of workers is a potential risk of operating the Beryllium Technology Center (BTC), Building 3-141, in the Sigma Complex. Other uses of beryllium at LANL are metals applications and present little risk. The worker risks associated with HE testing applications of beryllium at LANL are the same as that for the public MEI and are presented in section 5.2.6.1 above. There is additional risk at BTC because of powders processing. This risk is primarily from aerosol and small particulate inhalation (chapter 4, section 4.6). The BTC is configured as a clean facility; that is, it has the appearance and characteristics of a surgical theater. The consequences to the workers are minimized by multiple and redundant engineering controls, and workers are monitored though LANL's Industrial Hygiene (IH) Program. The engineering controls include: (1) flexible and robust heating, ventilation, and air conditioning (HVAC) systems supporting a variety of processing enclosures that capture aerosols and particulates at their point of generation in the process; (2) physical separation of higher hazard operations; (3) in-BTC IH monitoring laboratory allowing immediate detection of potential exposures to aerosols and particulates; (4) access limited to beryllium workers only;

and (5) waste minimization and contamination control via use of in-facility laundry and facility-wide filtration systems. It is not anticipated that consequences to workers would be measurable; that is, no sensitization to beryllium would be detected using the LANL IH monitoring program.

Physical Safety Hazards

Table 5.2.6.2–2 compares the projected reportable cases of accidents and injuries estimated to occur during normal operations (including from building modifications, maintenance and construction) for the No Action Alternative and that experienced during the index period. The No Action Alternative is expected to result in an increase in reportable accidents and injuries proportional to increases in worker population. These incidents are considered to be normal consequences of normal operations of LANL. These estimates of accident rate conservatively assume that the aggressive Health and Safety Program underway at LANL does not achieve any reduction in the accidents and injuries rate.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset, and subsequent physical therapy. Some injuries may also result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock.

TABLE 5.2.6.2–2.—*Projected Annual Reportable Worker Accidents and Injuries for Normal Operations in the No Action Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 10,000
Projected Reportable Accidents and Injuries	460/year
Change from Index (1993 to 1996)	+ 10%

5.2.7 Environmental Justice

As indicated in sections 5.2.1 and 5.2.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the No Action Alternative. Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface water, groundwater, and ecological resources associated with the No Action Alternative would affect all communities in the area equally (see sections 5.2.3 and 5.2.5 for additional information on the potential for impacts to these resources). Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Contaminants in air emissions decrease in concentration (and thus in impact) with distance from LANL. This is illustrated in Figure 5.2.7–1, which projects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL. Similarly, the concentrations of chemical contaminants from air emissions at LANL decrease as the distance from LANL increases. Thus, impacts due to air emissions are equal to or lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts do not disproportionately impact the minority or low-income populations. (See section 5.2.4

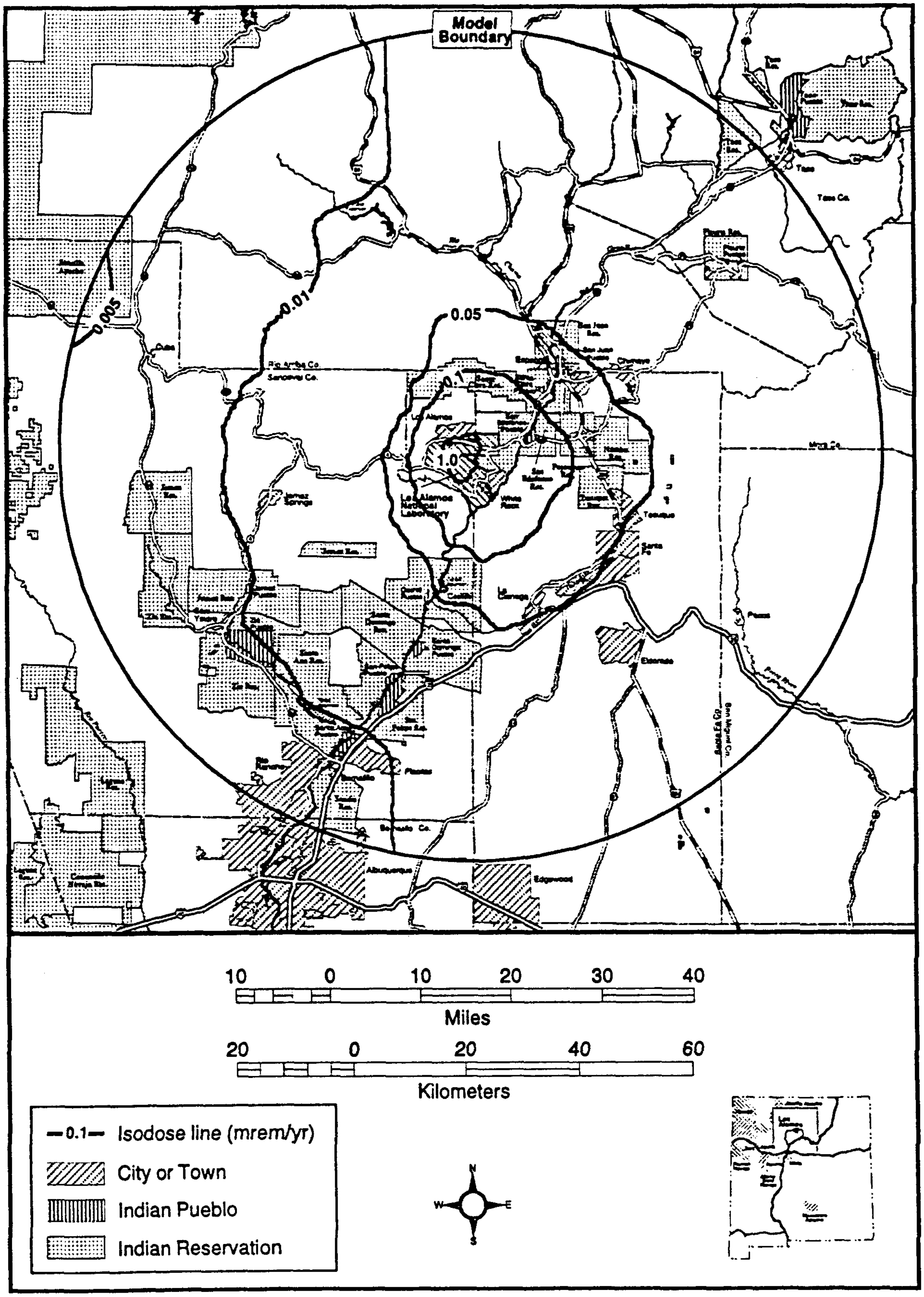


FIGURE 5.2.7–1.—*Isodose Lines from Airborne Releases for the No Action Alternative Within 50 Miles (80 Kilometers) of LANL.*

regarding the impacts anticipated for air emissions under the No Action Alternative.)

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.2.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the No Action Alternative. The human health analysis also includes an analysis of exposures through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce, absorption of contaminants in sediments through the skin, and inhalation of plant materials. The special pathways have the potential to be important to the environmental justice analysis, because some of these pathways may be more important or viable for the traditional or cultural practices of minority populations in the area. However, human health effects associated with these special pathways would not present disproportionately high or adverse impacts under the No Action Alternative.

As shown in section 5.2.10, impacts to public health from transportation on the site and from LANL to U.S. 84/285 are estimated to be 0.0016 excess LCFs per year from incident-free transportation and 0.040 deaths or injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment on U.S. 84/285 to I–25) are estimated to be 0.0016 excess LCFs per year from incident-free transportation and 0.090 deaths or injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to a member of the general public or to a member of a minority or low-income population due to transportation in the vicinity of LANL.

5.2.8 Cultural Resources

Impacts to prehistoric resources, historic resources, and TCPs are summarized in Table 5.2.8–1 and are discussed below. A brief statement regarding impacts to spiritual aspects follows these discussions. Common to all alternatives, coordination would be accomplished with the SHPO in compliance with Section 106 of the *National Historic Preservation Act* for any individual undertakings.

5.2.8.1 *Prehistoric Resources*

Impacts to prehistoric resources could potentially result from three general sources: shrapnel (material fragments) and vibration caused by high explosives testing at 13 existing firing sites, release of hazardous material (nonradioactive), and release of radioactive material.

Shrapnel and vibration from high explosives testing at 13 firing sites could potentially affect three types of prehistoric sites: cavate (cave) pueblos, rock shelters, and overhangs. Freestanding prehistoric (or pueblo) walls are not typically found on LANL; rather, LANL resources include a number of stable mounds of varying heights that were formed by collapsed walls and earth. Much of the material released by explosive tests is either aerosolized or reduced to millimeter size, dust-like particles upon detonation. However, some larger fragments are also released. Studies of hydrodynamic tests at Los Alamos have shown that fragments produced from explosive tests are released according to a well known fragmentation distribution. Based on fragmentation distributions for a series of computer studies of the breakup of various weapons systems during hydrodynamic tests (tests of mock-up nuclear packages during which high explosives are detonated) with different quantities of high explosives (up to 500 pounds of explosives), almost all particles

TABLE 5.2.8–1.—*Projected Impacts to Prehistoric Resources, Historic Resources, and TCPs Under the No Action Alternative*

ACTION TYPE	PUEBLO STRUCTURES	ERODED PUEBLOS/ RUBBLE/ ARTIFACT SCATTER	CAVATE PUEBLOS/ ROCK ART/ SHELTERS/ OVERHANGS	TRAILS/ STEPS/ STONE ARRANGE -MENTS	U.S. TERRITORIAL HOMESTEAD SITES	NUCLEAR ENERGY ERA (1943 TO 1989) BUILDINGS, DISTRICTS, AND SITES)	TRADITIONAL CULTURAL PROPERTIES (TCP)				
							CEREMONIAL AND ARCHAEOLOGICAL SITES	NATURAL FEATURES	ETHNOBOTANICAL GATHERING SITES	ARTISAN MATERIALS GATHERING SITES	SUBSISTENCE FEATURES
New Construction (buildings, facilities, etc.)	Negligible (construction is within existing buildings)										
Modifications in Facility Layout (roads, parking lots, pits)	Negligible (policy and procedures in place to avoid or minimize impacts)										
Modification of Existing Buildings (changing building function)	Negligible (policy and procedures in place to avoid or minimize impacts)					Negligible (policy and procedures in place to avoid or minimize impacts) for facilities continuing to operate. Potential for neglect for any facilities/operations that are discontinued.	Negligible (policy and procedures in place to avoid or minimize impacts).				
Change in Hydrology (surface and groundwater quality and quantity; erosion and siltation rates)	None						Traditional communities have indicated that water quality degradation produces adverse impacts: damage, introduction of elements out of character with the setting, and isolation of TCPs. Assessment of impacts to site specific TCPs is not possible because their locations and nature are not known.				
Explosives Impacts (shrapnel scatter)	Negligible (no resources sensitive to these impacts are located near enough to be impacted).		Minor effect—more quantitative study required to refine impacts.		None		Adverse impacts may be produced from destruction of or damage to the TCP, introduction of elements out of character with the setting, and/or isolation of sites within or near firing site hazard zones. Assessment of impacts to site specific TCPs is not possible because their specific locations and nature are not known.				
Explosives Impacts (vibration)	None		Potential for low level of impact.		None		Potential for disturbance. Assessment of impacts to site specific TCPs is not possible because their specific locations and nature are not known.		None		
Explosives (noise)	None						Explosives noise at any TCP may be considered as adverse due to the introduction of elements out of character with the setting of the TCP.				
Hazardous Material (non-radiological)	Legacy contaminants present the greatest concern. There is insufficient data available to evaluate this impact or to assess the additive effects of ongoing operations. However, contamination due to ongoing operations is projected to be small compared to legacy contamination and the background concentrations of hazardous materials in the area.					Potential for future operations to add contaminants that may limit preservation options.	All forms of hazardous materials near TCPs are considered by traditional communities as adverse impacts, producing damage, alteration, introduction, and isolation. Assessment of impacts to site specific TCPs is not possible because their specific locations and nature are not known.				
Radiation Hazards	Legacy contaminants present the greatest concern. There is insufficient data available to evaluate this impact or to assess the additive effects of ongoing operations. However, contamination due to ongoing operations is projected to be small compared to legacy contamination and the background concentrations of hazardous materials in the area.					Potential for future operations to add contaminants that may limit preservation options.	Traditional communities have stated that radioactive contamination of TCPs produces adverse impacts due to destruction, alternation, introduction of elements out of character with the TCP, and isolation. Assessment of impacts to site-specific TCPs is not possible because their specific locations and nature are not known.				
Security (fencing, lighting, monitoring)	Continued security at LANL will restrict access by the general public, and in essence, provide protection to these resources.						Continued restricted access by traditional communities to TCPs within security areas. Security measures also restrict access to these resources by other members of the public, and thus provide some measure of protection to TCPs.				

fall within 800 feet (244 meters) of the firing site and no particles are observed outside of 1,200 feet (366 meters).

Of the identified 23 cavate pueblos, rock shelters, and overhangs within the 1,200-foot (366-meter) radius of the firing sites, eight are within the 800-foot (244-meter) radius and 15 are within the 800- to 1,200-foot (244- to 366-meter) radius. Probability calculations that a fragment of firing debris would fall within 1 square foot (0.9 square meter) placed at the center of each archeological site indicate a likelihood of 0.07 or 7 in one hundred at 100 feet (30 meters), 0.000005 or 5 in 1 million at 800 feet (244 meters), and 0.0000002 or 2 in 10 million at 1,200 feet (366 meters). The influence of topographical variations and vegetation that may shield sites is not considered in these probabilities.

Physical impacts to cultural resources at firing sites from either explosion-generated fragments or vibration have not been well studied. However, the findings of October 1997 field observations of eight cultural resource (cavate/rock shelter/overhang) sites located within an 800-foot (244-meter) radius of active firing sites did not reveal any visible effects that could be attributable to fragments or vibration caused by past and current firing site activities (LANL 1997b). Based on these qualitative observations, the probability for cultural sites to be affected by firing site activities is low.

Studies of firing site generated ground vibrations conducted at LANL demonstrated that explosive amounts as high as 500 pounds would not induce vibrations that would affect structures at BNM. Any impacts caused by higher amounts of explosives is not known and would require further analysis.

Accumulated hazardous and radioactive materials at firing sites, contiguous areas, and any additive amounts resulting from No Action operational levels have the potential to limit access to archeological sites for future study. The extent of this potential is not known because of the scarcity of data. However, no instances of restricted access because of health-threatening levels of hazardous or radioactive materials are known to date. In addition, LANL's environmental monitoring and soil survey program has not identified firing sites as restricted to access because of any accumulated hazardous or radioactive materials. Additional data are needed for future studies regarding the preservation of prehistoric resources because isolating a site from access for future study would be an adverse impact.

Security levels would be maintained under the No Action Alternative. Security levels (and, thus, levels of protection for cultural resources) vary depending on the types of activities at a particular location. Surveillance of public access roads within LANL has been effective in protecting prehistoric resources, and archaeological sites within limited public access areas have been fenced or gated to prevent vandalism.

5.2.8.2 *Historic Resources*

Impacts to historic resources could potentially result as a consequence of additional contributions of hazardous and radioactive materials to what is currently present in some Nuclear Energy Period (1943 to 1989) buildings. Some contamination does exist in several buildings, a feature that was inherent in their past function and handling techniques. Investigations are currently ongoing to determine the extent of contamination and relationship to National Register of Historic Places (NRHP) eligibility. In cases where buildings have been demolished, mitigation measures (e.g., photographing, recording, and documenting of the property) have been accomplished in coordination with the SHPO. While the rules for implementing the *National Historic Preservation Act* (16 U.S.C. §470) do not preclude a site from being eligible for or listed on the NRHP because of contamination, additional contamination could potentially exceed some threshold level that would impede or slow down the process of evaluating the site for eligibility. However, numerous safeguards (e.g., strict hazardous materials handling and disposal procedures) are currently employed that minimize or preclude contamination. Therefore, the likelihood that additional contamination would significantly impact current levels of contaminants is considered negligible.

Many historic structures, particularly Nuclear Energy Period buildings, are not being actively utilized and, consequently, are not being actively maintained.

5.2.8.3 *Traditional Cultural Properties*

The Pajarito Plateau contains a high density of cultural resources and active traditional sites. These resources are significant to numerous Native American tribes and Hispanic groups, and represent areas of spiritual importance and traditional use. Many of these cultural sites are archaeological remains that are affiliated with several contemporary Native American tribes who consider them TCPs. Other tangible and intangible cultural resources in the LANL area contain no archaeological remains, but still retain cultural significance because of their use in traditional beliefs and practices. Overall, the traditional groups consulted considered all archaeological sites, human burials, shrines, rivers and water sources, trails, plants, animals, and minerals to be TCPs because these resources are integral to their traditional and cultural lifestyles.

Actions that may be perceived as impacting TCPs both on and adjacent to LANL consist of changes in hydrology features (surface and groundwater quality and quantity, erosion and siltation rates), explosives impacts (shrapnel, vibration, and noise), hazardous materials (nonradioactive), radiation hazards, and security features. Changes in hydrology features are viewed as adverse, damaging or altering features, and introducing elements that are out of character with the setting. Impacts resulting from explosives testing, presence of hazardous materials, and radiation hazards are viewed in much the same way—having the potential for damaging or altering features, introducing elements out of character with the setting, and limiting access to areas for conducting traditional or ceremonial activities. Security measures are viewed as limiting access to areas for conducting traditional or ceremonial activities; however, these same security measures may protect these TCPs from vandalism or other damage.

A detailed assessment of impacts to TCPs (other than archeological sites) is not possible because site-specific locations are not known. However, a continuation of activities at the No Action Alternative level is not anticipated to alter existing conditions and procedures are present that permit some limited access to restricted areas.

Spiritual Entities

The effect(s) that the continued presence and operation of LANL may have on any “unseen” or “spiritual” entities is unknown. The very esoteric nature of this issue precludes an assessment that would adequately reflect individual beliefs or faith.

5.2.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, infrastructure, and waste generation impacts of activities at LANL under the No Action Alternative.

5.2.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts to employment, salaries, and population are presented in Table 5.2.9.1–1 for the LANL workforce only. The secondary (indirect) impacts and the total population changes projected are presented in Table 5.2.9.1–2 for the Tri-County area. For the purposes of the SWEIS, it is assumed that these changes take place within a year of the ROD for the SWEIS.

Housing

The population changes anticipated in the Tri-County area, reflected in Table 5.2.9.1–2, are projected to result in demand for 559 additional (new) housing units. The distribution of this demand in the three counties is projected to be: 130 additional units in Los Alamos County; 201 additional units in Rio Arriba County; and 228 additional units in Santa Fe County.

In Los Alamos County, the projected housing demand can be accommodated from absorption of apartment vacancies and the inventory of houses for sale and new construction. Beyond 130 units, no new housing units can be anticipated because of the absence of buildable land in private ownership. This constraint upon supply would be expected to exert an upward pressure on rents and house prices.

The projected housing demand in Rio Arriba and Santa Fe Counties can be accommodated without significant pressure on rents and house sales prices. Both counties possess a sufficient inventory of finished lots and parcels, have access to adequate mortgage capital, and have sufficient entrepreneurial developer talent to absorb the demand.

Construction

Table 5.2.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. Construction activities associated with this alternative are expected to draw workers already present in the Tri-County area who historically have worked from job to job in the region. Thus, this employment is not expected to influence socioeconomic factors.

Local Government Finance

Under this alternative, the Tri-County annual gross receipts tax yields would be expected to increase by $1.2 million. This increase would be matched by increases in service levels adequate to meet public demand.

Services

Annual school enrollment in the Tri-County area would increase by 227 students. Additional annual funding assistance of about $910,000 from the State of New Mexico would be required for school operations because of these enrollment increases.

In Los Alamos, the school district can absorb the anticipated new enrollment levels. This school district has excess capacity because of its discretionary policy of accepting out-of-district students who are the children of LANL employees and subcontractors. In Rio Arriba County and the cities of Española and Santa Fe, adequate classroom capacity exists because of recent school construction projects.

The demand for police, fire, and other municipal services would be expected to increase in proportion to the increase in gross receipts tax yields, as discussed above. However, any changes in local government services tend to be inelastic in the short-term and typically are responsive only after the completion of at least one full budget cycle.

TABLE 5.2.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the No Action Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,995	2,090	2,032	9,117	664	9,781	196	9,977
Difference[c]	160	171	195	526	56	582	20	602 (+ 6%)
Salaries ($M)	264.2	52	85.4	401.6	19	420.7	10.1	430.8
Difference[c]	9.6	7	11.1	27.7	2.7	30.4	1.5	31.9 (+8%)
Procurement ($M)	217.1	1.7	21	239.8	123.8	363.6	236.7	600.2
Difference[c]	1.4	0.0	0.3	1.7	1.4	3.1	5	8.1 (+ 1%)

[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc.; Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to fiscal year 1996. Percent difference is shown in parentheses in the far right (TOTAL) column.

TABLE 5.2.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the No Action Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	526	899	1,425	421	270	691	1,337 (+ 1%)
Personal Incomes	$27 million	$26 million	$53 million (< +1%)				
Annual Business Activity	$2 million	$4 million	$6 million (< +1%)				

Note: Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total personal income change, and total annual business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935.

TABLE 5.2.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the No Action Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT $M	LABOR $M	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	208	50	1,426
2000	219	53	1,502
2001	210	50	1,440
2002	120	29	823
2003	91	22	624
2004	90	22	617
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Sources: DOC 1996, PC 1997a, and PC 1997b

5.2.9.2 *Infrastructure Impacts*

Annual electricity use projected under the No Action Alternative is a total of 717 gigawatt-hours, 372 gigawatt-hours for LANSCE, and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 108 megawatts, 58 megawatts for LANSCE and 50 megawatts for the rest of LANL[1]. The supply of electricity to the Los Alamos area (which includes LANL, the communities of Los Alamos and White Rock, and BNM) is provided by two 115 kilovolt transmission lines (contractually limited to 72 megawatts during winter months when El Vado and Abiquiu hydroelectric output is negligible, and to about 94 megawatts during the spring and early summer months) and supplemented by the LANL steam/power plant at TA–3 (with an operating capacity of about 12 megawatts in the summer and about 15 megawatts in the winter) (DOE 1997). The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected peak electrical demand for LANL operations under this alternative; thus, periods of brown-outs are anticipated unless measures are taken to increase the supply of electricity to the area. (See sections 1.6.3.1 and 4.9.2 regarding ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM, and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in chapter 4, section 4.9.2.)

Natural gas use is projected to be 1,840,000 decatherms annually. The gas delivery capacity to the Los Alamos area is between approximately 9,000,000 and about 11,000,000 decatherms per year (Kumar 1997). Although electrical demand may increase natural gas demand for the generation of electricity at TA–3, demand should continue to be dominated by heating requirements and is not expected to exceed this projection.

LANL water use projected under the No Action Alternative is a total of 712 million gallons (2.7 billion liters) per year, 218 million gallons (825 million liters) per year for LANSCE, and 494 million gallons (1.9 billion liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6.9 billion liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water demands of this community can be met within the existing water rights. (Water demand is also discussed in section 5.1.3.) The peak water requirements for the area were determined to be 7,300 gallons (27,740 liters) per minute; the firm rated capacity of the

1. These values include the proposed Strategic Computing Complex (SCC) Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

delivery system is 7,797 gallons (29,629 liters) per minute (Lundberg 1997).

The projected water use for the proposed Strategic Computing Complex (SCC) project is not reflected in the total number for LANL water use projections (for any of the alternatives) because DOE and LANL are committed to no net increase of water usage when the SCC project becomes operational at a 50-TeraOp level in approximately fiscal year 2002. The estimated water use for the SCC without water conservation would have been 120 gallons (450 liters) per minute or 63 million gallons (240 million liters) per year. The SCC project intends to make full use of the treated sanitary wastewater effluent from the TA–46 SWSC plant to meet its goal of no net increase of water usage (Holt 1998).

5.2.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.2.9.3–1. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities. Liquid waste is not projected by radioactive facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste (RLW) projected for receipt at TA–50 is 6.6 million gallons (25 million liters) per year for this alternative.

The other environmental impacts from waste management activities are presented elsewhere in this document. The impacts associated with the specific operations of the waste management facilities are found in the various impact areas analyzed in this document; all other facilities and specific effluents and source terms for the key facilities are summarized in chapter 3 (section 3.6) for waste management facilities (principally at TA–50 and TA–54). Transportation of waste, for example, is included in the analysis of transportation impacts of the various alternatives (volume III, appendix F, section F.6.6). The transportation of low-level radioactive waste (LLW) for off-site disposal and the expansion of Area G were the only variables identified from the review of waste management strategies. The differences between these strategies are reflected in the differences between the alternatives. (Expanded Operations is the only alternative that includes expansion of on-site disposal.)

Much of LANL TRU and chemical waste, as well as a portion of the LLW, would be treated and shipped off the site for disposal. (As noted in chapter 4, section 4.9.3.3, LANL receives small amounts of TRU waste from other sites. Some of that waste is from nondefense activities and is currently ineligible for disposal at the Waste Isolation Pilot Plant [WIPP]. Under all alternatives, such nondefense TRU waste would be stored at LANL pending the development of disposal options.) LANL is capable of meeting applicable WAC, and off-site disposal capacities are much greater than LANL's waste volumes.

5.2.9.4 *Contaminated Space*

The activities reflected in the No Action Alternative are projected to increase the total contaminated space at LANL by 63,000 square feet (5,853 square meters), as compared to the baseline established for the SWEIS as of May 1996 (section 4.9.4). The majority of this increase is due to implementation of actions that have already received a review in accordance with NEPA but that had not been implemented at the time the baseline was established (including the Nuclear Materials Storage Facility [NMSF] at TA–55; introduction of tritium into TA–16 Building 450 for neutron tube target loading; implementation of the low-energy demonstration accelerator [LEDA] and IPF at TA–53; size-reduction at the Waste Characterization, Reduction, and Repackaging [WCRR] Facility; and treatment research and

TABLE 5.2.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the No Action Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL RADIOACTIVE WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	5,250	52,500	688	6,880	12	120	124	1,240	36	360
Tritium Facilities[c]	TA–16 & 21	1,100	11,000	450	4,500	2	20	NA	NA	NA	NA
Chemical and Metallurgy Research Building[d]	TA–3	7,970	79,700	1,380	13,800	16.4	164	18.7	187	8.1	81
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	5,500	55,000	420	4,200	2	20	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	142,000	1.42×10^6	280	2,800	0	0	NA	NA	NA	NA
High Explosives Processing Facilities	TA–8, 9, 11, 16, 28 & 37	11,000	110,000	11	110	0.2	2	NA	NA	NA	NA
High Explosives Testing Facilities	TA–14, 15, 36, 39, 40	25,200	252,000	300	3,000	0.3	3	0.2	2	NA	NA
Los Alamos Neutron Science Center	TA–53	16,600	166,600	156	1,560	1	10	NA	NA	NA	NA
Health Research Laboratory[e]	TA–43	7,050	70,500	14	140	2.7	27	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	2,000	20,000	170	1,700	2	20	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[f]	TA–50 & 21	2,200	22,000	150	1,500	0	0	21	210	0	0
Waste Treatment, Storage, and Disposal Facilities[f]	TA–54 & 50	920	9,200	174	1,740	4.0	40	27	270	0	0
Non-Key Facilities		651,000	6.51×1^6	520	5,200	30	300	0	0	0	0
Environmental Restoration Project[g]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[h]		2.886×10^6	2.886×10^7	9,130	91,300	622	6,220	202	2,020	44	440

NA indicates that this facility does not routinely generate these types of waste.
[a] Radioactive liquid waste generation is not projected by facility (see text in section 5.2.9.3, Radioactive and Hazardous Waste Generation).
[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under the *Toxic Substance Control Act*. Biomedical waste is also included in this category of waste.
[c] These projections include 4,000 cubic meters of LLW due to backlogged waste.
[d] These LLW projections include 4,000 cubic meters of LLW generation anticipated due to the CMR Building Upgrades, Phase II.
[e] These projections include 10,000 kilograms of chemical waste, 250 kilograms of biomedical waste (a special form of chemical waste), 44 cubic meters of LLW, and 24 cubic meters of low-level radioactive mixed waste associated with ongoing efforts to remove obsolete and contaminated equipment.
[f] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.
[g] The ER Project is projected to generate 11 cubic meters per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.
[h] Grand totals have been rounded.

TRU waste characterization at the Radioactive Materials Research, Operations, and Demonstration [RAMROD] Facility at TA–50).

5.2.10 Transportation

The transportation impacts projected for the No Action Alternative are summarized in this section. More detailed information regarding these impacts is included in volume III, appendix F.

5.2.10.1 *Vehicle-Related Risks*

Truck Emissions in Urban Areas

For the No Action Alternative, the projected risk is 0.032 excess LCF over a lifetime per year of operation. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to 0.031 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (1.9 kilometers) less of urban highway mileage. Approximately 65 percent of the risks are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments.

Truck Accident Injuries and Fatalities

The impacts projected for the No Action Alternative are presented in Table 5.2.10.1–1 (additional information on these analyses is provided in appendix F, section F.6.3). Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Use of the Santa Fe Relief Route would not substantially change the risks of accidents, injuries, and fatalities on the remainder of New Mexico segment, as compared to the risks reflected for this segment in Table 5.2.10.1–1. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.2.10.2 *Cargo-Related Risks*

Incident-Free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the No Action Alternative are presented in Table 5.2.10.2–1; note that the total is the total dose and risk throughout the U.S. attributable to LANL operations, and that this total is dominated by the segments outside New Mexico. The aircraft segment is for overnight carrier service; the truck segment to/from the

TABLE 5.2.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the No Action Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On-Site	0.015	0.0031	0.00015
LANL to U.S. 84/285	0.17	0.035	0.0017
U.S. 84/285 to I–25	0.41	0.086	0.0041
Remainder of New Mexico	0.67	0.64	0.072
Outside New Mexico	3.2	3.0	0.30
Total	4.5	3.8	0.38

TABLE 5.2.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the No Action Alternative*

ROUTE SEGMENT	TRUCK OR AIR CREW		NONOCCUPATIONAL (PUBLIC)					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	5.9	0.0024	0.032	0.000016	0.51	0.00026	3.2	0.0016
U.S. 84/285 to I–25	7.9	0.0032	0.38	0.00019	3.6	0.0018	3.3	0.0016
Remainder of New Mexico	45	0.018	0.1	0.00005	1.7	0.00085	24	0.012
Outside New Mexico	410	0.16	2.8	0.0014	24	0.012	180	0.09
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
Totals	470	0.19	3.3	0.0017	30	0.015	210	0.11

NA = Not applicable

airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for many of the radioactive material shipments (those north-bound on I–25). Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route.

The MEI dose occurs between LANL and I–25 and is 0.0003 rem.

Driver Doses from On-Site Shipments of Radioactive Materials. The projected collective radiation dose for LANL drivers under the No Action alternative is 4.184 person-rem. This collective dose would be expected to result in 0.00167 excess LCF among these drivers.

The average individual driver dose is projected to be 0.174 rem per year, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the No Action Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments. The RADTRAN and ADROIT codes were used to analyze accident impacts for the bounding off-site radioactive material shipments. The MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding excess LCF per year for these shipments are presented in Table 5.2.10.2–3 for these accidents. ADROIT results that are separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in terms of excess LCF per year; for the No Action Alternative, the MEI dose risk due to plutonium-238 oxide and due to pit shipments were each less than 1×10^{-10} excess LCF per year.

TABLE 5.2.10.2–2.—*MEI Doses and Associated Frequencies for Off-Site Radioactive Materials Accidents*

ROUTE SEGMENT	SHIPMENT TYPE					
	AMERICIUM-241		CH TRU		RH TRU	
	MEI DOSE (rem)	FREQUENCY PER TRIP	MEI DOSE (rem)	FREQUENCY PER TRIP	MEI DOSE (rem)	FREQUENCY PER TRIP
LANL to U.S. 84/285	59	1.8×10^{-7}	21	6.4×10^{-8}	0.16	6.0×10^{-9}
U.S. 84/285 to I–25	59	2.5×10^{-7}	21	7.4×10^{-8}	0.16	5.6×10^{-9}
Remainder of New Mexico	59	9.9×10^{-7}	21	1.4×10^{-6}	0.16	1.3×10^{-7}
Rest of U.S.	59	0.000011	NA	NA	NA	NA

NA = Not available; CH TRU = contact-handled TRU waste; RH TRU = remote-handled TRU waste

TABLE 5.2.10.2–3.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the No Action Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM -241	CH TRU	RH TRU	PLUTONIUM -238	PITS	TOTAL	
	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	0.015	0.0014	3.1×10^{-6}	4×10^{-7}	2×10^{-6}	0.016	8.0×10^{-6}
U.S. 84/285 to I–25	0.24	0.019	0.000042	1×10^{-6}	0.00001	0.26	0.00013
Remainder of New Mexico	0.031	0.012	0.000026	4×10^{-7}	4×10^{-6}	0.043	0.000022
Rest of U.S.	2.5	NA	NA	4×10^{-6}	0.00002	2.5	0.0012

NA = Not available; CH TRU = contact-handled TRU waste; RH TRU = remote-handled TRU waste

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore the excess LCFs per year) by about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa Fe. This difference is primarily due to the difference in population density along these routes. (The lower traffic density on the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and therefore the excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [9.7 kilometers] more) in the distance traveled on I–25 for north-bound shipments.

On-Site Radioactive Materials Shipments. The bounding on-site shipments involving radioactive materials are the transport of plutonium-238 solution from the CMR to TA–55 and the transport of irradiated targets from the LANSCE to TA–48. Both types of shipments are made with the roads closed to all people except personnel directly involved in the transport. Therefore, no member of the public would be expected to be involved in the postulated truck accident or to be a bystander after the postulated truck accident.

The MEI dose is calculated using the following assumptions. In the case of plutonium-238 solution, it is assumed that a person would stand very close to the evaporating liquid for 10 minutes before being warned away. In the case of the irradiated target cask failure, a narrow radiation beam would be produced that would be lethal after 10 minutes of continuous exposure at a distance of 6 feet (1.8 meters) from the cask, and it is assumed that a person would stand in this beam for 10 minutes.

The resulting MEI doses, frequencies, and MEI risks per year of operation are given in Table 5.2.10.2–4. The bounding Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility or Pulsed High-Energy Radiation Machine Emitting X-Rays (PHERMEX) shipment accidents could result in an off-site MEI dose of 76 rem and fatalities to LANL truck crews and other individuals within 80 feet (24 meters) of the explosion (DOE 1995b). The frequency of such shipments has been added to the frequency of irradiated target shipments.

Hazardous Materials Shipments. The bounding hazardous materials shipments for transportation accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosives shipments. The consequences of an accident involving a major explosives shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

Accidental Chlorine Release. The probability of the bounding accidental chlorine release (event) was determined from event trees by

TABLE 5.2.10.2–4.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the No Action Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	8.8×10^{-8}	8.7 rem	7.7×10^{-7} rem/year (3.1×10^{-10} excess LCF per year)
Irradiated Targets	3.1×10^{-6}	acute fatality	3.1×10^{-6} fatalities per year

using 1-ton (908-kilogram) container failure thresholds (Rhyne 1994a) and force magnitude probabilities (Dennis et al. 1978). (Although LANL is not expected to store or handle chlorine containers this large, they have in the past, and the risks associated with transport of this size container bound the risks of toxic material shipments.) The ALOHA™ computer model (NSC 1995) was used to estimate release rates from the 1-ton (908-kilogram) container, and the DEGADIS (Havens and Spicer 1985) model was used to predict downwind chlorine concentrations following the postulated release. (A separate version of DEGADIS is used because the version incorporated in ALOHA™ does not readily provide time variation of downwind concentrations.)

The number of fatalities or injuries associated with the bounding chlorine accident would depend on the population density and the ability of people to avoid harmful exposure by going indoors or leaving the affected area. The ability of people to avoid harmful exposure (to escape) would depend on various factors; an escape fraction of 0.98 is used for all route segments. This fraction is based on analysis of a transportation accident producing fatal releases of ammonia (Glickman and Raj 1992) and should be applicable to chlorine because the same dispersion coefficients apply, resulting in similar plume shapes and gradients of concentration. For both, there will be objectionable odor a short time prior to concentrations that have serious effects. The plumes tend to be visible and of modest transverse dimension, with very objectionable odor and strong respiratory irritation at their edges, permitting recognition and urging prompt escape on foot. The projected frequencies, consequences and risks associated with major chlorine accidents under the No Action Alternative are presented in Table 5.2.10.2–5.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-tenth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in this risk of injuries and fatalities on the remainder of New Mexico segment because of the extra 6 miles (10 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release. The bounding consequence from a propane release would be the generation of a fireball. The fireball would likely occur too soon after the postulated truck accident for evacuation to be effective. The fireball would have a radius of about 148 feet (45 meters) and would burn for about 3 seconds. Many people would be protected by buildings or automobiles for this short duration. It is assumed that 50 percent of the available population would be shielded from the fireball, 10 percent would be fatalities, and the remainder would be injured (Geffen et al. 1980). In addition, fatal second-degree burns might be experienced out to a radius of 620 feet (189 meters). The percentages of available people that would be exposed to the radiant heat flux are assumed to be 0.16 percent, 12 percent, and 19 percent in urban, suburban, and rural areas, respectively (Geffen et al. 1980).

The number of people that would be affected depends on the population density. The projected frequencies, consequences, and risks associated with major propane accidents under the No Action Alternative are presented in Table 5.2.10.2–6.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-fifth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight decrease in the risk of injuries and fatalities on the

TABLE 5.2.10.2–5.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the No Action Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000028	0.065	0.24	8.6×10^{-6}	0.000032
	Suburban	4.6×10^{-6}	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.000022	0.053	0.2	0.00029	0.0011
	Suburban	0.000047	3.0	11		
	Urban	0.000014	11	40		
Remainder of New Mexico	Rural	0.00016	0.015	0.056	0.000052	0.00019
	Suburban	0.000017	1.5	5.5		
	Urban	2.8×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0012	0.028	0.1	0.0012	0.0047
	Suburban	0.0003	1.6	6.1		
	Urban	0.00007	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.2.10.2–6.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the No Action Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	9.8×10^{-6}	0.28	1.1	9.7×10^{-6}	0.000039
	Suburban	1.7×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	7.5×10^{-6}	0.23	0.92	0.00015	0.0006
	Suburban	0.000017	8.4	34		
	Urban	5.0×10^{-6}	1.8	7.3		
Remainder of New Mexico	Rural	0.000065	0.15	0.6	0.00012	0.00048
	Suburban	0.000021	5.1	20		
	Urban	2.6×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.000083	0.09	0.36	0.000067	0.00027
	Suburban	0.000011	4.8	19		
	Urban	5.4×10^{-6}	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

remainder of New Mexico segment because of the 6 miles (10 kilometers) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

5.2.11 Accident Analysis

Transportation accidents for the No Action Alternative are addressed in section 5.2.10. High-frequency (greater than 1 in 100) occupational accidents for the No Action Alternative are addressed in section 5.2.6.

5.2.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

Site-Wide Earthquake

Earthquakes are site-wide in nature. They are the only credible initiator that can release material from multiple facilities at the same time. Three scenarios have been postulated for site-wide earthquake-initiated releases. Each of the scenarios has a different magnitude earthquake that results in different degrees of damage and consequences. In addition, RAD–12 is a facility-specific accident scenario, discussed in the DARHT EIS (DOE 1995a), that is earthquake-initiated (by a very large earthquake) but has a substantially different probability for the scenario than is reflected in the site-wide scenario. The estimates for both structural damage to LANL facilities and the amount of material released are conservative. Earthquakes dominate the radiological accident risk.

Table 5.2.11.1–1 is a summary of the annual frequency of earthquake and wildfire scenarios and their consequences. For radiological releases, the consequences are expressed as excess LCFs, per year, in excess of the normal incidence of fatal cancers. Comparisons to the incidence of fatal cancers in the surrounding population can be made to evaluate the risk from these accidents relative to the public's inherent cancer risk. Overall, it should be noted that for the scenarios hypothesized for both SITE–01 and SITE–02, the number of excess LCFs is within the normal fluctuation in cancer fatalities from one year to the next. As noted in section 5.2.6, and in appendix D, section D.1.2.1, the lifetime risk of dying from cancer in the U.S. is more than 23 percent for men and more than 20 percent for women; based on this rate, approximately 40,000 people within the 50-mile (80-kilometer) radius of LANL would be expected to die from cancer.

Table 5.2.11.1–2 is a summary of the risk from exposure to toxic chemicals as a result of the site-wide accidents. (RAD–12 is not reflected on this table because this scenario does not involve the release of toxic chemicals.) Chemical exposure is evaluated as the expected number of people exposed annually to concentrations greater than a given ERPG–2 or ERPG–3.

For earthquakes, one can expect fatalities among workers and the public caused directly by the earthquake itself, irrespective of any releases. Many of the office buildings, including such facilities as the administration complex or off-site office buildings, etc., would be expected to suffer substantial damage from higher frequency, lower magnitude earthquakes. Therefore, the population effects resulting from exposures to hazardous materials are thought to be a small or modest increment to the human and material impacts directly attributable to the earthquake.

Site-Wide Wildfire

The frequency of a large fire encroaching on LANL is estimated as the joint probability of ignition in the adjacent forests, high extreme fire danger with a failure to promptly extinguish the fire, and a 3-day period of favorable meteorological conditions. (See volume III,

TABLE 5.2.11.1–1.—*Summary of Radiological Risks from Earthquake-Initiated and Wildfire Accident Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	FREQUENCY (EVENT PER YEAR)[a,e]	CONSEQUENCE MEASURES[b,c,d,f]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
NATURAL PHENOMENA			
SITE–01 Moderate earthquake on the Pajarito Fault or a large earthquake in the Rio Grande Rift zone, resulting in structural damage and/or severe internal damage to comparatively low capacity facilities.	Approximately 0.0029 per year (i.e., one such event in approximately 350 years); considered an unlikely event	Approximately 16 excess LCFs Mean population dose approximately 27,726 person-rem MEI doses 20 rem	0.046
SITE–02 Large earthquake on the Pajarito Fault, resulting in structural damage and/or severe internal damage to low and moderate capacity facilities.	Approximately 0.00044 per year (i.e., one such event in approximately 2,300 years); considered an unlikely event	Approximately 24 excess LCFs Mean population dose approximately 41,340 person-rem MEI dose ≤ 34 rem	0.011
SITE–03[g] Very large earthquake on the Pajarito Fault and perhaps the Embudo Fault, resulting in structural damage to essentially all facilities.	Approximately 0.000071 per year (i.e., one such event in approximately 14,000 years); considered an extremely unlikely event	Approximately 134 excess LCFs Mean population dose approximately 210,758 person-rem MEI dose 247 rem	0.0095
SITE–04 Large wildfire encroaching on Los Alamos, consuming combustible structures and vegetation.	Approximately 0.1 per year (i.e., one such event in approximately 10 years); considered a likely event.	Approximately 0.34 excess LCFs Mean population dose approximately 675 person-rem MEI dose < 25 rem	0.034
RAD–12[h] Plutonium release from a seismically initiated event	Approximately 1.5 x 10^{-6} per year (about one such event in about 1,000,000 years); considered an extremely unlikely event	18 excess LCFs Mean population dose approximately 35,800 person-rem MEI dose 138 rem	0.000027

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
[e] The frequency is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.
[f] Impacts, in terms of LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.
[g] There is a potential for fault rupturing to occur at the CMR Building (TA–3–29) at a somewhat lower frequency than the SITE–03 earthquake (estimated at 1 to 3 x 10^{-5}/year). Should this occur in association with the SITE–03 earthquake, a conservative estimate results in an additional 133,833 person-rem population dose (increasing excess LCFs by 99), and an increase to the MEI of 134 rem.
[h] This accident was analyzed in the DARHT EIS (DOE 1995a), and because it is an earthquake-initiated event, it is presented here for consistency.

TABLE 5.2.11.1–2.—*Summary of Chemical Exposure Risks from Site-Wide Accident Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a,d]	CONSEQUENCE MEASURE[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
NATURAL PHENOMENA			
SITE–01 Moderate earthquake on the Pajarito Fault or a large earthquake in the Rio Grande Rift zone, resulting in structural damage and/or severe internal damage to comparatively low capacity facilities.	Approximately 0.0029 per year (i.e., one such event in approximately 350 years); considered an unlikely event.	Several tens of people exposed at or above ERPG–2 or –3 levels at distances to a substantial fraction of a mile from multiple sources.	0.058
SITE–02 Large earthquake on the Pajarito Fault, resulting in structural damage and/or severe internal damage to low and moderate capacity facilities.	Approximately 0.00044 per year (i.e., one such event in approximately 2,300 years); considered an unlikely event.	Approximately 100 people exposed above ERPG–2 or 3 levels to a distance of about one mile from multiple sources.	0.044
SITE–03 Very large earthquake on the Pajarito Fault and perhaps the Embudo Fault, resulting in structural damage to essentially all facilities.	Approximately 0.000071 per year (i.e., one such event in approximately 14,000 years); considered an extremely unlikely event.	Approximately 100 people exposed above ERPG–2 or –3 levels to a distance of about 1 mile from the sources.	0.0071
SITE–04 Wildfire consuming vegetation and combustible structures	Approximately 0.1 per year.	Approximately 11 people exposed above the ERPG–2 level from a formaldehyde release.	1.1

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] The frequency is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.

appendix G for a complete discussion of the accident analysis.) The postulated scenario is quite credible in view of the present density and structure of fuel surrounding and within LANL and the townsite, and the historical occurrence of three major fires in the past 21 years.

This analysis has shown that these fire-favorable weather conditions occur on the order of once per year; the ignition sources are prevalent; and fire-fighting capability is hampered by limited accessibility. Therefore, this site-wide accident analysis concludes that a major fire, as described, is not only credible but also likely. The probability is on the order of 0.1 per year (1 every 10 years), a frequency that is identical for all alternatives. Although the probability of occurrence is 0.1 per year, the conditions for occurrence exist at least once every year.

The analysis for the joint probability of occurrence of weather and fire danger conditions and the fuel loading provides a conservative but realistic assessment of the potential for the occurrence of a wildfire scenario that will impact LANL facilities, buildings, and land.

The analysis conservatively assumes that all combustible structures and vegetation over the western part of LANL are burned. The public exposures were estimated separately for airborne radionuclides and beryllium from burning vegetation and soils, and from radiological and chemical releases from burning facilities. When available, existing analyses from facility fires were used; otherwise, new model calculations were run.

About 400 person-rem, or 75 percent of the total population exposure of 675 person-rem, results from a wildfire at TA–54. The results from RAD–08, an aircraft crash-initiated fire at TA–54, were used for the wildfire. The two fires would be quite different; one entails aircraft fuel that challenges waste containers. At present, the fuel loading within the dome structures is small, so that RAD–08 results very conservatively bound the consequences of a wildfire at TA–54. This facility and the others that contribute public exposure in the wildfire scenario are being considered for actions to reduce the external wildfire fuel.

Another 189 person-rem results from total release of the tritium inventory at the Weapons Engineering Tritium Facility (WETF), including 44.5 ounces (1,260 grams) in storage, which is assumed to bound an increased administrative limit that may be established. The storage containers are resistant to fire, but have been assumed to release their entire content in tritiated water form, in accord with the highly conservative nature of this analysis.

Because the frequency of the site-wide wildfire is 0.1 per year, the radiological risk (product of the frequency and consequence) from this accident is exceeded only by the site-wide earthquake. On the other hand, no excess LCFs are expected from the event. (See Table 5.2.11.1–1 for a summary of the wildfire analysis.) There would be unquantified health effects from smoke inhalation and possible fatalities from fighting the fires. There would be substantial impact from impairment of mission and from the loss of buildings at LANL and in the townsite. This impact is not evaluated, just as it is not evaluated for earthquakes.

5.2.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

A summary of the frequency and consequences for plutonium releases is given in Table 5.2.11.2–1. These releases reflect a variety of initiators depending on the type of activities or manmade hazards in the area, such as an aircraft crash. The consequences indicate that no excess LCFs are expected from any of the plutonium accident scenarios.

Due to the low consequences and frequencies, these accidents do not pose a significant risk to the public.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 is presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facililty and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiences detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

5.2.11.3 *Highly Enriched Uranium Release from Process Hazard Accident at LANL*

The site has only a few accident scenarios involving uranium among those with the highest risks evaluated. This is due to the difference in specific activity between plutonium and HEU. Of accidents releasing HEU, RAD–03 is dominant. The postulated source term was 16 pounds (7.2 kilograms) of uranium. The excess LCFs are estimated at less than 1; that is, no cancer fatality is expected. Details of the accident analysis can be found in appendix G. The results are summarized in Table 5.2.11.3–1.

5.2.11.4 *Tritium Release from a Manmade Hazard Accident*

The scenario initiated by an aircraft crash event is the dominant accident that involves tritium. In this scenario, the entire inventory of tritium at TSTA or TSFF is converted by fire to tritiated water. This is a conservative assumption because water is readily absorbed by the body; whereas, gaseous tritium is not. Nevertheless, for this accident, no excess LCFs are expected to occur, as indicated in Table 5.2.11.4–1.

5.2.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations. Details for each accident are found in volume III, appendix G. The results are summarized in Tables 5.2.11.5–1 and 5.2.11.5–2.

5.2.11.6 *Worker Accidents at LANL*

Worker accidents are characterized by higher frequencies and potential for prompt fatalities. Generally, the fatalities would be a consequence of the accident itself, such as a detonation of high explosives. Chemical and radiological exposures to workers depend heavily on the response to an event, such as putting on protective equipment and exiting the area. Accidents that affect workers only are summarized in Table 5.2.11.6–1. Table 5.2.11.6–2 summarizes the effects to workers from the accidents associated with public impacts. Additional details can be found in the appendix G, Accident Analysis.

TABLE 5.2.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a,e]	CONSEQUENCE MEASURES[b,c,d,f]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
MANMADE HAZARDS			
RAD–01 Plutonium release from RANT Facility transuranic waste container storage area fire.	Approximately 0.0016 per year (i.e., one event in approximately 600 years); considered an unlikely event	Approximately 0.04 excess LCF Mean population dose approximately 72 person-rem MEI at nearest public access (on Pajarito Road): approximately 46 rem, at most exposed residence: approximately 4 rem	0.000064
RAD–07 Plutonium release from WCRR Facility transuranic waste container storage area fire.	0.00015 per year (i.e., one in 7,000 years); considered an unlikely event	Approximately 0.7 excess LCF Mean population dose: approximately 1,300 person-rem MEI dose at closest public access (Pajarito Road): approximately 74 rem, MEI at habitation: approximately 4 rem	0.00011
RAD–08 Plutonium release from TWISP transuranic waste storage domes due to aircraft crash and fire.	4.3×10^{-6} per year (i.e., one event in approximately 200,000 years); considered an extremely unlikely event	Approximately 0.2 excess LCF Mean population dose: approximately 400 person-rem MEI at nearest public access (Pajarito Road and nearest border with White Rock): 22 rem	8.6×10^{-7}
RAD–16 Plutonium release due to aircraft crash at the CMR Building.	Approximately 3.5×10^{-6} per year (i.e., one event in approximately 300,000 years)	Approximately 0.03 excess LCF Mean population dose: approximately 56 person-rem, no expected excess LCFs; MEI at closest public access, approximately 3 rem, approximately 0.03 rem at nearest habitation	1×10^{-7}

TABLE 5.2.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—No Action Alternative*-Continued

SCENARIO DESCRIPTION	LIKELIHOOD[a,e]	CONSEQUENCE MEASURES[b,c,d,f]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
PROCESS HAZARD ACCIDENTS			
RAD–09 Plutonium release due to transuranic waste drum failure or puncture (for "high" and typical activity in drum).	0.0041per year (i.e., one in approximately 250 years for high-activity drum) 0.4 per year (i.e., one in 2.5 years for typical drum)	0.12 excess LCF from high activity drum Mean population dose for release: approximately 230 person-rem MEI (high activity drum) at closest access (Pajarito Road) approximately 23 rem; approximately 0.86 rem at closest habitation. 0.0022 excess LCF from typical activity drum Mean population dose: approximately 4.4 person-rem MEI (typical activity drum) at closest access (Pajarito Road) approximately 0.41 rem; approximately 0.86 rem at closest habitation	0.00049 0.0009
RAD–13 Plutonium release from flux trap irradiation experiment at TA–18.	0.000016 per year (i.e., one event in approximately 65,000 years)	Approximately 0.08 excess LCF Mean population dose: approximately 160 person-rem MEI at closest public access (Pajarito Road): approximately 120 rem; at closest habitation: approximately 0.12 rem.	1.3×10^{-6}
RAD–15 Plutonium release from CMR. (1) Laboratory Fire (2) Wing Fire	(1) 0.000036 per year (2) 0.000032 per year	(1) Approximately 0.0023 excess LCF Mean population dose: approximately 4.5 person-rem MEI approximately 4.1 rem (2) Approximately 0.85 excess LCF Mean population dose: approximately 1,700 person-rem MEI approximately 91 rem	(1) 8.3×10^{-8} (2) 2.7×10^{-5}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
e The frequency is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.
[f] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

TABLE 5.2.11.3–1.—*Summary of Radiological Consequences from Highly Enriched Uranium Release Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d,e]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
RAD–03 Highly enriched uranium release from power excursion accident with Godiva-IV outside Kiva #3.	3.4×10^{-6} per year	Approximately 0.06 excess LCF Mean population dose: approximately 110 person-rem MEI at nearest public access (Pajarito Road) Approximately 150 rem; at nearest habitation approximately 0.5 rem	2×10^{-7}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure. The MEI dose is provided for an individual located on Pajarito Road at a distance of 160 feet (50 meters) from the facility, even through Pajarito Road would be closed to the public during outdoor operations.
[e] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

TABLE 5.2.11.4–1.—*Summary of Radiological Consequences from Tritium Release Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d,e]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
RAD–05 Tritium oxide release due to aircraft crash at TSFF.	5.3×10^{-6} per year (i.e., one accident in 190,000 years).	Approximately 0.012 excess LCF Mean population dose: 24 person-rem MEI approximately 0.01 rem[f]	6.4×10^{-8}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
[e] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation
[f] This is at 1,200 feet (360 meters) distance. The closest public access would likely be involved in the crash.

TABLE 5.2.11.5–1.—*Summary of Chlorine Exposure Scenarios at LANL—No Action Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
PROCESS HAZARD ACCIDENTS			
CHEM–01 Chlorine release (150 pounds [68 kilograms]) from potable water treatment station, due to human error during cylinder changeout or maintenance, or due to random hardware failures.	Approximately 0.0012 per year (i.e., one such event in approximately 800 years)	For the risk-dominant large leak scenario, an average of approximately 43 persons exposed above ERPG–2 levels, and approximately 12 persons exposed above ERPG–3 levels, to distances of up to a few tenths of a mile.	0.052
CHEM–02 Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at gas plant, due to fire or aircraft crash.	Approximately 0.00013 per year (i.e., one in approximately 8,500 years)	Average of 292 people within LANL (ranging from none to 1,000 depending upon wind direction) exposed at or above ERPG–2 or –3 levels; town protected by canyon from highest concentrations.	0.038
CHEM–03 Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at gas plant, due to random failure or human errors during cylinder handling.	Approximately 0.00012 per year (i.e., one in approximately 8,000 years)	An average of approximately 263 exposed above ERPG–2 levels; or 239 above ERPG–3 levels, at distances to a fraction of a mile, all within LANL; town protected by canyon from highest concentrations.	0.032
CHEM–06 Chlorine gas release outside Plutonium Facility.	Approximately 0.063 per year (i.e., one event in approximately 16 years)	Average number exposed at or above ERPG–2 doses is approximately 102, and above ERPG–3, approximately 7 at ranges to a fraction of a mile.	6.426

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

TABLE 5.2.11.5–2.—*Summary of Chemical Exposure Scenarios—No Action Alternative*

SCENARIO	DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	Approximately 0.004 per year (i.e., one in about 250 years)	Average number of off-site persons exposed above ERPG–2 level is zero; toxic effects generally limited to the source's TA (TA–54).	0
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	Approximately 0.00051 per year (i.e., one event in approximately 7,000 years)	Under conservative daytime conditions, no one outside the source area (TA–54) would see levels above ERPG–2. Under least favorable conditions, 13 persons could be exposed above ERPG–3 levels.	0

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

TABLE 5.2.11.6–1.—*Summary of Worker Accident Scenarios at LANL—No Action Alternative*

SCENARIO	DESCRIPTION	FREQUENCY[a]	NUMBER OF WORKER CASUALTIES PER ACCIDENT
WORK–01	Inadvertent detonation of high explosives.	0.001 to 0.01 per year (i.e., one in approximately 100 to 1,000 years)	1 to 15 fatalities or injuries.
WORK–02	Biohazard contamination of a single worker.	0.01 to 0.1 per year (i.e., one in approximately 10 to 100 years)	One diagnosed infection.
WORK–03	Inadvertent criticality at CMR Facility, Critical Experiments Facility, or Plutonium Facility.	< 0.0001 per year (i.e., one in more than 10,000 years)	Substantial doses to those few workers in the immediate vicinity, with possible fatalities from acute exposures.
WORK–04	Inadvertent exposure of workers to electromagnetic radiation.	0.01 to 0.1 per year (i.e., one in approximately 10 to 100 years)	Typically one, rarely several, casualties.
WORK–05	Plutonium release from degraded storage container at Plutonium Facility.	0.23 per year for exposure to workers	Significant but nonlethal doses to one or two workers.

[a] Accident likelihood estimates are conservative, given the information available.

TABLE 5.2.11.6–2.—*Summary of Consequences to Workers at Origination Facilities for Accident Scenarios*

SCENARIO	DESCRIPTION	FACILITY WORKER CONSEQUENCES
SITE–01	Moderate earthquake on the Pajarito Fault or a large earthquake in the Rio Grande Rift zone resulting in structural damage and/or severe internal damage to comparatively low capacity facilities.	Workers in buildings that are structurally damaged or that suffer partial or total collapse (unusual, but possible) could be injured or killed. Worldwide experience with very severe earthquakes indicates that a priori predictions of the numbers of injuries and fatalities are not possible. The experience clearly indicates that large numbers of fatalities (i.e., many hundreds to thousands of deaths) are not commonly experienced except under special conditions. These special conditions include severe earthquakes with large numbers of persons in severely substandard structures that suffer complete collapse. Modern structures do not often experience such failures, even in very severe earthquakes. Other circumstances under which large numbers of fatalities could occur include seismically induced, widespread fires. Other impacts to workers could include delayed emergency response (including medical assistance) and indirect effects from releases of hazardous materials (both inside facilities and to the environment).
SITE–02	Large earthquake on the Pajarito Fault resulting in structural damage and/or severe internal damage to comparatively moderate capacity facilities.	See SITE–01.
SITE–03	Very large earthquake on the Pajarito Fault and perhaps the Embudo Fault resulting in structural damage to essentially all facilities.	See SITE–01.
SITE–04	Site-wide wildfire consuming combustible buildings and vegetation.	Most workers would be evacuated before the fire front arrives. However, there are possible fatalities from fighting the fire. There would be effects from smoke inhalation that are not predictable or quantified.
CHEM–01	Chlorine release (up to 150 pounds [68 kilograms]) from potable water treatment station due to human error during cylinder changeout or maintenance, or due to random hardware failures.	For the cylinder rupture event, it is unlikely that workers will be present because the nature of the event is assumed to occur at random rather than as a result of worker activity. Even with very prompt response by workers inside the building when the release occurs, severe injury or fatality is possible with large chlorine leak rates. The number of injuries and fatalities depends on the exact number and location of workers at the facility at the time of the event. For small leak rates, the likelihood of injury or death is low due to the “self-annunciating” nature of the event.
CHEM–02	Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at gas plant due to fire or aircraft crash.	Workers present at the gas plant facility (TA–3–170 and environs) could be injured or killed, depending upon wind direction and wind speed. However, the chlorine gas and fire causing the release will be readily visible, and escape from the plume, even on foot, is likely. Workers attempting to fight the fire without personal protective equipment could be overcome by chlorine gas.

TABLE 5.2.11.6–2.—*Summary of Consequences to Workers at Origination Facilities for Accident Scenarios*-Continued

SCENARIO	DESCRIPTION	FACILITY WORKER CONSEQUENCES
CHEM–03	Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at gas plant due to random cylinder failure or multiple human errors during cylinder handling.	Gas plant workers who are directly involved in handling the cylinders of chlorine could be exposed to ERPG–2 or ERPG–3 concentrations for the human error contributor to this event. In the case of random failures, it is unlikely that workers will be in the immediate vicinity of the cylinder. Gas plant workers could be exposed to high concentrations of chlorine if located outdoors, but these employees would be able to evacuate the area rapidly which would tend to reduce exposure consequences.
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	There are typically four or five employees in the area during normal work hours. Injuries or fatalities could occur due to exposures as well as missiles from cylinder rupture. Workers are trained to leave the area in the event of a gas release. Consequences would depend on wind speed and direction.
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	See CHEM–04.
CHEM–06	Chlorine gas release outside Plutonium Facility.	Air intakes at TA–55–4 are on the west end of the building about 18 feet above the ground and the chlorine release location is on the north side of the building at ground level. In addition, there is an isolation valve in the intake ductwork. Thus, it is unlikely that chlorine will be drawn into the building. Personnel located outdoors could be exposed to ERPG–2 and ERPG–3 concentrations of chlorine, but these employees would be able to evacuate the area rapidly that would tend to reduce exposure consequences.
RAD–01	Plutonium release from RANT facility TRU waste container storage area fire.	There are about a dozen employees at the facility during day shift who could be at risk of plutonium inhalation as a result of this fire. However, the employees would be expected to take shelter or evacuate the area, which would reduce exposures. No lethal exposures would be expected.
RAD–03	HEU release from power excursion accident with Godiva-IV outside Kiva #3.	Personnel would not be located outdoors during an experiment leading to this accident. The TA–18 control building provides 40% attenuation of gamma radiation, and ventilation systems would be secured in the event of an accident, minimizing the air exchange rate with the outdoors. No acute fatalities are expected for this accident.
RAD–05	Tritium oxide release due to aircraft crash at TSFF or TSTA.	An aircraft crash into the building could result in severe injuries or deaths to nearly all the occupants of the building. Nearby workers not within the facility could also be injured or killed as a result of the crash dynamics, explosion, fire, missiles, etc. Workers not directly affected by the aircraft crash could be exposed to tritium oxide, but the release plume would be elevated and may “skip over” the immediate crash site before returning to the ground at some distance.
RAD–07	Plutonium release from WCRRF TRU waste container storage area fire.	There are typically five WCRR Facility workers present during normal operations. The postulated accident would not result in an immediate release, providing time for implementation of evacuation or other protective measures. No fatal exposures are expected.

TABLE 5.2.11.6–2.—*Summary of Consequences to Workers at Origination Facilities for Accident Scenarios*-Continued

SCENARIO	DESCRIPTION	FACILITY WORKER CONSEQUENCES
RAD–08	Plutonium release from TWISP TRU waste storage domes due to aircraft crash and fire.	A small number of workers may be present during normal operations and could be directly affected by crash dynamics, explosion, fire, missiles, etc. Workers not directly affected by the aircraft crash could be exposed to plutonium, but the release plume would be elevated and may "skip over" the immediate crash site before returning to the ground at some distance.
RAD–09	Plutonium release due to TRU waste drum failure or puncture.	The accident would result in an immediate dispersal of plutonium to the area where the work is being performed. The dose to the worker would be dependent on ambient conditions and the speed with which protective actions could be taken (e.g., evacuation). No acute fatalities are expected for this accident.
RAD–10	Plutonium release from degraded storage container at Plutonium Facility (same as WORK–05, except that RAD–10 results in a release to the public, which was determined to be incredible).	See WORK–05.
RAD–13	Plutonium release from flux trap irradiation experiment at TA–18.	See RAD–03.
RAD–15	Plutonium release from hydride-dehydride glovebox fire.	From one to three workers may be present during the operations. These workers could be killed or injured due to the direct effects of a laboratory fire, or could be exposed to plutonium particulates via inhalation. Other workers could be affected by smoke inhalation. Workers outside the facility would not be expected to be impacted due to redundant trains of HEPA filtration between the accident location and the outside environment.
RAD–16	Plutonium release due to aircraft crash at the CMR Building.	An aircraft crash into the building could result in severe injuries or deaths to nearly all the occupants of the building. Nearby workers not within the facility could also be injured or killed as a result of the crash dynamics, explosion, fire, missiles, etc. Workers not directly affected by the aircraft crash could be exposed to plutonium, but the release plume would be elevated and may "skip over" the immediate crash site before returning to the ground at some distance.

5.3 IMPACTS OF THE EXPANDED OPERATIONS ALTERNATIVE

The DOE's Preferred Alternative is the Expanded Operations Alternative, with the exception that pit manufacturing would not be implemented at a 50 pits per year level, single shifts, but only at a level of 20 pits per year in the near term.

5.3.1 Land Resources

5.3.1.1 *Land Use Impacts*

Under the Expanded Operations Alternative, changes to the current overall land use categories are not expected from activities that are unique to this alternative, with the exception of a change to the land use designation at TA–67 if that site is chosen for the development of a new LLW disposal facility, as described in volume II, part I.

In the case of selecting that alternative, a roadway would be cleared and constructed from the R-Site Road to the TA–67 site; the combined total action would result in the clearing of about 60 acres (24 hectares) of forested land and a change in the current designation of that area from the Explosives land use category to a land use category of Explosives/Waste Disposal. The preferred alternative for the expansion of the TA–54/Area G LLW Disposal Area, expansion into Zones 4 and 6, would remove about 41 acres (17 hectares) from its current use as undeveloped wildlife habitat. Another alternative for the expansion of the LLW disposal site, the development of the North Site at TA–54, would remove about 49 acres (20 hectares) from that site's current use as undeveloped wildlife habitat. These changes at TA–54 would not alter the designated category of land use of Waste Disposal because the entirety of Mesita del Buey has been categorized for waste management and disposal activities usage.

Construction of a road between TA–55, the Plutonium Facility, and the TA–3, Chemistry and Metallurgy Research (CMR) Building area, to support pit production activities under the Expanded Operations Alternative (this applies to all project-specific siting and construction [PSCC] alternatives on this subject, as described in volume II, part II) would remove a small amount of acreage (about 7 acres [3 hectares]) from its current use as undeveloped, previously disturbed vegetated wildlife habitat; however, this would not alter the designated land use category of Research and Development use. Under the Preferred Alternative, at the 20 pits per year production rate, this road would not be constructed, and the corresponding land use impacts would not be incurred.

Other activities identified for this alternative also would occur, primarily within existing facilities or near to them and within the same type of land use category areas.

An increase in population in the Tri-County area due to an increase in employment would result in an increase in recreational use of surrounding lands and facilities. As shown in Table 5.3.9.1–2, there could be an estimated increase of about 4,230 individuals, or about 2.5 percent. This population level is within historical fluctuations due to changing laboratory activity levels. This increase in recreational use would likely include hiking, fishing, hunting, picnicking, camping, and skiing. Many of these activities, including visitation of archeological sites, would take place on adjacent lands administered by the SFNF and the NPS. This increase, while small, would contribute to increased recreational, wildlife, and cultural resource management measures being taken by these agencies to balance increasing numbers of visitors and accompanying noise and activity with natural and cultural resource needs.

5.3.1.2 *Visual Impacts*

The Expanded Operations Alternative would be expected to include the same effects as discussed under the No Action Alternative. Additionally, under this alternative there would be an expansion of the Area G LLW disposal landfill site at TA–54 or the construction and use of a new LLW disposal site and roadway at TA–67, and the construction of a roadway between TA–55 and TA–3, together with the possible construction of an add-on to the existing Plutonium Facility 4 at TA–55 or a new building nearby within the security fenced area at TA–55. The Area G landfill expansion would not be visible from Pajarito Road. However, the Area G landfill expansion would be visible from San Ildefonso land; Zones 4 and 6 are both farther away from the LANL boundary and would be less visible than the existing Area G landfill site, while the North Site is closer to the LANL boundary and would be more visible than the existing landfill site to people located on San Ildefonso land. The TA–67 landfill site would be visible from Pajarito Road, but would not be visible from San Ildefonso land.

Construction at the TA–67 site would change the view scape of the mesa top from that of forest to industrial development. Portions of the TA–55 to TA–3 roadway and its security fencing may be visible to motorists along Pajarito Road. The new roadway would be constructed in an already developed area and so would not significantly change the view scape of that area. Construction of an add-on to the Plutonium Facility or construction of a new building nearby would not alter the view scape of the TA–55 Plutonium Facility area because that area is already heavily developed.

Under the Expanded Operations Alternative there would be additional perimeter security floodlighting placed along the new roadway leading from TA–55 to TA–3, and around the new building within TA–55 if that alternative is chosen. This would result in very minor effects at the TA–55 and TA–3 area because of the limited area and length of the roadway. At the 20 pits per year production rate, the Preferred Alternative, these impacts would not be incurred because the road would not be constructed.

Similarly, additional perimeter security floodlighting would be placed around the Area G landfill expansion area or the TA–67 landfill area, both of which would be lighted for nighttime security purposes. The effect of additional lighting at the Area G landfill would be slightly noticeable during the night, especially to workers in the nearby areas. Nighttime lighting of the TA–67 area with both security floodlighting and parking lot safety lighting would be noticeable to LANL workers and potentially to off-site viewers because there are currently no areas along the Pajarito mesa that are similarly lighted. Additionally, such lighting might result in a short-term adjustment of wildlife use of the TA–67 site area. Use of these additional light fixtures at both the TA–54 and TA–67 locations and the TA–55 area could result in a slight increase in overall LANL area levels of light pollution, but is unlikely to result in a significantly expanded nighttime visibility of LANL from locations across the Rio Grande Valley.

Potential effects to the BNM and Dome Wilderness viewsheds would be similar to that of other area neighbors. Additional light sources could result in a slight increase in overall LANL levels of light pollution. Newly lighted areas may be visible to viewers at higher elevations at certain vantage points, but would not likely result in any appreciable expansion of the nighttime visibility of LANL as viewed from far distances. Expansion of the TA–54 Area G into Zones 4 and 6 would likely result in a minimal perception of clearing enlargement from BNM or Dome Wilderness vantage points due to forest growth between the vantage point and site location, the TA–54 site location on a mesa somewhat sloped to the southeast (away from these neighboring areas), and the amount of disturbance present in the general site area. A newly constructed disposal site at TA–67 would similarly be expected to result in a minimal perception of clearing enlargement from BNM or Dome Wilderness vantage points due to the forest growth between the vantage point and the site location, the TA–67 site location on a mesa somewhat sloped toward the southeast, and to the elevation of the TA–67 site relative to the neighboring vantage points in question. The construction of a roadway between TA–55 and TA–3 (which would not be constructed for the 20 pits per year production rate, the Preferred Alternative) would not likely be seen from off-site vantage points because of its relatively small size and the surrounding forest growth. If a vantage point exists from which the road can be viewed, it would likely result in little added viewshed impact given its location along Pajarito Road and the general state of development in the TA–3, TA–59, and TA–55 areas. An increase in the frequency of explosives should not affect the BNM and Dome Wilderness viewsheds.

5.3.1.3 *Noise*

Under the Expanded Operations Alternative there would be a slight increase in the amount of interior and outdoor construction activities at LANL. These would individually be within the level of effects described for the No Action Alternative, but may be ongoing for a longer total period of time. The construction of either the Area G landfill expansion or a new replacement facility within TA–67 would result in levels of sound and short-range ground vibrations that would be no different than those associated with current Area G landfill activities. Workers would be primarily affected by these noises, although motorists may occasionally hear low levels of equipment noises along Pajarito Road under certain climatic conditions. The construction of the roadway between TA–55 and TA–3 for pit production implementation would be short term and consistent with routine construction activities associated with road construction. Road construction would not be performed for a 20 pits per year production rate, the Preferred Alternative. Other planned construction activities under this alternative are mostly small-scale outdoor activities or interior to existing buildings, or the construction of an add-on to an existing building, or construction of a new building within close proximity to others. Effects of these construction activities would be primarily limited to involved workers and are not likely to result in any adverse effect to sensitive wildlife species or their habitat within the vicinity.

The primary noise, airblast waves, and ground vibration impacts from the implementation of this alternative would be generated by the increased number of HE tests, although these explosions and the resulting noise would still be occasional (rather than continuous) events. These would individually not result in effects that would be different than the effects currently generated whenever there is a HE test. The effects of these activities on cultural resources in the vicinity of the tests are addressed in section 5.3.8. It is not expected that such tests would adversely affect off-site sensitive receptors (e.g., those at BNM or at White Rock). Noises heard at that distance would be similar to thunder in intensity, and airblast and ground vibrations are not expected to be present off site of LANL at intensities great enough to adversely affect real properties. It is uncertain if any sensitive wildlife species would be adversely affected by additional numbers of "thunder-like" explosives testing events over that represented by the No Action Alternative. This is unlikely, however, given their continued presence in areas over the country that are known to be within higher-than-average lightning event areas.

5.3.2 Geology and Soils

Potential impacts for the Expanded Operations Alternative on geology and soils would be essentially the same as those for the No Action Alternative. LANL historical levels of firing site activities were 1.2 times greater than proposed for the Expanded Operations Alternative (LANL 1995d). For the same reasons as discussed under the No Action Alternative, the Expanded Operations Alternative should have little potential to contribute substantially to soil or sediment contamination. The expansion of Area G, TA–54, would temporarily result in slightly more disturbed soils than the other alternatives. This, however, would not have a significant impact on soil erosion or geology in the area because: (1) only a few disposal cells are open at any one time and (2) after a disposal cell is filled and closed, it is then revegetated. Because Zone 4 is currently designated for LLW disposal and Zone 6 is designated for solid waste management, this land is not available to be mined for mineral resources. These impacts would not change for other PSSC alternatives.

5.3.3 Water Resources

5.3.3.1 *Surface Water*

Table 5.3.3.1–1 shows the total flow from the NPDES outfalls for each of the major watersheds under the Expanded Operations Alternative. The estimated total gallons discharged into all watersheds equals 278 million gallons (1,052 million liters) under the Expanded Operations Alternative. This is an increase from the index effluent volume of 233 million gallons (882 million liters).

NPDES outfall effluent quality during the period of the SWEIS (1997 through 2006) is

TABLE 5.3.3.1–1.—*NPDES Discharges by Watershed Under the Expanded Operations Alternative*[a]

WATERSHED	#OUTFALLS		DISCHARGE (MGY) KEY FACILITIES					
			KEY FACILITIES		NON-KEY FACILITIES		TOTALS	
	INDEX	EXPANDED	INDEX	EXPANDED	INDEX	EXPANDED	INDEX	EXPANDED
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	44.6	0.5	0.2	19.7	44.8
Mortandad	12	7	42.0	32.3	10.9	5.1	52.9	37.4
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	42.8	103.5	127.9	107.9	170.7
Water	21	10	29.5	14.2	0.0	0.0	29.5	14.2
Totals	87	55	103.6	135.7	129.6	142.0	233.2	277.8

MGY: millions of gallons per year

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future, as discussed in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

expected to be the same under this alternative as described for the No Action Alternative, including the radionuclide concentrations in effluent from TA–50, as presented in Table 5.3.3.1–1. In volume III, appendix A, Table A.1–1 presents a more detailed table of the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. Similar to the No Action Alternative, the canyons that have an increase in outfall flow over the index are Los Alamos Canyon and Sandia Canyon. The increase in flow for Sandia Canyon is the same as that discussed for the No Action Alternative. The potential impacts from the increase in flow of 25 million gallons (95 million liters) per year in Los Alamos Canyon should be minimal for the same reasons as discussed in the No Action Alternative.

Under the Expanded Operations Alternative, a dedicated transportation corridor approximately 1 mile (1.6 kilometers) in length would be constructed between TA–55 and TA–3, parallel to Pajarito Road. It would occupy an area of approximately 7 acres (2.8 kilometers). This nearly paved surface would result in slightly more stormwater runoff. Construction activities at LANL employ engineering controls to prevent contamination of stormwater runoff. The effects at this slight increase in stormwater runoff should be minimal in terms of both erosion and sediment transport. At the 20 pits per year production rate (Preferred Alternative), the road would not be constructed.

5.3.3.2 *Alluvial Groundwater*

The increases in NPDES outfall discharges (as compared to the No Action Alternative) are expected to result in proportionally greater alluvial groundwater volumes.

The values listed above illustrate that under the Expanded Operations Alternative, the volume of effluent discharged into Mortandad Canyon from RLWTF (9.3 million gallons [35 million liters] per year) would approach double that of the RLWTF index volume of 5.5 million gallons (21 million liters) per year. Such an increase may substantially increase the volume of groundwater stored in the alluvium, raising the groundwater table and extending the groundwater body farther down the canyon. Previous estimates of water stored in the alluvium in Mortandad Canyon range from 4 to 8 million gallons (15 to 30 million liters). The capacity for additional storage is unknown. Also unknown are the rates of infiltration into the tuff below and the volume lost to evaporation. If evaporation rates or infiltration rates into the underlying tuff beneath the alluvium are sufficiently low, it is possible that increasing the discharge volume may eventually result in groundwater resurfacing as seeps or springs farther down the canyon. However, it is important to note that this is unlikely because under past conditions of maximum discharge (up to 13 million gallons [50 million liters] per year) at RLWTF, no springs or wetlands were created.

Another important factor to consider is that the overall flow from NPDES outfalls into Mortandad Canyon will be decreased from the baseline by 16 million gallons (61 million liters) per year. The majority of the outfalls with reduced flows are TA–48 and TA–35, and they are either just upstream or close to the RLWTF outfall.

The impacts to alluvial groundwater quality should be minimal; however, any additional groundwater could increase infiltration into the tuff below the alluvium. The potential for groundwater migration down the Guaje Mountain Fault zone, located approximately one-quarter mile (0.4 kilometer) downstream of RLWTF outfall, may also increase. Increased infiltration through the tuff or the fault zone may allow more rapid transport of contaminants to the main aquifer. As discussed in the No Action Alternative, tritium and nitrate have been detected in the main aquifer beneath Mortandad Canyon, indicating that migration pathways possibly do exist (LANL 1992, LANL 1993, LANL 1994, and LANL 1995c). LANL will continue to monitor downstream of the RLWTF the main aquifer and alluvial groundwater for any indicators of potential problems.

As discussed for the No Action Alternative, the new HELWTF became fully operational in 1998 and water quality will likely improve in Canyon de Valle near TA–16.

5.3.3.3 *Perched Groundwater*

Groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. It is possible that the increased NPDES discharges to Los Alamos and Sandia Canyons under this alternative could increase recharge of the intermediate perched groundwater and contaminant transport beneath these canyons.

5.3.3.4 *Main Aquifer*

Recharge mechanisms to the main aquifer are uncertain. However, for the same reasons as discussed under the No Action Alternative, impacts resulting from increased NPDES outfall flows to the main aquifer water quality should be negligible under the Expanded Alternative.

A conservative projection of LANL water use under the Expanded Operations Alternative is 759 million gallons (2,873 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the County used about 958 million gallons (3,626 million liters) from this water right and the NPS used about 5 million gallons (19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer; however, projected use may approach 100 percent of the existing water rights to the main aquifer under this alternative.

For the purposes of modeling drawdown of the main aquifer, annual water use projections were made. The total water usage from DOE water rights was projected to average 1,724 million gallons (6,525 million liters) per year under the Expanded Operations Alternative, with a maximum annual use of 1,751 million gallons (6,628 million liters) and a minimum annual use of 1,665 million gallons (6,302 million liters).

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.3.3.4–1 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the Expanded Operations Alternative; as noted in section 5.2.3.1, these changes are not all due to LANL operations. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. The impacts to the volume of water in the main aquifer under this alternative are very similar to those described for the No Action Alternative; the drawdowns in DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage.

Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

5.3.3.5 *Area G*

In 1997, a draft Performance Assessment (PA) and Composite Analysis (CA) were prepared for the current solid LLW disposal facility, Area G. The PA was approved by DOE in October 1998 (LANL 1998c). The purpose of the PA is to determine if Area G disposal of LLW generated and projected since September 26, 1988, would result in radiation doses to members of the public that exceed performance objectives specified by DOE

TABLE 5.3.3.4–1.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the Expanded Operations Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-15.6
Otowi Well Field (Well 0-4)	-15.2
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-9.3
Santa Fe Water Supply	
Buckman Well Field	+21.6
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.

[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid- cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite different from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and can not be considered as finite changes.

Order 5820.2A and the report, *Interim Format and Content Guide and Standard Review Plan for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments* (DOE 1996c). In a complementary fashion, the CA is used to evaluate options for ensuring that exposures from all waste disposed of at Area G will not impart doses to future members of the public in excess of specified limits. Together, the PA and CA provide a comprehensive evaluation of the potential radiological exposures to future members of the public from past, present, and future waste disposal at Area G. The PA includes as part of the "future disposal of waste at Area G" the expansion of Area G, as discussed in volume II, part I of this SWEIS. Doses are projected beyond 1,000 years after facility closure, which is assumed to occur in 2044. These results are compared with performance objectives. The results of the PA in terms of surface water and groundwater impact are summarized in the following paragraphs. While the PA and CA are specific to Zone 4 at Area G, the geologic features of the entire Mesita del Buey have essentially identical site characteristics, and the PA and CA results for Zone 4 would be applicable to the Zone 6 and North Site locations as well. While there are some differences between the characteristics between the Zone 4 and TA–67 sites, these are sufficiently similar that the PA and CA results would be expected to be applicable to TA–67; the one potential exception to this statement is that the fault underlying part of TA–67 could introduce some additional issues regarding the use of TA–67 for waste disposal (Newell 1998).

Flooding of the disposal facility is not a major concern due to the natural inclination for runoff from the mesa into canyon; temporary ponding within disposal pits, however, has occurred. A recent field study at Area G demonstrated that disposal cells covers are subject to sheet erosion, with only small, localized rill occurring infrequently. The expansion of Area G would temporarily result in slightly more disturbed soils. This, in turn, would result in slightly more stormwater runoff.

Observation wells and moisture-access holes were drilled in Cañada del Buey and Pajarito Canyon to determine if perched water existed within canyon alluvium and, if present, if it extended beneath Mesita del Buey. Wells in Cañada del Buey were essentially dry, and it was concluded that perched water in Pajarito Canyon, adjacent to Mesita del Buey, is confined to the alluvium in the stream and does not extend to the flank of the canyon.

It was concluded that the main aquifer is the only source capable of serving municipal and industrial water needs, and the PA results show that the design of Area G takes advantage of the natural ability of the site to contain radioactivity (Purtyman 1995). The very dry host rock effectively decouples radioactivity in LLW from the main aquifer for thousands of years. The groundwater performance objective is a maximum effective dose equivalent of 4 millirem per year to any member of the public from the consumption of drinking water drawn from wells outside of the land-use boundary. The groundwater protection analysis from the PA and CA resulted in peak annual doses within 1,000 years at the point of maximum exposure, the east-southeast boundary of Area G and Parjarito Canyon, of 7.5×10^{-8} and 0.000035 millirem, respectively. These doses are more than 100,000 times smaller than the dose performance objectives.

5.3.4 Air Quality

5.3.4.1 *Nonradiological Air Quality Impacts*

Criteria Pollutants

As stated in section 5.1.4, estimates of future emission rates were based on the operations anticipated under the Expanded Operations Alternative—the worst-case alternative with respect to emission rates from the combustion sources. The results of the Expanded Operations Alternative analysis of criteria pollutants demonstrate that the highest estimated concentration of each pollutant would be below the standards established to protect human health with an ample margin of safety. These results are presented in Table 5.3.4.1–1.

Toxic Air Pollutants

In all but two cases, the estimated pollutant concentrations were below the corresponding GVs established for this analysis. GVs are the levels established to screen emission rates for further analysis. The two cases where estimated emission rates were above GVs and were referred to the human health and ecological risk assessment processes are:

- Emissions from HE Firing Site operations at TA–14, TA–15, TA–36, TA–39, and TA–40 (appendix B, attachment 13); the estimated concentration of a pollutant is greater than its GV for the following releases:
  - DU, beryllium, lead, aluminum, copper, tantalum, tungsten, and iron from TA–15
  - DU, beryllium, lead, copper, and iron from TA–36
  - Beryllium, lead, aluminum, and copper from TA–39
  - DU and lead from TA–14
  - Copper from TA–40
- The additive emissions from all of the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center (appendix B, attachment 6)

The combined incremental cancer risks associated with releases of all carcinogenic pollutants from all TAs at the receptor locations where these impacts actually occur are slightly above GV of 1.0×10^{-6} only at the two locations within the LANL medical center: 1.17×10^{-6} at

TABLE 5.3.4.1–1.—*Results of Criteria Pollutants Analysis (Expanded Operations Alternative)*

POLLUTANT	TIME PERIOD	MAXIMUM ESTIMATED CONCENTRATIONS ($\mu g/m^3$)	ASSUMED BACKGROUND CONCENTRATIONS[a] ($\mu g/m^3$)	TOTAL POLLUTANT CONCENTRATIONS ($\mu g/m^3$)	NEW MEXICO CONTROLLING AMBIENT AIR QUALITY STANDARDS[b] ($\mu g/m^3$)
Carbon Monoxide	1 hour	2,712	2,350	5,062	11,750
	8 hours	1,436	1,560	2,996	7,800
Nitrogen Dioxide	24 hours	90[c]	29	119	147
	Annual	9	15	24	74
Sulfur Dioxide	3 hours	254	205	459	1,025
	24 hours	130	41	171	205
	Annual	18	8	26	41
Total Suspended Particulates	24 hours	18	30	48	150
	Annual	2	12	14	60
PM_{10}	24 hours	9	30	39	150
	Annual	1	10	11	50
Lead	3 months (calendar quarter)	0.00007	0.30	0.30	1.5

[a] No data exist for background values. It was conservatively assumed that background concentrations were 20 percent of the corresponding standard. As there are almost no other combustion sources in and around Los Alamos, the background concentrations would be much less than the 20 percent assumed concentrations.
[b] New Mexico Ambient Air Quality standards, for some of the pollutants, are stated in parts per million (ppm). These values were converted to micrograms per cubic meter ($\mu g/m^3$), with appropriate corrections for temperature and pressure (elevation) following New Mexico Dispersion Modeling Guidelines (NM 1996).
[c] New Mexico Air Quality Bureau accepts Ozone Limiting Method (OLM) to more accurately determine nitrogen dioxide (NO_2) concentrations. The 24-hour maximum modeled concentration for nitrogen oxide was 520 $\mu g/m^3$. This concentration, when modeled using OLM, is only 90 $\mu g/m^3$ of NO_2.

an air intake duct, and 1.07 x 10^{-6} at an operable window.

The major contributors to the estimated combined cancer risk values are chloroform, formaldehyde, and trichloroethylene from TA–43, the HRL, and multiple sources for methylene chloride. The estimated maximum cancer risk for each of these individual pollutants is 9 x 10^{-7}, 5 x 10^{-8}, 7 x 10^{-8}, and 7 x 10^{-8}, respectively. Of these, the relative contribution of chloroform emissions alone to the combined cancer risk value is more than 87 percent (conservatively assuming that 100 percent of the chloroform used is emitted). The impacts of TA–43 emissions are due to a combination of relatively high emission rates, close proximity between receptors and sources, and the elevation of the receptors.

5.3.4.2 *Radiological Air Quality Impacts*

This section addresses the radiation dose to the FS MEI, LANL MEI and the population dose from LANL radionuclide air emissions under the Expanded Operations Alternative.

Facility-Specific Maximally Exposed Individual

MEI dose estimates are shown in Table 5.3.4.2–1. This table shows the highest FS MEI dose is 5.44 millirems per year, which is 54.4 percent of the regulatory limit for the air pathway. The EPA regulatory limit would not be exceeded from emissions of these facilities under the Expanded Operations Alternative.

TABLE 5.3.4.2–1.—*Facility-Specific Information—Expanded Operations Alternative*

FACILITY	DOSE[a] (mrem/yr)
TA–3–29 (CMR)	1.32
TA–3–66 (Sigma Building)	1.32
TA–3–102 (Machine Shops)	1.02
TA–11 (High Explosive Testing)	0.73
TA–15/36 (Firing Sites)	4.99
TA–16 (WETF)	0.70
TA–18 (Pajarito Site: LACEF)	4.39
TA–21 (TSTA and TSFF)	2.55
TA–48 (Radiochemistry Laboratory)	3.67
TA–55 (Plutonium Facility)	3.67
TA–53 (LANSCE)[b]	5.44
TA–54 (Boundary)[c]	1.81
TA–54 (White Rock)	1.07

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. An MEI does not leave or take protective measures.
[b] This is also the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES-2, ES-3, IPF, LEDA and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54 because Area G is bordering San Ildefonso Pueblo land. The first is a MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

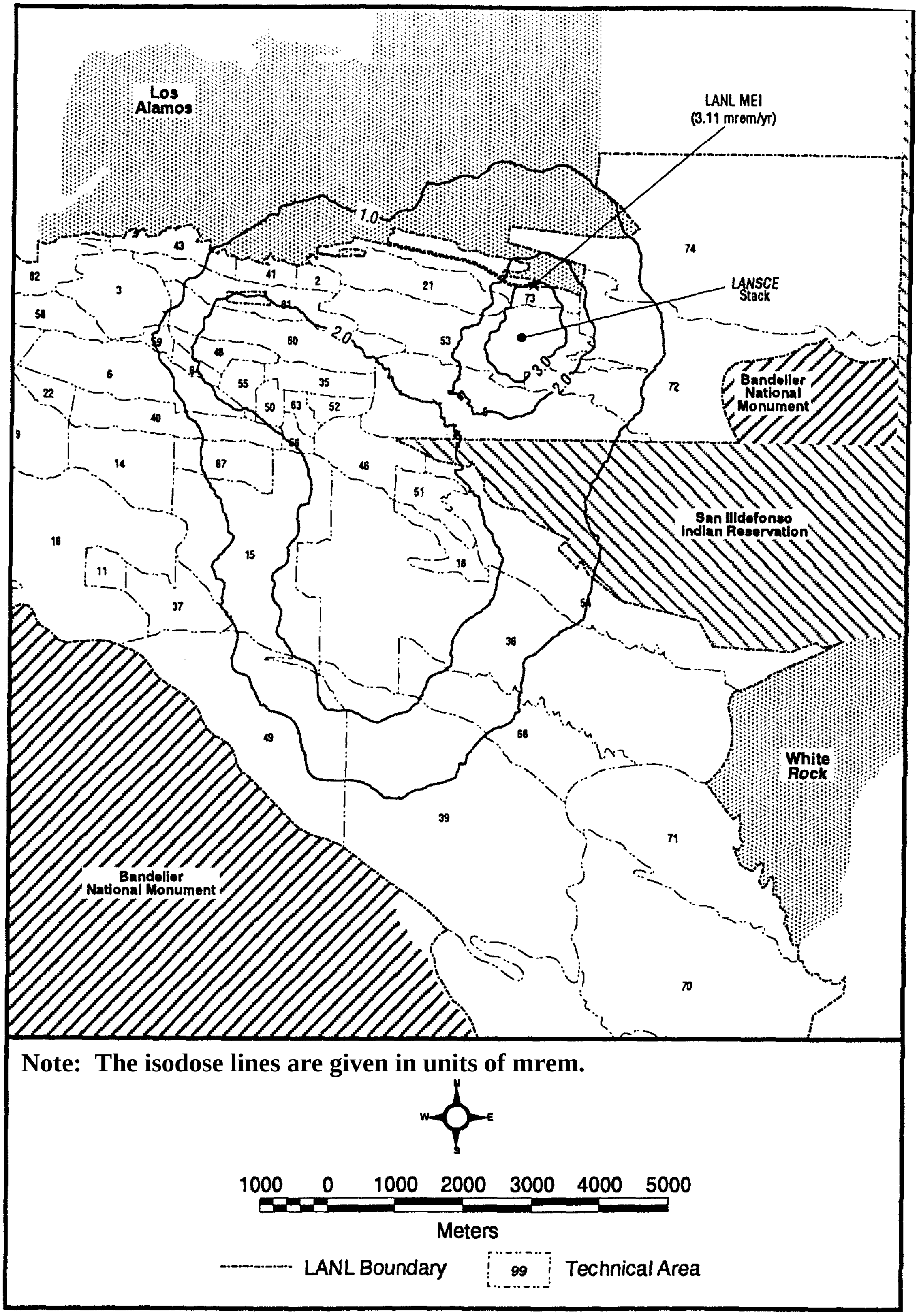
LANL Maximally Exposed Individual

The location of the LANL MEI (2,625 feet [approximately 800 meters] north-northeast of TA–53) was shown to be identical to the FS MEI with the highest dose under the Expanded Operations Alternative. The LANL MEI dose was also calculated to be 5.44 millirems per year.

Population Dose. The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated to be 33.09 person-rem per year. TA–15/36 accounts for 64.1 percent of this dose (collective diffuse emissions, including those from these TAs, account for 64.5 percent of this dose). The values reported for population doses for this alternative, as well as the other alternatives, is higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in chapter 3 (section 3.6).

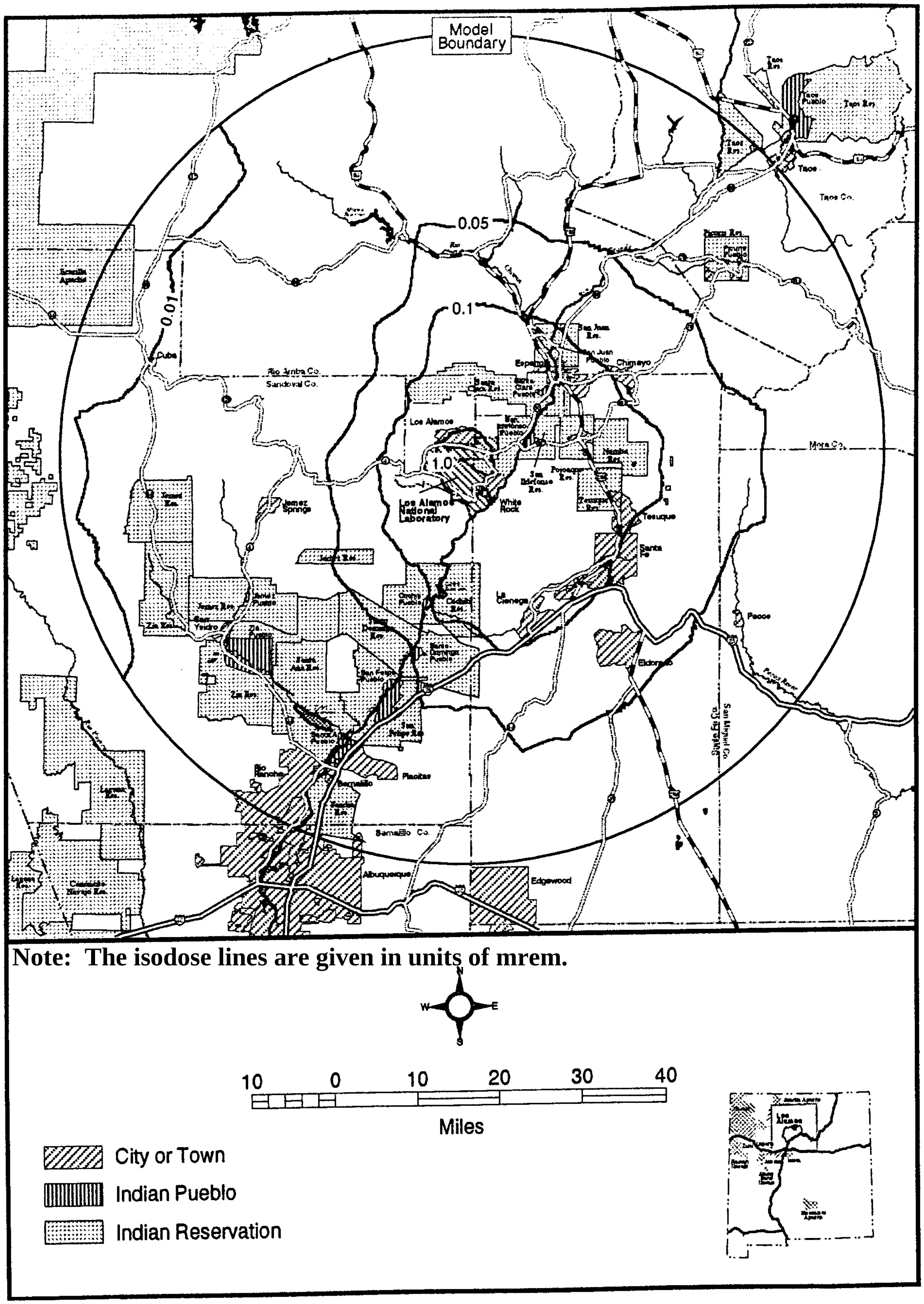
Isodose Maps. The isodose maps for the Expanded Operations Alternative are shown in Figures 5.3.4.2–1 and 5.3.4.2–2.

Pit Production. The impacts listed above are influenced only slightly by pit production activities. At the CMR Building, there are two types of contributions: (1) analytical chemistry support and (2) activities moved from TA–55 to the CMR Building under the "CMR Building Use" Alternative for pit production. At a pit production rate of 80 pits per year, regardless of the PSSC alternative, analytical chemistry support is projected to contribute about 13 microcuries per year to the total CMR Building air emissions (which are projected to be about 760 microcuries per year under the Expanded Operations Alternative).



Note: The isodose lines are given in units of mrem.

FIGURE 5.3.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the Expanded Operations Alternative.*



Note: The isodose lines are given in units of mrem.

FIGURE 5.3.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the Expanded Operations Alternative.*

At a pit production rate of 20 pits per year (Preferred Alternative), the analytical chemistry contribution to air emissions is projected to be about 3 microcuries per year (or about a quarter of the 80 pits per year contribution to emissions).

Under the Brownfield and TA–55 Add-on Alternatives, as well as at the 20 pits per year production rate (Preferred Alternative), the analytical chemistry contribution to air emissions is the only contribution directly attributable to pit production. However, under the PSSC "CMR Building Use" Alternative (at 80 pits per year), activities that contribute to air emissions are moved from TA–55 to the CMR Building. The total contribution of these activities to CMR Building emissions is projected to be about 25 microcuries per year (as compared to the CMR Building total emissions of 760 microcuries). Thus, the CMR Building radioactive air emission rates directly attributable to pit production work at LANL do not substantially influence the FS MEI dose, the LANL MEI dose, the population dose, or the isodose maps.

At TA–55, there are two types of activity contributions important to understanding pit production impacts: (1) pit production work within TA–55 and (2) activities that would be moved to the CMR Building under the PSSC "CMR Building Use" Alternative. The pit production work at LANL contributes about 11 microcuries per year to air emissions at the 80 pits per year rate; at the 20 pits per year rate (Preferred Alternative), the contribution would be about 3 microcuries per year. For the PSSC "CMR Building Use" Alternative, activities that contribute about 25 microcuries per year in emissions (under the Expanded Operations Alternative level of operations) are transferred to the CMR Building. Under the Brownfield and TA–55 Add-on PSSC Alternatives, as well as at the 20 pits per year rate (Preferred Alternative), those activities would remain at TA–55 (and those emissions would remain at TA–55).

The PSSC "CMR Building Use" Alternative results in total TA–55 particulate radioactive air emissions of about 27 microcuries per year. At the 20 pits per year rate (Preferred Alternative), the total TA–55 particulate air emissions would be about 44 microcuries per year. The radioactive particulate air emissions associated with TA–55 operations, including those associated with pit production activities, are substantially smaller than emissions throughout LANL that contribute substantially to the LANL MEI, the population dose, and the isodose map contours. While the TA–55 MEI dose could change slightly depending on the PSSC alternative selected (or as compared to that at the 20 pits per year rate, the Preferred Alternative), such changes would not be expected to be substantial for the following reasons:

- The 25 microcuries per year associated with activities that might move to the CMR Building under the PSSC "CMR Building Use" Alternative, is a small amount compared to other radioactive air emissions in the area.
- Whether those emissions (25 microcuries per year) occur at the CMR Building or at TA–55, they contribute to the TA–55 MEI dose. (Of course, their contribution to the TA–55 MEI dose is greater as a TA–55 emission than as a CMR Building emission.)
- The TA–55 MEI dose has substantial contributions from other facilities in the area—99 percent of the TA–55 MEI dose under the PSSC "CMR Building Use" Alternative is due to facility emissions other than those of TA–55. (See volume III, appendix B, Table B.1.2.1.–2.)

In short, the TA–55 radioactive air emissions differences due to the different PSSC alternatives (or the 20 pits per year rate, the Preferred Alternative) are not expected to result in substantial changes in the impacts reflected above.

5.3.4.3 *Project-Specific Siting and Construction Analyses*

As noted in volume II, part I, the expansion of Area G into Zones 4 and 6 would generate dust particles and vehicle exhaust during construction, in addition to the operational impacts discussed above. Additionally, trees cleared from the area may be chipped and burned on site. These construction impacts would be mitigated through dust suppression methods such as misting, and any burning would be performed under an open burning permit such that air quality standards would not be violated. These construction activities would not be expected to degrade the quality of air in residential areas. The impacts would be similar under any of the alternatives considered in this PSSC analysis, with the potential for increased clearing and wood burning associated with the TA–67 alternative.

As discussed in volume II, part II, the construction activities associated with the enhancement of pit manufacturing would not be expected to change radiological air emissions. Nonradiological emissions associated with this construction activity would be expected, but would not exceed regulatory standards and would not be expected to impact workers or the public. The impacts would be similar under any of the alternatives considered in this PSSC analysis. (Note that the nonradiological emission impacts associated with these construction activities would not be incurred at the 20 pits per year production rate, the Preferred Alternative.)

5.3.5 Ecological Resources, Biodiversity, and Ecological Risk

Impacts to ecological resources and biodiversity resulting from implementation of the Expanded Operations Alternative would be similar to that of the No Action Alternative, even considering the chemical emissions that exceeded GVs, as discussed in section 5.3.4. Ongoing LANL facility operation and planned actions would enhance current biological resources (including protected and sensitive species), ecological processes, and biodiversity. There would be a small habitat loss due to the expansions of pit manufacturing and Area G's disposal area, as discussed in section 5.3.5.1. Impact to wetlands as a consequence of outfall reduction and an increase in effluent discharges would be approximately the same as for the No Action Alternative. While effluent quantities would be higher than No Action, the potential for expansion of wetlands would remain low.

There would be an increase in the frequency of explosives testing associated with Expanded Operations. However, the noise and vibration associated with individual testing events would be the same as currently experienced, and no adverse impacts to animals, including threatened and endangered species, are anticipated from this increase in testing frequency.

As with the No Action Alternative, Expanded Operations would have little potential to contribute substantially to soil, water, and air contamination. The projected slight increase in deposition of contaminants resulting from an increase in the frequency of explosives testing would be small relative to historical deposition rates. Consequently, there would not be a discernible change from the No Action level of ecological risk. Again, the continued cleanup of legacy contamination is expected to reduce the contribution of past (legacy) LANL operations to ecological risk.

5.3.5.1 *Project-Specific Siting and Construction Analyses*

The proposals to expand pit manufacturing operations and expand Area G's LLW disposal area are integral components of expanded operations. These two components of expanded operations involve removal and disturbance of habitat as a consequence of facility construction.

The removal of vegetation (primarily ponderosa pine-Gambel oak woodland) due to the proposed road connecting TA–3 with TA–55 would remove a small amount of habitat for small mammals and birds, and the possible erection of a mile-long security fence could alter large mammal movement along Pajarito Road. This habitat loss would be small, and altered large animal movement should not appreciably affect animal behavior and habitat use. Disturbance to wildlife utilizing adjacent habitat due to construction noise and activity would be minor and short term. Under the Preferred Alternative, at the 20 pits per year production rate, this would not be built, so these impacts would not be incurred.

Both the peregrine falcon and the bald eagle could utilize the area proposed for the road as part of their overall foraging area. A preliminary model for Mexican spotted owl habitat indicates that fragmented patches of potential nesting/roosting habitat exists within 0.2 mile (0.32 kilometer) of the proposed connector road, and the road area includes foraging habitat. The bald eagle is not likely to be adversely affected by the very small loss of low use foraging habitat, and the loss of less than 0.05 percent of foraging habitat available for the peregrine falcon on LANL is not likely to result in an adverse effect. The Mexican spotted owl is not likely to be adversely affected because of the fragmented nature of potential nesting/roosting habitat, current high level of noise and disturbance in the area, and very small reduction (0.06 percent) of available foraging habitat within LANL boundaries. Because these impacts are related to the road, if the road is not built under any of the PSSC alternatives, these impacts would not be incurred. (Also, under the Preferred Alternative at 20 pits per year production rate, at the road would not be built and these impacts would not be incurred.)

The phased expansion of Area G would involve the gradual removal of approximately 41 acres (16 hectares) of pinyon-juniper woodland. This removal would change or eliminate bird and small mammal habitat in direct proportion to the acreage disturbed. Because of the local and regional abundance of this community type and partial ground cover restoration following pit closure, wildlife habitat loss and disturbance would be small. Disturbance resulting from construction noise and activity would be minor and short term. No new impacts to large mammals are anticipated. Area G is part of the LANL-wide foraging habitat for the peregrine falcon and a nest site is located more than 3 miles (4.8 kilometers) away. Implementation of the proposed action would not affect nesting habitat nor would the eventual loss of up to 41 acres (16 hectares) (0.05 percent) of available foraging habitat on LANL adversely affect the peregrine falcon. The nature of these impacts would be the same for any of the PSSC alternatives considered, with the only difference being the acreage involved (volume II, part I).

5.3.6 Human Health

The consequences of implementation of the Expanded Operations Alternative on public health and worker health are presented below. As discussed in section 5.1.6 and in volume III (appendix G, section G.1), “risk,” as used in the SWEIS human health analysis, refers to the probability of toxic or cancer mortality under the specific exposure scenarios analyzed.

5.3.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the Expanded Operations Alternative are presented below for the same topics discussed in section 5.2.6.1.

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

The LANL MEI was estimated to be 2,625 feet (approximately 800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose to the MEI at this location is 5.44 millirem per year (section 5.3.4.2), corresponding to a 72-year lifetime dose of 390 millirem. This location borders the Los Alamos townsite and is a conservative estimate for a MEI from LANL emissions. The background total effective dose equivalent (TEDE) dose in the Los Alamos area is estimated to be 360 millirem per year (section 4.6.1.1); thus, the dose to the MEI is 1.5 percent of the background dose.

Table 5.3.6.1–1 summarizes the LANL MEI dose and presents the corresponding risk of excess LCF to the MEI. These risks are presented on a lifetime basis, assuming that the LANL MEI received the estimated dose of 5.44 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.0002 over a lifetime.

The isodose maps showing both the estimated dose near LANL and within a 50-mile (80-kilometer) radius of LANL are given in Figures 5.3.4.2–1 and 5.3.4.2–2. The population dose within the 50-mile (80-kilometer) radius is also given in Table 5.3.6.1–1, estimated to be 33.1 person-rem per year. As reflected in the table, the annual operations excess LCF risk was estimated to be about 0.017.

In the Expanded Operations Alternative, there are 11 facilities with FS MEIs receiving a dose that would exceed 1 millirem per year (volume III, appendix B):

- LANSCE, 5.44 millirem per year to the FS MEI
- HE Testing Sites (TA–15 and TA–36), 4.99 millirem
- Pajarito Site (TA–18), 4.39 millirem
- Radiochemistry Laboratory (TA–48). 3.67 millirem
- Plutonium Facility (TA–55), 3.67 millirem
- TSTA and TSFF (TA–21), 2.55 millirem
- Area G (at LANL boundary), 1.81 millirem
- CMR Building, 1.32 millirem
- Sigma, 1.32 millirem
- Area G (at White Rock), 1.07 millirem
- Machine Shop, 1.02 millirem

External Radiation: Two Special Cases

As discussed in section 5.2.6.1, one contribution to public dose results from jogging or hiking for 96 hours on the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA. The MEI dose is not expected to change under the Expanded Operations Alternative from that estimated under the No Action Alternative (an EDE of 2.9 millirem per year and an excess LCF risk of about 1.4×10^{-6} per year).

Another contribution to public dose, as discussed in section 5.2.6.1, would result from TA–18 “road-open” operations. At the 95 percent confidence level, six exposures per

TABLE 5.3.6.1–1.—*Estimated Public Health Consequences for LANL MEI and the Population Within a 50-Mile (80-Kilometer) Radius of LANL for the Expanded Operations Alternative*

PARAMETER	LANL HYPOTHETICAL MEI	50-MILE (80-KILOMETER) RADIUS POPULATION
Dose	5.44 millirem/year	33.09 person-rem/year
Excess LCF	0.000196/lifetime (72 year)	0.017/year of operations

year of 4.75 millirem each would be expected for the MEI out of the 150 operations per year at TA–18 under the Expanded Operations Alternative. This would result in an annual projected MEI EDE of 28.5 millirem per year. The lifetime excess LCF risk for this dose is about 0.0000142 per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. The consequence of a public exposure to this source under the Expanded Operations Alternative is the same as for the No Action Alternative; as discussed in section 5.2.6.1, this consequence is negligible.

Consequences of Airborne Chemical Emissions

In the analysis of the Expanded Operations Alternative, four technical areas involved in HE testing were identified (TA–14, TA–15, TA–26, and TA–39) to require public health consequence analysis for specific chemicals (beryllium, lead, and DU). As discussed in section 5.2.6.1, other chemical emissions from HE testing operations were not analyzed in detail because their toxicity reference values and estimated concentrations in air were minor, as compared to those emissions analyzed in detail. Hazard indices were calculated for two of these three metals. An HI equal to or above 1 is considered consequential from a human toxicity standpoint. For the Expanded Operations Alternative, the worst-case HI for lead did not exceed 1.5 in 100,000 (0.000015). For DU, the worst-case HI did not exceed 6.5 in 100,000 (0.000065).

Beryllium has no established EPA reference dose from which to calculate the HI. Beryllium was evaluated as a carcinogen, however. The excess LCF for beryllium under the Expanded Operations Alternative was estimated to be 3.6×10^{-7} per year.

Carcinogenic Risk from Air Emissions

The screening process described in volume III, appendix B, identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs. The risk factors used are conservative, and represent the upper bound of the risk. The carcinogenic risk is also uncertain, and could be much smaller, as discussed in appendix D, section D.1.1.8.

This incremental combined cancer risk to the public due to all carcinogenic pollutants from all TAs exceeded the 1.0×10^{-6} GV level at two locations at the Los Alamos Medical Center: receptor site 175, the air duct 39 feet (12 meters) above grade (1.17×10^{-6}), and receptor site 180, an operable window 5 yards (1.5 meters) above grade (1.07×10^{-6}) (section 5.3.4.1 and appendix B, attachment 6, Table D). The incremental combined cancer risk estimated under the Expanded Operations Alternative for these two locations are dominated by the contribution estimated for chloroform emissions from HRL, next to the Los Alamos Medical Center.

The sensitivity of the incremental combined cancer risk analysis to chloroform is so great that the realism of the assumptions made for chloroform emissions estimation were examined. The assumptions were found to be unrealistic because the screening analysis assumed that 100 percent of the chloroform used was emitted into the air outside HRL. Records at HRL indicate that at least 50 percent of the annual usage of chloroform is disposed as liquid waste and could not be, therefore, released to the air. Using the more realistic but maximum concentrations of chloroform that could be emitted into the air, the incremental combined cancer risk at the two receptor locations at Los Alamos Medical Center would be 7.3 to 7.4×10^{-7}. This value is below the GV for human health consequences from carcinogenic air emissions. No further analysis was conducted because any further analysis would simply reduce the estimated incremental combined cancer risk toward more realistic levels. It is believed that negligible increase in incremental combined cancer risk will result from the Expanded Operations Alternative.

Consequences of Ingestion to Residents, Recreational Users, and Special Pathways Receptors

The risk to the public from ingestion under the Expanded Operations Alternative does not differ from that associated with the No Action Alternative; this is because most of the risk is attributable to the existing levels of contamination in water and soils in the area. This is discussed further in sections 5.1.6 and 5.2.6.1. Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6×10^{-6} per year of exposure and 9.1×10^{-7} per year of exposure for the individual who is also an avid recreational user. These worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in appendix D, section D.3.3. Table 5.2.6.1–3 summarizes the risk associated with metals ingestion to MEIs in the LANL region, which does not vary among alternatives. The risk factors used are conservative and represent the upper bound of the risk. The carcinogenic risk also is uncertain and could be much smaller, as discussed in appendix D, section D.1.1.8.

Consequences to the Public along Transportation Routes

Section 5.3.10 details the analysis of transportation consequences. Public health consequences include the dose and excess LCF risk associated with routine, accident-free transportation. Table 5.3.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments. The population dose and excess LCF associated with exposures occurring during stops for transportation segments near LANL is provided in Table 5.3.6.1–2. Doses associated with living along and sharing routes with these shipments are detailed in Table 5.3.10–2, and are less than those associated with stops. Risks associated with accidents during transportation also are discussed in section 5.3.10.

5.3.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological (ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the Expanded Operations Alternative are given below and detailed in volume III, appendix D, section D.2.2.

TABLE 5.3.6.1–2.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials and Wastes from LANL Under the Expanded Operations Alternative*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	4.0	0.0020
U.S. 84/285	4.2	0.0021

Radiological Consequences

Ionizing Radiation Consequences. Table 5.3.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the Expanded Operations Alternative.

The collective worker dose under the Expanded Operations Alternative is conservatively projected to be approximately four times that measured in 1993 to 1995. In terms of the average non-zero dose to an individual worker, the Expanded Operations Alternative is expected to result in 0.24 rem per year for Expanded Operations Alternative, as compared with 0.097 rem per year, 1993 to 1995. The estimated lifetime excess LCF risk is 0.000096 per year of operation.

Of the total worker radiation dose under this alternative (833 person-rem per year), about 220 person-rem per year is associated with pit production activities, regardless of the PSSC alternative selected. (This is an increase of about 150 person-rem per year over the exposures for such activities under the No Action Alternative.) Under the Preferred Alternative, at the 20 pits per year rate, the pit production contribution would be about 90 person-rem per year, and the total worker exposure would be about 704 person-rem per year (with a corresponding 15 percent decrease in the estimated excess LCF risk).

Nonionizing Radiation. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources, including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (Also see volume III, appendix D, section D.2.2 for evaluation used to estimate nonionizing radiation from LANL operations to humans and wildlife and section D.4, for estimated results.)

Chemical Exposure Consequences

It is anticipated that there will continue to be a few exposures annually, particularly exposures to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

TABLE 5.3.6.2–1.—*Annual Worker Doses and Associated Lifetime Excess LCF Risks Under the Expanded Operations Alternative*

LANL Collective Worker Dose (person-rem/year)	833
Estimated Excess LCF Risk (across the worker population) per year of operation	0.33
Average Non-Zero Worker Dose (rem/year)	0.24
Estimated Excess LCF Risk (average worker > 0 dose)	0.000096

Under the Expanded Operations Alternative, it is expected that there will be a worker population of approximately 11,000 individuals, approximately 22 percent higher than index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the chemical hygiene program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures from continued operations would increase over the next 10 to 15 years to a total of two to five reportable chemical exposures per year.

Beryllium Processing Consequences. It is anticipated that beryllium operations under the Expanded Operations Alternative would be 50 to 60 percent higher than in the No Action Alternative. However, it is not anticipated that consequences to workers would be measurable, that is, no sensitization to beryllium would be detected using the LANL IH monitoring program.

Physical Safety Hazards

Table 5.3.6.2–2 compares the projected reportable accidents and injuries estimated for normal operations occurring under the Expanded Operations Alternative and that experienced during the index period. The Expanded Operations Alternative is expected to result in an increase in reportable cases due to increases in worker population. These incidents are considered within the consequences of normal operations of LANL because of the relatively higher frequency of occurrence than major accidents (section 5.3.11). These results assume that the aggressive Health and Safety Program underway at LANL does not achieve any additional reduction in reportable cases.

TABLE 5.3.6.2–2.—*Projected Annual Reportable Accidents and Injuries for the Expanded Operations Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 11,000
Projected Reportable Accidents and Injuries	507/year
Change from Index (1993 to 1996)	+21 %

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset, and subsequent physical therapy. Some injuries may also result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock or electrocution.

Project-Specific Siting and Construction Analyses

As discussed in volume II, parts I and II, workers involved in the construction activities associated with the expansion of the LLW disposal area and the enhancement of pit manufacturing operations would be exposed to risks typical of construction activities (e.g., back injuries, being crushed beneath heavy equipment, electrical hazards, etc.). These risks are mitigated by administrative controls and personal protective equipment, as needed. These risks are essentially the same under each of the alternatives considered in these PSSC analyses.

As discussed in volume II, part II, workers involved in the construction activities associated with the enhancement of pit manufacturing operations would receive about 45 person-rem due to radiation exposures associated with work inside TA–55, PF–4, and another 1.2 person-rem due to radiation exposures associated with work inside the CMR Building under the PSSC "CMR Building Use" Alternative. This means that 0.018 total excess LCFs (out of the entire construction workforce for the period of construction activity) would be expected due to the construction activity in these facilities. These impacts would not be expected for the other PSSC alternatives because they do not involve construction within operating nuclear facilities. Under the Preferred Alternative, equipment installation associated with establishing pit production at the 20 pits per year level would result in a small fraction of the exposure described above.

5.3.7 Environmental Justice

As indicated in sections 5.3.1 and 5.3.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the Expanded Operations Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface and groundwater and ecological resources associated with the Expanded Operations Alternative would affect all communities in the area equally. (See sections 5.3.3 and 5.3.5 for additional information on the potential for impacts to these resources.) Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Figure 5.3.7–1 reflects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL under the Expanded Operations Alternative. As discussed in section 5.2.7, impacts due to air emissions are equal to or lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts are not disproportionately high or adverse with respect to the minority or low-income populations. (See section 5.3.4 regarding the impacts anticipated for air emissions under the Expanded Operations Alternative.)

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.3.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the Expanded Operations Alternative. Similarly, the special pathways have little potential to impact human health under this alternative. Thus, the Expanded Operations Alternative would not present disproportionately high or adverse impacts to human health in minority or low-income communities (section 5.3.6.1).

As shown in section 5.3.10, impacts from on-site transportation and from LANL to U.S. 84/285 are estimated to be 0.0020 excess LCFs per year from incident-free transportation and 0.082 deaths and injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment from U.S. 84/285 to I–25) are estimated to be 0.0021 excess LCFs per year from incident-free transportation and 0.18 deaths and injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to either a member of the general public or to a member of a minority or low-income population due to transportation in the vicinity of LANL transportation routes.

As noted in volume II of the SWEIS, none of the alternatives for the Expansion of Area G (part I of volume II) or for the Enhancement of Pit Manufacturing Operations (part II of volume II) would be expected to have high and adverse

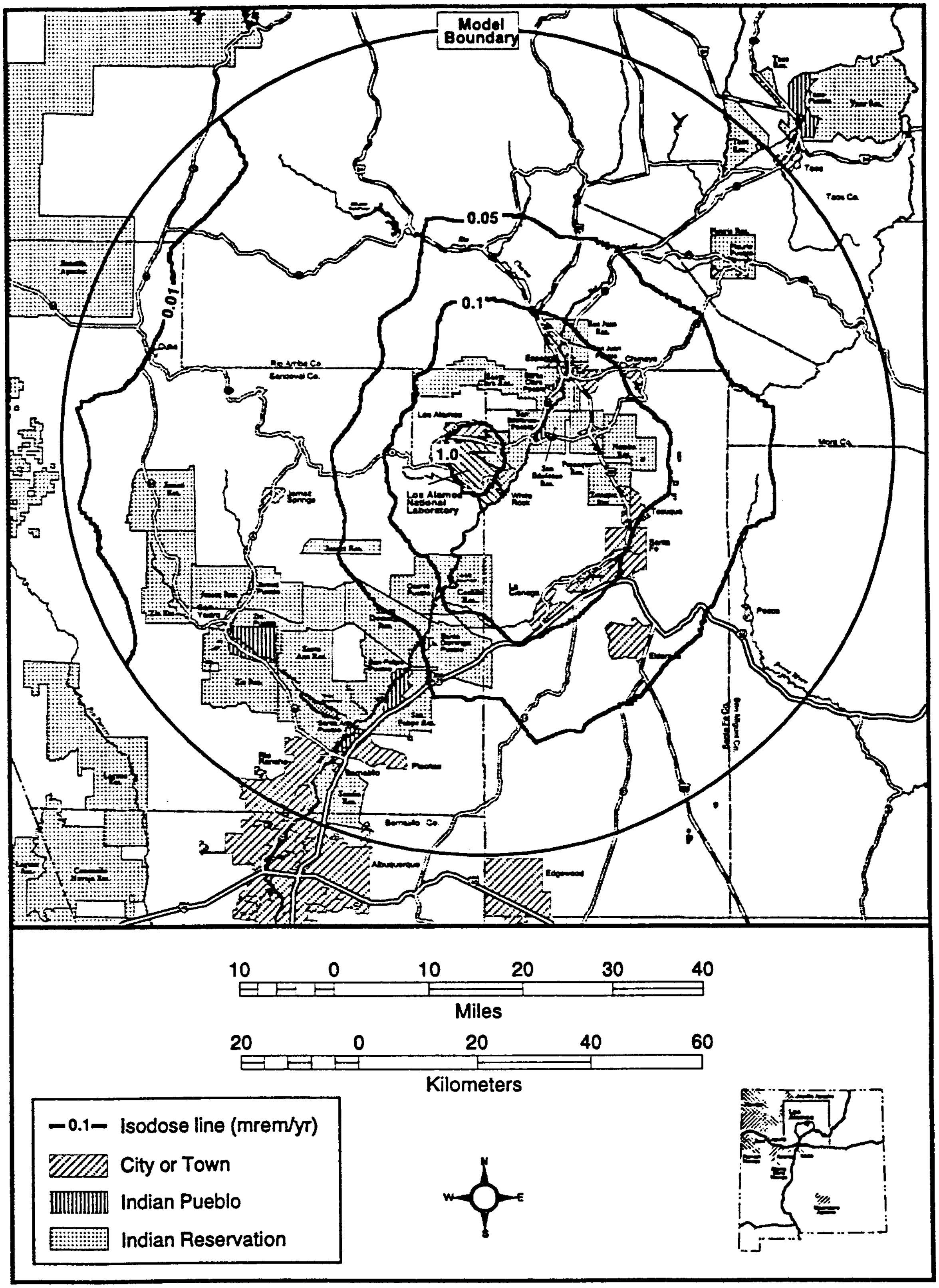


FIGURE 5.3.7–1.—*Isodose Lines from Airborne Releases for the Expanded Operations Alternative Within 50 Miles (80 Kilometers) of LANL.*

health or environmental effects to any populations. Thus, no environmental justice impacts are projected for siting and construction activities under this alternative. This would be true for any of the PSSC alternatives considered.

5.3.8 Cultural Resources

Impacts to prehistoric resources, historic resources, and TCPs are summarized in Table 5.3.8–1 and are discussed below. Note that any construction impacts associated with construction of the road between TA–55 and TA–3 (associated with pit production activities) would not be incurred at the 20 pits per year production rate, the Preferred Alternative.

5.3.8.1 *Prehistoric Resources*

Impacts to prehistoric resources as a consequence of implementing the Expanded Operations Alternative would be similar to those resulting from the No Action Alternative, with the only differences in operational impacts being due to frequency or intensity (e.g., increased radiological air emissions) of the impacts. However, the Expanded Operations Alternative also includes construction measures associated with the Expansion of Area G LLW Disposal Area that could potentially impact 15 prehistoric sites located at Zones 4 and 6 that have been determined eligible for inclusion in the NRHP. The other construction action included in the Expanded Operations Alternative, Enhancement of Pit Manufacturing Operations, includes construction that is in close proximity to one NRHP-eligible archaeological site and one historic site that is ineligible for the NRHP but would not affect these sites.

A data recovery plan has been prepared for the eight sites at Zone 4 and accepted by the SHPO. Consultation would have to be accomplished with the four Accord Pueblos, as well as any culturally affiliated or interested Pueblos. An accompanying data recovery plan would be prepared for the remaining seven sites at Zone 6. The recovery plan would include concerns resulting from consultation with the Accord Pueblos as well as any other Native American or Hispanic community with identified TCP and *Native American Graves Protection and Repatriation Act* (NAGPRA) (25 U.S.C. §3001) concerns. The New Mexico SHPO would review the data recovery plan for Zone 6 prior to implementation of any mitigation measures and would be requested to concur in a determination of no adverse effect before the start of project construction.

Should any historic resources (i.e., prehistoric, historic, and TCPs) be inadvertently discovered during the expansion of Area G, construction activities in the immediate vicinity of the property would cease until their significance and ultimate disposition is determined in consultation with the New Mexico SHPO, Indian tribes with the closest known cultural affiliation, and the Advisory Council on Historic Preservation. For purposes of compliance with Section 3(d) of the NAGPRA, inadvertent discovery of human remains and funerary objects (associated and unassociated), would result in the cessation of construction activities, protection of the discovered items, notice of the discovery sent to the Indian tribes with the closest known cultural affiliation, and direction asked for treatment and disposition of the human remains or funerary objects. The 30-day delay period following official certification that notification of the accidental discovery has been received by the agency or tribe would be followed.

An increase in the frequency of explosives testing under the Expanded Operations Alternative would correspondingly increase the potential for shrapnel impacts to those sites that are vulnerable. Similarly, a higher frequency of testing could accelerate vibration damage to susceptible sites. There would not be an increase in the magnitude of explosive tests with the Expanded Operations Alternative. As with the No Action Alternative, no impacts to resources at BNM are expected due to

TABLE 5.3.8–1.—*Projected Impacts to Prehistoric Resources, Historic Resources, and Traditional Cultural Properties Under the Expanded Operations Alternative*

ACTION TYPE	PUEBLO STRUCTURES	ERODED PUEBLOS/ RUBBLE/ ARTIFACT SCATTER	CAVATE PUEBLOS/ ROCK ART/ SHELTERS/ OVERHANGS	TRAILS/ STEPS/ STONE ARRANGE-MENTS	U.S. TERRITORIAL/ HOMESTEAD SITES	NUCLEAR ENERGY ERA (1943–1989) BUILDINGS, DISTRICTS, AND SITES)	TRADITIONAL CULTURAL PROPERTIES (TCP)				
							CEREMONIAL AND ARCHAEOLOGICAL SITES	NATURAL FEATURES	ETHNOBOTANICAL GATHERING SITES	ARTISAN MATERIAL GATHERING SITES	SUBSISTENCE FEATURES
New construction (buildings, facilities, etc.)	15 National Register eligible sites affected. It is anticipated that a determination of no adverse effect would be achieved based on a data recovery plan which would be developed in consultation with the NM SHPO, ACHP, and four Accord Pueblos. Procedures in place to address historic properties inadvertently discovered during construction.				Negligible (Policy and procedures in place to avoid or minimize impacts)		Consultation with four Accord Pueblos to identify and mitigate any potential adverse effects, including human remains and funerary objects.				
Modifications in facility layout (roads, parking lots, pits)	Same as the No Action Alternative										
Modification of existing buildings (changing building function)	Same as the No Action Alternative										
Change in hydrology (surface and groundwater quality and quantity; erosion and siltation rates)	Same as the No Action Alternative										
Explosives impacts (shrapnel scatter)	Similar to the No Action Alternative. The increased frequency of explosive testing could mean accelerated damage to resources.										
Explosives impacts (vibration)	Similar to the No Action Alternative. The increased frequency of explosive testing could mean accelerated damage to resources.										
Explosives (noise)	None (Same as No Action Alternative.)						Similar to the No Action Alternative. The increased frequency of explosive testing could mean accelerated damage to resources.				
Hazardous material (nonradiological)	Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.						Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.				
Radiation hazards	Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.						Similar to the No Action Alternative. The increased emissions could increase potential for adverse effects.				
Security (fencing, lighting, monitoring)	Same as the No Action Alternative										

explosion-generated ground vibrations from explosives as high as 500 pounds (227 kilograms). As stated, further research is necessary to quantitatively assess impacts from higher amounts of explosives.

In the event that unforeseen circumstances arise in the design of construction features associated with the enhancement of pit manufacturing operations that could affect the one NRHP-eligible site, appropriate mitigation measures, including data recovery, would be designed and implemented in consultation with the New Mexico SHPO and concerned Native American communities.

5.3.8.2 *Historic Resources*

Impacts to historic resources would be comparable to those for the No Action Alternative.

5.3.8.3 *Traditional Cultural Properties*

Impacts would be similar to those for the No Action Alternative (subsection 5.2.8) with the exception of construction activities associated with the expansion of Area G low-level waste disposal and enhancement of pit manufacturing. As stated, consultation would be accomplished with the Accord Pueblos as well as any culturally affiliated or interested Pueblos and tribes. Any concerns expressed would result in actions to negate or minimize any adverse impacts to TCPs associated with construction related actions. These impacts would be similar for any of the PSSC alternatives considered.

An increased level of operation resulting in increased production of shrapnel, vibrations, noise, hazardous materials, and radioactive hazardous could further increase any adverse affect to TCPs.

Construction and operational activities associated with the expansion of Area G and the enhancement of pit manufacturing is not expected to affect surface or groundwater quality—a traditional natural resource identified by some tribal groups. The potential for soil erosion during construction and operations would be avoided or minimized by measures such as fences, mulching, berms, slope contouring, trenching, and revegetation. Planned disposal practices at Area G (e.g., isolation of the closed burial pits) would minimize the potential for water running across and off the site and conveying erosional products to water drainages. Contamination of groundwater from the expansion of Area G is highly unlikely because of the natural resistance that Bandelier tuff has to fluid migration and the distance to area aquifers.

Spiritual Entities

As with the No Action Alternative, no assessment of impacts to "unseen" or "spiritual" entities was attempted.

5.3.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, and infrastructure impacts of activities at LANL under the Expanded Operations Alternative.

The socioeconomic and infrastructure aspects of all construction under the Expanded Operations Alternative, including the two projects discussed in volume II of the SWEIS, are included in the analyses and discussions in this section.

5.3.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts of the Expanded Operations Alternative on employment, salaries, and population are presented in Table 5.3.9.1–1 for the LANL workforce only.

TABLE 5.3.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the Expanded Operations Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,995	2,604	2,657	10,256	828	11,084	267	11,351
Difference[c]	160	685	820	1,665	220	1,885	91	1,976 (+21%)
Salaries ($M)	264.4	74.7	123.2	462.3	27.8	490.1	15.6	505.6
Difference[c]	9.8	29.7	48.9	88.4	11.5	99.8	6.9	106.7 (+27%)
Procurement ($M)	221	1.9	21.9	244.8	128.3	373	253.6	626.6
Difference[c]	5.3	0.2	1.2	6.8	5.9	12.5	22	34.5 (+6%)

[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc., Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to fiscal year 1996. Percent difference is shown in parentheses in the far right (TOTAL) column.

The secondary (indirect) impacts and the total population changes projected are presented in Table 5.3.9.1–2 for the Tri-County area. These changes are assumed to occur within a year of the ROD for the SWEIS. Note that about 260 of the total LANL employment listed is for pit production operations. Under the Preferred Alternative, at the 20 pits per year rate, pit production employment is estimated to be about 100 full-time equivalent employees (FTEs). This difference is a small fraction of total employment under the Expanded Operations Alternative, so impacts at the 20 pits per year level (Preferred Alternative) would not be substantially different than those presented in the remainder of the socioeconomics analyses in this section.

Housing

The population changes anticipated in the Tri-County area, as presented in Table 5.3.9.1–2, are projected to result in demand for 1,770 additional (new) housing units. The distribution of this demand in the three counties is projected to be: 130 additional units in Los Alamos County; 739 additional units in Rio Arriba County; and 901 additional units in Santa Fe County.

In Los Alamos County, the projected housing demand can be accommodated from absorption of apartment vacancies and the inventory of houses for sale and new construction. Beyond 130 units, no new housing units can be anticipated because of the absence of buildable land in private ownership. This constraint upon supply would be expected to exert an upward pressure on rents and house prices.

The projected housing demand in Rio Arriba and Santa Fe Counties can be accommodated without significant pressure on rents and house sales prices. Both counties possess a sufficient

TABLE 5.3.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the Expanded Operations Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	1,665	2,847	4,512	1,332	854	2,186	4,230 (+2.5%)
Personal Incomes	$88 million	$84 million	$172 million (< +1%)				
Annual Business Activity	$7 million	$13 million	$20 million (< +1%)				

Note: Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total personal income change, and total annual business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935.

inventory of finished lots and parcels, have access to adequate mortgage capital, and have sufficient entrepreneurial developer talent to absorb the demand.

Construction

Table 5.3.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. To some extent, construction under this alternative would draw workers already present in the Tri-County area who have historically worked from job to job in the region. To the extent that the Expanded Operations Alternative adds construction workers to the Tri-County area, this would be a seasonal occurrence. Thus, these construction activities are expected to only marginally affect general business activity, personal income levels, and employment levels.

TABLE 5.3.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the Expanded Operations Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT $M	LABOR $M	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	224	54	1,536
2000	251	60	1,721
2001	264	63	1,810
2002	215	52	1,474
2003	216	52	1,481
2004	139	33	953
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Source: (DOC 1996, PC 1997a, and PC 1997b)

Local Government Finance

Under this alternative, the Tri-County annual gross receipts tax yields would be expected to increase by $3.7 million. This increase would be matched by increases in service levels adequate to meet public demand.

Services

Annual school enrollment in the Tri-County area would be expected to increase by 719 students. Additional annual funding assistance of about $2.88 million from the State of New Mexico would be required for school operations because of these enrollment increases.

In Los Alamos, the school district can absorb the anticipated new enrollment levels. This school district has excess capacity because of its discretionary policy of accepting out-of-district students who are the children of LANL employees and subcontractors. In Rio Arriba County and the cities of Española and Santa Fe, adequate classroom capacity exists because of recent school construction projects.

The demand for police, fire, and other municipal services would be expected to increase in proportion to the increase in gross receipts tax yields, as discussed above. However, any changes in local government services tend to be inelastic in the short term and typically are responsive only after the completion of at least one full budget cycle.

5.3.9.2 *Infrastructure Impacts*

Annual electricity use projected under the Expanded Operations Alternative is a total of 782 gigawatt-hours, 437 gigawatt-hours for LANSCE and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 113 megawatts, 63 megawatts for LANSCE and 50 megawatts for the rest of LANL[1]. The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected electrical peak demand for LANL operations under this alternative; thus, periods of brownouts are anticipated unless measures are taken to increase the supply of electricity to the area. (Sections 1.6.3.1 and 4.9.2 discuss ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in section 4.9.2 of chapter 4.)

Natural gas use is projected to be 1,840,000 decatherms annually, the same as projected under the No Action Alternative. Although electrical demand may increase natural gas demand for the generation of electricity at TA–3, demand should continue to be dominated by heating requirements and is not expected to exceed this projection.

Water use projected under the Expanded Operations Alternative is a total of 759 million gallons (2.9 billion liters) per year, 265 million gallons (1 billion liters) per year for LANSCE, and 494 million gallons (1.9 million liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6.8 million liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water demands of this community can be met within the existing water rights. (Water demand is also discussed in section 5.3.3.) The peak water requirements are the same as identified under the No Action Alternative.

1. These values include the proposed SCC Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

These impacts have a minimal contribution from pit production activities. Thus, these impacts would not be substantially different regardless of which PSSC alternative is selected (nor would they be substantially different for pit production at the 20 pits per year rate, the Preferred Alternative).

5.3.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.3.9.3–1. Radioactive liquid waste is not projected by facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste projected for receipt at TA–50 is ___ million gallons (35 million liters) per year for this alternative. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities. In addition to the volumes reflected in Table 5.3.9.3–1, the "CMR Building Use" Alternative, discussed in the PSSC Analysis for Enhancement of Plutonium Pit Manufacturing Operations (volume II, part II), would generate an additional 427 cubic meters (559 cubic yards) of TRU waste, 288 cubic meters (377 cubic yards) of TRU mixed waste, 1,193 cubic meters (1,560 cubic yards) of LLW, and 31 cubic meters (41 cubic yards) of low-level radioactive mixed waste (LLMW) waste during construction activity. Neither of the other alternatives discussed in this PSSC are expected to generate any radioactive waste. (Under the Preferred Alternative, at the 20 pits per year rate, a fraction of the waste generation projected for the PSSC "CMR Building Use" Alternative would be incurred; this is a small portion of the totals generated for each of these waste types, so impacts would not be substantially different for construction to achieve this lower rate.) The PSSC analysis for the expansion of Area G (volume II, part I) reflects that no radioactive waste generation is expected under any of the alternatives analyzed. Pit production operations contribute little to waste generation, with the exception of TRU waste generation (which would increase by about 3,535 cubic feet [100 cubic meters] per year). Under the Preferred Alternative, at the 20 pits per year rate, this increase would be about 530 cubic feet (15 cubic meters) per year.

Under this alternative, LLW would be treated and disposed of on the site in an expanded Area G (see volume II, part I). As discussed for the No Action Alternative, much of LANL TRU and chemical waste would be treated and shipped off site for disposal; nondefense TRU waste from other sites would be stored at LANL pending the development of disposal options. As with the No Action Alternative, LANL is capable of meeting applicable waste acceptance criteria, and off-site disposal capacities are much greater than LANL's waste volumes.

5.3.9.4 *Contaminated Space*

The activities reflected in the Expanded Operations Alternative are projected to increase the total contaminated space at LANL by 73,000 square feet (6,782 square meters) over the next 10 years, as compared to the baseline established for the SWEIS as of May 1996 (chapter 4, section 4.9). The majority of this increase is due to implementation of actions that have already been reviewed under NEPA, but which had not been implemented at the time the baseline was established, as discussed in the No Action Alternative (section 5.2.9). Additional construction and operations in LANSCE (TA–53) and the Machine Shops (TA–3) result in an additional 5,000 square feet (460 square meters) in each of these facilities under this alternative.

Selection of either the Brownfield or TA–55 add-on alternatives from the PSSC Analysis of the Enhancement of Plutonium Pit Manufacturing (volume II, part II) would result in an additional 15,300 square feet (1,420 square meters) of contaminated space.

TABLE 5.3.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Expanded Operations Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	8,340	83,400	740	7,400	13	130	310	3,100	102	1,020
Tritium Facilities[c]	TA–16 & TA–21	1,700	17,000	480	4,800	3	30	NA	NA	NA	NA
Chemistry and Metallurgy Research Building[d]	TA–3	11,200	112,000	1,860	18,600	19.6	196	46.6	466	20.4	204
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	10,000	100,000	960	9,600	4	40	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	474,000	4.74×10^6	606	6,060	0	0	NA	NA	NA	NA
High Explosives Processing Facilities	TA–8, 9, 11, 16, 28 & 37	13,000	130,000	16	160	0.2	2	NA	NA	NA	NA
High Explosives Testing Facilities	TA–14, 15, 36, 39, 40	35,300	353,000	940	9,400	0.9	9	0.2	2	NA	NA
Los Alamos Neutron Science Center[e]	TA–53	16,600	166,600	1,085	10,850	1	10	NA	NA	NA	NA
Health Research Laboratory[f]	TA–43	13,280	132,800	34	340	3.4	34	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	3,300	33,000	270	2,700	3.8	38	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[g]	TA–50 & TA–21	2,200	22,000	160	1,600	0	0	30	300	0	0
Waste Treatment, Storage, and Disposal Facilities[g]	TA–54 & TA–50	920	9,200	174	1,740	4	40	27	270	0	0
Non-Key Facilities		651,000	6.51×10^6	520	5,200	30	300	0	0	0	0
ER Project[h]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[i]		3.2493×10^6	3.2493×10^7	12,240	122,400	633	6,330	425	4,250	122	1,220

TABLE 5.3.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Expanded Operations Alternative*[a]-Continued

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (see text in section 5.3.9.3).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under the *Toxic Substance Control Act*. This waste category also includes biomedical waste.

[c] These projections include 141,000 ft^3 (4,000 m^3) of LLW due to backlogged waste.

[d] These LLW projections include 141,000 ft^3 (4,000 m^3) of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections include 228,000 ft^3 (6,450 m^3) of LLW due to the construction of the new Long-Pulse Spallation Source Facility and 86,000 ft^3 (2,450 m^3) of LLW due to upgrades to Areas A5 and A6, as well as reduced operational waste generation during these construction activities.

[f] These projections include 22,000 lbs (10,000 kg) of chemical waste, 550 lbs (250 kg) of biomedical waste (a special form of chemical waste), 1,560 ft^3 (44 m^3) of LLW, and 850 ft^3 (24 m^3) of LLMW associated with ongoing efforts to remove obsolete and contaminated equipment.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[h] The ER Project is projected to generate 390 ft^3 (11 m^3) per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[i] Grand totals have been rounded.

The "CMR Building Use" Alternative from that PSSC Analysis, utilizes existing unused space in the CMR Building, would use existing nuclear space, and thus would not incrementally increase the contaminated space at LANL facilities.

Although not considered "contaminated space" for the purposes of this SWEIS, selection of the PSSC Preferred Alternative (expansion of Area G into Zones 4 and 6) would result in disposal of LLW in up to 41 acres (17 hectares) of land not previously used for disposal. Selection of the North site alternative or the TA–67 alternative would result in disposal of LLW in 49 acres (20 hectares) or 50 acres (21 hectares), respectively, of land not previously used for disposal.

5.3.10 Transportation

The transportation impacts projected for the Expanded Operations Alternative are summarized in this section. On-site and off-site shipments under this alternative are greater than these under the No Action Alternative (with the exception that no LLW is shipped off the site for disposal). More detailed information regarding these shipments and the impacts is included in volume III, appendix F.

5.3.10.1 *Vehicle-Related Risks*

Truck Emissions in Urban Areas

For the Expanded Operations Alternative, the projected impact from vehicle emissions is 0.066 excess LCF over a lifetime of operation per year. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to 0.064 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (2 kilometers) less of urban highway mileage. Approximately 65 percent of excess LCFs are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments.

Truck Accident Injuries and Fatalities

The impacts projected for the Expanded Operations Alternative are presented in Table 5.3.10.1–1. (Additional information is provided in appendix F, section F.6.3.) Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Use of the Santa Fe Relief Route would not substantially change the risks of accidents, injuries, and fatalities on the remainder of the New Mexico segment, as compared to the risks reflected for this segment in Table 5.3.10.1–1. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.3.10.2 *Cargo-Related Risks*

Incident-Free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the Expanded Operations Alternative are presented in Table 5.3.10.2–1; as noted in section 5.2.10.2, the total is the dose throughout the U.S., and is dominated by the segments outside of New Mexico. The aircraft segment is for overnight carrier service; the truck segment to and from the airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for north-bound shipments carrying the radioactive material. Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route.

TABLE 5.3.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the Expanded Operations Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On Site	0.033	0.007	0.00033
LANL to U.S. 84/285	0.34	0.071	0.0034
U.S. 84/285 to I–25	0.82	0.18	0.0082
Remainder of New Mexico	1.4	1.3	0.15
Outside New Mexico	6.4	6.0	0.62
Total	9.0	7.6	0.78

TABLE 5.3.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the Expanded Operations Alternative*

ROUTE SEGMENT	TRUCK OR AIR CREW		NONOCCUPATIONAL					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year
LANL to U.S. 84/285	7.4	0.003	0.04	0.00002	0.65	0.00032	4.0	0.002
U.S. 84/285 to I–25	10	0.004	0.49	0.00024	4.6	0.0023	4.2	0.0021
Remainder of New Mexico	55	0.022	0.12	0.000062	2.1	0.001	30	0.015
Outside New Mexico	510	0.2	3.5	0.0018	30	0.015	230	0.12
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
Total	580	0.23	4.2	0.0021	37	0.019	270	0.14

NA = Not applicable

MEI dose occurs between LANL and I–25 and is 0.00038 rem per year of operation.

Driver Doses from On-Site Shipments of Radioactive Materials

The projected collective radiation dose for LANL drivers under the Expanded Operations Alternative is 10.292 person-rem. This collective dose would be expected to result in 0.00412 excess LCFs over a lifetime per year of operation among these drivers.

The average individual driver dose is projected to be 0.429 rem per year, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the Expanded Operations Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments

The MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding lifetime excess LCF per year of operation for these shipments are presented in Table 5.3.10.2–2 for these accidents. ADROIT results separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in terms of excess LCF per year; for the Expanded Operations Alternative, MEI dose risk due to plutonium-238 oxide and due to pit shipments were each about 1×10^{-10} excess LCF per year.

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore, the excess LCFs per year) to about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa

TABLE 5.3.10.2–2.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the Expanded Operations Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM -241	CH TRU	RH TRU	PLUTONIUM -238	PITS	TOTAL	
	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	0.016	0.0019	3.8×10^{-6}	1×10^{-6}	6×10^{-6}	0.018	9.0×10^{-6}
U.S. 84/285 to I–25	0.25	0.024	0.000053	2×10^{-6}	0.00002	0.27	0.00014
Remainder of New Mexico	0.033	0.016	0.000033	1×10^{-6}	8×10^{-6}	0.049	0.000024
Rest of U.S.	2.7	NA	NA	8×10^{-6}	0.00004	2.7	0.0014

NA = Not available

Fe. This difference is primarily due to the difference in population density along these routes. (Lower traffic density projected on the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and, therefore, excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [10 kilometers] more) in the distance traveled on I–25 for northbound shipments.

On-Site Radioactive Materials Shipments

The MEI doses, frequencies, and MEI risks due to the bounding on-site shipments involving radioactive materials are given in Table 5.3.10.2–3. As noted in section 5.2.10.2, the frequency of the bounding DARHT and PHERMEX shipments has been added to the frequency of irradiated target shipments.

Hazardous Materials Shipments

The bounding hazardous materials shipments for accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosives shipments. The consequences of an accident involving a major explosives shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

TABLE 5.3.10.2–3.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the Expanded Operations Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	1.7×10^{-7}	8.7 rem	1.4×10^{-6} rem/year (5.8×10^{-10} excess LCF/year)
Irradiated Targets	3.2×10^{-6}	acute fatality	3.2×10^{-6} fatalities/year

Accidental Chlorine Release

The projected frequencies, consequences, and risks associated with major chlorine accidents under the Expanded Operations Alternative are presented in Table 5.3.10.2–4.

The use of the Santa Fe Relief Route would result in about one-sixth the risk of fatalities and injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in the risk of fatalities and injuries on the remainder of New Mexico segment because of the extra 6 miles (10 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release

The projected frequencies, consequences, and risks associated with major propane accidents under the Expanded Operations Alternative are presented in Table 5.3.10.2–5.

The use of the Santa Fe Relief Route would result in slightly less risk of fatalities and about one-third of the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in about half the risk of injuries and fatalities on the remainder of New Mexico segment because of the 6 miles (10 kilometers) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

TABLE 5.3.10.2–4.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the Expanded Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000062	0.065	0.24	0.000019	0.000072
	Suburban	0.00001	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.000048	0.053	0.2	0.00064	0.0024
	Suburban	0.0001	3.0	11		
	Urban	0.000032	11	40		
Remainder of New Mexico	Rural	0.00036	0.015	0.056	0.00011	0.00042
	Suburban	0.000038	1.5	5.5		
	Urban	6.2×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0026	0.028	0.1	0.0028	0.01
	Suburban	0.00066	1.6	6.1		
	Urban	0.00016	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.3.10.2–5.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the Expanded Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000022	0.28	1.1	0.000022	0.000086
	Suburban	3.7×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	0.000017	0.23	0.92	0.00033	0.0013
	Suburban	0.000037	8.4	34		
	Urban	0.000011	1.8	7.3		
Remainder of New Mexico	Rural	0.00014	0.15	0.6	0.00026	0.0011
	Suburban	0.000046	5.1	20		
	Urban	5.8×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.00018	0.09	0.36	0.00015	0.00059
	Suburban	0.000023	4.8	19		
	Urban	0.000012	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

Traffic Impacts from the Project-Specific Siting and Construction Analyses

The PSSC analyses in volume II (parts I and II) identify relatively minor increases in on-site traffic due to the construction associated with these two projects (Expansion of Area G and Enhancement of Plutonium Pit Manufacturing). The impact analyses identified in this section would not be expected to change due to these types of changes; the conservatism built into these analyses is considered adequate to address these relatively minor and transitory changes.

The alternatives examined for the Enhancement of Plutonium Pit Manufacturing did not reflect any variation in construction traffic across the alternatives. However, much of the on-site operational transportation examined in this section of the SWEIS may be reduced to approximately the No Action levels if the Brownfield or Add-on to TA–55 alternatives were selected. This is because such alternatives would not have the same level of transportation between TA–55 and CMR Building, and this would result in a reduction in driver doses from on-site transportation of radioactive materials to approximately the levels identified in the No Action Alternative for this type of impact. The frequency of on-site transportation accidents would also be reduced in this case. Under the Preferred Alternative, at the 20 pits per year rate, transportation impacts for on- and off-site transportation would be similar to, but slightly less than, the impacts presented in this section. (At this lower rate, there would be fewer shipments between TA–55 and the CMR Building, as well as fewer shipments to and from Oak Ridge and Pantex.) The selection of the “CMR Building Use” Alternative from this PSSC analysis would be expected to result in the operational impacts described in this section.

The alternatives examined for the expansion of Area G did not reflect any variation in construction traffic across the alternatives, except that a new burial site (other than at TA–54) would be expected to require increased construction activity and traffic, with a slightly higher probability of a traffic accident involving workers. This could result in a slightly higher probability of worker injury or death than is presented in this section of the SWEIS.

5.3.11 Accident Analysis

Transportation accidents for the Expanded Operations Alternative are addressed in section 5.3.10. High-frequency (greater than 1 in 100) occupational accidents for the Expanded Operations Alternative are addressed in section 5.3.6.

5.3.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

The risks from these accidents are driven primarily by the frequency and magnitude of an earthquake and wildfire in the area. Because the same types of operations will be conducted in the same facilities, and the inventories of MAR will be about the same; there are no substantial changes between the No Action and the Expanded Operations Alternatives. Therefore, there is no change in risk among the alternatives from site-wide earthquakes. Tables 5.2.11.1–1 and 5.2.11.1–2 show these results.

5.3.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

A summary of the frequency and consequences for plutonium releases is given in Table 5.3.11.2–1. These releases reflect a variety of initiators depending on the type of activities or manmade hazards in the area, such as an aircraft crash.

For these accidents there are minor variations in such activities as the handling of drums, the

TABLE 5.3.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—Expanded Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a,f]	CONSEQUENCE MEASURES[b,c,d,e,g]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
MANMADE HAZARDS			
RAD–01 Plutonium release from RANT Facility transuranic waste container storage area fire.	Approximately 1,600 per year (i.e., one event in approximately 600 years); considered an unlikely event	Approximately 0.04 excess LCF Mean population dose approximately 72 person-rem MEI at nearest public access (on Pajarito Road) approximately 46 rem, at most exposed residence approximately 4 rem	0.000064 No change in likelihood or severity among the alternatives.
RAD–07 Plutonium release from WCRRF transuranic waste container storage area fire.	0.0003 per year (i.e., one in 3,000 years); considered an unlikely event	Approximately 0.7 excess LCF Mean population dose: approximately 1,300 person-rem MEI dose at closest public access (Pajarito Road) approximately 74 rem, MEI at habitation: approximately 4 rem	0.00021 No change in the severity of the accident from the No Action Alternative. Likelihood increases, as compared to No Action.
RAD–08 Plutonium release from TWISP transuranic waste storage domes due to aircraft crash and fire.	4.3×10^{-6} per year (i.e., one event in approximately 200,000 years); considered an extremely unlikely event	Approximately 0.2 excess LCF Mean population dose: approximately 400 person-rem MEI at nearest public access (Pajarito Road and nearest boarder with White Rock): 22 rem	8.6×10^{-7} No change in the likelihood or severity of the accident from the No Action Alternative.
RAD–16 Plutonium release due to aircraft crash at the CMR Building.	Approximately 3.5×10^{-6} per year (i.e., one event in approximately 300,000 years)	Approximately 0.03 excess LCF Mean population dose: approximately 56 person-rem, no expected excess LCFs; MEI at closest public access, approximately 3 rem, approximately 0.03 rem at nearest habitation	1.05×10^{-7} No change in the likelihood or severity of the accident from the No Action Alternative.
PROCESS HAZARD ACCIDENTS			
RAD–09 Plutonium release due to transuranic waste drum failure or puncture (for “high” and typical activity in drum).	0.0049 per year (i.e., one in approximately 250 years for high-activity drum); 0.49 per year (i.e., one in 2 years for typical drum)	0.12 excess LCF from high activity drum Mean population dose for release approximately 230 person-rem MEI (high activity drum) at closest access (Pajarito Road) approximately 23 rem; approximately 0.86 rem at closest habitation 0.0022 excess LCF from typical activity drum Mean population dose approximately 4.4 person-rem MEI (typical activity drum) at closest access (Pajarito Road) approximately 0.41 rem; approximately 0.86 rem at closest habitation	0.00059 No change in the severity of the accident from the No Action Alternative. 0.0011 No change in the severity of the accident from the No Action Alternative.

TABLE 5.3.11.2–1.—*Summary of Radiological Consequences for Plutonium Release Scenarios at LANL—Expanded Operations Alternative*-Continued

SCENARIO DESCRIPTION	LIKELIHOOD[a,f]	CONSEQUENCE MEASURES[b,c,d,e,g]	SOCIETAL RISK (EXCESS LATENT CANCER FATALITIES PER YEAR)
RAD–13 Plutonium release from flux trap irradiation experiment at TA–18.	0.000016 per year (i.e., one event in approximately 65,000 years)	Approximately 0.08 excess LCF Mean population dose approximately 160 person-rem MEI at closest public access (Pajarito Road), approximately 120 rem; at closest habitation approximately 0.12 rem.	0.0000013 No change in the likelihood or severity of the accident from the No Action Alternative.
RAD–15 Plutonium release from CMR Building. (1) Laboratory Fire	(1) 0.000036 per year	(1) Approximately 0.088 excess LCF Mean population dose approximately 175 person-rem MEI at nearest public access (Diamond Road) approximately 0.41 rem; approximately 0.48 rem at closest habitation	(1) 3.2×10^{-6} Accident severity changes due to an increase in the amount of material.
(2) Wing Fire	(2) 0.000032 per year	(2) Approximately 1.7 excess LCF Mean population dose: approximately 3,400 person-rem MEI at nearest public access (Diamond Road) approximately 91 rem; approximately 90 rem at closest habitation	(2) 0.000054 Accident severity changes due to an increase in the amount of material.

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure.
[e] The symbol ~ means approximately.
[f] The frequency per year is more correctly described as the probability of occurrence in any 12-month period. See detailed explanation under Meaning of Risk and Frequency in volume III, appendix G, section G.1.
[g] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

number of trips, and the number of experiments. These changes tend to increase or decrease the risk by 10 to 20 percent. These changes do not alter the overall risk profile for the site or substantially alter the relative ranking of each of these accidents.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 are presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facility and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

5.3.11.3 *Highly Enriched Uranium Release from Process Hazard Accident*

As discussed in section 5.2.11.3, this accident is the dominant accident for the release of HEU. Because the number of pulse operations would increase for the Expanded Operations Alternative, the frequency of the scenario will increase. The associated risk is reflected in Table 5.3.11.3–1.

5.3.11.4 *Tritium Release from a Manmade Hazard Accident at LANL*

As presented in section 5.2.11.4, the aircraft crash event is the dominant accident that involves tritium. Because no changes in operations or inventories from the No Action Alternative are expected, the frequency and consequences of this scenario under the Expanded Operations Alternative are the same as presented under the No Action Alternative in Table 5.2.11.4–1.

5.3.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations. There is a small increase in risk for chemical accidents over the No Action Alternative. These results are shown in Tables 5.3.11.5–1 and 5.3.11.5–2.

5.3.11.6 *Worker Accidents*

Because the Expanded Operations Alternative includes the same types of activities that were considered for the No Action Alternative with no changes in the frequency or amounts of materials used in these activities, an individual worker is subject to the same risk. Therefore, the frequencies and consequences of worker accidents under the Expanded Operations Alternative are the same as those reflected in Table 5.2.11.6–1.

TABLE 5.3.11.3–1.—*Summary of Radiological Consequences from Highly Enriched Uranium Release Scenarios at LANL—Expanded Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d,e]	SOCIETAL RISK (EXCESS LATENT FATALITIES PER YEAR)
RAD–03 Highly enriched uranium release from power excursion accident with Godiva-IV outside Kiva #3.	4.3×10^{-6} per year	Approximately 0.06 excess LCF Mean population dose: approximately 110 person-rem MEI at nearest public access (Pajarito Road) Approximately 150 rem; at nearest habitation approximately 0.5 rem	2.6×10^{-7}

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.
[d] MEIs for each location are hypothetical individuals who do not leave and do not take protective actions to avoid exposure. The MEI dose is provided for an individual located on Pajarito Road at a distance of 160 feet (50 meters) from the facility, even through Pajarito Road would be closed to the public during outdoor operations.
[e] Impacts, in terms of excess LCFs per year of operation, are used to quantify the risks of exposure to radiation. When the impact is applied to an individual (e.g., an MEI), the risk is a lifetime incremental probability of a fatal cancer per year of operation. When applied to a population of individuals, the risk is the incremental number of fatal cancers anticipated in the exposed population for each year of operation.

TABLE 5.3.11.5–1.—*Summary of Chlorine Exposure Scenarios at LANL—Expanded Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
PROCESS HAZARD ACCIDENTS			
CHEM–01 Chlorine release (150 pounds [68 kilograms]) from potable water treatment station, due to human error during cylinder changeout or maintenance, or due to random hardware failures.	Approximately 0.0013 per year (i.e., one such event in approximately 800 years)	For the risk-dominant large leak scenario, an average of approximately 43 persons exposed above ERPG–2 levels, and approximately 12 persons exposed above ERPG–3 levels, to distances of up to a few tenths of a mile.	0.056 Small change in the likelihood or severity of the accident from the No Action Alternative.
CHEM–02 Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at Gas Plant, due to fire or aircraft crash.	Approximately 0.00015 per year (i.e., one in approximately 8,000 years)	Average of 292 people within LANL (ranging from none to 1,000 depending upon wind direction) exposed at or above ERPG–2 or –3 levels; town protected by canyon from highest concentrations.	0.044 (Frequency increases by 14% from the no action alternative; no change in severity)
CHEM–03 Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at Gas Plant, due to random failure or human errors during cylinder handling.	Approximately 0.00012 per year (i.e., one in approximately 8,000 years)	An average of approximately 263 exposed above ERPG–2 levels; or 239 above ERPG–3 levels, at distances to a fraction of a mile, all within LANL; town protected by canyon from highest concentrations.	0.032 No change in likelihood or severity over the No Action Alternative.
CHEM–06 Chlorine gas release outside Plutonium Facility.	Approximately 0.063 per year (i.e., one event in approximately 16 years)	Average number exposed at or above ERPG–2 doses is approximately 102, and above ERPG–3, approximately 7 at ranges to a fraction of a mile.	6.426 No change in likelihood or severity over the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

TABLE 5.3.11.5–2.—*Summary of Chemical Exposure Scenarios—Expanded Operations Alternative*

SCENARIO	DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c,d]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	Approximately 0.004 per year (i.e., one in about 250 years)	Average number of off-site persons exposed above ERPG–2 level is zero; toxic effects generally limited to the source's TA (TA–54).	0 No changes in frequency or severity from the No Action Alternative.
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	Approximately 0.00051 per year (i.e., one event in approximately 2,000 years)	Under conservative daytime conditions, no one outside the source area (TA–54) would see levels above ERPG–2. Under least favorable conditions, 13 persons could be exposed above ERPG–3 levels.	0 No changes in frequency or severity from the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available.
[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.
[c] Accident consequences are generally conservative (pessimistic), but utilize average (rather than most unfavorable) weather conditions.

5.4 IMPACTS OF THE REDUCED OPERATIONS ALTERNATIVE

5.4.1 Land Resources

5.4.1.1 *Land Use*

Changes to land use and land use categories under the Reduced Operations Alternative would be the same as for the No Action Alternative.

5.4.1.2 *Visual Resources*

Changes to visual resources under the Reduced Operations Alternative would be the same as for the No Action Alternative.

5.4.1.3 *Noise*

Changes to noise levels, air blasts and ground vibrations associated with high explosives testing under the Reduced Operations Alternative would be the same as for the No Action Alternative. The total of LANL activities would decrease with a corresponding slight decrease in total noise producing events, which would reduce the potential to impact workers.

5.4.2 Geology and Soils

Potential impacts for the Reduced Operations Alternative on geology and soils would be the same as those for the No Action Alternative.

5.4.3 Water Resources

5.4.3.1 *Surface Water*

Table 5.4.3.1–1 shows the total flow from the NPDES outfalls for each of the major watersheds under the Reduced Operations Alternative. In volume III, appendix A, Table A.1–1 presents a more detailed table of the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. The estimated total gallons discharged into all watersheds equals 218 million gallons (825 million liters) under the Reduced Operations Alternative. This is a decrease from the index effluent volume of 233 million gallons (882 million liters).

NPDES outfall effluent quality during the period of the SWEIS (1997 through 2006) is expected to be the same under this alternative as described for the No Action Alternative, including the radionuclide concentrations in effluent from TA–50, as presented in Table 5.2.3.2–2. The only canyon that has an increase in outfall flow over the baseline is Sandia Canyon. The projected increase in flow to Sandia Canyon is slightly more than one-half that projected for the No Action Alternative. The potential impacts resulting from this increase in flow in Sandia Canyon should be the same as discussed under the No Action Alternative. For the Reduced Operations Alternative, there are no new activities that would result in changes in stormwater runoff.

5.4.3.2 *Alluvial Groundwater*

The relative decreases in NPDES outfall discharges (as compared to No Action) are expected to result in proportionally lower alluvial groundwater volumes.

The projected discharge from RLWTF into Mortandad Canyon under the Reduced Operations Alternative is 5.3 million gallons (20 million liters) per year, about the same as the RLWTF index volume of 5.5 million gallons (21 million liters) per year.

The new HELWTF will likely result in improved water quality to Canyon de Valle, as discussed in the No Action Alternative.

TABLE 5.4.3.1–1.—*NPDES Discharges by Watershed Under the Reduced Operations Alternative*[a]

WATERSHED	# OUTFALLS		FLOWS (MGY)					
			KEY FACILITIES		NON-KEY		TOTALS	
	INDEX	REDUCED	INDEX	REDUCED	INDEX	REDUCED	INDEX	REDUCED
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	16.4	0.5	0.2	19.7	16.6
Mortandad	12	7	42.0	28.3	10.9	5.1	52.9	33.4
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	15.4	103.5	127.9	107.9	143.3
Water	21	10	29.5	14.1	0.0	0.0	29.5	14.1
Totals	87	55	103.6	76.0	129.6	142.0	233.2	218.1

MGY = millions of gallons per year

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future (as discussed in the *Environmental Assessment for Effluent Reduction* [DOE 1996e]) as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

5.4.3.3 *Perched Groundwater*

Groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. It is possible that NPDES discharges to Los Alamos and Sandia Canyons under the Reduced Operations Alternative, could contribute to recharge of the intermediate perched groundwater and contaminant transport beneath Los Alamos and Sandia Canyons. However, unlike the No Action and the other alternatives, NPDES discharges to Los Alamos Canyon under the Reduced Operations Alternative will be slightly less than the index.

5.4.3.4 *Main Aquifer*

Recharge mechanisms to the main aquifer are uncertain. However, for the same reasons as discussed under the No Action Alternative, impacts resulting from decreased NPDES outfall flows under the Reduced Alternative should be negligible. A conservative projection of LANL water use under the Reduced Operations Alternative is 602 million gallons (2,279 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the County used about 958 million gallons (3,626 million liters) from this water right and the NPS used about 5 million gallons (19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer.

For the purposes of modeling drawdown of the main aquifer, annual water use projections were made. The total water usage from DOE water rights was projected to average 1,451 million gallons (5,492 million liters) per year under the Reduced Operations Alternative, with a maximum annual use of 1,470 million gallons

(5,564 million liters) and a minimum annual use of 1,444 million gallons (5,466 million liters).

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.4.3.4–1 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the Reduced Operations Alternative; as noted in section 5.2.3.1, these changes are not all due to LANL operations. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. The impacts to the volume of water in the main aquifer under this alternative are very similar to those described for the No Action Alternative; the drawdowns in the DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage. Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

TABLE 5.4.3.4–1.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the Reduced Operations Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-10.7
Otowi Well Field (Well 0-4)	-10.3
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-8.1
Santa Fe Water Supply	
Buckman Well Field	+21.7
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.
[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid- cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite different from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and can not be considered as finite changes.

5.4.4 Air Quality

5.4.4.1 *Nonradiological Air Quality Impacts*

Criteria Pollutants

Criteria pollutant emissions under the Reduced Operations Alternative are less than those under the Expanded Operations Alternative. Because the bounding analysis of criteria pollutant emissions for all alternatives (based on the emissions under the Expanded Operations Alternative) results in estimated concentrations of each pollutant below the standards established to protect human health with an ample margin of safety, criteria pollutant emissions under the Reduced Operations Alternative would also be below these levels.

Toxic Air Pollutants

As discussed in section 5.1.4, the only toxic air emissions with the potential to impact human health and the environment under any alternatives are those associated with high explosives test site operations and the additive emissions from all the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. Under the Reduced Operations Alternative, such emissions are projected to be similar to those addressed in the No Action Alternative (section 5.1.4). Therefore, pollutants released from LANL operations under the Reduced Operations Alternative are not expected to cause air quality impacts that would affect human health and the environment.

5.4.4.2 *Radiological Air Quality Impacts*

This section addresses the radiation dose to the FS MEI, LANL MEI and the population dose from LANL radionuclide air emissions under the Reduced Operations Alternative.

Facility-Specific Maximally Exposed Individual

Table 5.4.4.2–1 shows the FS MEI doses under the Reduced Operations Alternative. The highest MEI dose was 1.88 millirem per year, which is 18.8 percent of the regulatory limit for the air pathway. This table shows the EPA regulatory limit would not be exceeded from emissions of these facilities under the Reduced Operations Alternative.

LANL Maximally Exposed Individual

The location of the highest dose from all facility emissions was 2,625 feet (approximately 800 meters) north-northeast of TA–53. LANL MEI dose was calculated to be 1.88 mrem per year under the Reduced Operations Alternative.

TABLE 5.4.4.2–1.—*Facility-Specific Information Reduced Operations Alternative*

KEY FACILITY	DOSE[a] (mrem/yr)
TA–3-29 (CMR)	0.36
TA–3-66 (Sigma)	0.36
TA–3-102 (Shops)	0.29
TA–11 (HE Testing)	0.31
TA–15/36 (Firing Sites)[c]	1.76
TA–16 (Tritium Facility)	0.22
TA–18 (Pajarito Site)	1.51
TA–21 (Tritium Facility)	1.22
TA–48 (Radiochemistry Laboratory)	1.08
TA–55 (Plutonium Facility)	1.08
TA–53 (LANSCE)[b]	1.88
TA–54 (Boundary)[c]	0.68
TA–54 (White Rock)	0.39

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. An MEI does not leave or take protective measures.
[b] This is also the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES–2, ES–3, IPF, LEDA, and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54 because Area G is bordering San Ildefonso Pueblo land. The first is a MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated to be 10.83 person-rem per year under the Reduced Operations Alternative. TA–15/36 accounted for 65.3 percent of this dose (collective diffuse emissions, including those from these TAs, accounted for 66.3 percent of this dose).

The values reported for population doses for this alternative, as well as the other alternatives, is higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in chapter 3, section 3.6.

Isodose Maps

The isodose maps for the 50-mile (80-kilometer) region are shown on Figures 5.4.4.2–1 and 5.4.4.2–2.

5.4.5 Ecological Resources, Biodiversity, and Ecological Risk

Impacts to ecological resources and biodiversity resulting from reducing the scale of operations would not vary appreciably from those of the No Action Alternative. An overall reduction in outfall discharges could cause a commensurate decrease in the extent of affected wetlands. There would not be any incremental changes from the No Action level of ecological risk.

5.4.6 Human Health

The consequences of implementing the Reduced Operations Alternative on public health and worker health are presented below. As discussed in section 5.1.6, “risk,” as used in the SWEIS human health analysis, refers to the probability of toxic or cancer mortality consequences under the specific exposure scenarios analyzed.

5.4.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the Reduced Operations Alternative are presented below for the same topics discussed in section 5.2.6.1.

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

The LANL MEI was estimated to be 2,625 feet (800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose at this location is estimated to be 1.88 millirem per year (section 5.4.4.2), corresponding to a 72-year lifetime dose of 0.14 rem. This location borders the Los Alamos townsite and is a conservative estimate for an MEI from LANL emissions. The background (TEDE) dose in the Los Alamos area is estimated to be 360 millirem per year; thus, the dose to the MEI is 0.5 percent of the background dose.

Table 5.4.6.1–1 summarizes the LANL MEI dose and presents the corresponding risk of excess LCF to the MEI. The risk of development of nonfatal cancer is also presented. These risks are presented on a lifetime basis, assuming that the hypothetical LANL MEI received the estimated dose of 1.88 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.000068 over a lifetime.

TABLE 5.4.6.1–1.—*Estimated Public Health Consequences for LANL MEI and the Population Within a 50-Mile (80-Kilometer) Radius of LANL for the Reduced Operations Alternative*

PARAMETER	LANL MEI	50-MILE (80-KILOMETER) RADIUS POPULATION
Dose	1.88 millirem/year	10.83 person-rem/year
Excess LCF	0.000068/lifetime (72 year)	0.0054/year of operations

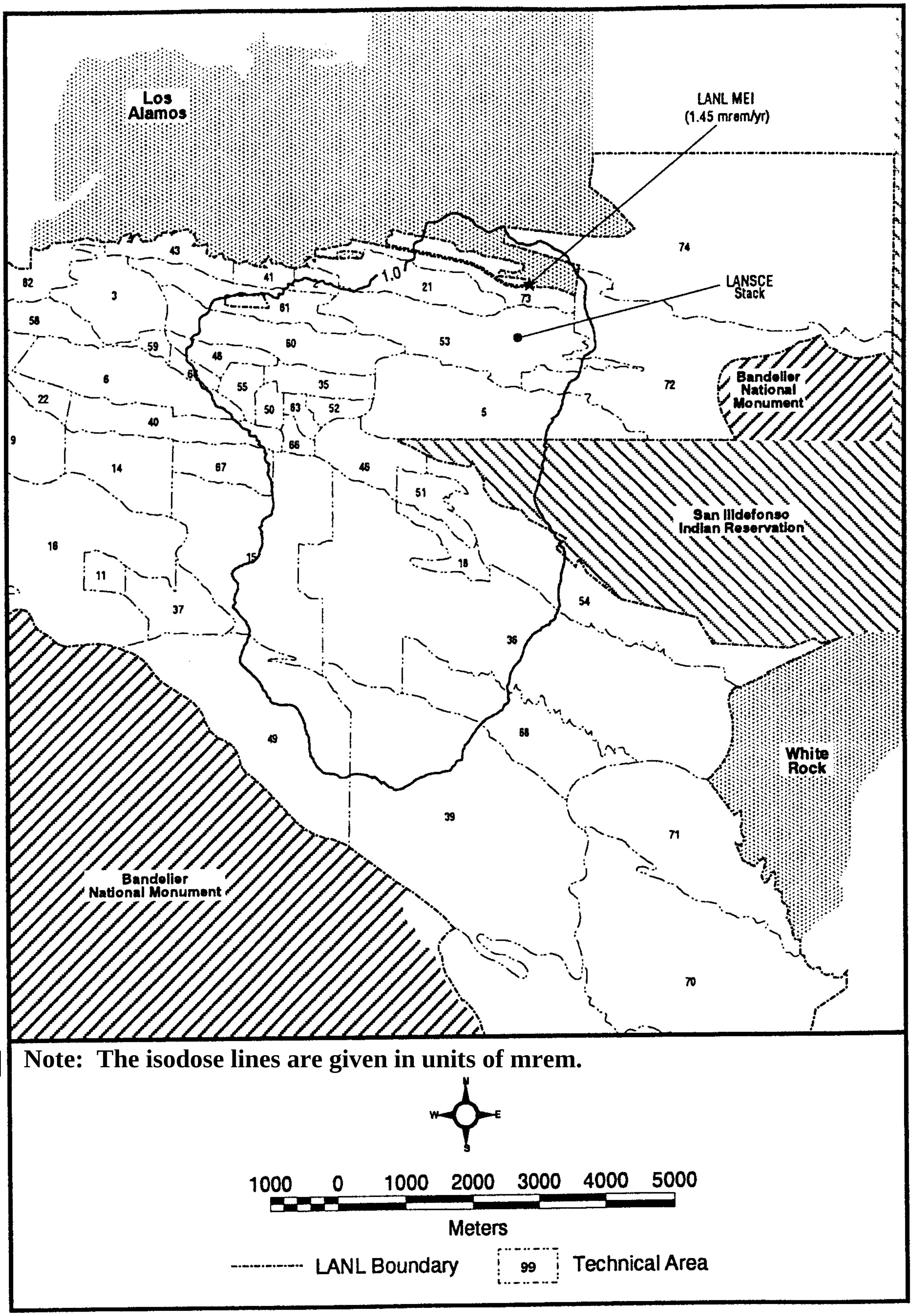
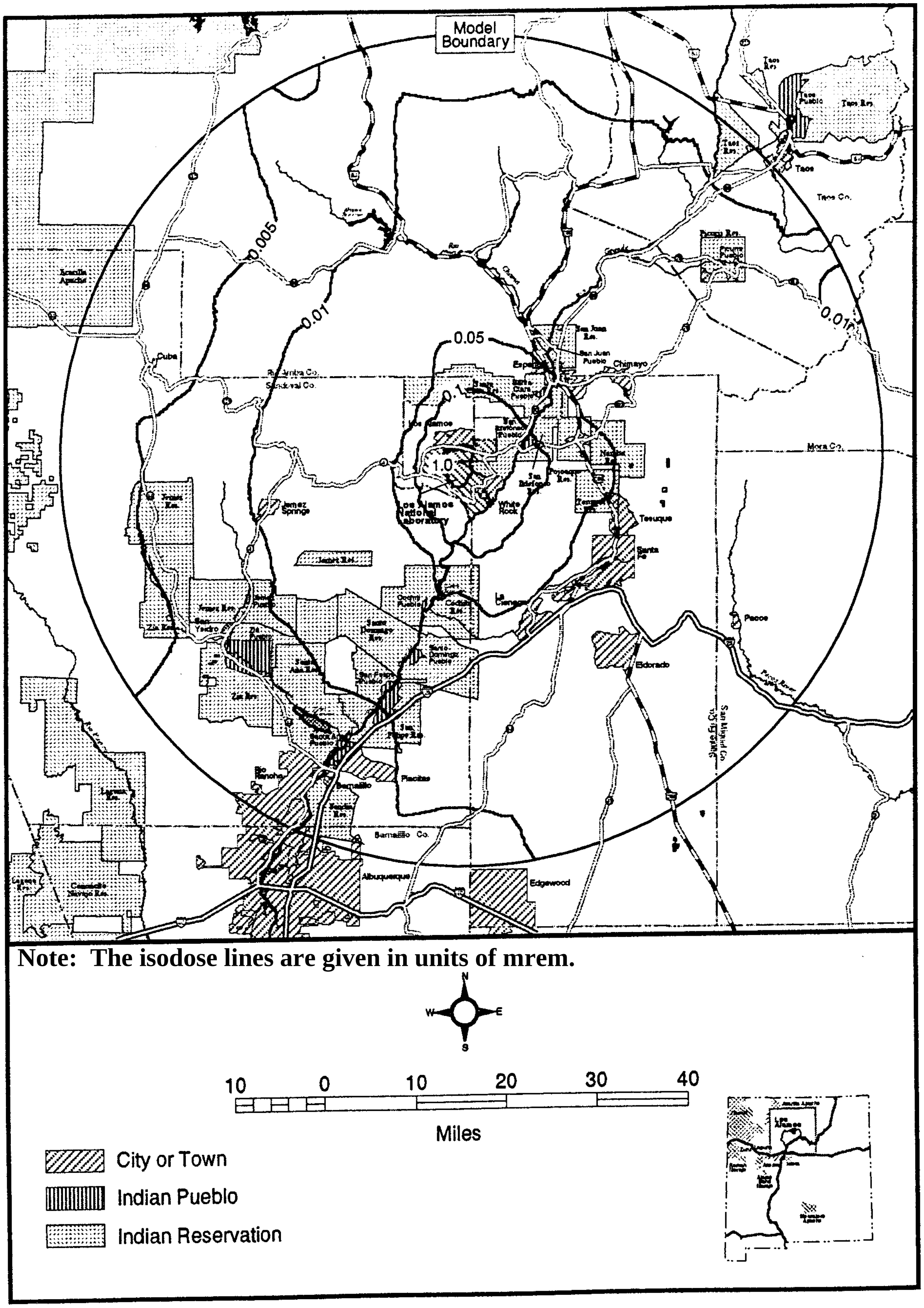


FIGURE 5.4.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the Reduced Operations Alternative*.



Note: The isodose lines are given in units of mrem.

FIGURE 5.4.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the Reduced Operations Alternative*.

The isodose maps showing both the estimated dose near LANL and within a 50-mile (80-kilometer) radius of LANL are given in Figures 5.4.4.2–1 and 5.4.4.2–2. The population dose within the 50-mile (80-kilometer) radius is also given in Table 5.4.6.1–1, estimated to be 10.8 person-rem per year. As reflected in the table, the annual operations excess LCF risk was estimated to be 0.0054.

In the Reduced Operations Alternative, there are six facilities with FS MEIs receiving a dose that would exceed 1 millirem per year (volume III, appendix B):

- LANSCE, 1.88 millirem per year to the facility MEI
- HE Testing Sites (TA–15 and TA–36), 1.76 millirem
- Pajarito Site (TA–18), 1.51 millirem
- TSTA and TSFF (TA–21), 1.22 millirem
- Radiochemistry Laboratory (TA–48), 1.08 millirem
- Plutonium Facility (TA–55), 1.08 millirem

External Radiation: Two Special Cases

As discussed in section 5.2.6.1, one contribution to public dose results from jogging or hiking for 96 hours on the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA. The MEI dose is not expected to change under the Reduced Operations Alternative from that estimated under the No Action Alternative (an EDE of 2.9 millirem per year and an excess LCF risk of about 1.4 x 10^{-6} per year).

The other contribution to public dose, as discussed in section 5.2.6.1, would result from TA–18 "road-open" operations. At the 95 percent confidence level, four exposures per year would be expected for the MEI out of the 100 operations per year at TA–18 under the Reduced Operations Alternative (the same as for the No Action Alternative). This would result in an annual projected MEI EDE dose of 19 millirem per year. The lifetime excess LCF risk for this dose is about 9.5 x 10^{-6} per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. The consequence of a public exposure to this source under the Reduced Operations Alternative is the same as for the No Action Alternative; as discussed in section 5.2.6.1, this consequence is negligible.

Consequences of Airborne Chemical Emissions

For the Reduced Operations Alternative, these consequences are the same as those under the No Action Alternative; the worst-case HI for lead did not exceed one in a million (10^{-6}); for depleted uranium, the worst-case HI did not exceed 1 in 100,000 (0.00010); and the excess LCF for beryllium (evaluated as a carcinogen) under the Reduced Operations Alternative was estimated to be less than 3.6 x 10^{-7} per year. These analyses are presented in detail in volume III, appendix D.

Carcinogenic Risk from Air Emissions

The screening process described in appendix B identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs (appendix B, attachment 6).

This combined cancer risk is less than 1 in 1 million for the Reduced Operations Alternative because projected emissions for this alternative are less than those analyzed for the Expanded Operations Alternative (which was just slightly above the screening guideline value of 1 x 10^{-6}).

It is believed that negligible increase in incremental combined cancer risk will result from the Reduced Operations Alternative.

Consequences of Ingestion to Residents, Recreational Users, and Special Pathways Receptors

The risk to the public from ingestion under the Reduced Operations Alternative does not differ from that associated with the No Action Alternative; this is because most of the risk is attributable to the existing levels of contamination in water and soils in the area. This is discussed further in section 5.2.6.1. Table 5.2.6.1–2 summarizes the ingestion radiological annual dose and excess LCF per year to the MEIs. Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6×10^{-6} per year of exposure and 9.1×10^{-7} per year of exposure for the individual who is also an avid recreational user. These worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in volume III, appendix D, section D.3.3. Table 5.2.6.1–3 summarizes the risk associated with metals ingestion to MEIs in the LANL region.

Consequences to the Public Along Transportation Routes

Section 5.4.10 details the analysis of transportation consequences under this alternative. Public health consequences include the dose and excess LCF risk associated with routine, accident-free transportation. Table 5.4.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments. The population dose and excess LCFs associated with exposures occurring during stops for transportation segments near LANL are provided in Table 5.4.6.1–2. Doses associated with living along route and sharing routes with these shipments are detailed in Table 5.4.10–2, and are less than those associated with stops. Risks associated with accidents during transportation also are discussed in section 5.4.10.

5.4.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological

TABLE 5.4.6.1–2.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials and Wastes from LANL*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	3.4	0.0017
U.S. 84/285	3.6	0.0018

(ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the Reduced Operations Alternative are given below and detailed in appendix D, section D.2.2.

Radiological Consequences

Ionizing Radiation Consequences. Table 5.4.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the Reduced Operations Alternative.

The collective worker dose under the Reduced Operations Alternative is conservatively projected to be 18 percent less than that measured in 1993 to 1995. In terms of the average non-zero dose, the Reduced Operations Alternative is expected to result in less than that experienced in recent years (0.08 rem per year for Reduced Operations compared with 0.097 rem per year, 1993 to 1995). The estimated lifetime excess LCF risk is 0.000033 per year of operation.

Nonionizing Radiation. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (Also see appendix D, section D.2.2.2 for evaluation used to estimate nonionizing radiation from LANL operations to humans and wildlife, and for the estimated results.)

Chemical Exposure Consequences

It is anticipated that there will continue to be a few exposures annually, particularly exposures to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

Under the Reduced Operations Alternative, it is expected that there will be a worker population of approximately 9,300 individuals, approximately equal to the index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the chemical hygiene program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures would not change from the index period, approximately one to three reportable chemical exposures per year.

Beryllium Processing Consequences. It is anticipated that beryllium operations in the Reduced Operations Alternative would be the same as in the No Action Alternative. It is not anticipated that consequences to workers would be measurable; that is, no sensitization to beryllium would be detected using the LANL industrial hygiene monitoring program.

TABLE 5.4.6.2–1.—*Annual Worker Doses and Associated Lifetime Excess LCF Risks Under the Reduced Operations Alternative*

LANL Collective Worker Dose (person-rem/yr)	170
Estimated Excess LCF Risk (across the worker population) per year of operation	0.07
Average Non-Zero Worker Dose (rem/yr)	0.08
Estimated Excess LCF Risk (average worker > 0 dose)	0.000033

Physical Safety Hazards

Table 5.4.6.2–2 compares the projected reportable accidents and injuries estimated for normal operations occurring under the Reduced Operations Alternative and that experienced during the index period. The Reduced Operations Alternative is expected to result in no change in reportable accidents or injuries due to increases in worker population. These accidents and injuries are considered as consequences of normal operations because of their frequency. These results assume that the aggressive Health and Safety Program underway at LANL does not achieve any additional reduction in reportable cases.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset, and subsequent physical therapy. Some injuries may also result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock or electrocution.

TABLE 5.4.6.2–2.—*Projected Annual Reportable Accidents and Injuries for the Reduced Operations Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 9,300
Projected Reportable Accidents and Injuries	417/year
Change from Index (1993 to 1996)	Negligible Change

5.4.7 Environmental Justice

As indicated in sections 5.4.1 and 5.4.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the Reduced Operations Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface and groundwater and ecological resources associated with the Reduced Operations Alternative would affect all communities in the area equally (see sections 5.4.3 and 5.4.5 for additional information on the potential for impacts to these resources). Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Figure 5.4.7–1 reflects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL under the Expanded Operations Alternative. As discussed in section 5.2.7, impacts due to air emissions are equal to lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts are not disproportionately high or adverse with respect to the minority or low-income populations (see section 5.4.4 regarding the impacts anticipated for air emissions under the Reduced Operations Alternative).

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.4.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the Reduced Operations Alternative. Similarly, the special pathways have little potential to impact human health under this alternative. Thus, the Reduced Operations Alternative would not present disproportionately high or adverse impacts to

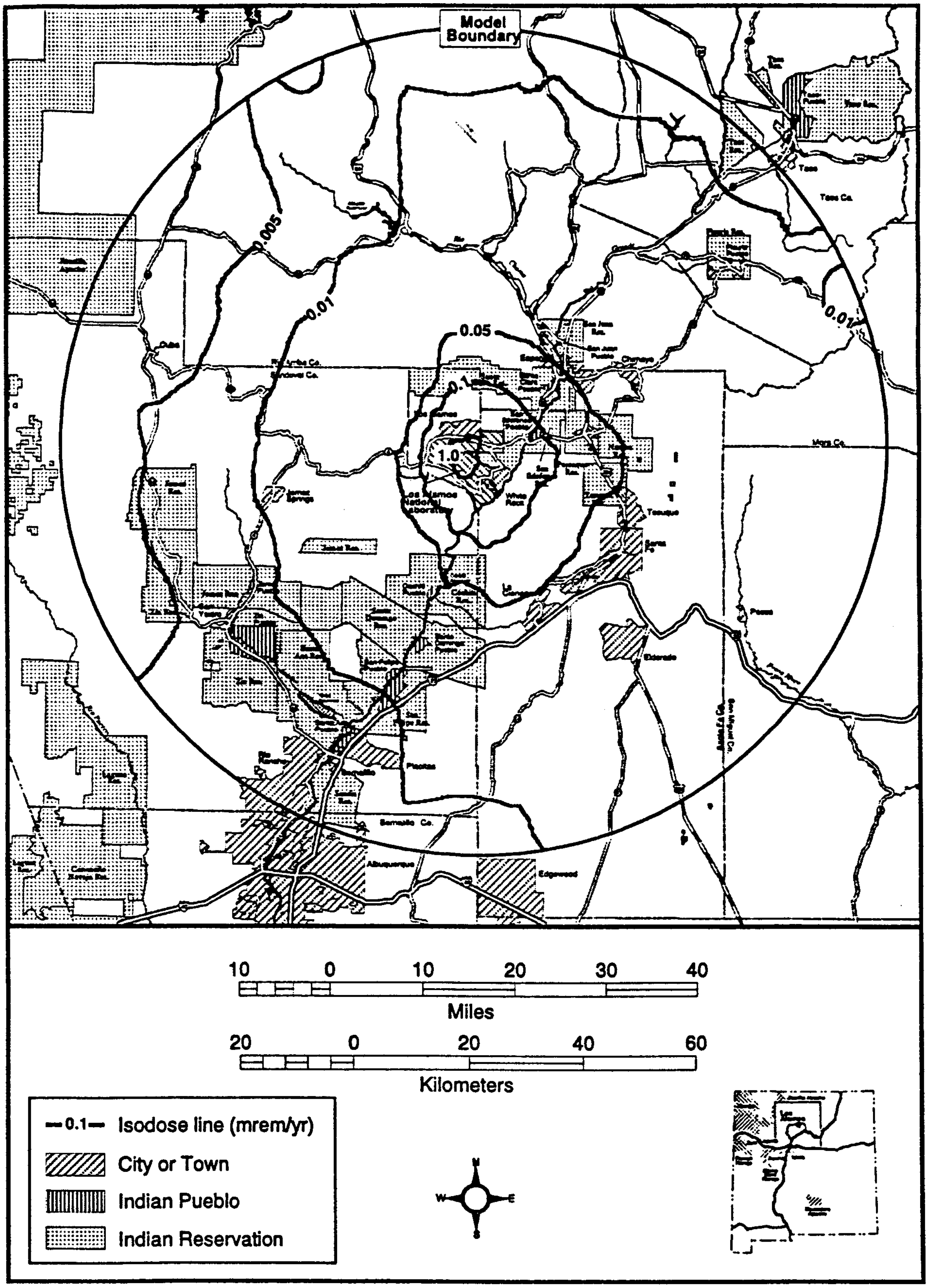


FIGURE 5.4.7–1.—*Isodose Lines from Airborne Releases for the Reduced Operations Alternative Within 50 Miles (80 Kilometers) of LANL.*

human health in minority or low-income communities (section 5.4.6.1).

As shown in section 5.4.10, impacts from on-site transportation and from LANL to U.S. 84/285 are estimated to be 0.0017 excess LCFs per year from incident-free transportation and 0.042 deaths and injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment from U.S. 84/285 to I–25) are estimated to be 0.0018 excess LCFs per year from incident-free transportation and 0.095 deaths or injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to either a member of the general public or to a member of a minority or low-income population due to transportation in the vicinity of LANL transportation routes.

5.4.8 Cultural Resources

Construction activities and explosive test activities under this alternative are essentially the same as those under the No Action Alternative. Because these are the activities with the most potential for impacts to cultural resources, impacts to prehistoric resources, historic resources, and TCPs under the Reduced Operations Alternative would be similar to those stated for the No Action Alternative in subsection 5.2.8, including the associated table. DOE would continue to manage and protect the 1,295 inventoried archaeological resources in compliance with the *Archaeological Resources Protection Act* (16 U.S.C. §470aa), Sections 3, 4, 6, and 7, and related legislation (see chapter 4). Management and protection of historic structures would be similar to that of the No Action Alternative (section 5.2.8).

Spiritual Entities

As with the No Action Alternative, no assessment of impacts to "unseen" or "spiritual" entities was attempted.

5.4.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, and infrastructure impacts of activities at LANL under the Reduced Operations Alternative.

5.4.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts of this type are presented in Table 5.4.9.1–1 for the LANL workforce only. The secondary (indirect) impacts and the total population changes projected are presented in Table 5.4.9.1–2 for the Tri-County area. These changes are assumed to occur within a year of the ROD for the SWEIS.

Housing

The population changes anticipated in the Tri-County area, based on the total employment changes described above, are projected to result in a reduction in demand of 27 housing units. The distribution of this reduction in the three counties is: a reduction of 6 units in Los Alamos County; a reduction of 10 units in Rio Arriba County; and a reduction of 11 units in Santa Fe County.

A reduction in housing demand at these levels is not expected to exert any significant pressure on rents and house prices, and is not expected to effect apartment vacancies or turnover periods for house sales in any of these three counties.

Construction

Table 5.4.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. Construction activities associated with this alternative are expected to draw workers already present in the Tri-County area who

TABLE 5.4.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the Reduced Operations Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,821	1,913	1,832	8,566	607	9,173	174	9,347
Difference[c]	(14)	(6)	(5)	(25)	(1)	(26)	(2)	(28) (-< 1%)
Salaries ($M)	252.4	44.6	73.7	370.7	16.3	387	8.5	395.4
Difference[c]	(2.9)	(0.4)	(0.6)	(3.2)	0	(3.3)	(0.2)	(3.5) (- 1%)
Procurement ($M)	215.4	1.7	20.6	237.7	121.8	359.5	228.8	588.4
Difference[c]	(0.3)	0.0	(0.1)	(0.3)	(0.6)	(1.0)	(2.8)	(3.7) (- 1%)

( ) indicates a decrease as compared to baseline.
[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc.; Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to fiscal year 1996. Percentage difference is shown in parentheses in the far right (TOTAL) column.

TABLE 5.4.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the Reduced Operations Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	(25)	(43)	(68)	(20)	(13)	(33)	(64) (-< 1%)
Personal Incomes	($3 million)	($3 million)	($6 million) (-< 1%)				
Annual Business Activity	($0.3 million)	($0.7 million)	($1 million) (-< 1%)				

( ) indicates a decrease as compared to baseline. Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total person income change, and total annual business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935 (and each worker leaving the area decreases the population by 1.935).

TABLE 5.4.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the Reduced Operations Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT $M	LABOR $M	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	208	50	1,426
2000	219	53	1,502
2001	210	50	1,440
2002	120	29	823
2003	91	22	624
2004	90	22	617
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Sources: DOC 1996, PC 1997a, and PC 1997b

historically have worked from job to job in the region. Thus, this employment is not expected to influence socioeconomic factors.

Local Government Finance

Under this alternative, the Tri-County gross receipts tax yields would not be expected to change substantially (about a $100,000 decrease from the baseline yield).

Services

Annual school enrollment in the Tri-County area would decrease by 11 students. This enrollment change would have no discernible effect on classroom capacity. Annual funding assistance from the State of New Mexico could be reduced by about $44,000 because of these enrollment decreases.

The demand for police, fire, and other municipal services would not be expected to change substantially.

5.4.9.2 *Infrastructure Impacts*

Annual electricity use projected under the Reduced Operations Alternative is a total of 508 gigawatt-hours, 163 gigawatt-hours for LANSCE, and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 88 megawatts, 38 megawatts for LANSCE, and 50 megawatts for the rest of LANL[1]. The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected electrical peak demand for LANL operations under this alternative; thus, periods of brownouts are anticipated unless measures are taken to increase the supply of electricity to the area. (Sections 1.6.3.1 and 4.9.2 discuss ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in section 4.9.2 of chapter 4.)

Natural gas use is projected to be 1,840,000 decatherms annually, the same as projected under the No Action Alternative. Demand should continue to be dominated by heating requirements.

Water use projected under the Reduced Operations Alternative is a total of 602 million gallons (2,279 million liters) per year, 108 million gallons (409 million liters) per year for LANSCE, and 494 million gallons (1,870 million liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6,836 million liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water

1. These values include the proposed SCC Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

demands of this community can be met within the existing water rights (water demand is also discussed in section 5.4.3). The peak water requirements are the same as identified under the No Action Alternative.

5.4.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.4.9.3–1. Radioactive liquid waste is not projected by facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste projected for receipt at TA–50 is 53 million gallons (200 million liters) over 10 years (or an average of 5.3 million gallons [20 million liters] per year) for this alternative. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities.

Due to the reduced level of operations under this alternative, this alternative generates less waste than is generated under the No Action Alternative. As with the No Action Alternative, much of LANL's LLW, TRU, and chemical waste would be treated and packaged to meet waste acceptance criteria and shipped off the site for disposal; nondefense TRU waste from other sites would be stored at LANL pending the development of disposal options. Off-site disposal capabilities are much greater than the waste volumes generated at LANL.

5.4.9.4 *Contaminated Space*

The activities reflected in the Reduced Operations Alternative are projected to increase the total contaminated space at LANL by 63,000 square feet (5,853 square meters) over the next 10 years (the same as the No Action Alternative), as compared to the baseline established for this SWEIS as of May 1996 (chapter 4, section 4.9). The majority of this increase is due to implementation of actions that have already been reviewed under NEPA, but which had not been implemented at the time the baseline was established (the same ones discussed in the No Action Alternative).

5.4.10 Transportation

The transportation impacts projected for the Reduced Operations Alternative are summarized in this section. More detailed information regarding these impacts is included in volume III, appendix F. Although the number of many types of operational shipments associated with the Reduced Operations Alternative are lower than in the other alternatives, the number of LLW shipments for off-site disposal increases substantially as compared to the number of LLW shipments under the No Action Alternative (because the Reduced Operations Alternative reflects off-site disposal of most LLW). Due to the larger number of LLW shipments under this alternative, the total number of shipments of radioactive materials under the Reduced Operations Alternative is actually larger than the number of such shipments under the No Action Alternative (although this is still fewer shipments than are associated with the Expanded Operations or Greener Alternatives). For this reason, the transportation impacts associated with off-site radioactive shipments under the Reduced Operations Alternative are actually greater than the impacts associated with such shipments under the No Action Alternative (this is not true for off-site radioactive materials accidents because LLW transportation accidents are not among the bounding accidents).

5.4.10.1 *Vehicle-Related Risks*

Truck Emissions in Urban Areas

For the Reduced Operations Alternative, the projected risk is 0.034 excess LCF per year. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to

TABLE 5.4.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Reduced Operations Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	5,250	52,500	688	6,880	12	120	81	810	27	270
Tritium Facilities[c]	TA–16 & 21	1,000	10,000	440	4,400	2	20	NA	NA	NA	NA
CMR Building[d]	TA–3	5,890	58,900	1,280	12,800	16.2	162	15.8	158	7.0	70
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	5,500	55,000	420	4,200	2	20	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	142,000	1.42×10^6	280	2,800	0	0	NA	NA	NA	NA
HE Processing Facilities	TA–8, 9, 11, 16, 28 & 37	7,000	70,000	8	80	0.2	2	NA	NA	NA	NA
HE Testing Facilities	TA–14, 15, 36, 39, 40	25,200	252,000	300	3,000	0.3	3	0.2	2	NA	NA
Los Alamos Neutron Science Center[e]	TA–53	16,600	166,600	156	1,560	1	10	NA	NA	NA	NA
Health Research Laboratory[f]	TA–43	5,050	50,500	14	140	2.5	25	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	1,600	16,000	120	1,200	1.3	13	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[g]	TA–50 & 21	2,200	22,000	150	1,500	0	0	21	210	0	0
Waste Treatment, Storage, and Disposal Facilities[g]	TA–54	920	9,200	174	1,740	4.0	40	27	270	0	0
Non-Key Facilities		651,000	6.51×10^6	520	5,200	30	300	0	0	0	0
ER Project[h]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[i]		2.878×10^6	2.878×10^7	8,960	89,600	621	6,210	156	1,560	34	340

TABLE 5.4.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Reduced Operations Alternative*[a]-Continued

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (section 5.4.9.3).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under *Toxic Substances Control Act*. This waste category also includes biomedical waste.

[c] These projections include 141,000 cubic feet (4,000 cubic meters) of LLW due to backlogged waste.

[d] These LLW projections include 141,000 cubic feet (4,000 cubic meters) of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections reflect reduced operational waste generation during construction activities that are included in this alternative.

[f] These projections include 22,000 pounds (10,000 kilograms) of chemical waste, 550 pounds (250 kilograms) of biomedical waste (a special form of chemical waste), 1,560 cubic feet (44 cubic meters) of LLW, and 850 cubic feet (24 cubic meters) of LLMW associated with ongoing efforts to remove obsolete and contaminated equipment.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[h] The ER Project is projected to generate 390 cubic feet (11 cubic meters) per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[i] Grand totals have been rounded.

0.033 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (1.9 kilometers) less of urban highway mileage. Approximately 65 percent of the excess LCFs are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. All shipments are conservatively assumed to result in an empty truck making the return trip. This is appropriate for WIPP and LLW shipments and for many SST shipments; however, most shipments are in general commerce and would not include the return of an empty truck.

Truck Accident Injuries and Fatalities

The impacts projected for the Reduced Operations Alternative are presented in Table 5.4.10.1–1. (Additional information is provided in volume III, appendix F, section F.6.3.) Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.4.10.2 *Cargo-Related Risks*

Incident-free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the Reduced Operations Alternative are presented in Table 5.4.10.2–1; as noted in section 5.2.10.2, the total is the dose throughout the U.S. and is dominated by the segments outside of New Mexico. The aircraft segment is for overnight carrier service; the truck segment to and from the airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for north-bound shipments carrying the radioactive material. Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route.

MEI dose occurs between LANL and I–25 and is 0.00032 rem.

Driver Doses from On-Site Shipments of Radioactive Materials

The projected collective radiation dose for LANL drivers under the Reduced Operations Alternative is 4.262 person-rem. This collective dose would be expected to result in 0.0017 excess LCFs among these drivers.

The average individual driver dose is projected to be 0.178 rem per year, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the Reduced Operations Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments

MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding excess LCF per year for these shipments are presented in Table 5.4.10.2–2 for these accidents. ADROIT results that are separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in

TABLE 5.4.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the Reduced Operations Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On-Site	0.014	0.0029	0.00014
LANL to U.S. 84/285	0.18	0.037	0.0018
U.S. 84/285 to I–25	0.43	0.091	0.0043
Remainder of New Mexico	0.70	0.68	0.075
Outside New Mexico	3.6	3.3	0.33
Total	4.9	4.1	0.41

TABLE 5.4.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the Reduced Operations Alternative*

ROUTE SEGMENT	TRUCK DRIVER OR AIRCREW		NONOCCUPATIONAL					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	6.4	0.0026	0.034	0.000017	0.56	0.00028	3.4	0.0017
U.S. 84/285 to I–25	8.7	0.0035	0.42	0.00021	3.4	0.0017	3.6	0.0018
Remainder of New Mexico	50	0.02	0.12	0.00006	1.9	0.00095	27	0.014
Outside New Mexico	440	0.18	2.9	0.0014	0.25	0.012	200	0.1
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
Total	510	0.21	3.5	0.0017	31	0.015	230	0.12

NA = Not applicable, rem = roentgen equivalent man

TABLE 5.4.10.2–2.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the Reduced Operations Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM -241	CH-TRU	RH-TRU	PLUTONIUM -238	PITS	TOTAL	
	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	0.015	0.0014	2.9×10^{-6}	4×10^{-7}	2×10^{-6}	0.016	8.0×10^{-6}
U.S. 84/285 to I–25	0.24	0.019	0.00004	1×10^{-6}	8×10^{-6}	0.26	0.00013
Remainder of New Mexico	0.031	0.012	0.000025	4×10^{-7}	4×10^{-6}	0.043	0.000022
Rest of U.S.	2.5	NA	NA	4×10^{-6}	0.00001	2.5	0.0012

NA = Not applicable

terms of excess LCF per year; for the Reduced Operations Alternative, MEI dose risk due to plutonium-238 oxide and due to pit shipments were each less than 1×10^{-10} excess LCF per year.

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore the excess LCFs per year) to about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa Fe. This difference is primarily due to the difference in population density along these routes. (The lower traffic density along the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and therefore excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [9.6 kilometers] more) in the distance traveled on I–25 for north-bound shipments.

On-Site Radioactive Materials Shipments

The MEI doses, frequencies, and MEI risks due to the bounding on-site shipments involving radioactive materials are given in Table 5.4.10.2–3. As noted in section 5.2.10.2, the frequency of the bounding DARHT and PHERMEX shipments has been added to the frequency of irradiated target shipments.

TABLE 5.4.10.2–3.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the Reduced Operations Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	8.8×10^{-8}	8.7 rem	7.7×10^{-7} rem/year (3.1×10^{-10} excess LCF/year)
Irradiated Targets	2.9×10^{-6}	acute fatality	2.9×10^{-6} fatalities/ year

Hazardous Materials Shipments

The bounding hazardous materials shipments for accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosive shipments. The consequences of an accident involving a major explosive shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

Accidental Chlorine Release

The projected frequencies, consequences, and risks associated with major chlorine accidents under the Reduced Operations Alternative are presented in Table 5.4.10.2–4.

The use of the Santa Fe Relief Route would result in about one-tenth the risk of fatalities and injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in the risk of fatalities and injuries on the remainder of New Mexico segment because of the extra 6 miles (9.6 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release

The projected frequencies, consequences, and risks associated with major propane accidents under the Reduced Operations Alternative are presented in Table 5.4.10.2–5.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-fourth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight decrease in the risk of injuries and fatalities on the Remainder of New Mexico segment because of the 6-mile (9.6-kilometer) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

5.4.11 Accident Analysis

Transportation accidents for the Reduced Operations Alternative are addressed in section 5.4.10. High-frequency (greater than 1 in 100) occupational accidents for the Reduced Operations Alternative are addressed in section 5.4.6.

5.4.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

The risks from these accidents are driven primarily by the frequency and magnitude of the earthquakes and wildfires in the area. Because the same types of operations will be conducted in the same facilities and the inventories of MAR will be about the same, there are no substantial changes in risk from earthquakes between the No Action and the Reduced Operations Alternatives.

For the wildfire scenario, the frequency will remain the same, but the MAR will be reduced by about 25 percent at TSTA, reducing the consequences by approximately 1 percent (6 person-rem) compared to the No Action Alternative. Table 5.2.11.1–1 and 5.2.11.1–2 can be referenced for the results of the No Action Alternative.

TABLE 5.4.10.2–4.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the Reduced Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000026	0.065	0.24	8.0×10^{-6}	0.00003
	Suburban	4.3×10^{-6}	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.00002	0.053	0.20	0.00027	0.001
	Suburban	0.000044	3.0	11		
	Urban	0.000013	11	40		
Remainder of New Mexico	Rural	0.00015	0.015	0.056	0.000048	0.00018
	Suburban	0.000016	1.5	5.5		
	Urban	2.6×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0011	0.028	0.10	0.0012	0.0044
	Suburban	0.00028	1.6	6.1		
	Urban	0.000066	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.4.10.2–5.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the Reduced Operations Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER TRIP	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	9.2×10^{-6}	0.28	1.1	9.2×10^{-6}	0.000037
	Suburban	1.6×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	7.1×10^{-6}	0.23	0.92	0.00014	0.0006
	Suburban	0.000016	8.4	34		
	Urban	4.8×10^{-6}	1.8	7.3		
Remainder of New Mexico	Rural	0.000062	0.15	0.6	0.00011	0.00048
	Suburban	0.00002	5.1	20		
	Urban	2.5×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.000078	0.09	0.36	0.000063	0.00027
	Suburban	9.9×10^{-6}	4.8	19		
	Urban	5.1×10^{-6}	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

5.4.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

For the Reduced Operations Alternative, the frequencies and consequences of these accidents are the same as under the No Action Alternative. These are presented in Table 5.2.11.2–1.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between Rocky Flats and TA–55–4 are presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facility and operations being conducted in TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including enhanced seismic resistance and fire containment.

5.4.11.3 *Highly Enriched Uranium Release from Process Hazard Accident*

As discussed in section 5.2.11.3, this accident is the dominant accident for release of HEU. Because there are no planned changes in the number of experiments or the inventories associated with this activity, the frequency and consequences of this scenario under the Reduced Operations Alternative are the same as presented under the No Action Alternative. These are reflected in Table 5.2.11.3–1.

5.4.11.4 *Tritium Release from a Manmade Hazard Accident at LANL*

As presented in section 5.2.11.4, the aircraft crash event is the dominant accident that involves tritium. Because no changes in operations or inventories from the No Action Alternative are made, the consequences and frequencies associated with these scenarios are the same as those presented in Table 5.2.11.4–1.

5.4.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations.

The number of accidental releases of chlorine depends upon the number of times the material is handled. The minor changes in activity levels cause the risk to decrease by about 5 to 10 percent. The incremental risk for this alternative over the No Action Alternative is essentially zero. These changes do not alter the overall risk profile for the site or substantially alter the relative ranking of each of these accidents. These results are provided in Tables 5.4.11.5–1 and 5.4.11.5–2.

5.4.11.6 *Worker Accidents*

Because there are no changes in the types of activities, frequencies, or inventories from the No Action Alternative, an individual worker is subject to the same risk, as presented in Table 5.2.11.6–1.

TABLE 5.4.11.5–1.—*Summary of Chlorine Exposure Scenarios at LANL—Reduced Operations Alternative*

SCENARIO DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
PROCESS HAZARD ACCIDENTS			
CHEM–01 Chlorine release (150 pounds [68 kilograms]) from potable water treatment station, due to human error during cylinder changeout or maintenance, or due to random hardware failures.	Approximately 0.0011 per year (i.e., one such event in approximately 900 years)	For the risk-dominant large leak scenario, an average of approximately 43 persons exposed above ERPG–2 levels, and approximately 12 persons exposed above ERPG–3 levels, to distances of up to a few tenths of a mile.	0.047 The Reduced Operations Alternative is 5% less likely than the No Action due to the handling of one less chlorine cylinder; no change in severity.
CHEM–02 Multiple cylinder (1,500 pounds [680 kilograms]) from toxic gas storage shed at Gas Plant, due to fire or aircraft crash.	Approximately 0.00012 per year (i.e., one in approximately 8,500 years)	Average of 292 people within LANL (ranging from none to 1,000 depending upon wind direction) exposed at or above ERPG–2 or –3 levels; town protected by canyon from highest concentrations.	0.035 Frequency increases by 8% from the No Action Alternative; no change in severity.
CHEM–03 Chlorine release (150 pounds [68 kilograms]) from toxic gas storage shed at Gas Plant, due to random failure or human errors during cylinder handling.	Approximately 0.00012 per year (i.e., one in approximately 8,000 years)	An average of approximately 263 exposed above ERPG–2 levels; or 239 above ERPG–3 levels, at distances to a fraction of a mile, all within LANL; town protected by canyon from highest concentrations.	0.032 No change in likelihood or severity over the No Action Alternative.
CHEM–06 Chlorine gas release outside Plutonium Facility.	Approximately 0.063 per year (i.e., one event in approximately 16 years)	Average number exposed at or above ERPG–2 doses is approximately 102, and above ERPG–3, approximately 7 at ranges to a fraction of a mile.	6.426 No change in likelihood or severity over the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available. However, for the particularly unlikely accidents, it is possible that there are causal mechanisms that were missed, so the possibility of a more probable scenario cannot be rigorously ruled out.

[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.

[c] Accident consequences are generally conservative (pessimistic), but do not bound the effects of accidents occurring under unusually unfavorable weather conditions. The results quoted are weather averaged.

TABLE 5.4.11.5–2.—*Summary of Chemical Exposure Scenarios—Reduced Operations Alternative*

SCENARIO	DESCRIPTION	LIKELIHOOD[a]	CONSEQUENCE MEASURES[b,c]	SOCIETAL RISK (NUMBERS AT OR ABOVE ERPG–2 PER YEAR)
CHEM–04	Bounding single container release of toxic gas (selenium hexafluoride) from waste cylinder storage.	Approximately 0.004 per year (i.e., one in about 250 years)	Average number of off-site persons exposed above ERPG–2 level is zero; toxic effects generally limited to the source's TA (TA–54).	0 No changes in frequency or severity from the No Action Alternative.
CHEM–05	Bounding multiple cylinder release of toxic gas (sulfur dioxide) from waste cylinder storage.	Approximately 0.00014 per year (i.e., one event in approximately 7,000 years)	Under conservative daytime conditions, no one outside the source area (TA–54) would see levels above ERPG–2. Under least favorable conditions, 13 persons could be exposed above ERPG–3 levels.	0 No changes in frequency or severity from the No Action Alternative.

[a] Accident likelihood estimates are conservative, given the information available. However, for the particularly unlikely accidents, it is possible that there are causal mechanisms that were missed, so the possibility of a more probable scenario cannot be rigorously ruled out.

[b] Conservative assumptions have been employed in estimating the quantity and form of the hazardous materials available for release.

[c] Accident consequences are generally conservative (pessimistic), but do not bound the effects of accidents occurring under unusually unfavorable weather conditions. The results quoted are weather averaged.

5.5 IMPACTS OF THE GREENER ALTERNATIVE

5.5.1 Land Resources

5.5.1.1 *Land Use*

Changes to land use under the Greener Alternative would be the same as for the No Action Alternative.

5.5.1.2 *Visual Resources*

Changes to visual resources under the Greener Alternative would be the same as for the No Action Alternative.

5.5.1.3 *Noise*

Changes to noise levels and air blasts associated with high explosives testing under the Greener Alternative would be the same as for the No Action Alternative. The overall LANL on-site activities (due to the increased operational levels in activities not related to weapons) would increase under implementation of the Greener Alternative resulting in an overall greater total number of noise producing events for workers. This could be a slight negative impact to the worker noise environment, as compared to the No Action Alternative.

5.5.2 Geology and Soils

Potential impacts for the Greener Alternative on geology and soils would be the same as those for the No Action Alternative.

5.5.3 Water Resources

5.5.3.1 *Surface Water*

Table 5.5.3.1–1 shows the total flow from the NPDES outfalls for each of the major watersheds under the Greener Alternative. In volume III, appendix A, Table A.1–1 presents more detailed information on the NPDES outfalls for all four alternatives by facility (key and non-key), watershed, and location. The estimated total gallons discharged into all watersheds totals 275 million gallons (1,041 million liters) under the Greener Alternative. This is an increase from the index effluent volume of 233 million gallons (882 million liters).

NPDES outfall effluent quality during the period of the SWEIS (1997 through 2006) is expected to be the same under this alternative as described for the No Action Alternative, including the radionuclide concentrations in effluent from TA–50, as presented in Table 5.2.3–2. The canyons with increased NPDES outfall flows (Los Alamos and Sandia) are the same as the No Action and the Expanded Operations Alternatives. The increased flow volumes in these two canyons are the same as the Expanded Operations Alternative, and the potential impacts should be minimal for the same reasons as discussed in the No Action and the Expanded Operations Alternatives. For the Greener Alternative, there are no new activities that will result in changes to stormwater runoff.

5.5.3.2 *Alluvial Groundwater*

The NPDES outfall discharges are similar to those under Expanded Operations and are expected to result in similar alluvial groundwater volumes.

The projected discharge from the RLWTF into Mortandad Canyon under the Greener Alternative is 6.6 million gallons (25 million liters) per year, as compared to the RLWTF index volume of 5.5 millions gallons (21 million liters) per year.

The new HELWTF will result in improved water quality to Canyon de Valle as discussed under the No Action Alternative.

TABLE 5.5.3.1–1.—*NPDES Discharges by Watershed Under the Greener Alternative*[a]

WATERSHED	#OUTFALLS		DISCHARGES (MGY)					
			KEY FACILITIES		NON-KEY		TOTALS	
	INDEX	GREENER	INDEX	GREENER	INDEX	GREENER	INDEX	GREENER
Ancho	2	0	0.1	0.0	0.0	0.0	0.1	0.0
Cañada del Buey	3	3	0.0	0.0	6.4	6.4	6.4	6.4
Chaquehui	1	0	0.0	0.0	5.8	0.0	5.8	0.0
Guaje	7	7	0.0	0.0	0.7	0.7	0.7	0.7
Los Alamos	12	8	19.2	44.5	0.5	0.2	19.7	44.7
Mortandad	12	7	42.0	29.6	10.9	5.1	52.9	34.7
Pajarito	17	11	8.4	1.8	0.8	0.8	9.2	2.6
Pueblo	1	1	0.0	0.0	1.0	1.0	1.0	1.0
Sandia	11	8	4.4	42.8	103.5	127.9	107.9	170.7
Water	21	10	29.5	14.1	0.0	0.0	29.5	14.1
Totals	87	55	103.6	132.3	129.6	142.0	233.2	274.9

MGY: millions of gallons per year

[a] NPDES Information Sources: Index information was provided by the Surface Water Data Team Reports of August 1996 (Bradford 1996) and as modified in 1997 (Garvey 1997). Outfall flow projections for the alternatives were based on the outfalls remaining as of November 1997. Additional outfalls may be eliminated in the future, as discussed in the *Environmental Assessment for Effluent Reduction* (DOE 1996e), as well as several other outfalls that may be closed as part of LANL's ongoing outfall reduction program.

5.5.3.3 *Perched Groundwater*

Groundwater flow and contaminant pathways to the intermediate perched groundwater bodies are not well characterized nor understood. It is possible that the increased NPDES discharges to Los Alamos and Sandia Canyons under this alternative could increase recharge of the intermediate perched groundwater and contaminant transport beneath these canyons.

5.5.3.4 *Main Aquifer*

Recharge mechanisms to the main aquifer are uncertain. However, for the same reasons as discussed under the No Action Alternative, impacts resulting from increased NPDES outfall flows under the Greener Alternative should be negligible.

A conservative projection of LANL water use under the Greener Alternative is 759 million gallons (2,873 million liters) per year. Los Alamos County and the NPS did not provide projections, but in 1994 the County used about 958 million gallons (3,626 million liters) from this water right and the NPS used about 5 million gallons (19 million liters). Based on this information, it is expected that the water requirements of this community can be met within the existing water rights from the main aquifer; however, projected use may approach 100 percent of the existing water rights to the main aquifer under this alternative.

For the purposes of modeling drawdown of the main aquifer, annual water use projections were made. The total water usage from DOE water rights was projected to average 1,670 million gallons (6,321 million liters) per year under the Greener Alternative, with a maximum annual use of 1,697 million gallons (6,423 million liters) and a minimum annual use of 1,611 million gallons (6,098 million liters).

The model results reflect water level changes at the top of the main aquifer across the alternatives, given continued draw from the aquifer by DOE, Española, and Santa Fe. Table 5.5.3.4–1 shows predicted water level changes at the surface of the main aquifer during the period from 1997 through 2006 for the Greener Alternative; as noted in section 5.2.3.1, these changes are not all due to LANL operations. Although the water use modeled includes water use in Española and Santa Fe, the differences between the alternatives are due only to LANL operations. The impacts to the volume of water in the main aquifer under this alternative are very similar to those described for the No Action Alternative; the drawdowns in DOE well fields are minimal relative to the total thickness of the main aquifer, and the volume of water to be used over the period from 1997 through 2006 is negligible relative to the volume of water in storage. Details of the conceptual model, assumptions, uncertainties and limitations, and input parameters for the groundwater model are described in volume III, appendix A.

TABLE 5.5.3.4–1.—*Maximum Water Level Changes at the Top of the Main Aquifer Under the Greener Alternative (1997 Through 2006)*

WATER LEVEL CHANGE IN FEET[a,b]	
AREA OF CONCERN ON SITE	
Pajarito Well Field	-14.5
Otowi Well Field (Well 0-4)	-14.2
AREA OF CONCERN OFF SITE	
DOE - Guaje Well Field	-9.0
Santa Fe Water Supply	
Buckman Well Field	+21.6
Santa Fe Well Field	-20.6
San Juan Chama Diversion	0.0
Springs	
White Rock Canyon Springs, Maximum Drop	0.0
White Rock Canyon Springs, Maximum Rise	+1.0
Other Springs (Sacred, Indian)	+3.8
San Ildefonso Pueblo Supply Wells	
West of Rio Grande	
Household, Community Wells	+0.6
Los Alamos Well Field	+3.8
East of Rio Grande	
Household, Community Wells	0.0

[a] Negative value (-) indicates water level drop; positive value (+) indicates water level rise.

[b] Also, the water level changes projected by the regional MODFLOW model represent average changes over a whole grid-cell (i.e., a square that is a mile on a side). They are, for the most part, not predictive of the water level changes at any single point within the cell (for example, a supply well). Pumping wells have characteristic "cones of depression" where the water surface reflects an inverted cone, and water levels at the well may be quite different from levels even a few ten's of feet away. Whether any individual well would exhibit water level changes consistent with the predicted grid-cell average change is a function of, for example, its location within the grid-cell; proximity to other pumped wells; and the individual well operation, construction, and hydraulics. Hence, the water level changes predicted by the model can only be considered qualitatively and cannot be considered as finite changes.

5.5.4 Air Quality

5.5.4.1 *Nonradiological Air Quality Impacts*

Criteria pollutant emissions under the Greener Alternative are less than those under the Expanded Operations Alternative. Because the bounding analysis of criteria pollutant emissions for all alternatives (based on the emissions under the Expanded Operations Alternative) results in estimated concentrations of each pollutant below the standards established to protect human health with an ample margin of safety, criteria pollutant emissions under the Greener Alternative would also be below these levels.

As discussed in section 5.1.4, the only toxic air emissions with the potential to impact human health and the environment under any alternatives are those associated with HEFS operations and the additive emissions from all the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. Under the Greener Alternative, such emissions are projected to be similar to those addressed in the No Action Alternative (section 5.1.4). Therefore, pollutants released from LANL operations under the Greener Alternative are not expected to cause air quality impacts that would affect human health and the environment.

5.5.4.2 *Radiological Air Quality Impacts*

This section addresses the radiation dose to the FS MEI, LANL MEI, and the population dose from LANL radionuclide air emissions under the Greener Alternative.

Facility-Specific Maximally Exposed Individual

Table 5.5.4.2–1 shows the FS MEI for each facility analyzed under the Greener Alternative. The highest MEI dose was 4.52 millirems per year, which is 45.2 percent of the regulatory limit for the air pathway. The EPA regulatory limit would not be exceeded from emissions of these facilities under the Greener Alternative.

TABLE 5.5.4.2–1.—*Facility-Specific Information—Greener Alternative*

FACILITY	DOSE[a] (MREM/YR)
TA–3–29 (CMR)	0.35
TA–3–66 (Sigma)	0.35
TA–3–102 (Shops)	0.28
TA–11 (High Explosive Testing)	0.31
TA–15/36 (Firing Sites)	2.17
TA–16 (Tritium Facility)	0.31
TA–18 (Pajarito Site)	1.93
TA–21 (Tritium Facility)	1.54
TA–48 (Radiochemistry Laboratory)	1.64
TA–55 (Plutonium Facility)	1.64
TA–53 (LANSCE)[b]	4.52
TA–54 (Boundary)[c]	0.79
TA–54 (White Rock)	0.45

[a] For each FS MEI, the total dose was calculated by adding the contributions from each modeled facility. An MEI does not leave or take protective measures.
[b] This is also the LANL MEI. Five specific sources were modeled from TA–53. These include the TA–53 ES–2, ES–3, IPF, LEDA and combined diffuse emissions.
[c] Two FS MEI locations were considered for TA–54 because Area G is bordering San Ildefonso Pueblo land. The first is a MEI location at the LANL boundary, 1,197 feet (365 meters) northeast of Area G. No person from the Pueblo currently is known to live along this boundary. The second is an actual MEI location in the town of White Rock, approximately 5,331 feet (1,625 meters) southeast of Area G.

LANL Maximally Exposed Individual

The location of the LANL MEI (2,625 feet [approximately 800 meters] north-northeast of TA–53) was shown to be identical to the FS MEI with the highest dose under this alternative. The LANL MEI dose was calculated to be 4.52 millirems per year under the Greener Alternative.

Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from LANL was calculated for emissions from all key facilities and found to be 13.79 person-rem per year. TA–15/36 account for 51.3 percent of this dose, and collectively, collective diffuse emissions, including those from these TAs, account for 52.1 percent of this dose. The values reported for population doses for this alternative, as well as the other alternatives, is higher than has been reported in the recent annual environmental reports. It is important to recognize that the alternatives analyzed represent increased operations when compared to recent history. The material throughput at the different facilities under the various alternatives is presented in chapter 3, section 3.6.

Isodose Maps

The isodose maps for the 50-mile (80-kilometer) region are shown on the isodose maps in Figures 5.5.4.2–1 and 5.5.4.2–2.

5.5.5 Ecological Resources, Biodiversity, and Ecological Risk

Impacts to ecological resources and biodiversity resulting from the Greener Alternative would not vary appreciably from those of the No Action alternative. There would not be any incremental changes from the No Action level of ecological risk.

5.5.6 Human Health

The consequences of implementing the Greener Alternative on public health and worker health are presented below. As discussed in section 5.1.6, "risk," as used in the SWEIS human health analysis, refers to the probability of toxic or cancer mortality under the specific exposure scenarios analyzed.

5.5.6.1 *Public Health*

The consequences of continued operations of LANL on public health under the Greener Alternative are presented below for the same topics discussed in section 5.2.6.1.

Regional Consequences of Airborne Radioactivity Inhalation and Immersion

The LANL MEI was estimated to be 2,625 feet (approximately 800 meters) north-northeast of LANSCE (TA–53). This location is within the LANL reservation, and the dose at this location is estimated to be 4.5 millirem per year (section 5.5.4.2), corresponding to a 72-year lifetime dose of 320 millirem. This location borders the Los Alamos townsite and is a conservative estimate for an MEI from LANL emissions. The background (TEDE) dose in the Los Alamos area is estimated to be 360 millirem per year; thus, the dose is 1.3 percent of the background dose.

Table 5.5.6.1–1 summarizes the LANL MEI dose and presents the corresponding excess risk of excess LCF to the MEI. These risks are presented on a lifetime basis, assuming that the hypothetical LANL MEI received the estimated dose of 4.5 millirem each year for a 72-year life. The excess LCF risk was estimated to be 0.0002 over a lifetime.

The isodose maps showing both the estimated dose near LANL and within a 50-mile (80-kilometer) radius of LANL are given in Figures 5.5.4.2–1 and 5.5.4.2–2. The population dose within the 50-mile (80-kilometer) radius is also given in Table 5.5.6.1–1, estimated to be 13.8 person-rem per year. As reflected in the table, the annual operations excess LCF risk was estimated to be 0.0069.

In the Greener Alternative, there are six facilities with FS MEIs receiving a dose that would exceed 1 millirem per year (volume III, appendix B):

- LANSCE, 4.52 millirem per year to the facility MEI
- HE Testing Sites (TA–15 and TA–36), 2.17 millirem
- Pajarito Site (TA–18), 1.93 millirem
- Radiochemistry Laboratory (TA–48), 1.64 millirem
- Plutonium Facility, 1.64 millirem
- TSTA and TSFF (TA–21), 1.54 millirem

External Radiation: Two Special Cases

As discussed in section 5.2.6.1, one contribution to public dose results from jogging or hiking the access road north of TA–21 and is attributable to cesium-137 known to be on the ground within the TA. The MEI dose is not expected to change

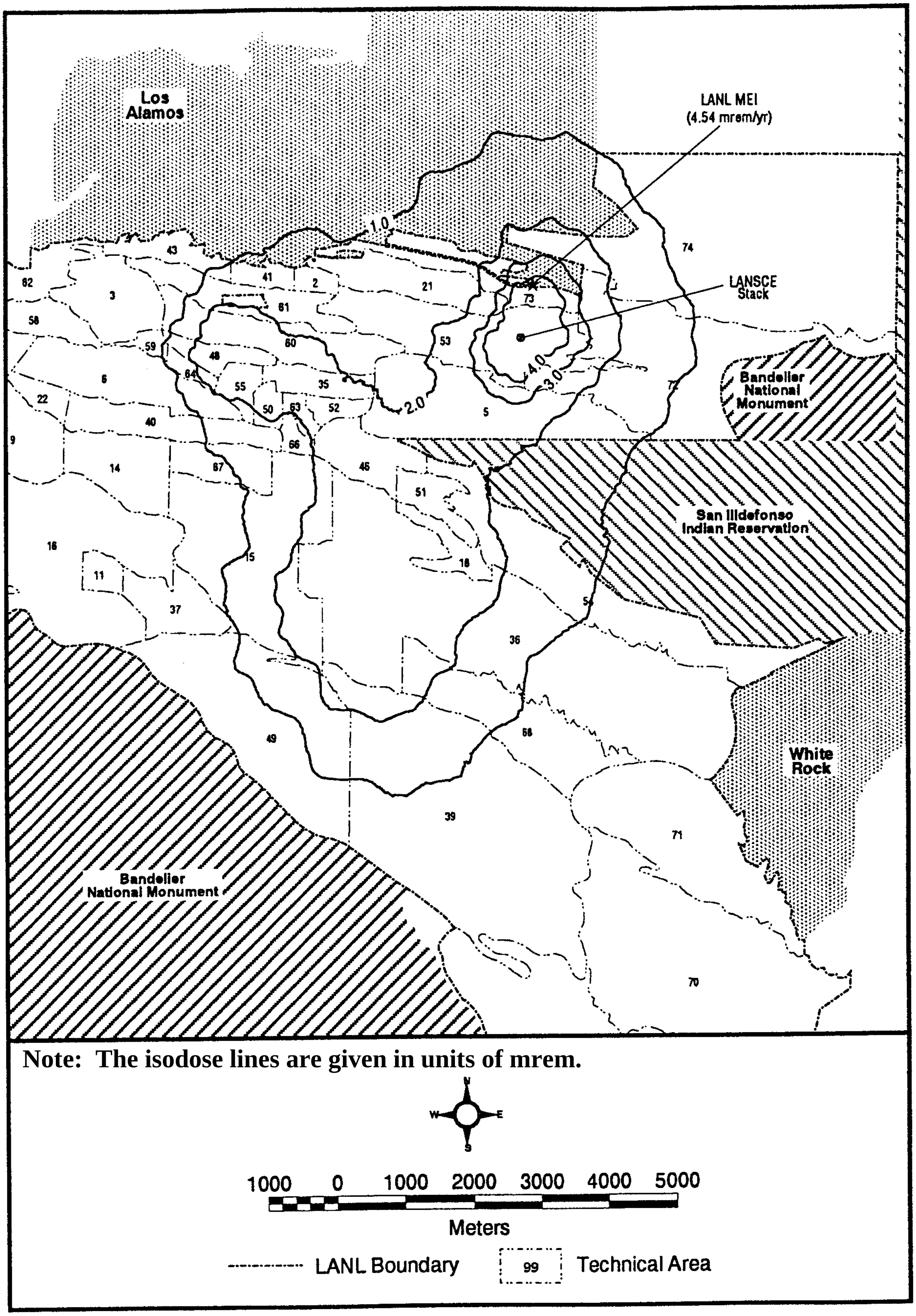


FIGURE 5.5.4.2–1.—*Isodose Map Showing Doses Greater Than 1 Millirem per Year for the Greener Alternative.*

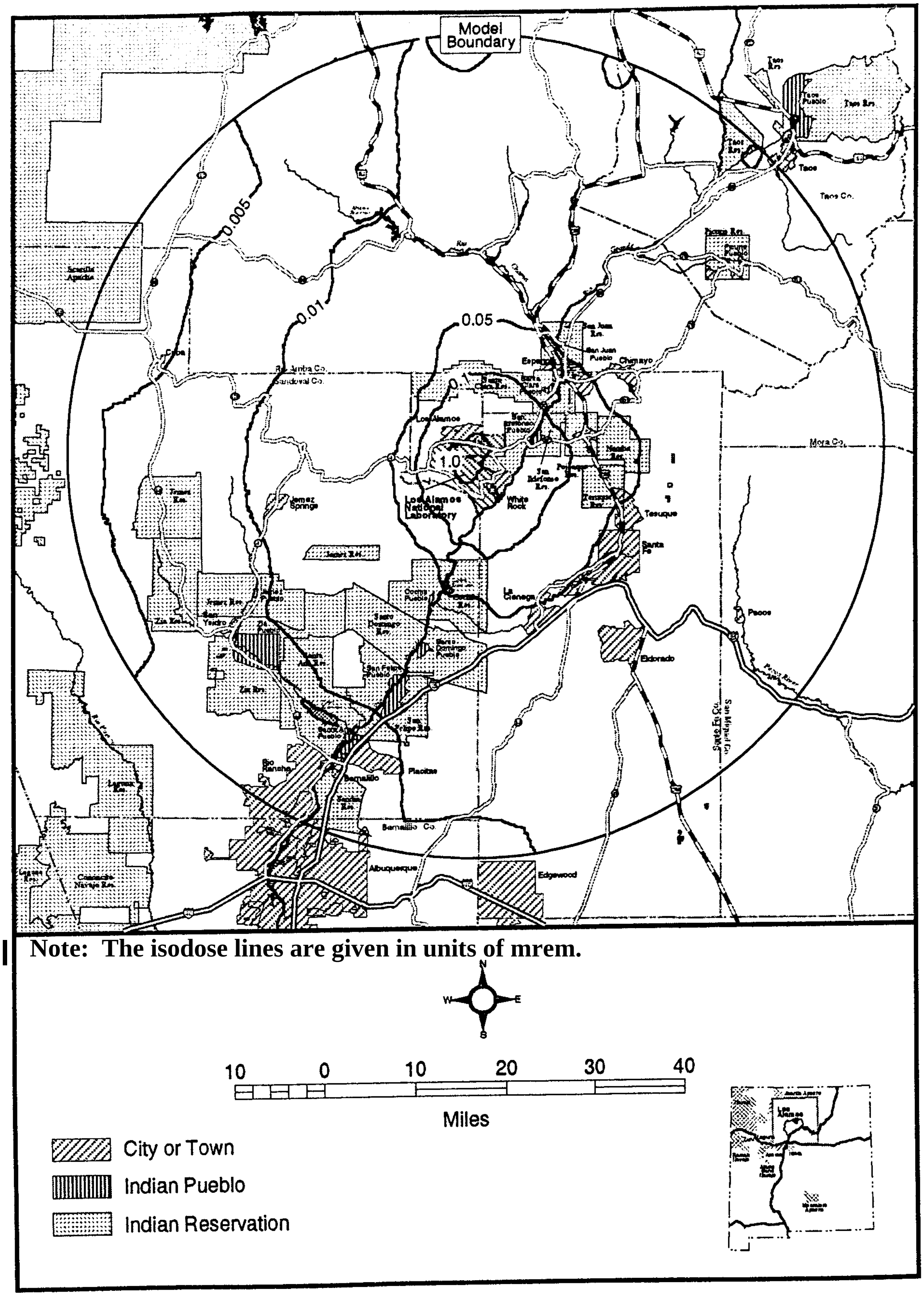


FIGURE 5.5.4.2–2.—*Isodose Map Showing Doses Less Than 1 Millirem per Year for the Greener Alternative*.

TABLE 5.5.6.1–1.—*Estimated Public Health Consequences for LANL MEI and the Population Within 50-Mile (80-Kilometer) Radius of LANL for the Greener Alternative*

PARAMETER	LANL HYPOTHETICAL MEI	50-MILE (80-KILOMETER) RADIUS POPULATION
Dose (Committed Effective Dose Equivalent)	4.52 millirem/year	13.79 person-rem/year
Excess LCF	0.0002/lifetime (72 year)	0.0069/year of operations

under the Greener Alternative from that estimated under the No Action Alternative (an EDE of 2.9 millirem per year and a lifetime excess LCF risk of about 1 x 10^{-6} per year of operation).

The other contribution to public dose, as discussed in section 5.2.6.1, would result from TA–18 "road-open" operations. At the 95 percent confidence level, four exposures per year would be expected for the MEI out of the 100 operations per year at TA–18 under the Greener Alternative (the same as for the No Action Alternative). This would result in an annual projected MEI EDE dose of 19 millirem per year. The lifetime excess LCF risk for this dose is about 9.5 x 10^{-6} per year of operation.

Nonionizing Radiation

The only uncontained nonionizing radiation source in use or planned for LANL is the microwave transmitter in TA–49. The consequence of a public exposure to this source under the Greener Alternative is the same as for the No Action Alternative; as discussed in section 5.2.6.1, this consequence is negligible.

Consequences of Airborne Chemical Emissions

For the Greener Alternative, these consequences are the same as those under the No Action Alternative; the worst case HI for lead did not exceed one in a million (10^{-6}); for DU, the worst case HI did not exceed 1 in 100,000 (0.00010); and the excess LCF for beryllium (evaluated as a carcinogen) under the Greener Alternative was estimated to be less than 3.6 x 10^{-7} per year. These analyses are presented in detail in volume III, appendix D.

Consequences of Ingestion and Dermal Exposures to Residents, Recreational Users, and Special Pathways Receptors

The risk to the public from ingestion under the Greener Alternative does not differ from that associated with the No Action Alternative; this is because most of the risk is attributable to the existing levels of contamination in water and soils in the area. This is discussed further in section 5.2.6.1. Table 5.2.6.1–2 summarizes the ingestion radiological annual dose and excess LCF per year to the MEIs. Tables 5.2.6.1–2 and 5.2.6.1–3 summarize the total radiological annual ingestion dose and excess LCF to members of the public. Per Table 5.2.6.1–3, the total worst-case ingestion doses for the off-site resident of Los Alamos County and non-Los Alamos County resident are 0.011 and 0.017 rem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose ranges up to 0.001 rem per year, according to the amount of time spent in the canyons (see footnote b in Table 5.2.6.1–3). If the individual has traditional Native American or Hispanic lifestyles, the values found in the final columns of the table should be used in place of the values in the first columns for off-site residents. Per the values in the final columns, these "special pathways receptors" can have worst-case 3.1 millirem per year additional dose. The associated excess LCF risks for the off-site residents are 8.6 x 10^{-6} per year of exposure and 9.1 x 10^{-7} per year of exposure for the individual who is also an avid recreational user. These worst-case doses are for a 95th percentile intake of the 95th percentile contamination level, referred to as the UCL. Ingestion pathway calculations included all radionuclides detected in the media. This includes natural background, weapons testing fallout, and previous releases. The actual contribution from continued operations at LANL is only a small fraction of this value. These values apply to the baseline and to all four alternatives. The data and analyses for these calculations are in appendix D, section 3.3. Table 5.2.6.1–3 summarizes the risk associated with metals ingestion to MEIs in the LANL region.

Consequences to the Public along Transportation Routes

Section 5.5.10 details the analysis of transportation consequences. Public health consequences include the dose and excess LCF risk associated with routine, accident-free, transportation. Table 5.5.10–2 shows the population dose and excess LCF for normal (accident-free) off-site shipments. The population dose and excess LCF that are associated with exposures occurring during stops for transportation segments near LANL are provided in Table 5.5.6.1–2. Doses associated with living along route and sharing routes with these shipments are detailed in Table 5.5.10–2, and are less than those associated with stops. Risks associated with accidents during transportation also are discussed in section 5.5.10.

TABLE 5.5.6.1–2.—*Radiation Doses and Excess LCF Risks Estimated to the Public at Stops During Transportation of Materials and Wastes from LANL*

ROUTE SEGMENT	PERSON-REM PER YEAR (AT STOPS)	EXCESS LCF RISK PER YEAR
LANL to U.S. 84/285	3.6	0.0018
U.S. 84/285	3.8	0.0019

5.5.6.2 *Worker Health*

Worker risks associated with continued operations of LANL include radiological (ionizing and nonionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the Greener Alternative are given below and detailed in volume III, appendix D, section D.2.2.

Radiological Consequences

Ionizing Radiation Consequences. Table 5.5.6.2–1 summarizes the projected doses and associated excess LCF risks from implementation of the Greener Alternative.

The collective worker dose under the Greener Alternative is conservatively projected to be approximately 2.3 times that measured in 1993 to 1995. In terms of the average non-zero dose, the Greener Alternative is expected to result in

TABLE 5.5.6.2–1.—*Annual Worker Doses and Associated Lifetime Excess LCF Risks Under the Greener Alternative*

LANL Collective Worker Dose (person-rem/year)	472
Estimated Excess LCF Risk (across the worker population) per year of operation	0.19
Average Non-Zero Worker Dose (rem/year)	0.14
Estimated Excess LCF Risk (average worker > 0 dose)	0.000056

0.14 rem per year for Greener, compared with 0.097 rem per year, 1993 to 1995. The estimated lifetime excess LCF risk is 0.000056 per year of operation.

Nonionizing Radiation. It is expected that there will continue to be negligible effects to LANL worker health from nonionizing radiation sources including ultraviolet sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves (including the large station at TA–49). (Also see volume III, appendix D, section D.2.2.2 for evaluation used to estimate nonionizing radiation from LANL operations to humans and wildlife and for the estimated results.)

Carcinogenic Risk from Air Emissions

The screening process described in appendix B identified no individual carcinogenic chemical air emission that required analysis for public health consequences. For carcinogens, an estimate also was made of the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs (appendix B, attachment 6).

This incremental combined cancer risk is less than 1 in 1 million for the Greener Alternative because the projected emissions for this alternative are less than for the Expanded Operations Alternative (which was slightly above the screening guideline value of 1×10^{-6}). It is believed that negligible increase in incremental combined cancer risk will result from the Greener Alternative.

Chemical Exposure Consequences

It is anticipated that there will continue to be a few chemical exposures annually, particularly exposures to:

- Airborne asbestos
- Lead paint particulates
- Crystalline silica
- Fuming perchloric acid, hydrofluoric acid
- Skin contact with acids or alkalis

Under the Greener Alternative, it is expected that there will be a worker population of approximately 10,000 individuals, approximately 10 percent higher than the index period employment levels. For the purposes of the SWEIS, it is assumed that there is negligible additional benefit of the Chemical Hygiene Program at LANL over the period analyzed, and that the rate of chemical exposures continues at the index period rates. Therefore, it is expected that reportable chemical exposures would not change appreciably from the index period, approximately one to three reportable chemical exposures per year.

Beryllium Processing Consequences. It is anticipated that beryllium operations in the Reduced Operations Alternative would be the same as in the No Action Alternative. It is not anticipated that consequences to workers would be measurable; that is, no sensitization to beryllium would be detected using the LANL IH monitoring program.

Physical Safety Hazards

Table 5.5.6.2–2 compares the projected reportable cases of accidents and injuries estimated for normal operations occurring under the Greener Alternative and that experienced during the index period. The Greener Alternative is expected to result in a slight increase in reportable cases due to increases in worker population. These accidents and injuries are considered as consequences of normal operations because of their frequency. These results assume that the aggressive Health and Safety Program underway at LANL does not achieve any additional reduction in reportable cases.

The consequences of these accidents and injuries are expected to be similar to those experienced in the past, and typically are those

TABLE 5.5.6.2–2.—*Projected Reportable Annual Accidents and Injuries for the Greener Alternative Compared with the Index Period*

PARAMETER ESTIMATED	PARAMETER VALUE AND UNITS
Projected Worker Population	Approximately 10,000
Projected Reportable Accidents and Injuries	460/year
Change from Index (1993 to 1996)	+ 10%

associated with health response and recovery from acute trauma. Therefore, the consequences include physical pain and therapy/treatment for recovery such as those associated with bone setting, shoulder dislocation reset and subsequent physical therapy. Some injuries also may result in continuing consequences to the worker that could affect productivity or lifestyle, such as motor skill loss due to nerve damage or cardiovascular debilitation resulting from electrical shock or electrocution.

5.5.7 Environmental Justice

As indicated in sections 5.5.1 and 5.5.2, no substantive adverse impacts to land resources or geology and soils are anticipated for the continued operation of LANL under the Greener Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these impact areas. The potential impacts to surface and groundwater and ecological resources associated with the Greener Alternative would affect all communities in the area equally (see sections 5.5.3 and 5.5.5 for additional information on the potential for impacts to these resources). Thus, no disproportionately high or adverse impacts to minority or low-income communities are anticipated to be associated with these resource areas.

Figure 5.5.7–1 reflects the dose from radiological air emissions within 50 miles (80 kilometers) of LANL under the Greener Alternative. As discussed in section 5.2.7, impacts due to air emissions are equal to or lower in the sectors with substantial minority and/or low-income populations than they are in sectors 1–3 and 6–16, and such impacts are not disproportionately high or adverse with respect to the minority or low-income populations (see section 5.5.4 regarding the impacts anticipated for air emissions under the Expanded Operations Alternative).

The air pathway is one example of the analysis of potential human health impacts. As presented in section 5.5.6, there is minimal potential for LANL operations to adversely affect human health for off-site residents or recreational users in the area around LANL under the Greener Alternative. Similarly, the special pathways have little potential to impact human health under this Alternative. Thus, the Greener Alternative would not present disproportionately high or adverse impacts to human health in minority or low-income communities (section 5.4.6.1).

As shown in section 5.5.10, impacts from on-site transportation and from LANL to U.S. 84/285 are estimated to be 0.0018 excess LCFs per year from incident-free transportation and 0.040 deaths or injuries per year from transportation accidents. Impacts from transportation on route segments that pass through minority or low-income communities (particularly the segment from U.S. 84/285 to I–25) are estimated to be 0.0019 excess LCFs per year from incident-free transportation and 0.091 deaths or injuries per year from transportation accidents. Therefore, no high and adverse impact is expected to either a member of the general public or to a member of a minority or low-income population due to

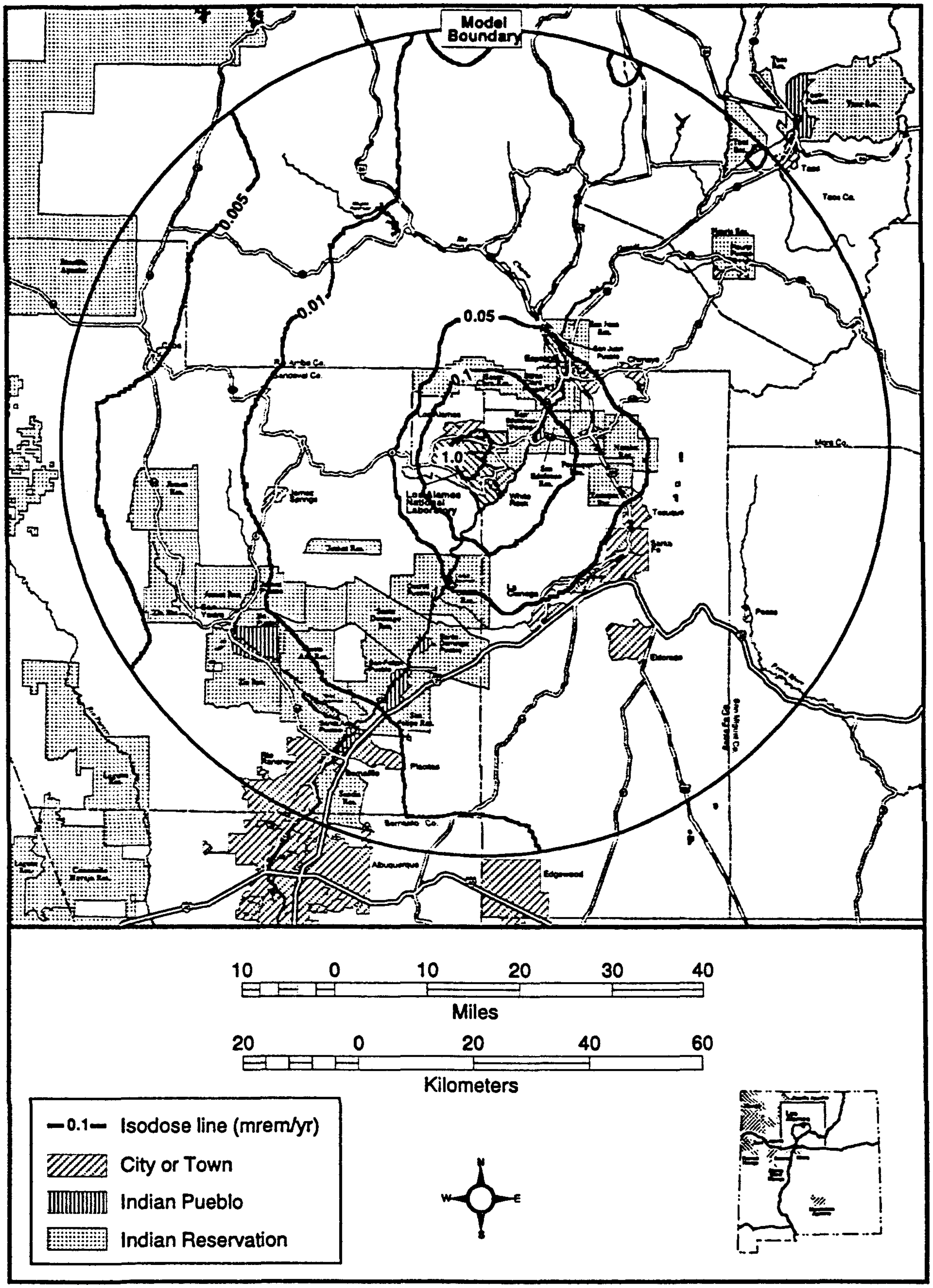


FIGURE 5.5.7–1.—*Isodose Lines from Airborne Releases for the Greener Alternative Within 50 Miles (80 Kilometers) of LANL.*

transportation in the vicinity of LANL transportation routes.

5.5.8 Cultural Resources

Construction activities and explosive test activities under this alternative are essentially the same as those under the No Action alternative. Because these are the activities with the most potential for impacts to cultural resources, impacts to prehistoric resources, historic resources, and TCPs under the Greener Alternative would be similar to those stated for the No Action Alternative in section 5.2.8. Management and protection of prehistoric and historic resources also would be similar to that of the No Action Alternative.

Spiritual Entities

As with the No Action Alternative, no assessment of impacts to "unseen" or "spiritual" entities was attempted.

5.5.9 Socioeconomics, Infrastructure, and Waste Management

This section describes the social, economic, and infrastructure impacts of activities at LANL under the Greener Alternative.

5.5.9.1 *Socioeconomic Impacts*

Employment, Salaries, and Population

The primary (direct) impacts of this type are presented in Table 5.5.9.1–1 for the LANL workforce only. The secondary (indirect) impacts and the total population changes projected are presented in Table 5.5.9.1–2 for the Tri-County area. These changes are assumed to occur within a year of the ROD for the SWEIS.

Housing

The population changes anticipated in the Tri-County area, based on the total employment changes described above, are projected to result in 551 additional (new) demand for housing units. The distribution of this demand in the three counties is projected to be: 130 additional units in Los Alamos County, 197 additional units in Rio Arriba County, and 224 additional units in Santa Fe County.

In Los Alamos County, the projected housing demand can be accommodated from absorption of apartment vacancies and the inventory of houses for sale and new construction. Beyond 130 units, no new housing units can be anticipated because of the absence of buildable land in private ownership. This constraint upon supply would be expected to exert an upward pressure on rents and house prices.

The projected housing demand in Rio Arriba and Santa Fe counties can be accommodated without significant pressure on rents and house sales prices. Both counties possess a sufficient inventory of finished lots and parcels, have access to adequate mortgage capital, and have sufficient entrepreneurial developer talent to absorb the demand.

Construction

Table 5.5.9.1–3 contains the results of the analysis of construction spending, labor salaries, and labor employment for the period fiscal year 1997 through fiscal year 2006. Construction activities associated with this alternative are expected to draw workers already present in the Tri-County area who historically have worked from job to job in the region. Thus, this employment is not expected to influence socioeconomic factors such as local government finance.

Under this alternative, the Tri-County annual gross receipts tax yields would be expected to increase by $1.1 million. This increase would

TABLE 5.5.9.1–1.—*Summary of Primary LANL Employment, Salaries[a], and Procurement Under the Greener Alternative[b]*

	LOS ALAMOS COUNTY	RIO ARRIBA COUNTY	SANTA FE COUNTY	TRI-COUNTY TOTAL	OTHER NEW MEXICO COUNTIES	NEW MEXICO TOTAL	OUTSIDE NEW MEXICO	TOTAL
Employees	4,995	2,082	2,032	9,109	661	9,770	198	9,968
Difference[c]	160	163	195	518	53	571	22	593 (+6%)
Salaries ($M)	264.4	51.5	85.5	401.4	19	420.4	10.3	430.7
Difference[c]	9.8	6.5	11.2	27.5	2.7	30.1	1.6	31.8 (+8%)
Procurement ($M)	217.3	1.8	21	240.1	124.2	364.3	237.5	601.8
Difference[c]	1.6	0.1	0.3	2.1	1.8	3.8	5.9	9.7 (+2%)

[a] Salaries are for UC employees only; subcontractor salaries (Johnson Controls, Inc.; Protection Technology of Los Alamos, etc.) are included in the procurement dollars.
[b] Reflects projected locations of employee residences and LANL procurement activities.
[c] Difference is as compared to baseline (fiscal year 1996). Percent difference is shown in parentheses in the far right (TOTAL) column.

TABLE 5.5.9.1–2.—*Summary of Total Tri-County Employment, Salaries, Business Activity, and Population Changes Under the Greener Alternative*

	PRIMARY CHANGE	SECONDARY CHANGE	TOTAL TRI-COUNTY CHANGE	TRI-COUNTY PRIMARY WORKER CHANGE[a]	TRI-COUNTY SECONDARY WORKER CHANGE[b]	TOTAL TRI-COUNTY WORKER CHANGE	TOTAL TRI-COUNTY POPULATION CHANGE[c]
Employment/ Population	518	886	1,404	414	266	680	1,316 (+1%)
Personal Incomes	$28 million	$27 million	$55 million (+ < 1%)				
Annual Business Activity	$2 million	$4 million	$6 million (+ < 1%)				

Note: Percentages in parentheses are the percentage change that the number represents. These are provided for total population change, total personal income change, and total business activity change.
[a] This is the number of direct workers moving to the Tri-County area, assuming that 80 percent of new LANL employees are from outside this area.
[b] This is the number of secondary workers moving to the Tri-County area, assuming that 30 percent of secondary employment is from outside this area.
[c] This is the total population increase in the Tri-County area, assuming that, on average, each worker moving to the area increases the population by 1.935.

TABLE 5.5.9.1–3.—*Construction Spending, Labor Salaries, and Labor Employment Numbers Under the Greener Alternative (Fiscal Year 1997 Through 2006)*

YEAR	CONTRACT ($M)	LABOR ($M)	EMPLOYEES
1997	63	15	432
1998	187	45	1,282
1999	208	50	1,426
2000	219	53	1,502
2001	210	50	1,440
2002	120	29	823
2003	91	22	624
2004	90	22	617
2005	109	26	747
2006	108	26	741

$M = dollars given in millions
Source: (DOC 1996, PC 1997a, and PC 1997b)

be matched by increases in service levels adequate to meet public demand.

Services

Annual school enrollment in the Tri-County area would increase by 224 students. Additional annual funding assistance of about $898,000 from the State of New Mexico would be required for school operations because of these enrollment increases.

In Los Alamos, the school district can absorb the anticipated new enrollment levels. This school district has excess capacity because of its discretionary policy of accepting out-of-district students who are the children of LANL employees and subcontractors. In Rio Arriba County and the cities of Española and Santa Fe, adequate classroom capacity exists because of recent school construction projects.

The demands for police, fire, and other municipal services would be expected to increase in proportion to the increase in gross receipts tax yields, as discussed above. However, any changes in local government services tend to be inelastic in the short term and typically are responsive only after the completion of at least one full budget cycle.

5.5.9.2 *Infrastructure Impacts*

Annual electricity use projected under the Greener Alternative is a total of 782 gigawatt-hours, 437 gigawatt-hours for LANSCE, and 345 gigawatt-hours for the rest of LANL. The peak electrical demand is projected to be 113 megawatts, 63 megawatts for LANSCE and 50 megawatts for the rest of LANL[1]. The existing supply of electricity to the Los Alamos area is not sufficient year-round to meet the projected electrical peak demand for LANL operations under this alternative; thus, periods of brown-outs are anticipated unless measures are taken to increase the supply of electricity to the area. (In chapter 1, sections 1.6.3.1 and 4.9.2 discuss ongoing efforts to increase electrical power supply to this area.) This situation is exacerbated by the additional electrical demand for BNM, and the communities of Los Alamos and White Rock. (While these organizations did not provide use projections, their historical usage is reflected in chapter 4, section 4.9.2.)

Natural gas use is projected to be 1.84×10^6 decatherms annually, the same as projected under the No Action Alternative. Although electrical demand may increase natural gas demand for the generation of electricity at TA–3, demand should continue to be dominated by heating requirements and is not expected to exceed this projection.

Water use projected under the Greener Alternative is a total of 759 million gallons

1. These values include the proposed SCC Project annual electricity and peak electrical demand for a 50-TeraOp operation and are reflected in all the alternatives. The SCC project was as an interim action to the SWEIS.

(2,873 million liters) per year, 265 million gallons (1,003 million liters) per year for LANSCE and 494 million gallons (1,869 million liters) per year for the rest of LANL. This is well within DOE water rights, about 1,806 million gallons (6,836 million liters) per year; however, this water right also provides for water used by Los Alamos County and BNM. Based on existing information regarding non-LANL water use, the water demands of this community can be met within the existing water rights (water demand is also discussed in section 5.5.3). The peak water requirements are the same as identified under the No Action Alternative.

5.5.9.3 *Waste Management*

The annual and 10-year total generation projections for radioactive and hazardous waste are reflected in Table 5.5.9.3–1. Radioactive liquid is not projected by facility because measurements of individual contributions are not made for all facilities. The total amount of radioactive liquid waste projected for receipt at TA–50 is 66 million gallons (250 million liters) over 10 years (or an average of 6.6 million gallons [25 million liters] per year) for this alternative. These projections include waste from key facilities, all other LANL facilities, waste management facilities, the ER Project, and construction activities.

The waste volumes generated under this alternative are very similar to those under the No Action Alternative; TRU and mixed TRU wastes under this alternative are lower (due to the reduced weapon-related activities), while the other categories are slightly higher (due to the increased nonweapons work). As with the No Action Alternative, much of LANL's LLW, TRU, and chemical waste would be treated and packaged to meet WAC and shipped off the site for disposal; nondefense TRU waste from other sites would be stored at LANL pending the development of disposal options. Off-site disposal capabilities are much greater than the waste volumes generated at LANL.

5.5.9.4 *Contaminated Space*

The activities reflected in the Greener Alternative are projected to increase the total contaminated space at LANL by 63,000 square feet (5,853 square meters) over the next 10 years (the same as for the No Action Alternative), as compared to the baseline established for the SWEIS as of May 1996 (chapter 4, section 4.9). The majority of this increase is due to implementation of actions that have already been reviewed under NEPA, but which had not been implemented at the time the baseline was established (the same ones discussed in the No Action Alternative).

5.5.10 Transportation

5.5.10.1 *Vehicle-Related Risks*

The transportation impacts projected for the Greener Alternative are summarized in this section. As with the Reduced Operations Alternative, most of the LLW generated is shipped off the site for disposal under the Greener Alternative. While most other shipments are similar to those under the No Action Alternative, these LLW shipments increase the total number of shipments and total shipment miles enough that the transportation impacts under the Greener Alternative approach (but are less than) those of Expanded Operations for off-site radioactive material shipments. More detailed information regarding these impacts is included in volume III, appendix F.

Truck Emissions in Urban Areas

For the Greener Alternative, the projected risk is 0.036 excess LCF per year. Use of the Santa Fe Relief Route would have a very small effect on this risk (it would change to 0.035 excess LCF per year). The only difference is that the Santa Fe Relief Route would have 1.2 miles (1.93 kilometers) less of urban highway mileage. Approximately 65 percent of the excess LCFs are due to radioactive material

TABLE 5.5.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Greener Alternative*[a]

FACILITY	TECHNICAL AREAS	CHEMICAL WASTE[b] (kilograms)		LOW LEVEL WASTE (cubic meters)		MIXED LOW LEVEL WASTE (cubic meters)		TRANSURANIC WASTE (cubic meters)		MIXED TRANSURANIC WASTE (cubic meters)	
		ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR	ANNUAL AVERAGE	10-YEAR
Plutonium Facility Complex	TA–55	5,250	52,500	688	6,880	12	120	127	1,270	35	350
Tritium Facilities[c]	TA–16 & TA–21	1,300	13,000	450	4,500	2	20	NA	NA	NA	NA
CMR Building[d]	TA–3	8,270	82,700	1,410	14,100	16.5	165	19.5	195	8.7	87
Pajarito Site	TA–18	4,000	40,000	145	1,450	1.5	15	NA	NA	NA	NA
Sigma Complex	TA–3	5,500	55,000	420	4,200	2	20	NA	NA	NA	NA
Materials Science Laboratory	TA–3	600	6,000	0	0	0	0	NA	NA	NA	NA
Target Fabrication Facility	TA–35	3,800	38,000	10	100	0.4	4	NA	NA	NA	NA
Machine Shops	TA–3	142,000	1.42×10^6	280	2,800	0	0	NA	NA	NA	NA
HE Processing Facilities	TA–8, 9, 11, 16, 28 & 37	7,000	70,000	8	80	0.2	2	NA	NA	NA	NA
HE Testing Facilities	TA–14, 15, 36, 39, 40	25,200	252,000	300	3,000	0.3	3	0.2	2	NA	NA
Los Alamos Neutron Science Center[e]	TA–53	16,600	166,600	1,085	10,850	1	10	NA	NA	NA	NA
Health Research Laboratory[f]	TA–43	13,280	132,800	34	340	3.4	34	NA	NA	NA	NA
Radiochemistry Laboratory	TA–48	2,900	29,000	240	2,400	3.4	34	NA	NA	NA	NA
Radioactive Liquid Waste Treatment Facility[g]	TA–50 & TA–21	2,200	22,000	150	1,500	0	0	21	210	0	0
Waste Treatment, Storage, and Disposal Facilities[g]	TA–54	920	9,200	174	1,740	4.0	40	27	270	0	0
Non-Key Facilities		651,000	6.51×10^6	520	5,200	30	300	0	0	0	0
Environmental Restoration Project[h]		2×10^6	2×10^7	4,257	42,570	548	5,480	11	110	0	0
Grand Total[i]		2.89×10^6	2.89×10^7	10,200	102,000	625	6,250	206	2,060	44	440

TABLE 5.5.9.3–1.—*Projected Annual and 10-Year Total Waste Generation Under the Greener Alternative*[a]-Continued

NA indicates that this facility does not routinely generate these types of waste.

[a] Radioactive liquid waste generation is not projected by facility (see text in section 5.5.9.3, Radioactive and Hazardous Waste Generation).

[b] The chemical waste numbers reflect waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a hazardous waste. This includes waste that is subject to regulation under RCRA, as well as PCB waste and asbestos waste regulated under *Toxic Substance Control Act.* This category also includes biomedical waste.

[c] These projections include 141,000 cubic feet (4,000 cubic meters) of LLW due to backlogged waste.

[d] These LLW projections include 141,000 cubic feet (4,000 cubic meters) of LLW generation anticipated due to the CMR Building Upgrades, Phase II.

[e] These projections include 228,000 cubic feet (6,450 cubic meters) of LLW due to the construction of the new Long-Pulse Spallation Source Facility and 86,000 cubic feet (2,450 cubic meters) of LLW due to upgrades to Areas A5 and A6, as well as reduced operational waste generation during these construction activities.

[f] These projections include 22,000 pounds (10,000 kilograms) of chemical waste, 550 pounds (250 kilograms) of biomedical waste (a special form of chemical waste), 1,560 cubic feet (44 cubic meters) of LLW, and 850 cubic feet (24 cubic meters) of LLMW associated with ongoing efforts to remove obsolete and contaminated equipment.

[g] These facilities provide for storage, treatment, and disposal of waste generated throughout LANL. These activities generate secondary waste, the quantities of which are reflected in this table for these facilities.

[h] The ER Project is projected to generate 390 cubic feet (11 cubic meters) per year of TRU and mixed TRU waste together. All of this waste is presented under the TRU waste columns.

[i] Grand totals have been rounded.

shipments and 35 percent are due to hazardous chemical shipments. All shipments are conservatively assumed to result in an empty truck making the return trip. This is appropriate for WIPP and LLW shipments and for many SST shipments; however, most shipments are in general commerce and would not include the return of an empty truck.

Truck Accident Injuries and Fatalities

The impacts projected for the Greener Alternative are presented in Table 5.5.10.1–1 (additional information is provided in volume III, appendix F, section F.6.3). Use of the Santa Fe Relief Route would reduce the risks of accidents, injuries, and fatalities by almost one-half of those indicated for the segment from U.S. 84/285 to I–25 due to the assumption that the accident rate on the Santa Fe Relief Route would be much lower than for the route through Santa Fe. Use of the Santa Fe Relief Route would not substantially change the risks of accidents, injuries, and fatalities on the remainder of New Mexico segment, as compared to the risks reflected for this segment in Table 5.5.10.1–1. Approximately 65 percent of the impacts are due to radioactive material shipments and 35 percent are due to hazardous chemical shipments. Again, all shipments are assumed to result in a return by an empty truck.

5.5.10.2 *Cargo-Related Risks*

Incident-Free Radiation Exposure

The incident-free radiation exposure impacts projected for the off-site shipments under the Greener Alternative are presented in Table 5.5.10.2–1; as noted in section 5.2.10.2, the total is the dose throughout the U.S. and is dominated by the segments outside of New Mexico. The aircraft segment is for overnight carrier service; the truck segment to and from the airport is included in the truck results. In general, use of the Santa Fe Relief Route would result in only small changes in this type of impact. Truck crew doses and nonoccupational doses for people at rest stops would increase due to the increased length of the Santa Fe Relief Route for north-bound shipments carrying the radioactive material. Nonoccupational doses for people sharing the road would decrease due to the lower traffic density projected for the relief route. The MEI dose occurs between LANL and I–25 and is 0.00034 rem.

Driver Doses from On-Site Shipments of Radioactive Materials

The projected collective radiation dose for on-site shipments of radioactive materials is 4.5 person-rem. This collective dose would be expected to result in 0.00181 excess LCFs among these drivers.

The average individual driver dose is projected to be 0.189 rem, which is well below the DOE radiation protection limit of 5 rem per year.

Transportation Accidents

The following discussion addresses the potential impacts of accidents leading to the release of either radioactive or hazardous material being transported in support of LANL operations under the Greener Alternative. Results are given for both off-site and on-site shipments.

Off-Site Radioactive Materials Shipments. The MEI doses calculated with RADTRAN do not vary by alternative and are given in Table 5.2.10.2–2. The population dose and corresponding excess LCF per year for these shipments are presented in Table 5.5.10.2–2 for these accidents. ADROIT results that are separated into frequency and consequence components are not readily available. The product, MEI dose risk, can be presented in terms of excess LCF per year; for the Greener Alternative, the MEI dose risk due to plutonium-238 oxide and due to pit shipments were each less than 1×10^{-10} excess LCF per year.

TABLE 5.5.10.1–1.—*Truck Accident Injuries and Fatalities Projected for LANL Shipments Under the Greener Alternative*

ROUTE SEGMENT	NUMBER OF ACCIDENTS PER YEAR	NUMBER OF INJURIES PER YEAR	NUMBER OF FATALITIES PER YEAR
On-Site	0.015	0.0031	0.00015
LANL to U.S. 84/285	0.17	0.035	0.0019
U.S. 84/285 to I–25	0.41	0.086	0.0046
Remainder of New Mexico	0.67	0.64	0.08
Outside New Mexico	3.2	3.0	0.35
Total	4.5	3.8	0.44

TABLE 5.5.10.2–1.—*Incident-Free Population Dose and Lifetime Excess LCFs for Off-Site Shipments per Year of Operation Under the Greener Alternative*

ROUTE SEGMENT	TRUCK OR AIR CREW		NONOCCUPATIONAL					
			ALONG ROUTE		SHARING ROUTE		STOPS	
	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year	person-rem/year	excess LCF/ year
LANL to U.S. 84/285	6.8	0.0027	0.036	0.000018	0.59	0.0003	3.6	0.0018
U.S. 84/285 to I–25	9.2	0.0037	0.44	0.00022	4.2	0.0021	3.8	0.0019
Remainder of New Mexico	52	0.021	0.13	0.000065	2.0	0.001	28	0.014
Outside New Mexico	460	0.18	3.0	0.0015	26	0.013	210	0.1
Aircraft	2.4	0.0012	NA	NA	NA	NA	NA	NA
TOTAL	530	0.21	3.6	0.0018	33	0.015	250	0.12

NA = Not applicable

TABLE 5.5.10.2–2.—*Bounding Radioactive Materials Off-Site Accident Population Risk for the Greener Alternative*

ROUTE SEGMENT	ANNUAL POPULATION DOSE RISK AND EXCESS LCF RISK						
	SHIPMENT TYPE						
	AMERICIUM-241	CH TRU	RH TRU	PLUTONIUM-238	PITS	TOTAL	
	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	person-rem/year	excess LCF/year
LANL to U.S. 84/285	0.016	0.0015	3.2×10^{-6}	4×10^{-7}	2×10^{-6}	0.018	9.0×10^{-6}
U.S. 84/285 to I–25	0.25	0.02	0.000044	1×10^{-6}	8×10^{-6}	0.27	0.00014
Remainder of New Mexico	0.033	0.013	0.000027	4×10^{-7}	4×10^{-6}	0.046	0.000023
Rest of U.S.	2.7	NA	NA	4×10^{-6}	0.00001	2.7	0.0014

NA = Not available; CH TRU = contact-handled TRU waste; RH TRU = remote-handled TRU waste

The use of the Santa Fe Relief Route would reduce the projected population dose (and therefore, the excess LCFs per year) by about one-third for the U.S. 84/285 to I–25 segment, as compared to use of the route through Santa Fe. This difference is primarily due to the difference in population density along these routes. (The lower traffic density along the relief route is also a factor.) The use of the Santa Fe Relief Route would increase the projected population dose (and therefore the excess LCFs per year) for the remainder of New Mexico segment to about double that identified if the route through Santa Fe is used. This difference is due to the increase (6 miles [9.65 kilometers] more) in the distance traveled on I–25 for northbound shipments.

On-Site Radioactive Materials Shipments. The MEI doses, frequencies, and MEI risks due to the bounding on-site shipments involving radioactive materials are given in Table 5.5.10.2–3. As noted in section 5.2.10.2, the frequency of the bounding DARHT and PHERMEX shipments has been added to the frequency of irradiated target shipments.

Hazardous Materials Shipments. The bounding hazardous materials shipments for accident analyses are major chlorine shipments (toxic), major propane shipments (flammable), and major explosive shipments. The consequences of an accident involving a major explosive shipment is bounded by the consequences of an accident involving a major propane shipment, so the frequency of

TABLE 5.5.10.2–3.—*MEI Doses and Frequencies for Bounding On-Site Radioactive Materials Accidents Under the Greener Alternative*

SHIPMENT TYPE	EVENT FREQUENCY PER YEAR	MEI DOSE	MEI RISK
Plutonium-238 Solution	8.8×10^{-8}	8.7 rem	7.7×10^{-7} rem/year (3.1×10^{-10} excess LCF/ year)
Irradiated Targets	3.2×10^{-6}	acute fatality	3.2×10^{-6} fatalities/year

explosives shipments was added to the frequency of propane shipments (rather than analyzing them separately).

Accidental Chlorine Release. The projected frequencies, consequences, and risks associated with major chlorine accidents under the Greener Alternative are presented in Table 5.5.10.2–4.

The use of the Santa Fe Relief Route would result in about one-sixth the risk of fatalities and one-tenth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight increase in injuries and fatalities on the remainder of New Mexico segment because of the extra 6 miles (9.65 kilometers) traveled on I–25 for northbound traffic (chlorine shipments are all assumed to travel north on I–25).

Accidental Propane Release. The projected frequencies, consequences, and risks associated with major propane accidents under the Greener Alternative are presented in Table 5.5.10.2–5.

The use of the Santa Fe Relief Route would result in about one-third the risk of fatalities and one-fourth the risk of injuries on the U.S. 84/285 to I–25 segment, as compared to the use of the route through Santa Fe. These differences are due to the lower population density along the Santa Fe Relief Route. The use of the Santa Fe Relief Route would result in a slight decrease in injuries and fatalities on the remainder of New Mexico segment because of the 6 miles (9.5 kilometers) reduction in distance traveled on I–25 for southbound traffic (propane shipments are all assumed to travel south on I–25).

5.5.11 Accident Analysis

Transportation accidents for the Greener Alternative are addressed in section 5.5.10. High-frequency (greater than 1 in 100) occupational accidents for the Greener Alternative are addressed in section 5.5.6.

5.5.11.1 *Multiple Source Release of Hazardous Material from Site-Wide Earthquake and Wildfire*

The risks from these accidents are driven primarily by the frequency and magnitude of an earthquake and wildfire in the area. Because the same types of operations will be conducted in the same facilities and the inventories of MAR will be about the same, there are no substantial changes between the No Action and the Greener Alternatives. Tables 5.2.11.1–1 and 5.2.11.1–2 show these results.

5.5.11.2 *Plutonium Releases from Manmade and Process Hazards at LANL*

For the Greener Alternative, the activities and conditions that determine the material release and accident progressions do not change. Therefore, the frequencies and consequences of these scenarios under the Greener Alternative are the same as those presented for the No Action Alternative in Table 5.2.11.2–1.

An overview of the 1969 plutonium fire at the Rocky Flats site and a comparison of the design and operational differences between the Rocky Flats Plant and TA–55–4 are presented in volume III, appendix G, section G.4.1.2.

Substantial differences exist between the nuclear facility and operations being conducted at TA–55–4 today and those that were present at the Rocky Flats Plant in 1969. TA–55–4 was designed to correct the deficiencies detected in older facilities such as the Rocky Flats Plant and is being upgraded to meet the even more stringent requirements of the 1990's, including

TABLE 5.5.10.2–4.—*Frequencies, Consequences, and Risk for a Major Chlorine Accident Under the Greener Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	0.000028	0.065	0.24	8.6×10^{-6}	0.000032
	Suburban	4.6×10^{-6}	1.5	5.6		
U.S. 84/285 to I–25	Rural	0.000022	0.053	0.2	0.00029	0.0011
	Suburban	0.000047	3.0	11		
	Urban	0.000014	11	40		
Remainder of New Mexico	Rural	0.00016	0.015	0.056	0.000052	0.00019
	Suburban	0.000017	1.5	5.5		
	Urban	2.8×10^{-6}	8.4	32		
Remainder of U.S.	Rural	0.0012	0.028	0.1	0.0012	0.0047
	Suburban	0.0003	1.6	6.1		
	Urban	0.00007	10	39		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

TABLE 5.5.10.2–5.—*Frequencies, Consequences, and Risk for a Major Propane Accident Under the Greener Alternative*

ROUTE SEGMENT	AREA	EVENT FREQUENCY PER YEAR	ESTIMATED NUMBER OF FATALITIES PER EVENT	ESTIMATED NUMBER OF INJURIES PER EVENT	RISK OF FATALITIES PER YEAR[a]	RISK OF INJURIES PER YEAR[a]
LANL to U.S. 84/285	Rural	9.6×10^{-6}	0.28	1.1	9.7×10^{-6}	0.000039
	Suburban	1.6×10^{-6}	4.2	17		
U.S. 84/285 to I–25	Rural	7.4×10^{-6}	0.23	0.92	0.00015	0.0006
	Suburban	0.000016	8.4	34		
	Urban	5.0×10^{-6}	1.8	7.3		
Remainder of New Mexico	Rural	0.000064	0.15	0.6	0.00012	0.00048
	Suburban	0.000021	5.1	20		
	Urban	2.6×10^{-6}	1.5	6.1		
Remainder of U.S.	Rural	0.000081	0.09	0.36	0.000067	0.00027
	Suburban	0.00001	4.8	19		
	Urban	5.3×10^{-6}	1.9	7.5		

[a] Because individual factors were rounded for presentation, multiplication of the factors on this table may not exactly match the results in these columns.

enhanced seismic resistance and fire containment.

5.5.11.3 *Highly Enriched Uranium Release from Process Hazard Accident at LANL*

As discussed in section 5.2.11.3, this accident is the dominant accident for the release of HEU. Because there are no planned changes in the number of experiments or the inventories associated with this activity, the frequency and consequences of this scenario under the Greener Alternative are the same as presented under the No Action Alternative in Table 5.2.11.3–1.

5.5.11.4 *Tritium Release from a Manmade Hazard*

As presented in section 5.2.11.4, the aircraft crash event is the dominant accident that involves tritium. Because no changes in operations or inventories from the No Action Alternative are made, the consequences and frequencies associated with these scenarios are the same as those presented for the No Action Alternative in Table 5.2.11.4–1.

5.5.11.5 *Chemical Releases from Manmade and Process Hazard Accidents at LANL*

For the chlorine releases, on-site personnel could be exposed to concentrations in excess of ERPG–2. Chlorine has a highly objectionable odor, which prompts sheltering and escape; however, personnel can be quickly overcome when exposed to high concentrations.

Because no changes in operations or inventories from the No Action Alternative are made, the frequencies and consequences of these scenarios are the same as those under the No Action Alternative, as presented in Tables 5.2.11.5–1 and 5.2.11.5–2.

5.5.11.6 *Worker Accidents at LANL*

Although there are some planned decreases under this alternative in the handling of high explosives, the accident frequencies remain within same range of values as for the No Action Alternative. Therefore, the frequencies and consequences of these scenarios under the Greener Alternative are the same as those presented for the No Action Alternative in Table 5.2.11.6–1.

5.6 CUMULATIVE AND UNAVOIDABLE IMPACTS

5.6.1 Cumulative Impacts

Cumulative impact is defined by the CEQ NEPA regulations as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or not federal) or person undertakes such other actions." This discussion of cumulative impacts deals with the effect of LANL operations when added to similar effects from the actions of other entities within the same region of influence. Effects are discussed by impact or resource area, and as can be seen from the discussions of each environmental impact area of analysis in chapter 5, the region of influence can vary. Some effects of LANL operations are not detectable beyond the facility or site boundary, while others involve effects with the potential to extend beyond site boundaries, interact with other sources of the same impact, and so may be managed under a regional regulatory authority (such as for criteria pollutants under the *Clean Air Act)*. Other effects, such as fire control or the movement of grazing animals, are best viewed within a common habitat or natural resource area.

This site-wide analysis in large measure is, by its scope, an analysis of cumulative impacts. To analyze the effects of LANL operations, regions of influence were selected to identify the maximum extent of impacts while still providing a discussion of effects that can be evaluated meaningfully. These impacts represent the effects from all operations at the site, and some effects do not have contributors from sources other than LANL. The following discussion represents all operational alternatives. The nature of the impacts from LANL operations and those of the surrounding area are such that the analyses presented in the previous sections of chapter 5 are, in fact, most of the relevant materials on this subject. The discussion that follows is not greatly influenced by the variation in impacts from the alternatives because most of these impacts are not significant and/or there is little contribution to impacts from other sources that are in the same region of influence as LANL. Information was gathered from city, county, state, tribal, and other federal organizations concerning future plans for development and to get information on any regional planning efforts. Following is a summary of the effects from LANL operations presented in this regional context and in a cumulative sense where such additional information was not already used in the previous section of the impact analysis.

5.6.1.1 *Land Use*

Much of the area around LANL is undeveloped USFS and NPS land, and is projected to remain undeveloped. Future land use patterns are projected to remain the same within the LANL site, and trends in population growth for the region immediately surrounding Los Alamos are likely to continue to increase the urban nature of development. Sections on land use in chapters 4 and 5 of this document provide more detail on these subjects and the cumulative impacts for this aspect of the analysis.

There is a potential for a change in these projections in land use for some parcels on the LANL site that have been identified for possible conveyance and transfer as part of PL 105-119 (also see chapter 4, section 4.1.1.4). The DOE has submitted the first required deliverable to Congress that gives a preliminary identification of 10 parcels that could be considered for transfer, comprising a total of approximately 4,600 acres (1,860 hectares). Those parcels are being evaluated further in the LANL Conveyance and Transfer (CT) EIS (DOE 1998a) (see chapter 1, section 1.5.10) for possible restrictions that may limit their use because of cultural and ecological resource impacts. These parcels also will be evaluated by the ER Project to determine whether any needed remedial actions to allow unrestricted use are practical and could be completed in a 10-year time frame. Transferred lands are available for historic, cultural, or environmental preservation purposes; economic diversification purposes; or community self-sufficiency purposes, as stated in the law. A maximum of 1,158 acres (468 hectares) of the total acreage proposed to be transferred and conveyed would be developed or the land use otherwise changed (DOE 1998a).

5.6.1.2 *Water Resources*

Direct wastewater discharges to the canyons were evaluated in previous sections of this chapter, and no impacts were identified from the quality of current discharges. Soil contaminants from past operations can be affected by surface water flows within the canyons and potentially be carried further down the canyons and into the perched water zones or the underlying deep aquifer. The potential for this type of transport from stormwater runoff as well as transport caused by potential variation in future industrial discharges are discussed in this document. These also are factors in mitigative actions and specific risk analyses for each of the units to be evaluated under the ER Project. No other major water discharge to upper and middle reaches of these canyons occurs from human activity other than from LANL operations and the sanitary wastewater treatment that is performed for these operations as well as for the county, and no other planned discharges were evident. The Los Alamos County sewage treatment plant that discharges into the lower portions of Cañada del Buey is not likely to be a factor of concern for contaminant transport because no contamination above regional background reference levels is found in sediments in that portion of Cañada del Buey or in the lower portion of Mortandad Canyon, which receives the waters from Cañada del Buey. LANL operations are therefore the only activities of interest from the standpoint of cumulative impacts. The Los Alamos County sewage treatment plant in Bayo Canyon does discharge into an area of measurable radioactive contamination from past operations. Levels of contaminants have remained relatively constant in recent years and are slightly above background levels in the vicinity of the plan. While stormwater events are the primary force for movement of sediments, there is the potential for this discharge to contribute to the movement of sediments contaminated with radionuclides in the lower portions of Pueblo Canyon and Los Alamos Canyon. More details on these subjects may be found in the water resource sections of this document.

New development under the CT EIS (DOE 1998a) proposed action could degrade the surface water quality, increasing the pollutant loads and surface runoff volumes from construction activity and the increase in impermeable areas. Increases in discharges to wastewater treatment plants could be 132 million gallons (500 million liters) per year for the Bayo plant and 41 million gallons (155 million liters) per year for the White Rock plant.

5.6.1.3 *Air Quality*

No sources of air pollutants, other than those from LANL operations, were identified that would be of relevance for an evaluation of cumulative impacts; therefore, to give perspective on this situation, a brief description is provided below of the region that could be influenced by LANL operations. Except for Bernalillo County (greater Albuquerque area), the State of New Mexico manages the entire state as one air quality district. This district includes several wilderness areas, national parks, and national monuments and must consider the special status of these areas under the regulations for the prevention of significant deterioration (PSD). The proximity of BNM's wilderness area to LANL is of special note. The largest sources in the state for criteria pollutants are in the Four Corners area, about 200 miles (320 kilometers) to the northwest, and the Bernalillo County area about 50 miles (80 kilometers) to the southwest; but neither areas exhibit major influence in the proximity of the LANL site. Sources in the immediate area are relatively small and separated from one another. Past ambient air quality monitoring by LANL and the State of New Mexico in the vicinity of BNM showed values well below standards developed to protect human health with an ample margin of safety, and monitoring was discontinued in 1994. No future development at LANL is proposed that would require evaluation under PSD regulations. Industrial development in the general area puts little pressure on ambient air quality concerns, and complex permitting or monitoring strategies are not necessary in this area to prevent degradation of air quality.

Only very minor effects from LANL operations could be identified from emissions of toxic air pollutants. No other sources of pollutants having the same potential effect at these receptors of concern for LANL operations were identified. Although some of the impact analyses considered receptors within a 50-mile (80-kilometer) radius of the site, impacts are primarily associated with areas close to the site.

There would be increases in criteria pollutants from mobile sources and homes using natural gas or propane from implementing the CT EIS proposed action. Slight increases in emissions of hazardous air pollutants would be expected from the development of new industrial facilities.

Implementation of the draft Surplus Plutonium Disposition (SPD) EIS Lead Assembly Alternative (DOE 1998b) at LANL would increase the radiological emissions to the MEI by no more than 0.01 millirem per year. Overall, LANL would be expected to remain within the 10 millirem per year NESHAP limit.

5.6.1.4 *Ecological Resources*

The analysis of direct effects on ecological resources from LANL operations in previous sections of this chapter shows that these effects do not, in most cases, extend beyond the perimeter of the site. Where contaminants from LANL are found off the site, contributions from sources other than worldwide fallout were not identified. Analysis of these effects are found in previous sections of this chapter. Additionally, potential effects on biota and ecosystems discussed in those sections are presented within the context of the larger regional ecosystem in which the LANL site is immersed. Potential effects from existing soil contaminants were identified, some dominated by naturally occurring metals, some dominated by legacy contamination from LANL operations. No current or planned additions of contaminants of concern by LANL or any other entity were identified.

The LANL site is relatively large and undeveloped, and serves as a reservation for a wide diversity of plants and animals. Although the impacts to biota and ecosystems are beneficial in this aspect, the site is affected by land uses predating LANL and influenced by fragmented management strategies. Resolution of problems such as risk of catastrophic wildfire, erosion, elk overpopulation, and habitat loss and fragmentation, will benefit from permanent interagency coordination and the development of a joint planning and management program with the other land management agencies. The continuation of and implementation of ongoing site programs and planning actions such as the ER Project, the Threatened and Endangered Species Habitat Management Plan, and the Natural Resources Management Plan will place site managers in a position to contribute in a meaningful way to regionalized strategies as they develop. Discussions in previous sections of this chapter present this regional context in the evaluation of impacts.

Implementation of the CT EIS proposed action would cause approximately 1,230 acres (498 hectares) of ponderosa pine forest and pinyon-juniper woodland habitat to be heavily modified or lost. Also, approximately 3.8 percent of American peregrine falcon and Mexican spotted owl preferred habitat available at DOE/LANL would be affected.

5.6.1.5 *Cultural Resources*

The presence of federal lands adjacent to LANL and the highly restricted nature of the LANL site tends to prevent impacts to these resources from activities other than those directly attributable to LANL operations, and therefore, the discussion of impacts in previous sections of the chapter represents the analysis of cumulative impacts for this aspect of the analysis. Impacts from LANL operations extending beyond the site boundaries were not noted. The analysis in previous sections noted the potential for on-site impacts to TCPs from explosives, residual contamination, and restriction of access; but insufficient information on locations of these sites limits this area of analysis. More information may be found in chapter 4, (section 4.8), chapter 5, and appendix E.

The proposed action under the CT EIS would cause the development of approximately 1,020 acres (413 hectares) and use of tracts for recreation that could result in physical destruction, damage, or alteration of cultural resources on the subject tracts and in adjacent areas.

5.6.1.6 *Socioeconomics*

Government operations (federal, state, local, tribal) and service-sector businesses dominate the economics of the region influenced by LANL by a very large margin. Activities at LANL itself are estimated to directly and indirectly account for more than a third of employment, wage and salary, and business activity in the Tri-County region. The service sector aspect of the economy has experienced little growth in recent years, although projections of population growth, particularly in Santa Fe County, can reasonably be expected to result in the continued major influence of this economic sector. No major fluctuation in other aspects of the economy or introductions of significant new activities were identified. The discussion of impacts in previous sections of this chapter evaluates impacts in the area influenced by LANL (the Tri-County region) and in the context of identified growth patterns. Those sections may therefore be referred to for details on cumulative impacts for this aspect of the analysis.

Short-term economic gains would be expected from employment due to construction activities for new development under the CT EIS proposed action. The long-term gains would be dependent on the intensity and success of the development.

5.6.1.7 *Infrastructure*

LANL is a significant user of electric power in the region, but is not the dominant user in northern New Mexico. Within the electric power pool that serves LANL, direct use by LANL is about 80 percent of the total. The system serving LANL is near capacity, and future projections on electric power use from LANL under all alternatives, except Reduced Operations, indicate that demand will exceed capacity. Consideration of options to increase system capacity is complicated by the fact that the systems for other major power users in the region (the cities in northern New Mexico) are also nearing capacity, and demand from these users is also projected to exceed capacity. While the regional system capacity problem will exist regardless of the alternative selected for LANL operations, selection of an option to deal with LANL alone is strongly influenced by these regional considerations. No specific proposals have been fully developed to remedy this situation (although, as noted in chapter 1, section 1.6.3.1, some specific solutions are being evaluated), and further analysis of environmental impacts will be necessary as future options are developed sufficiently to analyze them. Previous sections of this chapter discuss these electric power issues in the context of regional problems and may therefore be referred to for details on cumulative impacts for this aspect of the analysis.

Natural gas use is projected to remain within the capacity of the current system to provide it. Even if electricity demand increases natural gas demand for the generation of electricity at the LANL main power plant, demand for natural gas should continue to be dominated by heating requirements, and increase in demand sufficient to exceed capacity is not expected. Currently, there are no projections from other consumers in the region using the same natural gas supply lines that show demand potentially exceeding capacity. The evaluation of impacts in this resource area in previous sections of this chapter discuss natural gas use in this regional user context, and may therefore be referred to for details on this aspect of the cumulative impact analysis.

Potable water use was analyzed in previous sections of this chapter in the context of multiple users of a common aquifer and projected future use patterns of these users. The potential drawdown associated with LANL activities as well as services provided to other entities under the DOE water rights were modeled along with the other users in the region. All the users of the aquifer in the Española Basin are assumed to influence one another, but the exact relationships are unknown. Effects such as reduction in the height of the water table at a particular location are primarily influenced by major pumping operations in the immediate area. As pumping by DOE or by the City of Santa Fe shifts from one well field to another, water table height increases in the abandoned area and reduces in the new area. Therefore, even though Santa Fe may be the major water user in the area, total water use in the region still comprises a small fraction of the total volume within the main aquifer, and overall effects, while measurable, are not pronounced. Water use is projected to remain within existing water rights (which cumulatively constitute less than 1 percent of the estimated volume of the aquifer, as discussed in volume III, appendix A, section A.5), and no reduction in the discharge volume from springs in the area is foreseen.

The only aspects of solid waste management that have considerations of cumulative impact are those associated with the multiple users of the Los Alamos County landfill, and the potential for use of the LANL LLW disposal area by other DOE generators. Sufficient capacity in the county solid waste landfill will remain for the foreseeable future, and a decision on expansion of the LLW disposal area is likely to be driven by needs at LANL and not elsewhere. Sections of this document dealing with waste management activities contain more information on this aspect of cumulative impacts.

The total increases in utility usage for the CT EIS proposed action would be as follows:

- Electric use, 31 gigawatt-hours
- Peak power, 5 megawatts
- Natural Gas, 459 million cubic feet
- Water, 382 million gallons per year
- Solid Waste, 2,385 tons per year

Land development under the proposed CT EIS could result in an increased use of 382 million gallons (1,450 million liters) per year of groundwater, a significant increase over the water rights allocation of 1,805 million gallons (6,830 million liters) per year. Under the Expanded Operations and Preferred

Alternatives, the estimated water rights use would be 1,724 million gallons (6,525 million liters) per year. Implementation of the CT EIS proposed action would exceed the water rights allocation. Implementation of the Special Neutron Source (SNS) EIS proposed action of the 1-megawatt beam would use 42 million gallons (160 million liters) per year of groundwater, which could not be met with the current water infrastructure and water rights.

The Spallation Neutron Source (SNS) EIS proposed 1-megawatt beam would use 62 megawatts of peak power. LANL's existing electrical infrastructure is not adequate to support the additional power demand. The increase in peak power demand would exacerbate the power supply-demand problems in the Los Alamos region.

The additional impacts from implementing the draft SPD EIS, Lead Assembly Alternative at LANL would include a total of 4,840 cubic feet (137 cubic meters) of TRU waste, 24,900 cubic feet (705 cubic meters) of LLW, and relatively small quantities of other hazardous and nonhazardous wastes. These impacts are not a significant contributor to the waste management activities at LANL. The annual electricity requirements would increase by 0.72 gigawatt-hours, with an increase peak power demand of 0.3 megawatts. The annual process water usage would increase by 20,000 gallons (76,000 liters) per year. Both the electrical power and water usages are minor in the context of LANL's overall requirements and, thus, are not significant contributors to the power and water concerns at LANL.

5.6.1.8 *Transportation*

The future population of Los Alamos is not projected to increase significantly, although future land transfers may increase local traffic. As discussed in other sections, no other major cause for growth in the region has been identified, although some communities are expected to increase in size just as other areas of the state. Impacts associated with traffic congestion and vehicle emissions discussed in previous sections of this chapter consider the effects attributable to LANL operations in the context of effects that may be present from other sources, as well as the effect of future growth in the area. More detail on cumulative impacts may be found in those sections. Hazardous chemical and radioactive materials shipments comprise about 1 percent of the off-site truck shipments for LANL. The number of these type of shipments may increase above the No Action levels for the Expanded Operations, Reduced Operations (driven by waste shipments) and Greener Alternatives, but the percentage is likely to remain about the same. For perspective on the regional context for these types of shipments, the percentage of truck shipments that carry hazardous chemicals or radioactive materials in the State of New Mexico has been estimated by state transportation officials to be about 10 percent, although some segments of highway, such as I–40, may be much higher.

Under the CT EIS proposed action, the peak traffic entering or exiting all 10 tracts could increase by a range of approximately 751 to 3,775 trips per day. Many of the current roads and intersections would have to be upgraded to accommodate the new traffic levels.

The draft SPD EIS (DOE 1998b), Lead Assembly Alternative, documents the additional transportation impacts should LANL, be selected for this activity. Plutonium dioxide would already be at LANL, so no shipping would be required for this material. LANL would receive uranium dioxide and other material needed to assemble mixed oxide (MOX) fuel bundles from a nuclear fuel fabricator and would ship MOX fuel assemblies to a reactor site. Approximately 20 shipments of radiative materials would be carried out by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be about 34,000 miles (55,000 kilometers). The dose to transportation workers from all transportation activities under this lead assembly alternative has been estimated at 1.5 person-rem; the dose to the public has been estimated at 10.3 person-rem. Accordingly, the incident-free transportation of radioactive material would result in 5.9×10^{-4} excess LCFs; among transportation workers and 5.1×10^{-3} excess LCFs in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions would be 1.5×10^{-4}. Estimates of the total ground transportation accident risks indicate a radiological dose to the population of 6.2 person-rem, resulting in a total population risk of 3.1×10^{-3} excess LCFs and traffic accidents resulting in 6.7×10^{-4} traffic fatality.

5.6.1.9 Human Health

The development of the CT EIS proposed action could bring as many as 900 new residents into closer proximity to LANL facilities at the DOE Los Alamos Area Office and DP Road Tracts, and another 2,200 residents and lodgers at the White Rock Tract. Commercial development could bring as many as 6,000 private-sector employees into existing radiation buffer zones at the DP Road, TA–21, and Airport Tracts. These developments would mean increased public exposures to radiological and chemical emissions from LANL, from normal operations and hypothetical accidents. A substantial increase in the public collective radiation dose would result.

Implementation of the Lead Assembly Alternative, analyzed in the draft SPD EIS (DOE 1998b), at LANL would contribute the following impacts. The expected number of excess LCFs as a result of the radiation released from these activities in the general population residing within 50 miles (80 kilometers) of LANL would be 1.2×10^{-5}. The expected number of excess LCFs to involved workers would be 0.011. The expected annual dose to the MEI is 9.0×10^{-3} millirem per year, which corresponds to an associated excess LCF risk of 4.5×10^{-9}. Transportation related to these activities would not be expected to result in any excess LCFs either. Thus, implementation of the lead assembly fabrication activities at LANL would pose no significant health risks to the public.

5.6.2 Unavoidable Adverse Impacts

Operating LANL under any alternative involves the release of small quantities of radioactive and hazardous materials via routinely monitored air and water effluent discharges. Analysis has shown these discharges to be of minimal consequence; nonetheless, they represent an impact that is unavoidable. Control measures commensurate with potential risk are in place, and in an evolutionary manner, seek to reduce these discharges to the lowest practical levels. Solid radioactive and hazardous waste, and sanitary wastes also result from routine operations, and must be treated and disposed. The active recycle, waste minimization, and waste avoidance programs at LANL continuously work to reduce the volume and types of these wastes. Potential disturbance of biological and cultural resources can result from operations, and restricted access to some traditional cultural properties might be viewed as adverse.

5.6.3 Irreversible and Irretrievable Commitments of Resources

Operations at LANL under the various alternatives require the consumption of a number of resources. Table 3.6.2–1 in chapter 3 shows the projected usage of water, natural gas, and electricity across the SWEIS alternatives. (These resources are also discussed by alternative in sections 5.2.9.2, 5.3.9.2, 5.4.9.2, and 5.5.9.2.) While deficiencies in some of the local distribution systems for gas and electricity were discussed in this analysis, no shortages in total regional supplies were noted. There also are many materials requirements for maintenance of facilities, and operations require the consumption of the entire range of expected products and materials, such as chemicals. There is an active recycling program at LANL; most products are expended or disposed. Approximately 43 square miles (111 square kilometers) are reserved for laboratory operations. A large amount of that area remains undisturbed, and development has been, and will continue to be, concentrated in areas of like operations. While it is theoretically possible to consider that the entire facility could be decommissioned and removed, operations, including waste disposal, are expected to continue into the foreseeable future. These lands are therefore removed from use for other purposes. An active environmental restoration program seeks to reduce the risk from past discharges of radioactive and hazardous materials; but, not all areas are expected to be restored to their original condition. LLW disposal at LANL places strict limitations on alternative or future uses of the disposal areas. The disposal sites would require monitoring and various forms of protective actions, including administrative access control, for an extended period of time.

5.6.4 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

A decision to operate LANL under any alternative requires the commitment of resources that cannot be recovered, the acceptance of impacts from normal operations that release pollutants and cause disturbances. The national resource embodied in LANL, which is continually tapped by different entities throughout the U.S. as well as abroad, is used to work on problems involving national security, energy resources, environmental quality, and in science.

A large portion of the knowledge and capability necessary to support the nuclear weapons program resides at LANL. The program implemented by DOE, and as discussed in the SSM PEIS (DOE 1996d), has been reduced in size, refocused, and operations consolidated to a fewer number of sites.

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CHAPTER 6.0
MITIGATION MEASURES

The regulations promulgated by the Council on Environmental Quality (CEQ) to implement the procedural provisions of NEPA (42 United States Code [U.S.C.] §4321) require that an EIS include a discussion of appropriate mitigation measures (40 Code of Federal Regulations [CFR] 1502.14[f]; 40 CFR 1502.16[h]). The term "mitigation" includes the following:

- Avoiding an impact by not taking an action or parts of an action
- Minimizing impacts by limiting the degree of magnitude of an action and its implementation
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact by preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20)

This chapter describes mitigation measures that are built into the alternatives analyzed and those additional measures that will be considered by DOE to further mitigate the adverse impacts identified in chapter 5. These measures address the range of potential impacts of continuing to operate LANL (including those areas where the lack of information regarding resources or mechanisms for impact to resources results in substantial uncertainty in impact analyses). The mitigation measures built into the alternatives analyzed (section 6.1) are of two types: (1) existing programs and controls (including regulations, policies, contractual requirements, and administrative procedures); and (2) specific measures built into the alternatives that serve to minimize the effects of activities under the alternatives. The existing programs and controls are too numerous to list here; but a general description is provided, as well as the role of existing programs in operating LANL and pertinent examples of how these mitigate adverse impacts.

Additional mitigation measures that could further reduce the adverse impacts identified in chapter 5 are discussed in section 6.2. The description of these measures in this chapter does not constitute a commitment to undertake any of these measures. Any such commitments would be reflected in the Record of Decision (ROD) following this SWEIS, with a more detailed description and implementation plan in a Mitigation Action Plan following the ROD.

6.1 MITIGATION MEASURES INCLUDED IN THE SWEIS ALTERNATIVES

6.1.1 Existing Programs and Controls

The activities undertaken at LANL are performed within the constraints of applicable regulations, applicable DOE orders, contractual requirements, and approved policies and procedures. The laws and regulations applicable to federal facilities are discussed in chapter 7; many of these requirements are established with the intent of protecting human health and the environment. It is assumed that these or similar regulatory controls will be in place for the next 10 years. These regulations, when complied with, mitigate the potential adverse impacts of operations to the public, the worker, and the environment. For example, the *Clean Air Act* (CAA) (42 U.S.C. §7401) regulates air emissions and the *Clean Water Act* (33 U.S.C. §1251) regulates liquid effluent discharges in a manner designed to protect human health and reduce the adverse environmental effects of routine operations.

In addition to the regulations applicable to LANL, chapter 7 also discusses other requirements (including DOE orders and external standards and regulations that would not otherwise apply to federal facilities) that apply to operations at LANL through the contract between DOE and the University of California (UC). As discussed in chapter 7, these requirements are established and enforced through contractual mechanisms. As with the regulations that apply to LANL, it is assumed that these or similar controls will be in place for the next 10 years. These requirements also mitigate the potential for adverse impacts. For example, the application of DOE design standards results in more robust facility designs for modern nuclear facilities, which reduces the potential for catastrophic releases from such facilities in the event of earthquakes, high winds, or other natural phenomena. Similarly, the application of occupational safety and health regulations in 29 CFR 1900, and other standards promulgated by the American National Standards Institute (ANSI), the U.S. Department of Defense (DoD), and DOE, as well as the use of other life safety and fire safety codes and manuals, limit worker exposures to workplace hazards, which reduces the potential for adverse worker health effects.

DOE and LANL also have instituted policies and procedures that apply to work conducted at LANL that mitigate the potential adverse effects of operations; it is assumed that these or similar policies and procedures will continue over the next 10 years. These are numerous and include, but are not limited to:

- Procedures that control work conducted at LANL (to ensure that work conducted is planned and reviewed, funded, within the applicable regulations and requirements, within the range of risks accepted by DOE and UC, and is otherwise authorized)
- Policies regarding the knowledge, skills, and abilities of personnel assigned to perform hazardous work (including required training)
- Policies reflected in agreements with other entities (such as the Accords with the four Pueblos located nearest to LANL) that establish policies and protocols regarding consultations and other discussions regarding LANL activities
- Policies and procedures regarding the stoppage and restart of work where unexpected hazards or resources are identified (for example, the policies regarding recovery of information from archaeological sites uncovered by excavation)

Work controls reduce potential impacts by ensuring that work conducted is within the range of activities that have been studied for potential environmental and human health effects. Policies regarding the knowledge, skills, and abilities of personnel conducting work at LANL reduce potential impacts by ensuring that only personnel with an appropriate understanding of the work and its potential hazards may undertake that work (which minimizes the potential for adverse human health and environmental effects from inadvertent actions due to a lack of this understanding). Policies for consultations and discussions with other entities mitigate effects by providing an opportunity to avoid or change actions that could cause an adverse impact. For example, consultation with Pueblos could identify the potential to impact traditional cultural properties (TCPs) prior to implementing a construction project or operations and could identify alternative siting or operational approaches that would avoid the impact. Policies and procedures regarding the stoppage and restart of work are similar in effect to work controls; when unexpected situations occur that impose unexpected hazards or reveal unexpected resources (e.g., cultural resources), work is stopped (as soon as this can be done safely) until work plans and authorizations can be modified in consideration of the newly uncovered information. This reduces potential impacts in a manner similar to work controls, as discussed above.

DOE also has established programs and projects at LANL to increase the level of knowledge regarding the environment around LANL, health of LANL workers, health of the public around LANL, and the effects of LANL operations on these, as well as to avoid or reduce impacts and remediate contamination from previous LANL activities. These programs and projects reduce potential adverse impacts by providing for heightened understanding of the resources that could be impacted; avoidance of some impacts (where mechanisms for impact to specific resources are known and avoidable); early identification of impacts (which can enable stoppage or mitigation of the impacts); reduction of ongoing impacts; or providing for beneficial management opportunities for natural, cultural, and sensitive resources, where appropriate. It is assumed that such activities will continue for the next 10 years. Examples of these programs and projects are:

- The Environmental Surveillance and Compliance Program at LANL monitors LANL for permit and environmental management requirements. This program also includes evaluation of samples from various environmental media for radioactive materials and other hazardous materials locally and regionally (chapter 4, page 4–1). The data generated under this program are collected routinely and publicly reported at least annually, and these data are analyzed to determine regulatory compliance and to determine environmental trends over long periods of time.
- The Threatened and Endangered Species Habitat Management Plan is intended to provide long-range planning information for future LANL projects, and protect habitat at LANL for these species (section 4.5.1.6).
- A Natural Resource Management Plan is being developed (in various stages) at LANL to determine existing conditions of natural resources in the area (including expanded biomonitoring) and to recommend management measures that will restore, sustain, and enhance the biological quality and ecosystem integrity at LANL (section 4.5.1.6).
- Studies of public and worker health in and around LANL have been conducted (some by DOE and some by other agencies) to assess human health in the region and to assess the potential for adverse human health effects due to LANL operations (section 4.6).
- LANL is also implementing a Groundwater Protection Management Program Plan (GWPMPP) to assess current groundwater conditions and monitor and protect groundwater. A *Resource Conservation and Recovery Act* (RCRA) Hydrogeologic Workplan is also being implemented to supplement and verify existing information on the environmental setting at LANL and to collect analytical data on groundwater contamination (sections 4.3.2.1 and 4.3.2.2).
- The Safeguards and Security Program restricts unauthorized access to areas of LANL with high potential for impact to human health and the environment. Such access restrictions aid in limiting the potential for intentional or inadvertent actions that could result in environmental or human health effects (section 4.9.2.2).
- Emergency management and response capabilities at LANL provide for planning, preparedness, and response capabilities that can aid in containing and remediating the effects of accidents or adverse operational impacts (section 4.6.3.1).
- LANL's Fire Protection Program ensures that personnel and property are adequately

protected against fire or related incidents, including fire protection and life safety (section 4.6.3.3).

- Pollution Prevention and Waste Minimization Programs at LANL reduce the wastes generated and to some extent the effluents and emissions from facilities (section 2.1.2.1).
- Water and Energy Conservation Programs at LANL are intended to reduce use of these resources, which should assist in mitigating the effects of water withdrawal and electrical consumption that occasionally exceed supply.
- The Environmental Restoration (ER) Project at LANL (which includes decontamination and decommissioning [D&D]) was established to assess and remediate contaminated sites that either were or still are under LANL control (section 2.1.2.5). The ER Project serves an important role in reducing the potential for future impacts to human health and the environment due to legacy contaminants in the environment. It is assumed that the current mitigation practices used in remediation actions will continue to be used (section 2.1.2.5).
- Electric power reliability is an issue under all alternatives due to the limited supply lines and the age of the distribution system equipment, as well as the limits of the on-site supplemental power supply (section 4.9.2.1). DOE is evaluating a proposed action that would bring a third power line (from the Norton substation) to LANL (chapter 1, section 1.6.3.1).

While this list is not all-inclusive, it does reflect the importance of these programs in mitigating the potential adverse impacts of operating LANL.

6.1.2 Specific Mitigation Measures Incorporated in the SWEIS Alternatives

Several specific mitigation measures are included in the SWEIS alternatives. Unless otherwise noted below, the analyses in chapter 5 assume that these measures are implemented. These specific measures are:

- *Development and Use of a Dedicated Transportation Corridor Between TA–55 and TA–3 (TA–55 and TA–3, Expanded Operations Alternative, section 3.2.1, section 5.3.10, and volume II, part II)*. The proposed transportation corridor is included in the Expanded Operations Alternative to mitigate the on-site transportation risk and inconvenience to the public (due to road closures) that would be attributed to the increase in transportation between TA–55 and the Chemistry and Metallurgy Research (CMR) Building under this alternative. The analysis in the Expanded Operations Alternative is very conservative because it includes the impacts of constructing the road and impacts of transport on existing roads. If the road is not constructed, the transportation risk would be that analyzed in section 5.3.10 for on-site shipments. The impacts attributable to constructing the road (see volume II, part II and section 5.3.5) would not be incurred. If the road is built and used, the impacts due to road construction would be the same as those analyzed, and the on-site transportation risk would be reduced because shipments between TA–55 and the CMR Building would no longer routinely use public roads. This measure would not be implemented under the Preferred Alternative.
- *The Santa Fe Relief Route (All LANL Facilities, All Alternatives, sections 5.1.10, 5.2.10, 5.3.10, 5.4.10, 5.5.10, and appendix F)*. DOE has made the agreed upon contributions to construction of this route and continues to work with state and

local governments to ensure its completion. This route is expected to be available for use in 1998. The transportation impact analyses in this SWEIS address impacts for use of existing routes as well as use of the relief route.

- *CMR Building Upgrades (CMR Building at TA–3, All Alternatives, section 3.1.3).* DOE is working to upgrade the CMR Building to maintain existing capabilities and improve safety features, and completion of these upgrades is presumed in the impact analyses.
- *Planned Maintenance and Refurbishment Activities (e.g., Plutonium Facility at TA–55 and Sigma at TA–3, All Alternatives, sections 2.1.2.3, 3.1.1, and 3.1.5).* It is assumed that DOE maintenance of existing facilities in use at LANL will continue in a manner that maintains or improves (reduces) the level of risk associated with facility operations.
- *Radioactive Liquid Waste Treatment Upgrades (TA–50, All Alternatives, sections 3.1.14, 4.3, 5.1.3, 5.2.3, 5.3.3, 5.4.3, and 5.5.3).* It is assumed that the planned treatment upgrades to TA–50 will proceed, resulting in improved quality of effluent from this facility.
- *Effluent Reduction Activities (All LANL Facilities, All Alternatives, sections 4.3, 5.1.3, 5.2.3, 5.3.3, 5.4.3, and 5.5.3).* It is expected that activities to reduce the number of outfalls and the total effluent from these outfalls will continue, as presented in section 4.3.
- *Phased Containment for Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility (One of the High Explosives [HE] Firing Sites, All Alternatives, section 3.1.10).* Implementation of the phased containment approach, as described in the DARHT Final EIS (DOE 1995) and ROD (60 *Federal Register* [FR] 53588) is assumed in the SWEIS impact analyses.
- *Design of the Long-Pulse Spallation Source (LPSS) (TA–53, Expanded Operations and Greener Alternatives, section 3.2.11).* The air emissions associated with operations in this proposed experimental facility are dominated by the "activation" of air in the path of the proton beam. The design of the facility is to include evacuation (removal) of much of the air in the beam path as well as a short enough beam path to limit the emissions from this operation so that it contributes, at most, 1 millirem per year to the facility and site-wide maximally exposed individual (MEI).

6.2 Other Mitigation Measures Considered

In addition to those mitigation measures described in section 6.1, other feasible mitigation measures considered in the preparation of this SWEIS are presented in this section. Those specific measures are:

- *Eliminate Public Access to Part or All of LANL*. At various times DOE has considered the possibility of closing public access to part or all of the LANL site. While this is typically suggested for security reasons, such an action would also tend to reduce public health risk by removing access to on-site locations that contribute most to public health risk. While such an action could potentially reduce public health consequences, it could also substantially alter traffic patterns and loadings on the remaining public roads in the area and could have other positive and negative effects. A more detailed NEPA analysis of the potential effects of this type of action would be necessary before it could be implemented.
- *Land Transfers and Financial Assistance*. Transfers of portions of LANL land are being examined, as discussed in section 4.1.1.4. Such action would provide land resources that could be used to reduce

economic dependence on LANL and/or provide the means for growth in housing, parks, and recreational space. Thus, land transfers could mitigate the effect of changes in LANL employment and spending on the area's economy. At times, financial assistance has been provided to communities near LANL for similar reasons (community development, funding for community services, etc.). While land transfers are neither proposed or analyzed in this SWEIS, such actions could mitigate the socioeconomic impacts presented in chapter 5. On May 6, 1998, DOE published a Notice of Intent (NOI) to prepare an EIS for the Proposed Conveyance and Transfer of Certain Land Tracts in the *Federal Register* (63 FR 25022).

- *Extensive Ethnographic Study.* An extensive ethnographic study regarding the traditional and cultural practices and resources in the LANL area could increase knowledge of specific TCPs at LANL and could provide opportunities for mitigation of impacts to specific TCPs. Attempts to identify specific TCPs at LANL have encountered concerns from traditional groups because of the potential for increased risk to these resources if they are identified.
- *Develop a Cultural Resources Management Plan*. Such a plan would include studies to increase the level of knowledge regarding potential shrapnel and vibration damage to prehistoric and historic resources near firing sites, existing levels of contamination for prehistoric and historic resources and plans to avoid levels that would limit data recovery, plans for management of former nuclear weapons complex properties, and implementation of programmatic agreements with the State Historic Preservation Office(r) (SHPO).
- *Develop a Wildfire Management Plan for the LANL Site*. Such a plan would reduce the fuel loading surrounding the site and around individual facilities that have moderate or higher vulnerability to burning as a result of wildfire. The probability of an approaching wildfire encroaching upon the site can be reduced by removing and thinning vegetation on the site boundary and within the site. Ongoing efforts to reduce the vegetation at the site boundary exist that would be accelerated. The vulnerability of individual facilities depends upon the amount and height of the exterior fuel loading and its proximity to the facility (see "Evaluation of Building Fires" in volume III, appendix G, section G.5.4.4). Consideration is being given to reducing the vulnerability of individual facilities that contribute to potential public exposure. Long-term actions would be taken to reduce the fuel loads in the forested areas surrounding LANL, and a forest and land management program would be undertaken to prevent or mitigate the potential for large wildfires to occur. In the near term, mitigation actions, such as for TA–54, will be taken to ensure that the wildfire risk to this facility is reduced to low or extremely low prior to the start of the 1999 fire season.
- *Limited Power Supply.* DOE and other regional electric power users continue to work with suppliers to remedy foreseeable power supply and reliability issues. The impact analyses in this SWEIS emphasize the severity of these issues and the consequences if they are not resolved. Solutions to power supply issues are essential to mitigate the effects of power demand under all alternatives. DOE is committed to measures that will conserve energy and avoid, or at least minimize, periods of brownouts. Some of the measures being contemplated by DOE include: (1) limiting operation of large users of electricity to periods of low demand, (2) reduced operation of low-energy demonstration accelerator (LEDA) (not implement all phases of this project), and (3) contractual mechanisms to bring additional electric power to the region.

REFERENCES

DOE 1995 *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement.* DOE/EIS-0228. U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico. August 1995.

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CHAPTER 7.0
APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

7.0 INTRODUCTION

As part of the NEPA process, the SWEIS must consider if actions described under its alternatives would result in a violation of any federal, state, or local laws or requirements (40 Code of Federal Regulations [CFR] 1508.27) or require a federal permit, license, or other entitlement (40 CFR 1502.25). This chapter provides a baseline summary assessment of the major existing environmental requirements, agreements, and permits that relate to continuing operations at LANL.

Requirements governing operations at LANL arise primarily from six sources: Congress, federal agencies, executive orders, the New Mexico State Legislature, state agencies, and local governments. In general, the federal statutes establish national policies, create broad legal requirements, and authorize federal agencies to create regulations that conform to the statute. Detailed implementation of these statutes is delegated to various federal agencies, such as DOE, the U.S. Department of Transportation (DOT), and the EPA. For many environmental laws under the jurisdiction of EPA, state agencies may be delegated responsibility for the majority of program implementation activities, such as permitting and enforcement, but EPA usually retains oversight of the delegated program.

In addition to implementing some federal programs, state legislatures develop their own laws. In New Mexico, the statutes passed by the New Mexico State Legislature are found in the New Mexico Statutes Annotated, and regulations are found in the New Mexico Administrative Code (NMAC). State statutes, much like federal statutes, establish broad policies and legal requirements. State regulations, developed by state agencies, establish specific legal requirements as authorized by the statutes.

Executive orders establish policies and requirements for federal agencies. Executive orders are applicable to executive branch agencies, but do not have the force of law or regulation.

Regulatory agreements and compliance orders may also be initiated to establish responsibilities and time frames for federal facilities to come into compliance with provisions of applicable federal and state laws. There are also other agreements, memorandums of understanding, or formalized arrangements that establish cooperative relationships and requirements.

DOE has authority to regulate some environmental activities, as well as the health and safety aspects of operation of its nuclear facilities. The *Atomic Energy Act of 1954* (AEA), as amended (40 United States Code [U.S.C.] §2011), is the principal authority for DOE regulatory activities not externally regulated by other federal or state agencies. Regulation of DOE activities is primarily established through the use of DOE orders and regulations. External environmental laws, regulations, and executive orders can be categorized as applicable to broad environmental planning and consultation requirements, or as applicable to regulatory environmental protection and compliance activities, although some requirements are applicable to both planning and operations compliance.

7.1 DOE REGULATORY AUTHORITIES FOR ENVIRONMENT, SAFETY AND HEALTH

7.1.1 *Atomic Energy Act of 1954*

The AEA (42 U.S.C. §2011 *et seq.*) makes the federal government responsible for regulatory control of the disposal of radioactive waste, as well as production, possession, and use of three types of radioactive material: source, special nuclear, and byproduct material. Regulations promulgated by the U.S. Nuclear Regulatory Commission (NRC) under the AEA establish standards for the management of these radioactive materials, licensing of nuclear facilities, and the protection of the public and property against radiation. The AEA authorizes DOE to set radiation protection standards for itself and its contractors for DOE nuclear facilities, and provides exclusions from NRC licensing for defense production facilities. NRC regulates private and commercial nuclear activities, but currently has no regulating authority at most DOE facilities. In December 1996, DOE announced that it would begin a process of transferring oversight of nuclear safety to the NRC for all DOE nuclear facilities (DOE 1996). The transfer will require legislative action.

The AEA authorizes DOE to establish standards that protect health and minimize danger to life or property from activities under DOE's jurisdiction. The mechanisms through which DOE manages its facilities are the promulgation of regulations and issuance of DOE orders and associated standards and guidance. Requirements for environmental protection, safety and health are implemented at DOE sites, primarily through contractual mechanisms that establish the applicable DOE requirements for management and operating contractors.

DOE orders apply to LANL through the management and operating contract with the University of California (UC) (DOE 1997b). The applicable DOE orders or parts thereof, and applicable external and internal standards, are listed and maintained current in Appendix G of the contract and are enforced and modified through contractual mechanisms. Appendix G of the contract establishes a wide range of internal requirements for business systems and reporting, safeguards and security, and environment, safety, and health. In the current contract (effective October 1, 1997), all applicable environment, safety, and health protection standards (including both external and DOE requirements) are found in a set of Work Smart Standards in Appendix G of the contract.

The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) regulations generally do not directly apply to DOE nuclear facilities and management and operating contractors. However, for protection of worker safety and health, the Work Smart Standards adopted in Appendix G of the contract include the applicable occupational safety and health regulations (29 CFR 1900); American National Standards Institute (ANSI) standards; National Fire Protection Association (NFPA) standards; U.S. Department of Defense (DoD) standards (for explosives operations); DOE orders (for firearms safety, explosives safety, nuclear facilities safety, pressure safety, construction safety, packaging and transportation, and emergency management); various other codes, manuals, and standards for safety; and various LANL internal standards. This set of Work Smart Standards contractually establishes worker safety and health protection requirements for LANL, as well as emergency response and public protection requirements where there is no external regulatory authority.

Nuclear safety regulations are found in Title 10 of the CFR. Several nuclear safety rules and environmental procedural rules are in effect (for example, 10 CFR 835, *Occupational Radiation*

Protection), and more are in final stages of promulgation. Nuclear safety regulations are effective under the schedule and implementing requirements in each rule, regardless of whether they are included in the contract. DOE contractors are also required to comply with all applicable external laws and regulations, regardless of contract language.

The principal DOE orders having a direct impact on environmental protection and compliance activities at LANL are summarized in the following sections.

7.1.1.1 *DOE Order 451.1A, National Environmental Policy Act Compliance Program*

This order establishes DOE internal requirements and responsibilities for implementing NEPA, the *Council on Environmental Quality (CEQ) Regulations Implementing the Procedural Provisions of NEPA* (40 CFR 1500 through 1508), and the *DOE NEPA Implementing Procedures* (10 CFR 1021).

7.1.1.2 *DOE Order 5400.1, General Environmental Protection Program*

This order establishes the environmental protection program requirements, authorities, and responsibilities for DOE operations for ensuring compliance with applicable federal, state, and local environmental protection laws and regulations, executive orders, and internal DOE policies. This order provides for environmental protection standards, notification of and reporting requirements for discharges and unplanned releases, environmental protection and program plans, and environmental monitoring and surveillance requirements. It establishes formal recognition that DOE's environmental management activities are extensively, but not entirely, regulated by EPA, state, and local environmental agencies, and it provides requirements for satisfying these externally imposed regulations. In addition, it establishes requirements for those environmental protection programs that are not externally regulated.

7.1.1.3 *DOE Order 5400.5, Radiation Protection of the Public and Environment*

This order establishes standards and requirements for operations of DOE and its contractors with respect to protection of members of the public and the environment against undue risk from ionizing radiation. This order provides for general standards; requirements for radiation protection of the public and the environment; derived concentration guides (DCGs) for air and water; and guidelines, limits, and controls for residual radioactive materials. The order also establishes DOE's objective to operate its facilities and conduct its activities so that radiation exposures to members of the public are maintained within the limits established by this order, and to control radioactive contamination through the management of DOE's real and personal property. The requirements of this order are incorporated into the proposed 10 CFR 834, which is being promulgated as a nuclear safety regulation.

7.1.1.4 *DOE Order 5820.2A, Radioactive Waste Management*

DOE Order 5820.2A establishes the policies, guidelines, and minimum requirements by which DOE and its contractors manage radioactive waste, mixed waste, and contaminated facilities. This order establishes the DOE policy that radioactive and mixed wastes be managed in a manner that ensures protection of the health and safety of the public, DOE, contractor employees, and the environment. In addition, the generation, treatment, storage, transportation, and/or disposal of radioactive wastes, and the other pollutants or hazardous substances they contain, must be accomplished in a manner that minimizes the generation of such wastes across program office functions and complies with all applicable federal, state, and local environmental, safety, and health laws and regulations and DOE requirements.

These DOE orders are implemented by DOE, and by UC/LANL (through contractual direction). With the exception of radioactive materials, all environmental protection and compliance activities at LANL are externally regulated by other federal and state agencies. Environmental planning and consultation requirements are applicable to DOE and LANL in accordance with the specific language in each law, regulation, or executive order. The above-listed DOE orders and any applicable nuclear safety regulations are discussed in the following sections as they relate to external environmental planning and consultation requirements, or as applicable to regulatory environmental protection and compliance activities.

7.2 LAWS, REGULATIONS AND EXECUTIVE ORDERS RELATED TO ENVIRONMENTAL PLANNING AND CONSULTATION

7.2.1 *National Environmental Policy Act of 1969*, as Amended and Executive Order 11514, as Amended by Executive Order 11991

The NEPA of 1969, as amended (42 U.S.C. §4321 *et seq.*), requires federal agencies to evaluate the effect proposed actions would have on the quality of the human environment and to document this evaluation with a detailed statement. NEPA requires consideration of environmental impacts of an action during the planning and decision-making stages of a project.

Implementing regulations for NEPA have been developed by the CEQ, which oversees the NEPA process for the Executive Branch of the federal government. These regulations (40 CFR 1500 through 1508) set forth the general requirements that federal agencies must follow. DOE also has issued agency NEPA implementing procedures that are codified at 10 CFR 1021.

There are other environmental and cultural resource consultation requirements that must be complied with to ensure NEPA compliance. Each of these other laws or executive orders has unique review and compliance procedures established that are independent of NEPA. Accordingly, although compliance with these statutes comprises an important subset of the NEPA process, compliance with applicable requirements is mandatory for all projects, independent of NEPA. For example, under NEPA review, proposed actions are evaluated for possible effects on cultural resources (archaeological sites or historic buildings) in accordance with the *National Historic Preservation Act of 1966* (16 U.S.C. §470); for their potential impact on floodplains or wetlands in accordance with relevant executive orders; and for effects on threatened, endangered, or sensitive species in accordance with the *Endangered Species Act* (16 U.S.C. §1531). A discussion of the planning and consultation requirements for these types of resources is found in the following sections.

Executive Order 11514, *Protection and Enhancement of Environmental Quality,* as amended by Executive Order 11991, requires federal agencies to monitor and control their activities continually to protect and enhance the quality of the environment. The executive order contains requirements to ensure that federal agencies include the public in the decision-making process. The DOE NEPA implementing regulations (10 CFR 1021) and DOE Order 451.1A address this executive order through implementation of 40 CFR 1500–1508.

7.2.2 *Endangered Species Act*, as Amended, and Related Requirements

This act requires that federal agencies ensure that any actions authorized, funded, or carried out by federal agency are not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat. The act is jointly administered by the U.S. Department of Commerce and the U.S. Department of the Interior (DOI). The *Endangered Species Act* (16 U.S.C. §1531 *et seq.*) requires federal agencies to consult with the U.S. Fish and Wildlife Service (FWS). While biological assessment procedures may be integrated into the NEPA process, the consultation requirements with FWS must still be followed for any LANL activity with the potential to affect threatened or endangered species. Implementing regulations are delineated in *Endangered and Threatened Wildlife and Plants* (50 CFR 17) and *Interagency Cooperation* (50 CFR 402). The state has also issued regulations pertaining to plants specific to the state entitled, *Endangered Plants* (75-6-1, NMSA 1978).

There are several additional federal statutes that provide protection to sensitive or otherwise regulated wildlife species, two of which are the *Migratory Bird Treaty Act*, as amended (16 U.S.C. §703), and the *Bald Eagle Protection Act*, as amended (16 U.S.C. §668). The first act protects migratory birds by specifying mode of harvest, hunting seasons, and bag limits. The act is intended to protect birds that have common migratory patterns within the U.S., Canada, Mexico, Japan, and Russia. Implementing regulations are found in *Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants* (50 CFR 10) and *Migratory Bird Hunting* (50 CFR 20). The second act makes it unlawful to take (capture, kill, or destroy), molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the U.S. A permit must be obtained from the DOI to relocate a nest that interferes with resource development or recovery operations. Implementing regulations are delineated in *Eagle Permits* (50 CFR 22).

The New Mexico *Wildlife Conservation Act* (17-2-37 *et seq.*, NMSA 1978) also establishes requirements for protecting wildlife, primarily related to taking for sport purposes and permits for collecting and use.

DOE meets the requirements of these laws by contacting and consulting with federal and state agencies responsible for protecting animal and plant species within the State of New Mexico. FWS, the U.S. Forest Service (USFS), the National Park Service (NPS), the Bureau of Indian Affairs (BIA), the National Biological Service, New Mexico Environment Department (NMED), and the New Mexico Department of Game and Fish (NMDGF), are contacted regarding concerns each agency may have about LANL activities.

In accordance with Section 7 of the *Endangered Species Act*, a biological assessment and Section 7 Endangered Species Consultation for activities included in the SWEIS are being conducted with the FWS.

7.2.3 *National Historic Preservation Act*, as Amended

This act provides that sites with significant national historic value be placed on the National Register of Historic Places (NRHP). Government agencies must locate and inventory historic properties and cultural resources under their jurisdiction prior to undertaking an activity that might harm them, with the intent of minimizing such harm through appropriate mitigation actions. As required by Section 106 of the *National Historic Preservation Act* (16 U.S.C. §470), proposed LANL activities are evaluated in consultation with the State Historic Preservation Office(r) (SHPO) for possible effects on cultural resources. Most surveys are conducted on DOE property; however, when appropriate, surveys are conducted on land owned by other federal agencies, state-owned land, tribal lands, or other private holdings, and LANL holds discussions, as appropriate, with various Indian tribes to determine how new LANL activities might affect cultural resources. The tribes are also requested to provide input on what mitigation measures they want implemented before LANL begins an activity. DOE must also obtain comments from the Advisory Council on Historic Preservation prior to undertaking a potentially damaging activity at LANL. Implementing regulations include *Protection of Historic and Cultural Properties* (36 CFR 800). Consultation requirements are applicable to actions discussed in the SWEIS, as well as any future activities at LANL.

7.2.4 *National Historic Preservation,* Executive Order 11593

This executive order requires federal agencies, including DOE, to locate, inventory, and nominate properties under their jurisdiction or control to the NRHP if those properties qualify. DOE is required to provide the Advisory Council on Historic Preservation the opportunity to comment on possible impacts of a proposed activity on any potentially eligible or listed resources.

7.2.5 *American Indian Religious Freedom Act of 1978*

This act establishes that it is U.S. policy to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise their traditional religions, including access to sites, uses and possession of sacred objects, and the freedom to worship through ceremonies and traditional rites. In accordance with the *American Indian Religious Freedom Act* (42 U.S.C. §1996), LANL activities are planned so that they do not adversely affect the practice of traditional religions. Tribal groups are notified of projected construction activities and are requested to inform DOE if any activity will affect a traditional cultural property.

7.2.6 *Native American Graves Protection and Repatriation Act of 1990*

This act states that tribal descendants shall own American Indian human remains and cultural items discovered on federal lands after November 16, 1990. When items are discovered during an activity on federal lands, the activity is to cease and appropriate tribal governments are to be notified. Work on the activity can resume 30 days after the receipt of certification that notice has been received by the tribal governments. As required by the *Native American Graves Protection and Repatriation Act* (NAGPRA) (25 U.S.C. §3001), LANL has completed a summary list of cultural items excavated in the past from archaeological sites on LANL property, including prior to 1990. Copies of this summary were sent to local Pueblos having ancestral ties to the Pajarito Plateau. This summary provides a basis for future repatriation of cultural items to tribal governments.

7.2.7 *Archaeological Resource Protection Act,* as Amended

The *Archaeological Resource Protection Act* (16 U.S.C. §470aa) requires the preservation and management of archaeological resources on lands administered by federal agencies. LANL maintains a cultural resources management database, and this information continues to be used in planning remediation and other construction activities to prevent damage to or destruction of archaeological resources at LANL. Archaeological survey reports are prepared by LANL cultural resource specialists and are submitted to Native American communities for review and concurrence.

7.2.8 *Indian Sacred Sites*, Executive Order 13007

Executive Order 13007 requires: "In managing federal lands, each executive branch agency with statutory or administrative responsibility for the management of federal lands shall, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies shall maintain the confidentiality of sites." Requests by the Pueblos to use sacred sites on LANL are accommodated to the extent practicable, and consultation regarding potential impacts to sacred sites is conducted through the NEPA review process and through ongoing processes established in the Pueblo Accords and Cooperative Agreements, which are discussed below.

7.2.9 Pueblo Accords

Four federally recognized Indian tribes, the Pueblos of Cochiti, Jemez, Santa Clara, and San Ildefonso, have special relationships with the land now occupied by LANL. Federal laws and executive orders guarantee tribal members access to religious sites and recognize tribal rights to cultural properties, burial materials, and other articles of antiquity. However, Congress has assigned responsibilities to DOE that preclude open access to LANL land. Thus, some of the tribes' interests in, and uses for LANL land are difficult to reconcile.

To achieve mutual goals of improved understanding and cooperation, the four Pueblos and DOE are recognized as sovereign entities that will interact with one another on a government-to-government basis. DOE and each of these four Pueblos have executed formal accord documents setting forth these relationships (DOE 1992a, DOE 1992b, DOE 1992c, and DOE 1992d). The governor of each Pueblo signed an accord on behalf of the Pueblo. Each accord was also signed by the Assistant Secretary for Defense Programs on behalf of DOE and was approved as to form by the Area Director of the BIA, DOI.

The accords provide a framework for government-to-government relationships between each of the Pueblos and DOE. Further, the accords identify general procedures by which the sovereign entities will interact. By signing the accords, DOE has made a commitment to provide information and involve the Pueblos in long-range planning and decisions. The accords state DOE's commitment to working with its contractors and subcontractors and with other federal, state, and local agencies to clarify the roles and responsibilities of these entities that appear to conflict or overlap as they relate to the Pueblos.

DOE has also executed Cooperative Agreements with each of the four Pueblos that provide funding to the tribes for cooperative activities (DOE 1993, DOE 1994a, DOE 1994b, and DOE 1997a). UC, which operates LANL for DOE, also signed Cooperative Agreements with the Pueblos of Jemez, Cochiti, San Ildefonso, and Santa Clara (UC 1994a, UC 1994b, UC 1994c, and UC 1996). The agreements address Pueblo participation in health and safety matters; in LANL activities concerning the SWEIS and other NEPA activities; in environmental restoration, waste and environmental planning and management; and in other cooperative and collaborative efforts.

7.2.10 *Protection of Wetlands*, Executive Order 11990, and *Floodplain Management*, Executive Order 11988

Executive Order 11990 requires government agencies to avoid short- and long-term adverse impacts to wetlands whenever a practicable alternative exists. Executive Order 11988 directs federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken. Impacts to floodplains are to be avoided to the extent practicable. DOE issued regulations (10 CFR 1022) that establish procedures for compliance with these executive orders. DOE follows these regulations in evaluating proposed actions for wetlands and floodplain impacts. No floodplain/wetlands impacts were identified for the SWEIS that require coordination under these executive orders.

7.2.11 *Environmental Justice*, Executive Order 12898

This order directs each federal agency to identify and address disproportionately high adverse human health or environmental impacts on minority and low-income populations resulting from an agency's programs, policies, or activities. The order further directs each federal agency to collect, maintain, analyze, and make information publicly available on the race, national origin, and income level of populations in areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on these populations. This requirement applies when such facilities or sites become the subject of a substantial federal environmental administrative or judicial action. Environmental justice impacts are being identified and addressed through the SWEIS, and the policies and data analysis requirements of this executive order remain applicable to future actions at LANL.

7.2.12 New Mexico Environmental Oversight and Monitoring Agreement

The Environmental Oversight and Monitoring Agreement, known as the Agreement in Principle (AIP), between DOE and the State of New Mexico, provides for technical and financial support by DOE for state activities in environmental oversight, monitoring, access, and emergency response. The agreement, which was initially signed in October 1990, covers Los Alamos and Sandia National Laboratories, the Waste Isolation Pilot Plant (WIPP), and the Inhalation Toxicology Research Institute. Under the agreement, NMED is the lead state agency and provides independent environmental monitoring and emergency planning review services related to all DOE activities at these sites in New Mexico. On October 2, 1995, DOE and NMED extended the AIP for an additional 5 years (DOE 1995).

7.2.13 *Recreational Fisheries*, Executive Order 12962

This order directs federal agencies to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreation fishing opportunities; establishes a National Recreational Fisheries Coordination Council and mandates the preparation of a comprehensive Recreational Fishery Resources Conservation Plan; requires federal agencies to aggressively work to identify and minimize conflicts between recreational fisheries and their respective responsibilities under the *Endangered Species Act of 1973*; and expands the role to the Sport Fishing and Boating Partnership Council.

7.2.14 *Migratory Bird Treaty Act*

This act (16 U.S.C. §703) makes it unlawful to pursue, hunt, take, capture, kill (or attempt any of the preceding) any migratory bird or nest or eggs of such bird.

7.3 LAWS, REGULATIONS, AND EXECUTIVE ORDERS RELATED TO REGULATORY ENVIRONMENTAL PROTECTION AND COMPLIANCE

Regulatory environmental protection requirements are designed to protect human health and the environment, including the air, water, and land. Environmental protection statutes and regulations derived from authorities in statutes: (1) create procedures for examining actions that may harm the environment before carrying out that action; (2) establish standards that protect human health and the environment; (3) provide limits for releases into the environment; and (4) create management requirements for specific substances (e.g., asbestos and pesticides).

Federal Compliance with Pollution Control Standards, Executive Order 12088, amended by Executive Order 12580, requires federal agencies, including DOE, to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the *Clean Air Act (CAA)*, *Noise Control Act*, *Clean Water Act*, *Safe Drinking Water Act*, *Toxic Substance Control Act*, and the *Resource Conservation and Recovery Act* (RCRA). In general, DOE and LANL must comply with applicable federal and state requirements to the same extent as any other entity. Noncompliance with these requirements can lead to enforcement actions.

Since LANL was constructed and began operations in the 1940's, before the advent of current environmental requirements, operational nuclear safety and national security were the dominant factors in the early design and operation of facilities. With the enactment of environmental laws and regulations from the 1960's to the present, resources and philosophies have changed to shift to a greater emphasis on environmental protection and achieving compliance with all applicable environmental requirements. Due to its long history, LANL has had difficulty in achieving compliance with some regulatory requirements, and has a legacy of environmental clean-up requirements from past management practices for waste, spills, and releases. Several compliance orders and agreements are also in effect with regulatory agencies to bring LANL into full compliance with specific regulatory requirements.

Depending on the regulatory background and framework of each federal and state law, there may be a primary regulatory enforcement authority at the federal level or at the state level. For some environmental resources, there may be both federal and state laws with applicable requirements, or DOE orders and regulations may be the primary considerations. Permitting for emissions and/or effluent discharges may also be at the federal level, state level, or both levels.

Applicable regulatory environmental laws and regulations can be categorized by media into air, water, land (which includes waste management, toxic substances, pollution prevention, and environmental restoration), and community right-to-know and emergency planning. For each resource category, there is a framework consisting of federal, state, local or DOE order requirements, which together regulate operations at LANL.

7.4 AIR RESOURCES

7.4.1 *Clean Air Act*, as Amended

The CAA (42 U.S.C. §7401 *et seq.*) establishes air quality standards to protect public health and the environment from the harmful effects of air pollution. The act requires establishment of national standards of performance for new stationary sources of emissions limitations for any new or modified structure that emits or may emit an air pollutant, and standards for emission of hazardous air pollutants (HAPs). In addition, the CAA requires that specific emission increases be evaluated to prevent a significant deterioration in air quality.

The *Clean Air Act Amendments of 1990*, signed into law on November 15, 1990, both enhanced and expanded existing authorities and created new programs in the areas of permitting, enforcement, operations in nonattainment areas (areas not meeting air quality standards), control of acid rain, regulation of air toxins, mobile sources, and protection of the ozone layer. Section 118 of the act and Executive Order 12088 require that each federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all federal, state, interstate, and local requirements" with regard to the control and abatement of air pollution to the same extent as any nongovernmental entity.

EPA is the regulating authority for the CAA. However, EPA has granted the State of New Mexico primacy for regulating air quality under an approved State Implementation Plan (SIP). Authority for implementing the regulations promulgated for stratospheric ozone protection and the accidental release provisions of the act have not yet been delegated to the state. EPA also administers the National Emission Standards for Hazardous Air Pollutants (NESHAP) for radioactive emissions, including radon (subparts B, H, I, K, Q, R, T, and W). In New Mexico, all of the CAA regulations, with these exceptions, have been adopted by the state as part of the SIP, and are regulated under the *New Mexico Air Quality Control Act* (74-6-1, NMSA 1978).

NESHAP limits the radiation dose to the public from airborne radionuclide emissions from DOE facilities to 10 millirem per year effective dose equivalent (40 CFR 61.92). The standards also prescribe emission monitoring and test procedures for determining compliance with the 10 millirem per year standard, and reporting and permit provisions. EPA issued Notices of Noncompliance to DOE in 1991 and 1992 for not meeting all the provisions of 40 CFR 61, Subpart H. A Federal Facilities Compliance Agreement signed June 13, 1996, with EPA Region 6, provided an enforceable mechanism for bringing LANL into compliance (EPA 1996a). The compliance agreement required full compliance for all sources by March 1997, and LANL achieved full compliance in June 1996. In November 1994, Concerned Citizens for Nuclear Safety (CCNS) filed a CAA citizens' suit against DOE and UC, alleging LANL was not in compliance with Subpart H. In January 1997, DOE and UC entered into both a settlement agreement and consent decree. Highlights of the settlement agreement and consent decree include DOE-funded independent technical audits of LANL's radionuclide air emissions compliance program, the addition of some environmental monitoring stations, and quarterly public meetings conducted by UC on the environment.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, also incorporates the EPA NESHAP standard for public doses from air emissions and provides for additional monitoring and evaluation of total public radiation dose from other pathways. Unplanned releases of radioactive effluents to the air are also reported and analyzed under provisions of DOE Order 5400.5. LANL has reported 13 air releases of radioactive materials through effluent stacks in the period 1991 through 1996. These reported releases usually involved a higher than normal operational limit radionuclide measurement determined through stack monitoring processes in place, or an unplanned release. These have usually included small quantities of tritium, and also occasionally very small quantities of other radionuclides. Only one release of tritium, in January 1994, exceeded the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (42 U.S.C. §9601) reportable quantity. All air releases were analyzed for impact on the environment and the public both in terms of dose and need for corrective action in accordance with DOE requirements in DOE Order 5400.5, DOE Order 232.1, and 40 CFR, Subpart H.

The federal regulations promulgated to implement the requirements of CAA Title VI, "Stratospheric Ozone Protection," are codified in *Protection of Stratospheric Ozone* (40 CFR 82). The primary purpose of these regulations is to eliminate the production of certain ozone-depleting substances and require users of the substances to reduce emissions to the atmosphere through recycling and mandatory use of certified maintenance technicians. These requirements are applicable to LANL, and are implemented accordingly.

On June 20, 1996, EPA promulgated *Accidental Release Prevention Requirements: Risk Management Programs* under CAA, Section 112 (r)(7), which amended 40 CFR 68. The intent of this regulation is to prevent accidental releases to the air and mitigate the consequences of such releases by focusing prevention measures on chemicals that pose the greatest risk to the public and the environment. This regulation will require the preparation of risk management plans for listed regulated chemicals at LANL by June 1999, and within 3 years after listing any new regulated chemical.

On July 18, 1997, the EPA adopted a new National Ambient Air Quality Standard (NAAQS) for particulate matter (PM) with a diameter less than or equal to 2.5 micrometers ($PM_{2.5}$), and reference methods for determining attainment with the standard. Also on July 18, 1997, EPA revised the NAAQS and associated reference method for determining ozone attainment. Both standards will be incorporated into the SIP for New Mexico and be applicable to LANL. Determination of attainment of both standards is based on a reference method utilizing 3-year averaging.

In addition to the existing federal programs, the *Clean Air Act Amendments of 1990* mandate new programs that may affect future LANL programs. These programs require technology for controlling hazardous air pollutants and replacing chlorofluorocarbons. Regulations are still being developed to implement these aspects of the act.

7.4.2 *New Mexico Air Quality Control Act*

Nonradioactive air emissions from LANL facilities are subject to the regulatory requirements established under the *New Mexico Air Quality Control Act* (sections 74-2-1 *et seq.*, NMSA 1978). The New Mexico Environmental Improvement Board, as provided by the *New Mexico Air Quality Control Act*, regulates air quality through a series of air quality control regulations in NMAC. These regulations are administered by NMED. NMAC provides emission standards for emission sources and processes such as open burning, boilers, and asphalt plants. Some of the main regulations relevant to LANL operations are discussed below.

7.4.2.1 *Construction Permits*

Provisions of 20 NMAC 2.72 require construction permits for any new or modified source of any regulated air contaminant if they exceed threshold emission rates. More than 500 toxic air pollutants are regulated, and each chemical's threshold hourly rate is based on its toxicity. Each new or modified air emission source is reviewed, and conservative estimates are made of maximum hourly chemical use and emissions. These estimates are compared with the applicable 20 NMAC 2.72 limits to determine whether additional permits are required.

7.4.2.2 *Operating Permits*

On July 21, 1992, EPA promulgated 40 CFR 70, O*perating Permit Program*, which implements Title V of the CAA. The purpose of this program is to: (1) identify all the air quality regulations and emission limitations applicable to an air pollution source; and (2) establish monitoring, record keeping, and reporting requirements necessary to demonstrate continued compliance with these requirements. This regulation required each state to develop an operating permit program meeting the minimum requirements set forth in 40 CFR 70 and submit their program to EPA for review by November 1993. The NMED Operating Permit Program established under 20 NMAC 2.70 was approved by EPA in December 1994. It requires that all major producers of air pollution obtain an operating permit from NMED. Due to LANL's potential to emit large quantities of regulated air pollutants (nitrogen oxides and carbon monoxide—primarily from steam plants), LANL is considered a major source.

In accordance with 20 NMAC 2.70, LANL submitted an operating permit application to NMED in December 1995. NMED has issued a Notice of Completeness for the application but has not yet issued an operating permit.

7.4.2.3 *Prevention of Significant Deterioration*

This regulation (20 NMAC 2.74) has stringent requirements that must be addressed before construction of any new, large stationary source can begin. Under 20 NMAC 2.74, wilderness areas, national parks, and national monuments receive special protection; thus, the proximity of Bandelier National Monument's (BNM) Wilderness Area could have an impact on any proposed new construction at LANL. All of the new or modified air emission sources at LANL are reviewed for compliance with the requirements of 20 NMAC 2.74. Because the total emissions of any criteria pollutant from LANL are below the regulation's threshold of 250 tons a year, currently this regulation does not apply to LANL.

7.4.2.4 *Emission Standards for Hazardous Air Pollutants*

In its regulation governing emission standards for HAPs (20 NMAC 2.78), NMED has adopted by reference all of the federal NESHAP provisions, except those for radionuclides. The only two nonradionuclide NESHAP provisions applicable to LANL are those for asbestos and beryllium.

Under NESHAP for asbestos, LANL is required to notify NMED of asbestos removal operations and disposal quantities and to ensure that these operations produce no visible emissions. Asbestos removal activities involving less than 160 square feet (15 square meters) are covered by an annual small-job notification to NMED. Projects involving greater amounts of asbestos require separate advance notification to NMED. Quantities of asbestos wastes for both small and large jobs are reported to NMED on a quarterly basis. These reports include any asbestos contaminated, or potentially contaminated, materials with radionuclides. Radioactivity contaminated material is disposed of in a designated radioactive asbestos burial area. Nonradioactive asbestos is transported off the site to designated commercial asbestos disposal areas.

The beryllium NESHAP includes requirements for preconstruction and preoperation approval of beryllium machining operations and for start-up testing of stack emissions from these operations. Before the beryllium NESHAP became applicable for DOE operations in the mid 1980's, NMED, DOE, and LANL agreed to follow the NMED new-source preconstruction/preoperation approval process for large, existing beryllium-machining operations at LANL. Since then, several very small beryllium machining operations that were already in existence have been registered with NMED.

7.4.3 *Noise Control Act of 1972*

By the *Noise Control Act of 1972* (42 U.S.C. §4901), Congress directed all federal agencies to carry out the programs under their control to promote an environment free from noise that jeopardizes public health or welfare. Furthermore, it requires any federal agency engaged in any activity resulting, or which may result, in the emission of noise, to comply with federal, state, interstate, and local requirements respecting control and abatement of environmental noise to the same extent that any person is subject to such requirements. Beyond the general obligation in the act and implementing regulations, there are no specific federal requirements regulating environmental noise, nor are there state requirements. Noise exposures to occupational workers are regulated under OSHA, and for DOE contractors through an equivalent program implemented by DOE orders. The Los Alamos County Code (Chapter 8.28) does have noise restrictions, with identified permissible noise levels for residential areas during specified times. Permits can be requested for exceedances for noise generating activities of a temporary nature.

7.5 WATER RESOURCES

7.5.1 *Clean Water Act*, as Amended

The *Clean Water Act* (33 U.S.C. §1251) has a goal to "restore and maintain the chemical, physical and biological integrity of the nation's waters," including to "provide for the protection and propagation of fish, shellfish, and wildlife." The regulations that implement the *Clean Water Act* contain limitations and permitting requirements for discharges of pollutants from point sources; disposal of dredged or fill material at wetlands and other waters of the U.S.; stormwater discharges from construction and industrial runoff; and oil discharges. Key elements of the act include: (1) nationally applicable, technology-based effluent limitations set by EPA for specific industry categories; and (2) water quality standards set by states.

EPA is the regulating authority for point source and stormwater discharge permits in New Mexico. Permits are issued and enforced by EPA Region 6 in Dallas, Texas. New Mexico does not have a state point source discharge permit program. However, NMED performs some compliance evaluation inspections and monitoring for EPA through a water quality grant issued under Section 106 of the act. The U.S. Army Corps of Engineers administers the dredged or fill material permit program (Section 404) of the *Clean Water Act*. LANL submits applications as necessary for disposal of dredged and fill material under Section 404 for construction activities. The *New Mexico Groundwater Protection Act* (74-6B-1 *et seq.*, NMSA 1978), *Water Quality Act* (74-6-1 *et seq.*, NMSA 1978) and implementing regulations establish state standards for protection of surface and groundwater resources that are also applicable to LANL activities.

7.5.1.1 *National Pollutant Discharge Elimination System Permit Program/ Liquid Radioactive Discharges*

The *Clean Water Act* contains provisions for the National Pollutant Discharge Elimination System (NPDES), a permitting program for the discharge of pollutants from any point source into waters of the U.S. Individual NPDES permits set limitations for specified pollutants at specific outfalls.

LANL has operated under three primary NPDES permits. UC and DOE are co-operators on a site-wide NPDES permit (EPA 1994) issued by EPA Region 6 and effective August 1, 1994, covering the industrial and sanitary effluent discharges at Los Alamos. Industrial discharges from the hot dry rock geothermal facility, Fenton Hill (Technical Area [TA]–57), are permitted separately (EPA 1979). This permit was canceled as of December 1997. A General Permit for storm water associated with industrial activity (EPA 1992) was also issued in September 1992. These permits regulate all routine effluent discharges at LANL. Storm water discharges associated with facility construction or environmental restoration activities are also authorized through the applicable NPDES program. Then they are included in the General Industrial Storm Water Permit or terminated as applicable. The number of NPDES General Permits for construction storm water discharges varies, with usually five to eight in effect at one time.

During the early 1990's, LANL was listed as a "Significant Non-Compliant Federal Facility" by EPA Region 6 for NPDES violations. DOE and LANL have had several Federal Facility Compliance Agreements and parallel administrative orders in effect to correct NPDES deficiencies. The current DOE compliance agreement (Docket No. VI–96–1237, December 12, 1996) (EPA 1996b) and the current LANL administrative order (AO Docket No. VI–96–1236, December 10, 1996) (EPA 1996c) include schedules for coming into full compliance with the *Clean Water Act* by completing the High Explosives Wastewater Treatment Facility (HEWTF) and Waste Stream Characterization projects. These corrective actions required by the compliance agreement and the administrative order are continuing.

Although maintaining a 98 to 99 percent compliance rate with required permit limitations, LANL has had, and continues to have, chronic problems meeting NPDES industrial/sanitary permit conditions. Exceedances are self reported under the conditions of the permit, and have consisted of occasional exceedances at some outfalls of arsenic, chlorine, total suspended solids, hydrogen-ion concentration, chemical oxygen demand, biological oxygen demand, cyanide, vanadium, copper, iron, oil and grease, silver, phosphorus, and radium. The total number of exceedances for calendar years 1991 through 1996 are shown in Figure 7.5.1.1–1.

LANL actions to improve compliance with permit conditions are continually being taken including, elimination of outfalls, improvements and corrective actions at specific outfalls, and implementation of the Waste Stream Characterization Program and Corrections Project.

Radioactive liquid effluent discharges are regulated by DOE Order 5400.5. One NPDES permitted outfall at TA–50, the Radioactive Liquid Waste Treatment Facility, began operations in 1963. This outfall has continued to discharge residual radionuclides to Mortandad Canyon in liquid effluents to the present time. DOE Order 5400.5 specifies DCGs for liquid radioactive effluents, which provide a reference for determining dose to various exposure pathways. For liquid radioactive effluents, the "as low as reasonably achievable" (ALARA) and "best available

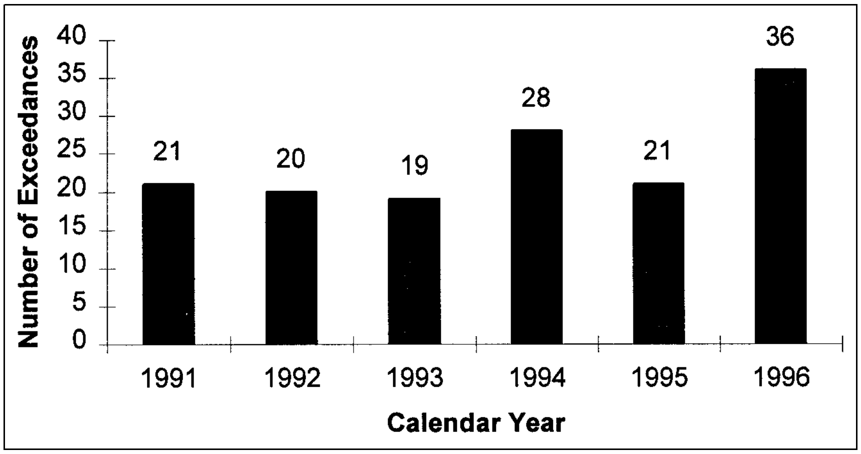

FIGURE 7.5.1.1–1.—*National Pollutant Discharge Elimination System Permit Exceedances.*

technology" (BAT) processes are adopted to determine the appropriate level of treatment. If discharges are below the DCG reference values at the point of discharge to a surface waterway, generally no further treatment is required due to cost/benefit considerations. Historic discharges to Mortandad Canyon have resulted in above background residual radionuclide concentrations in alluvial groundwater and sediments. For calendar year 1996, two DCGs were exceeded in TA–50 effluents (for americium-241 and plutonium-238). The TA–50 discharge also contains nitrates that have caused the alluvial groundwater to exceed the state groundwater standard of 10 milligrams per liter. LANL is working to continue to upgrade the treatment process at TA–50 to correct these problems. Investigation and cleanup, if required, are conducted through the Environmental Restoration Project, and interim controls (sediment traps) have been implemented to control movement of contaminants off the site.

7.5.1.2 *Unplanned Discharges, Spills, and Releases*

LANL also has had continuing problems with unplanned liquid discharges, or spills of water contaminants, which are required to be reported to NMED as unpermitted discharges to surface water or groundwater under the New Mexico Water Quality Control Commission (NMWQCC) regulations. Primarily, these have consisted of unpermitted or unplanned releases of potable water, wastewater or sewage, cooling water, and steam condensate from line breaks and overflows, with occasional reportable small quantity releases of mineral oil, gasoline, diesel oil, hydraulic oil, ethylene glycol, and other liquids. Some discharges of oil are also reportable to the National Response Center pursuant to 40 CFR 110.6. Spills and releases are reported in accordance with regulations, and cleanup is conducted by LANL as necessary. NMED administratively reviews and closes actions taken on reported spills as staff and time permits. The total number of liquid spills reportable to NMED for the period 1991 through 1996 are shown in Figure 7.5.1.1–2.

LANL has had six releases involving spills, leaks, or seepage of water with low levels of radioactive contamination in the period 1991 through 1996. These are evaluated and cleaned up if necessary in accordance with DOE Order 5400.5 criteria.

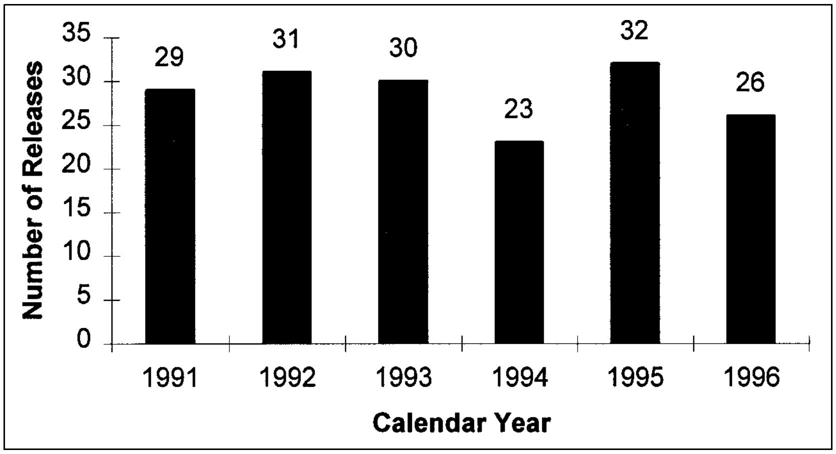

FIGURE 7.5.1.1–2.—*Liquid Release Notifications.*

7.5.1.3 *Spill Prevention Control and Countermeasure Plan*

LANL has a spill control and countermeasure plan for oil spills (LANL 1997), as required by 40 CFR 112 under the *Clean Water Act*. This plan requires that secondary containment be provided for all aboveground storage tanks containing oil. The plan also provides for spill control at oil storage sites at LANL. This plan meets requirements of both EPA and NMED for control of spills to surface areas and below the ground surface.

7.5.1.4 *Sanitary Sewage Sludge Management Program*

In December 1992, EPA promulgated 40 CFR 503, *Standards for Use or Disposal of Sewage Sludge*. The purpose of these regulations is to establish numerical, management, and operational standards for the beneficial use or disposal of sewage sludge through land application or surface disposal. Under the Part 503 regulations, LANL is required to collect representative samples of sewage sludge to demonstrate that it is not a hazardous waste and that it meets the minimum federal standards for pollutant concentrations. In 1996, analytical sampling demonstrated 100 percent compliance with land application standards. However, low levels of polychlorinated biphenyls (PCBs) detected in the sludge have caused LANL to suspend land application of sludge, in preference to other disposal options. All sewage sludge generated at the TA–46 Sewage Treatment Plant is now handled as PCB-contaminated waste and disposed of off the site rather than by land application.

7.5.1.5 *Safe Drinking Water Act, as Amended*

The *Safe Drinking Water Act* (SDWA) (42 U.S.C. §300f) sets national standards for contaminant levels in public drinking water systems, regulates the use of underground injection wells, and prescribes standards for groundwater aquifers that are a sole source of drinking water. Primary enforcement responsibility for the act is by the states. EPA has given NMED authority to administer and enforce federal drinking water regulations and standards in New Mexico. This act authorizes regulations that establish national drinking water standards for contaminants in public drinking water systems. The implementing regulations are found in *National Interim*

Primary Drinking Water Regulations. The regulations also set maximum contaminant level goals (40 CFR 142) and secondary standards to control contaminants in drinking water that primarily affect aesthetic qualities related to public acceptance of drinking water (40 CFR 143). These standards have been adopted by New Mexico and are included in the *New Mexico Drinking Water Regulations*. The state has issued regulations containing maximum contaminant levels (MCLs) and standards for radioactive contamination (20 NMAC 7.1). EPA maintains oversight responsibilities over the states, sets new contaminant standards as appropriate, and maintains separate enforcement responsibility for the Underground Injection Control Program.

The SDWA applies to federal facilities that own or operate a public water system. A "public water system" means a system for the provision of piped water for human consumption that has at least 15 service connections or regularly serves at least 25 individuals. DOE provides drinking water to LANL, Los Alamos County, and BNM. LANL, as operator of the water system, is required to monitor drinking water quality for organic and inorganic compounds, radionuclides, metals, and coliforms. LANL has established a sampling program for ensuring SDWA compliance.

7.5.1.6 *Groundwater Protection Requirements*

There are numerous federal, state, and DOE requirements related to groundwater protection and management. The State of New Mexico protects groundwater via the NMWQCC regulations, which control discharges of water contaminants onto or below the ground surface to protect all groundwater of the State of New Mexico. Under these regulations, a groundwater discharge plan may be required to be submitted to and approved by NMED for a discharging facility (or by the Oil Conservation Division for energy/mineral extraction activities). Subsequent discharges must comply with the terms and conditions of the discharge plan. In 1997, LANL had three Groundwater Discharge Plans in effect. The NMWQCC regulations were significantly expanded in 1995 with the adoption of comprehensive abatement regulations. The purpose of these regulations is to abate both surface and subsurface contamination for designated or future uses. Of particular importance to DOE and LANL is the contamination that may be present in alluvial groundwater.

Groundwater monitoring and protection requirements are also included in DOE Order 5400.1, *General Environmental Protection Program*. The order requires LANL to prepare a Groundwater Protection Management Program Plan (GWPMPP) and to implement the program outlined by that plan. The GWPMPP also fulfills the requirements of Chapter IV, Section 9, of DOE Order 5400.1, which requires development of a groundwater monitoring plan. The groundwater monitoring plan identifies all DOE requirements and regulations applicable to groundwater protection and includes strategies for sampling, analysis, and data management. LANL's GWPMPP was most recently approved by DOE on March 15, 1996 (LANL 1996).

Section 9c of Chapter IV of DOE Order 5400.1 requires that groundwater monitoring needs be determined by site-specific characteristics and, where appropriate, that groundwater monitoring programs be designed and implemented in accordance with RCRA regulations 40 CFR 264, Subpart F, or 40 CFR 265, Subpart F. The section also requires that monitoring for radionuclides be in accordance with DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

In addition to DOE Order 5400.1, Module VIII of the LANL RCRA permit requires LANL to collect information to supplement and verify existing information on the environmental setting at the facility and collect analytical data on groundwater contamination. Under Task III, Section A.1, LANL is required to conduct a program to evaluate hydrogeological conditions. Under Task III, Section C.1, LANL is required to conduct a groundwater investigation to characterize any plumes of contamination at the facility.

Historically, the groundwater monitoring requirements of RCRA (40 CFR 264 Subpart F) have not been applied to LANL's regulated hazardous waste management units (treatment, storage, and disposal) because DOE and LANL had submitted groundwater monitoring waiver demonstrations based on the depth to groundwater and lack of physical evidence of contaminant migration to these depths. However, on May 30, 1995, NMED denied DOE/LANL groundwater monitoring waiver demonstrations, and groundwater monitoring program plans were requested for DOE/LANL to bring the laboratory into compliance with RCRA. In the denial letter, NMED recommended the development of a comprehensive groundwater monitoring program plan that addresses both site-specific and LANL-wide groundwater monitoring objectives. This was in part satisfied with submittal of a revised GWPMPP in 1995. In an August 17, 1995, letter, NMED again expressed concerns over groundwater protection, listed four unresolved issues, and requested a RCRA Hydrogeologic Workplan. On December 6, 1996, a draft Hydrogeologic Workplan was submitted to NMED addressing these unresolved issues. LANL is currently implementing actions defined in the Hydrogeologic Workplan. The Hydrogeologic Workplan was approved by NMED March 1998 and revised by LANL May 1998 (LANL 1998).

7.6 LAND RESOURCES (WASTE MANAGEMENT, TOXIC SUBSTANCES, POLLUTION PREVENTION, AND ENVIRONMENTAL RESTORATION)

Federal facilities are subject to a variety of federal and state environmental statutes and implementing regulations related to waste management, prevention of pollution, and environmental cleanup. These requirements are primarily oriented toward prevention of pollution of land resources, and cleanup of past spills and releases. These include the RCRA; the *Federal Facility Compliance Act*; the *Toxic Substances Control Act* (TSCA); the *Federal Insecticide, Fungicide, and Rodenticide Act* (FIFRA); and the CERCLA. These acts address the management of waste and hazardous substances, and the release or threat of release of hazardous substances, primarily to soil and groundwater. The *Hazardous Material Transportation Act* is also included, which governs the transportation of hazardous materials and waste.

7.6.1 *Resource Conservation and Recovery Act*

The RCRA (42 U.S.C. §6901 *et seq.*) regulates the management of solid waste. Solid waste is broadly defined to include any garbage, refuse, sludge, or other discarded material including solid, liquid, semisolid, or contained gaseous materials resulting from industrial, commercial, mining, or agricultural activities. Specifically excluded as solid waste is source, special nuclear, or byproduct material as defined by AEA. Nonhazardous solid waste is regulated under subtitle D of RCRA, the *New Mexico Solid Waste Act* (NMSWA) (74-9-1 *et seq.*, NMSA 1978), and its implementing regulations, the New Mexico Solid Waste Management Regulations (20 NMAC 9). New Mexico has primary regulatory authority. The state does not have authority to regulate the management and disposal of radioactive waste from DOE facilities operated under AEA.

LANL maintains an industrial solid waste landfill at Area J of TA–54 (on Mesita del Buey), which is subject to and operates under New Mexico's Solid Waste Management Regulations (20 NMAC 9.1). The landfill is used as a disposal site for solid wastes (such as classified wastes, other nonhazardous waste materials, and "special solid waste" as defined by the State of New Mexico) and as a staging area for nonradioactive asbestos waste, which is later shipped off the site to an approved commercial disposal facility. Radioactive asbestos waste and asbestos waste suspected of being contaminated with radioactive material (excluded as solid wastes under the New Mexico regulations) are disposed in a dedicated cell constructed at TA–54, Area G.

LANL disposes of most sanitary solid waste and rubble at the Los Alamos County Landfill and an adjacent rubble pile on East Jemez Road. This landfill lies on DOE property, but is owned and operated by Los Alamos County under a special-use permit (an agreement between DOE's Los Alamos Area Office and the county specifies the types of wastes that may be disposed of in the landfill). LANL contributes about one-third of the total volume of wastes entering this landfill. As the owner and operator, Los Alamos County is responsible for day-to-day operational compliance and obtaining necessary permits from the state under 20 NMAC 9.1.

In 1976, RCRA established requirements and procedures for the management of hazardous wastes. As amended by the *Hazardous and Solid Waste Amendments of 1984* (HSWA), RCRA Subtitle C defines hazardous wastes that are subject to regulation and sets standards for generation of waste and for treatment, storage, and disposal facilities. The HSWA emphasizes reducing the volume and toxicity of hazardous waste. The RCRA and HSWA also establish permitting and corrective action (i.e., cleanup) requirements for RCRA-regulated hazardous waste facilities.

Original jurisdiction for implementing hazardous waste management aspects of the RCRA was with the EPA; however, the RCRA authorizes EPA to delegate responsibility to individual states as they develop satisfactory implementation programs. EPA granted base RCRA authorization to New Mexico on January 25, 1985, transferring regulatory authority over hazardous wastes under the RCRA to NMED. State authority for hazardous waste regulation is set forth in the *New Mexico Hazardous Waste Act* and Hazardous Waste Management Regulations (20 NMAC 4.1), which adopt, with a few minor exceptions, all of the federal regulations in effect. On July 25, 1990, the State of New Mexico's Hazardous Waste Program was authorized by EPA to regulate mixed waste in lieu of the federal program.

On November 8, 1989, DOE and UC, as co-operators of LANL, were granted a RCRA operating permit, which establishes requirements for hazardous waste management units. A Part A application for mixed waste storage and treatment units throughout LANL was submitted on January 25, 1991. Permit modifications and additional revised Part A and Part B applications have been submitted since 1991 for mixed waste units. All existing mixed waste units are operating either under permit or interim status pending permit issuance.

DOE and EPA signed a Federal Facility Compliance Agreement on March 15, 1994, addressing identified noncompliances with stored mixed waste treatment requirements under the land disposal restrictions (LDRs). This compliance agreement was terminated with issuance by the State of New Mexico of a *Federal Facility Compliance Order* in October 1995 under the *Federal Facility Compliance Act*, which addresses treatment schedules for mixed waste to meet LDR standards.

LANL has received a number of compliance orders issued by NMED for noncompliances with hazardous waste management requirements. DOE and LANL are subject to a three-party consent agreement for compliance orders issued by NMED in 1993 regarding corrective actions that resolved the Transuranic Waste Inspectable Storage Project (TWISP) at TA–54, Area G (NMED 1993). This project involves the recovery of transuranic (TRU) and TRU-mixed waste containers stored on earthen covered pads at TA–54, Area G, and placement of that waste into compliant inspectable storage. The deadline for completion of this project is September 2003.

LANL also is currently subject to an Amended Stipulations, dated May 23, 1995, that is part of a settlement reached in response to Compliance Order NMHWA 94-09 (NMED 1995a). The Amended Stipulation requires LANL to exercise due diligence in addressing and working off 644 gas cylinders that had exceeded the allowable 1-year storage limit for land disposal restriction. All but four of the gas cylinders have been dealt with under the terms of the Amended Stipulation. Until these four cylinders meet the terms of the Amended Stipulation, LANL will continue to submit quarterly progress reports, as required by the Amended Stipulation, to demonstrate due diligence in working off the cylinders. All other compliance orders relating to hazardous waste activities have been closed.

The HSWA (1984) modified the hazardous waste permitting sections of the RCRA (Sections 3004 and 3005). In accordance with these provisions, LANL's permit to operate includes a section (HSWA Module VIII) that prescribes a specific corrective action program for LANL, the primary focus of which is the investigation and cleanup, if required, of inactive sites called solid waste management units (SWMUs). The HSWA Module specifies the corrective action process, which is being implemented at LANL by the Environmental Restoration Project.

The corrective action process at LANL consists of: (1) preparing RCRA facility investigations to identify the extent of contamination in the environment and the pathways along which these contaminants could travel to human and environmental receptors; (2) preparing corrective measures studies if needed to evaluate alternative remedies for reducing risks to human and environmental health and safety in a cost-effective manner; and (3) corrective measures implementation—the remedy chosen is implemented, its effectiveness is verified, and ongoing control and monitoring requirements are established.

7.6.2 Radioactive Waste Management Requirements

Low-level radioactive waste (LLW) is a waste that contains radioactivity and is not classified as high-level radioactive waste, TRU waste, or spent nuclear fuel. Solid LLW usually consists of clothing, tools, and glassware. Low-level radioactive liquid waste consists primarily of water circulated as cooling water. Radioactive waste management at LANL is regulated under the AEA, through applicable DOE orders (primarily DOE Order 5820.2A, *Radioactive Waste Management*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*). DOE Order 5400.5 also provides criteria and processes for the release of materials (through sale or disposal) to assure that released materials do not constitute a hazard to the public and the environment due to their radioactive content. This includes materials that are not waste. LANL has reported and taken corrective action for a number of incidents involving the inadvertent release of contaminated materials not releasable under the criteria in DOE Order 5400.5. During the period 1991 through 1996, these incidents have usually consisted of the discovery of contaminated equipment at salvage yards or in other uncontrolled locations, and in two reported incidents at the Los Alamos County Landfill. When incidents are discovered, actions are taken to immediately control the material as radioactive contaminated, and it is removed to a controlled area or decontaminated in accordance with DOE radiation control requirements.

Low-level radioactive mixed waste (LLMW) is waste containing both hazardous and low-level radioactive components. As a hazardous waste, mixed waste is regulated under the RCRA and New Mexico hazardous waste management regulations. Because it is radioactive, the radioactive component is also regulated under the AEA through applicable DOE orders. LLMW is disposed of at off-site facilities.

Due to the nationwide lack of DOE treatment capacity and capability for mixed waste, LANL has continued to store many mixed wastes on the site. On March 15, 1994, DOE and EPA signed a Federal Facility Compliance Agreement to address compliance with the storage prohibitions for mixed waste at LANL. This agreement was terminated with the issuance of the Federal Facility Compliance Order in October 1995 with NMED implementing the Site Treatment Plan for LANL, under provisions of the *Federal Facility Compliance Act*.

TRU waste, regardless of form or source, is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than or equal to 100 nanocuries per gram at the time of assay. TRU waste at LANL is scheduled to be sent to the WIPP when that facility opens. TRU waste is subject to the waste acceptance criteria (WAC) for WIPP, DOT shipping requirements, and applicable DOE orders dealing with its safe handling and management.

7.6.3 *Federal Facility Compliance Act*

The *Federal Facility Compliance Act* (Public Law [PL] 102–386, 106 Stat. 1505), enacted in 1992, amended RCRA and waives sovereign immunity from fines and penalties for RCRA violations at federal facilities. However, the act postponed the waiver for 3 years for storage prohibition violations with regard to land disposal restrictions for DOE's mixed wastes. It also required DOE to prepare plans for developing the required treatment capacity for its mixed waste for each site at which it stores or generates mixed waste. Each plan (referred to as a site treatment plan) must be approved by the state or EPA after consultation with other affected states, consideration of public comments, and issuance of an order by the regulatory agency requiring compliance with the plan. The act further provides that DOE will not be subject to fines and penalties for storage prohibition violations for mixed waste as long as it is in compliance with an existing agreement, order, or permit.

The *Federal Facility Compliance Act* requires that site treatment plans contain schedules for developing treatment capacity for mixed waste for which identified technologies exist. For mixed waste without an identified existing treatment technology, DOE must provide schedules for identifying and developing technologies.

LANL has submitted site treatment plans to NMED to address the development of new treatment capabilities in compliance with the act. A Federal Facility Compliance Order was issued on October 4, 1995, to address treatment schedules for mixed waste (NMED 1995b). The Mixed Waste Land Disposal Restriction Federal Facility Compliance Agreement with EPA of March 15, 1994, was terminated with this new agreement.

7.6.4 Underground Storage Tanks, RCRA Subtitle I

Underground storage tanks (USTs) containing petroleum or hazardous substances are regulated as a separate program under Subtitle I of the RCRA, which establishes regulatory requirements for USTs containing hazardous or petroleum materials. NMED has been delegated authority for regulating USTs under the New Mexico Underground Storage Tank Regulations, which implement the *New Mexico Hazardous Waste Act* and the *New Mexico Groundwater Protection Act*. These regulations include requirements for: (1) design, construction, and installation of new tanks; (2) maintenance of a leak detection system and associated record keeping; (3) reporting of hazardous or petroleum releases; (4) corrective action in the event of a release; and (5) closure of UST systems. All existing tank systems must either meet new tank performance standards or undergo closure by December 22, 1998. All LANL USTs will be upgraded or undergo closure by the December 22, 1998 deadline. LANL complied with the deadline for upgrading, replacing, or properly closing all USTs at LANL.

7.6.5 *Comprehensive Environmental Response, Compensation, and Liability Act*, as Amended

CERCLA (PL 96-510) (42 U.S.C. §9601 *et seq.*), as amended by *Superfund Amendments and Reauthorization Act* (SARA) of 1986 (PL 99-499), provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and cleanup of inactive hazardous substances disposal sites. The CERCLA also established a fund that is financed by hazardous waste generators and is used to financially support clean-up and response actions of abandoned hazardous waste sites when no financially responsible party(ies) can be found. Parties responsible for the contamination of sites are liable for all costs incurred in the clean-up and remediation process. EPA is the regulating authority for the act. Some applicable implementing regulations are contained in the *National Oil and Hazardous Substances Pollution Contingency Plan* (40 CFR 300), and *Designation, Reportable Quantities, and Notification* (40 CFR 302).

LANL has been evaluated and did not score high enough to be placed on the National Priority List for past releases into the environment. Therefore, all legacy contamination found in the environment at LANL is primarily cleaned up under RCRA corrective action authority (HSWA Permit Module VIII). Executive Order 12580, which applies to facilities that are not on the National Priorities List, delegates responsibility to the heads of executive departments and agencies at those facilities for undertaking remedial and removal actions for releases or threatened releases. This authority applies to any clean-up actions not included as a RCRA corrective action.

The CERCLA was amended by the SARA in 1986. The SARA Title III establishes additional requirements for emergency planning and reporting of hazardous substance releases. The SARA Title III is also known as the *Emergency Planning and Community Right-to-Know Act* (EPCRA), which, due to its unique requirements, is discussed separately below. The SARA also created liability for damages to or loss of natural resources resulting from releases into the environment, and required the designation of federal and state officials to act as public trustees for natural resources. The *New Mexico Natural Resources Trustee Act* (75-7-1 *et seq.*, NMSA 1978) is the state statute designed to protect state natural resources. DOE, as the federal trustee, and the State of New Mexico have authority to act as trustees for most resources at LANL. The DOI retains authority for certain designated sensitive natural resources. Other natural resource trustees act for lands surrounding LANL, including the Pueblo tribes. Procedures for conducting natural resource damage assessments are codified at 43 CFR 11. A strategy and plan for integrating the natural resource damage assessment requirements into the HSWA corrective action (environmental restoration) process at LANL is being developed.

LANL is subject to and required to report releases to the environment under the notification requirements in 40 CFR 302. In the period 1991 through 1996, LANL has had four releases to the environment exceeding a reportable quantity in 40 CFR 302.4. One was a planned release by remote detonation of an overpacked chlorine cylinder on May 18, 1993, resulting in the release of a maximum of 100 pounds of chlorine under controlled conditions. Another was a stack release of tritium exceeding 100 curies on January 25, 1994, at TA–33. Two additional reportable releases involved the release of a water/ethylene glycol mixture (coolant) in excess of 1 pound on June 18, 1993 and June 22, 1993.

7.6.6 *Toxic Substances Control Act*

The TSCA (15 U.S.C. §2601 *et seq.*) is administered by EPA. Unlike other statutes that regulate chemicals and their risk after they have been introduced into the environment, the TSCA was intended to require testing and risk assessment before a chemical is introduced into commerce. The TSCA also establishes record-keeping and reporting requirements for new information regarding adverse health and environmental effects of chemicals. The TSCA also governs the manufacture, use, storage, handling, and disposal of PCBs; sets standards for cleaning up PCB spills; and establishes standards and requirements for asbestos identification and abatement in schools.

Because LANL's research and development activities are not usually related to the manufacture of new chemicals, PCB regulations (40 CFR 761) are LANL's main concern under the TSCA. Activities at LANL that are governed by PCB regulations include, but are not limited to, management and use of authorized PCB-containing equipment, such as transformers and capacitors; management and disposal of substances containing PCBs (dielectric fluids, contaminated solvents, oils, waste oils, heat transfer fluids, hydraulic fluids, paints, slurries, dredge spoils, and soils); and management and disposal of materials or equipment contaminated with PCBs as a result of spills.

The TSCA regulates PCB items and materials having concentrations exceeding 50 parts per million. The regulations contain an antidilution clause that requires waste to be managed based on the PCB concentration of the source (transformer, capacitor, PCB equipment, etc.), regardless of the actual concentration in the waste. If the concentration at the source is unknown, the waste must be managed as though it were a spill of mineral oil with an assumed PCB concentration of 50 to 500 parts per million. At LANL, PCB-contaminated wastes are transported off the site for treatment and disposal unless they also have a radioactive component. Wastes in solid form containing both radionuclides and PCBs are disposed at Area G (TA–54), which has been approved by EPA for such disposal (provided that strict requirements are met with respect to notification, reporting, record keeping, operating conditions, environmental monitoring, packaging, and types of wastes disposed).

LANL has reported four small spills (0.34 fluid ounces [10 milliliters] to 0.5 gallons [1.9 liters]) involving PCB-contaminated materials during the period 1991 through 1996. None of these spills exceeded CERCLA reportable quantities, and they were cleaned up using the policy and guidelines in 40 CFR 761.

LANL currently has no treatment or disposal facilities for liquid wastes that contain both radionuclides and PCBs. Such wastes have been stored at Area L at TA–54 for longer than 1 year (in violation of TSCA regulations that stipulate a maximum of 1 year for "storage for disposal" of PCBs). However, commercial facilities do not exist to accept these wastes because of the radionuclide component. In August 1996, EPA and DOE signed a national Federal Facility Compliance Agreement allowing long-term storage of these radioactive liquid wastes containing PCBs, and establishing requirements for DOE to meet in the interim (EPA 1996d).

The asbestos abatement regulations of the TSCA (40 CFR 763) relate primarily to the identification and abatement of asbestos containing materials in schools. LANL conducts asbestos abatement projects in accordance with OSHA requirements (29 CFR 1926), and applicable requirements of the CAA NESHAP 40 CFR 61, Subpart M for notification and waste management/disposal, and the New Mexico Solid Waste Management Regulations.

7.6.7 *Hazardous Materials Transportation Act*

This act defines the requirements of DOT applicable to the packaging and transportation of hazardous materials. The regulations list and classify the materials that DOT (the regulating authority) has designated as "hazardous."

Implementing regulations include *General Information, Regulations, and Definitions* (49 CFR 171); *Hazardous Materials Tables, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements* (49 CFR 172); *General Requirements for Shipments and Packagings* (49 CFR 173); *Carriage by Rail* (49 CFR 174); *Carriage by Public Highway* (49 CFR 177); and *Specifications for Packagings* (49 CFR 178). Specific packaging requirements for radioactive materials are in 49 CFR 173, Subpart I. The requirements prescribed in Subpart I are in addition to, not in place of, requirements of the NRC set forth in 10 CFR 71.

DOE must comply with the *Hazardous Materials Transportation Act* (49 U.S.C. §801 *et seq.*) and implementing regulations, and with specific facility WAC when packaging and transporting waste destined for WIPP and other off-site federal or commercial facilities. LANL must also meet applicable manifesting requirements for shipping hazardous materials such as preparing shipping papers, marking and labeling packages, and placarding transport vehicles as outlined in the act and implementing regulations. Because LANL consists of many separate TAs connected in many instances by public roads, inter-TA transportation requirements must consider applicable packaging and transportation requirements for the movement of hazardous materials within LANL as well. This may include meeting the transportation requirements fully, or utilizing road closures or other means to maintain compliance with the regulations. The state agency regulating transportation of hazardous materials is the Motor Transportation Division of the New Mexico Tax and Revenue Department (65-3-13, NMSA 1978). New Mexico has adopted by reference the hazardous materials transportation regulations promulgated by DOT.

7.6.8 *Federal Insecticide, Fungicide, and Rodenticide Act*

This act regulates the use, registration, and disposal of several classes of pesticides. In order to ensure that pesticides are applied in a manner that protects the applicators, workers, and the environment, LANL must meet requirements of the FIFRA (7 U.S.C. §136 *et seq.*). Implementing regulations include recommended procedures for the disposal and storage of pesticides (40 CFR 165 [proposed regulation]) and worker protection standards (40 CFR 170). EPA is the regulating authority for LANL. LANL is also regulated by the *New Mexico Pest Control Act*, administered by the Board of Regents of New Mexico State University. The LANL Pest Control Management Plan, which includes programs for vegetation, insects, and small animals, was established in 1984 and is revised as necessary.

7.6.9 *Pollution Prevention Act of 1990*

The *Pollution Prevention Act of 1990* (42 U.S.C. §13101 *et seq.*) sets the national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and disposal. In response to this act, DOE committed to voluntary participation in EPA's 33/50 Pollution Prevention Program, as set forth in Section 313 of SARA. The goal, for facilities already involved in Section 313 compliance, was to achieve a 33 percent reduction in release of 17 priority chemicals by 1997 from a 1993 baseline. LANL did not have releases that exceeded reportable thresholds for any of the 17 priority chemicals listed. In August 1993, Executive Order 12856 was issued, expanding the 33/50 program and requiring DOE to reduce its total release of all toxic chemicals by 50 percent by December 31, 1999. In response, DOE has developed Departmental Pollution Prevention Goals and Pollution Prevention Program Plans to meet these goals. Each DOE site, including LANL, develops its own site goals contributing to the DOE-wide goals and implements actions to achieve those goals. For Fiscal Year 1996, LANL met or exceeded all waste pollution prevention commitments.

7.7 COMMUNITY RIGHT-TO-KNOW AND EMERGENCY PLANNING

7.7.1 *Emergency Planning and Community Right-to-Know Act* and Executive Order 12856

This act is also known as SARA Title III. Section 313 of the EPCRA (42 U.S.C. §11001 *et seq.*) requires facilities meeting certain standard industrial classification code criteria to submit an annual toxic chemical release inventory report (*Toxic Chemical Release Reporting: Community-Right-to-Know* [40 CFR 372]). For facilities subject to the EPCRA requirements, a report describing the use of, and emissions from, Section 313 chemicals stored or used on site and meeting threshold planning quantities, must be submitted to EPA and the New Mexico Emergency Management Bureau every July for the preceding calendar year.

Other provisions of the EPCRA require planning notifications (Section 302–303), extremely hazardous substance release notifications (Section 304), and annual chemical inventory/Material Safety Data Sheet reporting (Section 311–312). Implementing regulations include but are not limited to *Emergency Planning and Notification* (40 CFR 355), *Material Safety Data Sheet Reporting* (40 CFR 370.21), and *Inventory Reporting* (40 CFR 370.28).

On August 3, 1993, Executive Order 12856, *Right-to-Know Laws and Pollution Prevention Requirements* directed all federal agencies to reduce and report toxic chemicals entering any waste stream; improve emergency planning, response, and accident notification; and encourage clean technologies and testing of innovative prevention technologies. Federal agencies were also defined as persons for the purposes of the EPCRA, requiring all federal facilities, regardless of standard industrial classification code to meet the requirements of the act.

LANL does not meet standard industrial classification code criteria for Section 313 reporting but has voluntarily submitted annual toxic chemical release inventory reports since 1987. All research operations are exempt under provisions of the regulation, and only pilot plants, production, or manufacturing operations at LANL are reported.

The *New Mexico Hazardous Chemicals Information Act* (74-4E-1 to 74-4E-9, NMSA 1978) implements the hazardous chemical information and toxic release reporting requirements of SARA Title III for covered facilities in New Mexico. Applicable reporting requirements under the provisions of the EPCRA and the state law are met by DOE and LANL in accordance with the executive order.

APPENDIX 7.A
CONSULTATIONS

In the process of preparing this SWEIS, DOE has had discussions with numerous organizations (including the New Mexico Department of Game and Fish, the BIA, the USFS, the NPS, and counties and municipalities near LANL) regarding issues, concerns, and interests associated with the operation of LANL and with the preparation of the SWEIS. Of these discussions, a few of them are considered to be consultations for the purposes of the SWEIS, where DOE specifically requested positions, advice, or input from organizations. The subjects of these consultations and the agencies or organizations consulted were:

SUBJECT OF CONSULTATIONS	AGENCIES OR ORGANIZATIONS CONSULTED
Threatened and Endangered Species	U.S. Fish and Wildlife Service
Environmental Monitoring Data	New Mexico Environment Department
Cultural Resources	New Mexico State Historic Preservation Office(r)
Traditional Cultural Properties[a]	Pueblo of Acoma Pueblo de Cochiti Pueblo of Jemez Pueblo of Laguna Pueblo of Nambe Jicarilla Apache Tribe Mescalero Apache Tribe Navajo Nation Hopi Tribe Pueblo of Picuris Pueblo of Pojoaque Pueblo of Sandia Pueblo of San Ildefonso Pueblo of Santa Clara Pueblo of Santa Domingo Pueblo of Taos Pueblo of Tesuque Pueblo of Zia Pueblo of Zuni Pueblo of San Juan Western Network New Mexico Acequia Association

[a] Many tribal governments and other organizations were contacted. Those listed here are the ones that agreed to a consultation relationship with DOE for the purposes of the SWEIS.

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DOE 1992c Accord between the Pueblo of Jemez, a Federally Recognized Indian Tribe and the U.S. Department of Energy. December 8, 1992.

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EPA 1996c Administrative Order Regarding Compliance with the *Clean Water Act* at Los Alamos National Laboratory. U.S. Environmental Protection Agency, Region 6. December 10, 1996.

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NMED 1995b Federal Facility Compliance Order, Compliance with the Site Treatment Plan for the Treatment of Mixed Waste at the Los Alamos National Laboratory. New Mexico Environment Department. Santa Fe, New Mexico. October 4, 1995.

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UC 1994c	Cooperative Agreement between the Pueblo of San Ildefonso, a Federally Recognized Indian Tribe and the University of California as Operator of the Los Alamos National Laboratory. University of California. November 14, 1994.
UC 1996	Cooperative Agreement between the Pueblo of Santa Clara, a Federally Recognized Indian Tribe and the University of California as Operator of the Los Alamos National Laboratory. University of California. December 12, 1996.

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CHAPTER 8
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Education:	B.S., Geology, University of New Mexico
Technical Experience:	11 years of experience performing hydrogeologic site characterizations (includes work at environmental restoration and uranium tailings sites)
SWEIS Responsibility:	Geology and water resources

Name:	**Helen Ginzburg**
Affiliation:	Parsons Brinckerhoff
Education:	M.S., Air Quality, Leningrad Hydro Meteorological Institute
Technical Experience:	16 years in air quality meteorology and mathematical modeling
SWEIS Responsibility:	Nonradiological air quality

Name:	**Shiv N. Goel**
Affiliation:	U.S. Department of Energy
Education:	M.S., Environmental Engineering, University of New Mexico B.S., Mining Engineering, Indian School of Mines Registered Professional Engineer in the states of New Mexico and California
Technical Experience:	29 years of Environmental Engineering experience including: • 7 years as an Environmental Engineer responsible for DOE Albuquerque Operations Office • 2 years as a Supervisor of the Engineering Section for the City of Albuquerque Environmental Health Division • 4.5 years as a Supervisory Engineer/Environmental Engineer with the State of New Mexico, Environmental Improvement Division
SWEIS Responsibility:	Lead Preparer for nonradiological air analysis

Name:	**Timothy J. Goering**
Affiliation:	GRAM, Inc.
Education:	B.A., Environmental Science, University of Virginia M.S., Hydrology, University of Arizona
Technical Experience:	12 years of experience in environmental analysis and remediation
SWEIS Responsibility:	Environmental restoration

Name:	**Kathleen Gorman-Bates**
Affiliation:	GRAM, Inc.
Education:	B.S., Biology, St. Mary's College, Dodge City Kansas
Technical Experience:	9 years in radiochemistry, biology, microbiology, and health and safety
SWEIS Responsibility:	Nonradiological air quality

Name:	**Davin G. Greenly**
Affiliation:	Tetra Tech, Inc.
Education:	B.S., Environmental Engineering, California Polytechnic State University
Technical Experience:	2 years of experience in NEPA analysis
SWEIS Responsibility:	Aircraft crash accident analysis, transportation, and biological resources

Name:	**William L. Harrell**
Affiliation:	U.S. Department of Energy
Education:	B.S., Wildlife Science, Texas A&M University (with Honors) Graduate studies (20 hours), Environmental Science, Texas Christian University
Technical Experience:	27 years of experience in Environmental Protection and Compliance Programs, including planning and operations of federal water resource projects and DOE plants and laboratories; wildlife and ecological effects analysis and resource management; environmental restoration program and environmental compliance management; and NEPA compliance for federal projects
SWEIS Responsibility:	Lead Preparer for regulatory background and compliance (chapter 7)

Name:	**John Hogan**
Affiliation:	GRAM, Inc.
Education:	B.S., Biology, University of New Mexico
Technical Experience:	11 years of experience in field biology and ecology
SWEIS Responsibility:	Ecological risk and biodiversity

Name:	**William R. James**
Affiliation:	GRAM, Inc.
Education:	B.S., Biological Sciences, Wright State University M.S., Health Physics, University of Cincinnati
Technical Experience:	• 6 years in Occupational and Environment Health Physics • 1 year in Emergency Preparedness • 1 year in Occupational Health and Safety
SWEIS Responsibility:	Radiological risk assessment for workers and on-site transportation

Name:	**Kevin Keller**
Affiliation:	Parsons Brinckerhoff
Education:	B.A., Geography, California State University, Fullerton
Technical Experience:	8 years of experience preparing environmental documents, computer-aided drafting and design, and geographic information systems
SWEIS Responsibility:	Land use

Name:	**Jeffrey Kimball**
Affiliation:	U.S. Department of Energy
Education:	B.S., Oceanography, University of Michigan M.S., Geology (Seismology), University of Michigan
Technical Experience:	17 years of experience, primarily in siting and design of critical facilities to resist the loads from natural phenomena
SWEIS Responsibility:	Technical Advisor on geology (seismic) and accident analysis

Name:	**J. Randall Kirchner**
Affiliation:	H&R Technical Associates, Inc.
Education:	B.S., Nuclear Engineering, University of Tennessee
Technical Experience:	Over 13 years of experience in probabilistic risk assessment, nuclear facility safety analysis, and transportation risk analysis
SWEIS Responsibility:	Transportation risk analysis

Name:	**Vadim Kogan**
Affiliation:	Parsons Brinckerhoff
Education:	Ph.D., Chemical Engineering, Moscow Institute of Chemical Technology
Technical Experience:	22 years in environmental engineering field
SWEIS Responsibility:	Nonradiological air quality

Name:	**John Lambright**
Affiliation:	BETA Corporation, International, and Self-Employed Consultant
Education:	B.S., Nuclear Engineering M.S., Nuclear Engineering Ph.D., Nuclear Engineering
Technical Experience:	More than 20 years in risk assessment, safety analysis, and hazards analysis
SWEIS Responsibility:	Accident analysis

Name:	**Alice Lovegrove**
Affiliation:	Parsons Brinckerhoff
Education:	B.E., State University of New York at Stony Brook M.S., State University of New York at Stony Brook
Technical Experience:	10 years in air quality
SWEIS Responsibility:	Nonradiological air quality

Name:	**Beth Medina**
Affiliation:	Parsons Brinckerhoff
Education:	B.A., Art, California State University, Long Beach
Technical Experience:	11 years of experience preparing environmental documents and graphics
SWEIS Responsibility:	Land use

Name:	**Paul E. McCluer**
Affiliation:	H&R Technical Associates, Inc.
Education:	B.S., Chemical Engineering, Tennessee Technological University
Technical Experience:	8 years of experience in DOE nuclear facility safety analysis and process hazards analysis in the refining and chemical processing industries and author or co-author of more than 30 reports and publications in the areas of DOE nuclear facility safety analysis and process hazards analysis
SWEIS Responsibility:	Transportation risk analysis

Name:	**Donna McCormick**
Affiliation:	Parsons Brinckerhoff
Education:	B.L.A., Landscape Architecture, California Polytechnic University
Technical Experience:	11 years of experience preparing environmental documents, visual assessments, and landscape architecture
SWEIS Responsibility:	Land use

Name:	**Jere Millard**
Affiliation:	Dames & Moore, Inc.
Education:	B.A., Biology & Psychology, Colorado State University M.S., Radiobiology, Colorado State University M.S., Health Physics, Colorado State University Ph.D., Health Physics, Colorado State University
Technical Experience:	18 years in radiation physics/radiation ecology
SWEIS Responsibility:	Human health and ecological risk

Name:	**Douglas Minnema**
Affiliation:	U.S. Department of Energy
Education:	B.S., Nuclear Engineering, University of Michigan M.S., Nuclear Engineering, University of Michigan M.S., Radiological Health, University of Michigan Ph.D. Candidate, Nuclear Engineering, University of New Mexico (in progress)
Technical Experience:	• 18 years in nuclear engineering, health physics, and radiological control • Certified Health Physicist
SWEIS Responsibility:	Lead Preparer for human health risk; Technical Advisor on transportation, and accident analysis

Name:	**Robert A. Monsalve-Jones**
Affiliation:	GRAM, Inc.
Education:	A.S., Nuclear Engineering, Pennsylvania State University B.S., Radiation Protection, Thomas Edison State College
Technical Experience:	24 years as a Radiation Protection Specialist and Health Physicist in nuclear powerplants and at decontamination and decommissioning projects, and performing environmental investigations, risk analysis, and dose assessments for DOE and private clients, nationally and internationally
SWEIS Responsibility:	Radioactive air quality and human health

Name:	**Elizabeth Mooney**
Affiliation:	Dames & Moore, Inc.
Education:	B.S., Zoology and Wildlife Ecology, Michigan State University M.A., Environmental Toxicology, The American University
Technical Experience:	• 10 years in toxicology • 5 years in risk assessment • 10 years in ecology
SWEIS Responsibility:	Ecological risk

Name:	**Abby Nagy**
Affiliation:	Dames & Moore, Inc.
Education:	B.S., Chemical Engineering, Ohio State University
Technical Experience:	7 years in chemical engineering process and environmental analysis
SWEIS Responsibility:	Transportation and environmental restoration

Name:	**Marilyn Norcini**
Affiliation:	GRAM, Inc.
Education:	M.A., History, Museum Studies, Cooperstown Graduate Programs, State University of New York, Oneonta M.A., Anthropology, University of Arizona Ph.D., Anthropology, University of Arizona
Technical Experience:	22 years of experience in cultural resources interpretation
SWEIS Responsibility:	Cultural resources

Name:	**Claudia Oakes**
Affiliation:	Parsons Brinckerhoff
Education:	Ph.D. (ABD), Geography, University of Texas at Austin
Technical Experience:	5 years as an environmental specialist in biogeographic studies and geophysical and cultural applications
SWEIS Responsibility:	Cultural resources

Name:	**John Ordaz**
Affiliation:	U.S. Department of Energy
Education:	B.S., Chemical Engineering, New Jersey Institute of Technology
Technical Experience:	20 years of experience, including over 7 years in DOE program management and NEPA compliance
SWEIS Responsibility:	DOE/HQ Program Manager; also, Lead Preparer for the Comment Response Document (volume IV)

Name:	**Carol S. Pazera**
Affiliation:	Parsons Brinckerhoff
Education:	B.A., Secondary Education, University of Illinois M.A., Latin American Studies, University of Texas at Austin M.S., Community and Regional Planning, University of Texas at Austin
Technical Experience:	3 years in socioeconomics
SWEIS Responsibility:	Socioeconomics

Name:	**Chuck Pergler**
Affiliation:	GRAM, Inc.
Education:	B.S., Range and Wildlands Science, University of California M.S., Range Management, University of California
Technical Experience:	14 years developing and implementing natural resource range plans, biological assessments, NEPA manager, and technical author
SWEIS Responsibility:	Biodiversity and ecological risk

Name:	**Susan Perlman**
Affiliation:	SWCA Environmental Consultants
Education:	B.S., Environmental Forestry, Colorado State University M.A., History, New Mexico State University
Technical Experience:	8 years of historical research in ethnography
SWEIS Responsibility:	Cultural resources

Name:	**Jeffrey P. Petraglia**
Affiliation:	Tetra Tech, Inc.
Education:	B.A., Nuclear Engineering, Pennsylvania State University
Technical Experience:	14 years of experience in safety and accident analyses
SWEIS Responsibility:	Aircraft crash accident analysis

Name:	**Beverly Ausmus Ramsey**
Affiliation:	Enterprise Advisory Services, Inc.
Education:	B.S., Chemistry/Biology M.S., Systems Ecology Ph.D., Systems Ecology
Technical Experience:	29 years of experience in environmental management and facility operations, especially radiological, hazardous and mixed waste management, facilities licensing, and regulatory compliance. Experience includes more than 25 years of experience in NEPA analysis and documentation, including human health impacts, ecological impacts, and cumulative impacts analysis
SWEIS Responsibility:	Technical Advisor on human health

Name:	**William R. Rhyne**
Affiliation:	H&R Technical Associates
Education:	B.S., Nuclear Engineering, University of Tennessee M.S., Nuclear Engineering, University of Virginia D.Sc., Nuclear Engineering, University of Virginia
Technical Experience:	• Over 30 years of experience in transportation risk analysis, DOE nuclear facility safety analysis, and commercial nuclear reactor safety analysis • Author or co-author of more than 50 reports and publications in the areas of transportation risk analysis and nuclear facility safety analysis • Author of Hazardous Materials Transportation Risk Analysis: Quantitative Approaches for Truck and Train
SWEIS Responsibility:	Transportation risk analysis

Name:	**Eric Rogoff**
Affiliation:	GRAM, Inc.
Education:	B.S., Geology, with Distinction, University of Kansas M.S., Hydrology, University of Arizona M.Phil., Geology, Yale University
Technical Experience:	7 years of experience in environmental consulting
SWEIS Responsibility:	Water resources, geology, and soils

Name:	**Francis Rowsome**
Affiliation:	U.S. Department of Energy
Education:	B.A., Physics (cum laude), Harvard University Graduate studies in theoretical physics, Cornell University
Technical Experience:	24 years of experience in nuclear safety engineering
SWEIS Responsibility:	Technical Advisor for accident analysis

Name:	**Noel Savignac**
Affiliation:	Self-employed Consultant
Education:	B.A., Biology, Lake Forest College M.S., Physiology, University of New Mexico Ph.D., Health Physics, Colorado State University
Technical Experience:	27 years in radiation protection, environmental assessment, and impact analyses
SWEIS Responsibility:	Human health

Name:	**Steve Sholly**
Affiliation:	BETA Corporation, International
Education:	B.S., Shippensburg State College
Technical Experience:	15 years in risk assessment, safety analysis, and hazards analysis
SWEIS Responsibility:	Accident analysis

Name:	**Mark Sifuentes**
Affiliation:	U.S. Department of Energy
Education:	B.S., Biology (Chemistry minor) M.S., Microbiology (Radiobiology minor)
Technical Experience:	28 years in NEPA compliance and biological sciences
SWEIS Responsibility:	Lead Preparer for: biological and ecological resources, and cultural resources

Name:	**Donald G. Silva**
Affiliation:	GRAM, Inc.
Education:	E.M.B.A., Management, University of New Mexico M.S.C.E., Air Pollution, New York University M.S., Industrial Hygiene, Environmental Health, Harvard University B.C.E., Sanitary Engineering, Manhattan College
Technical Experience:	• 38 years in environmental field including 27 years in direct NEPA documentation and methodology development • Diplomat of American Academy of Environmental Engineers
SWEIS Responsibility:	Contractor (GRAM, Inc.) Project Manager 1996 to 1997

Name:	**Bret E. Simpkins**
Affiliation:	Tetra Tech, Inc.
Education:	B.S., Nuclear Engineering, University of New Mexico M.S., Nuclear Engineering, University of New Mexico
Technical Experience:	13 years of experience in Safety and Accident Analyses
SWEIS Responsibility:	Accident analysis

Name:	**Constance L. Soden**
Affiliation:	U.S. Department of Energy
Education:	B.A., Radiation Biophysics
Technical Experience:	23 years of experience in the areas of occupational health and environmental protection
SWEIS Responsibility:	Lead Preparer for cumulative and unavoidable impacts

Name:	**Joel Soden**
Affiliation:	Parsons Brinckerhoff
Education:	M.S., Hunter College
Technical Experience:	• 24 years in air quality • Supervised a number of projects in various air quality fields
SWEIS Responsibility:	Nonradiological air quality

Name:	**John Stanford**
Affiliation:	GRAM, Inc.
Education:	B.A., Architecture, University of Houston M.S., City Planning, Georgia Tech
Technical Experience:	• 10 years in city/county urban planning • 3 years at Los Alamos National Laboratory, Facility Management
SWEIS Responsibility:	Land use

Name:	**Arlan Swihart**
Affiliation:	BETA Corporation, International
Education:	B.S., Emergency Administration and Planning, University of North Texas
Technical Experience:	• 3 years in solid waste management • 4.5 years in emergency planning/hazard management (hazard identification, scenario development, and consequence analysis)
SWEIS Responsibility:	Transportation analyses

Name:	**Erich C. Thomas**
Affiliation:	GRAM, Inc.
Education:	B.S., Western Washington University M.S., Western Washington University
Technical Experience:	17 years of technical geologic investigations and related assessments
SWEIS Responsibility:	Environmental restoration

Name:	**Gordon L. Tucker**
Affiliation:	GRAM, Inc.
Education:	M.S., Systems Management, University of Southern California M.S., Meteorology, University of Wisconsin B.S., Electrical Engineering, University of Massachusetts
Technical Experience:	• 25 years in meteorology/atmospheric science • 4 years of hazardous chemicals safety training
SWEIS Responsibility:	Air quality (meteorology and atmospheric dispersion modeling)

Name:	**Leonard R. Voellinger**
Affiliation:	Parsons Brinckerhoff
Education:	B.A., George Washington University M.A., Southwest Texas State University
Technical Experience:	19 years in cultural resource analysis and management
SWEIS Responsibility:	Cultural resources

Name:	**Darlene Williams**
Affiliation:	GRAM, Inc.
Education:	B.A., Geology and Mineralogy, Williams College
Technical Experience:	• 6 years in the hazardous waste management industry • Experience includes oversight work for the EPA, Remedial Investigation/Feasibility Study report preparation and work on DOE's Transuranic Waste Program
SWEIS Responsibility:	Geology and soils

Name:	**Michael Williams**
Affiliation:	BETA Corporation, International
Education:	B.S., Environmental & Resource Management, Southwest Texas State University
Technical Experience:	10 years of experience in environmental assessments, environmental restoration, emergency response, accident analysis/accident investigation, and regulatory compliance
SWEIS Responsibility:	Accident analysis and transportation analysis

Name:	**Elizabeth Withers**
Affiliation:	U.S. Department of Energy
Education:	B.S., Botany, Louisiana Tech University M.S., Life Sciences, Louisiana Tech University
Technical Experience:	16 years in environmental analysis experience, including 5 years in plant taxonomy and wetland ecology, 5 years in RCRA and CERCLA compliance and human health risk analysis, and 6 years in NEPA compliance
SWEIS Responsibility:	Lead Preparer for land resources; also participated in ecological resources analysis

Name:	**Steven Wolf**
Affiliation:	Parsons Brinckerhoff
Education:	M.S., Mathematics
Technical Experience:	22 years of preparing risk assessments to include noise and vibrations
SWEIS Responsibility:	Noise and vibration analysis

CHAPTER 9.0
LIST OF AGENCIES, ORGANIZATIONS, AND INDIVIDUALS TO WHOM COPIES OF THIS SWEIS HAVE BEEN SENT

UNITED STATES SENATE

The Honorable Jeff Bingaman
Washington, D.C.

The Honorable Jeff Bingaman
Albuquerque, New Mexico

The Honorable Jeff Bingaman
Subcommittee on Strategic Forces
Committee on Armed Services
Washington, D.C.

The Honorable Pete V. Domenici
Washington, D.C.

The Honorable Pete V. Domenici
Albuquerque, New Mexico

The Honorable Pete V. Domenici
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, D.C.

The Honorable Harry Reid
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, D.C.

The Honorable Robert Smith
Subcommittee on Strategic Forces
Committee on Armed Services
Washington, D.C.

UNITED STATES HOUSE OF REPRESENTATIVES

The Honorable Duncan Hunter
Subcommittee on Military Procurement
Committee on National Security
Washington, D.C.

The Honorable Ron Packard
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, D.C.

The Honorable Norman Sisisky
Subcommittee on Military Procurement
Committee on National Security
Washington, D.C.

The Honorable Joseph Skeen
Washington, D.C.

The Honorable Joseph Skeen
Roswell, New Mexico

The Honorable Thomas Udall
Washington, D.C.

The Honorable Thomas Udall
Santa Fe, New Mexico

The Honorable Peter Visclosky
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, D.C.

The Honorable Heather Wilson
Washington, D.C.

The Honorable Heather Wilson
Albuquerque, New Mexico

FOUR ACCORD PUEBLOS

Governor Isaac Herrera
Pueblo of Cochiti
Cochiti, New Mexico

Governor Raymond Gachupin
Pueblo of Jemez
Jemez, New Mexico

Governor Terry Aguilar
Pueblo de San Ildefonso
Santa Fe, New Mexico

Governor Walter Dasheno
Pueblo of Santa Clara
Española, New Mexico

PUEBLOS AND TRIBAL GOVERNMENTS

Northern Pueblos and Tribal Governments

Governor David Perez
Pueblo of Nambe
Santa Fe, New Mexico

Governor Eagle Rael
Pueblo of Picuris
Peñasco, New Mexico

Governor Jacob Viarrial
Pueblo of Pojoaque
Santa Fe, New Mexico

Governor Anthony Moquino
Pueblo of San Juan
San Juan, New Mexico

Governor Carl Concha
Pueblo of Taos
Taos, New Mexico

Governor Milton Herrera
Pueblo of Tesuque
Santa Fe, New Mexico

President Arnold Cassador
Jicarilla Apache Tribe
Dulce, New Mexico

President A. Paul Ortega
Mescalero Apache Tribe
Mescalero, New Mexico

President Kelsey Begay
Navajo Nation
Window Rock, Arizona

Southern Pueblos

Governor Lloyd Tortalita
Pueblo of Acoma
Acomita, New Mexico

Governor Alvino Lucero
Pueblo of Isleta
Isleta, New Mexico

Governor Harry Early
Pueblo of Laguna
Laguna, New Mexico

Governor Anthony Ortiz
Pueblo of San Felipe
San Felipe, New Mexico

Governor Inez Baca
Pueblo of Sandia
Bernalillo, New Mexico

Governor Bruce Sanchez
Pueblo of Santa Ana
Bernalillo, New Mexico

Governor Alex Bailon
Pueblo of Santo Domingo
Santo Domingo, New Mexico

Governor Amadeo Shije
Pueblo of Zia
Zia Pueblo, New Mexico

Governor Malcolm Bowekaty
Pueblo of Zuni
Zuni, New Mexico

ADDITIONAL TRIBAL AND PUEBLO GOVERNMENT AND ORGANIZATIONS

Stanley Pino, Chairman
All Indian Pueblo Council
Albuquerque, New Mexico

Bernie Teba, Director
Eight Northern Indian Pueblo Council
San Juan Pueblo, New Mexico

William Weahkee, Director
Five Sandoval Indian Pueblos, Inc.
Bernalillo, New Mexico

Leigh Jenkins
Hopi Cultural Preservation Office
Kykotsmovi, Arizona

Department of Environmental and Cultural Preservation
Pueblo de San Ildefonso
Santa Fe, New Mexico

FEDERAL AGENCIES

Don Klima
Advisory Council on Historic Preservation
Office of Planning and Review
Washington, D.C.

J. Michael Bremer
U.S. Department of Agriculture
Forest Service
Santa Fe National Forest
Santa Fe, New Mexico

Robert Remillard
U.S. Department of Agriculture
Santa Fe National Forest
Forest Service
Los Alamos, New Mexico

Mary Elizabeth Hoinkes
Arms Control and Disarmament Agency
Washington, D.C.

John Bellinger
U.S. Army Corps of Engineers
Office of Environmental Policy
Washington, D.C.

Carol McKinney
U.S. Army Corps of Engineers
Albuquerque, New Mexico

Bill Spurgeon
U.S. Army Corps of Engineers
Albuquerque, New Mexico

Assistant to the Secretary for
U.S. Department of Defense
Nuclear, Chemical, and Biological Defense Programs
Washington, D.C.

Albert G. Jordan
Defense Nuclear Facilities Safety Board
Washington, D.C.

Andrew Thibadeau
Defense Nuclear Facilities Safety Board
Washington, D.C.

Michael P. Jansky
U.S. Environmental Protection Agency
Dallas, Texas

Richard Sanderson
U.S. Environmental Protection Agency
Office of Federal Activities
Washington, D.C.

Bob Barker
U.S. Department of the Interior
Bureau of Indian Affairs
Albuquerque, New Mexico

Willie R. Taylor
U.S. Department of the Interior
Office of Environmental Policy and Compliance
Washington, D.C.

Jennifer Fowler-Propst
U.S. Department of the Interior
Fish and Wildlife Service
Albuquerque, New Mexico

Joel D. Lusk
U.S. Department of the Interior
Fish and Wildlife Service
Albuquerque, New Mexico

Stephen Fettig
U.S. Department of the Interior
National Park Service
Bandelier National Monument
Los Alamos, New Mexico

Brian Jacobs
U.S. Department of the Interior
National Park Service
Bandelier National Monument
Los Alamos, New Mexico

Roy Weaver
U.S. Department of the Interior
National Park Service
Bandelier National Monument
Los Alamos, New Mexico

William Cohen
U.S. Department of Justice
Washington, D.C.

Robert Fairweather
Office of Management and Budget
Washington, D.C.

Carl J. Paperiello
U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Washington, D.C.

NEW MEXICO STATE GOVERNMENT

Governor Gary Johnson
Santa Fe, New Mexico

Alletta Belin
Assistant Attorney General
Santa Fe, New Mexico

The Honorable Shannon Robinson
Albuquerque, New Mexico

Senator DeDe Feldman
Albuquerque, New Mexico

The Honorable Jeannette Wallace
State Representative
Los Alamos, New Mexico

Gedi Cibas
New Mexico Environment Department
Santa Fe, New Mexico

Michael Dale
New Mexico Environment Department/AIP
Los Alamos, New Mexico

Benito Garcia
New Mexico Environment Department
Santa Fe, New Mexico

Tom Tatkin
New Mexico Environment Department
Santa Fe, New Mexico

Mark Weidler
New Mexico Environment Department
Santa Fe, New Mexico

Regis Pecos
New Mexico Office of Indian Affairs
Santa Fe, New Mexico

Charles E. Spath
New Mexico State Land Office
Santa Fe, New Mexico

Steve Cary
Office of Natural Resources Trustee
Santa Fe, New Mexico

LANL SWEIS COOPERATING AGENCY

Fred Brueggeman
Los Alamos County
Los Alamos, New Mexico

Denise Smith
Los Alamos County Council
Los Alamos, New Mexico

Lawry Mann
Los Alamos County Council
Los Alamos, New Mexico

LOCAL GOVERNMENT

Mayor Ross Chavez
City of Española
Española, New Mexico

Mayor Larry Delgado
City of Santa Fe
Santa Fe, New Mexico

COMPANIES AND INSTITUTIONS

Battelle
Evergreen, Colorado

Ann Berkley Rodgers
Chestnut Law Offices
Albuquerque, New Mexico

William Sayre
The College of Santa Fe
Santa Fe, New Mexico

Beth Ekerman
EASI
Oak Ridge, Tennessee

Betsy Kraus
EE&G
Albuquerque, New Mexico

Dave Peterson
Intera
Albuquerque, New Mexico

Bob Monslave-Jones
IT
Los Alamos, New Mexico

Cory Wilkinson
Lawrence Livermore National Laboratory
Germantown, Maryland

John Hickey
Los Alamos Economic Development Corp.
Los Alamos, New Mexico

Stephen Shankland
Los Alamos Monitor
Los Alamos, New Mexico

Tom Baca
Los Alamos National Laboratory
Los Alamos, New Mexico

Kathleen Gorman-Bates
Los Alamos National Laboratory
Los Alamos, New Mexico

Sue King
Los Alamos National Laboratory
Los Alamos, New Mexico

John Sisneros
Los Alamos National Laboratory
Los Alamos, New Mexico

Ron Stafford
Los Alamos National Laboratory
Los Alamos, New Mexico

Roger Mayes
Los Alamos Technical Associates, Inc.
Idaho Falls, Idaho

Paul Voilleque
MJP Risk Assessment, Inc.
Idaho Falls, Idaho

Institute for Policy Research
Northwestern University
Evanston, Illinois

Charles Thomas
Nuclear Tech. Consultants
Santa Fe, New Mexico

Our Lady of Guadalupe Parish
Taos, New Mexico

Suzan Dagg
Oxford Brookes University
Headington, Oxford
England

Bill Roman
Parsons Brinckerhoff
New York, New York

Joel Soden
Parsons Brinkerhoff
New York, New York

Larry Icerman
Regional Development Corp.
Santa Fe, New Mexico

Sue Martin/Abe Zeitoun
SAIC
Germantown, Maryland

Will Keener
Sandia National Laboratories
Albuquerque, New Mexico

Lucie Mayeux
Sandia National Laboratories
Albuquerque, New Mexico

Richard Orthen
Tetra Tech NUS, Inc.
Aiken, South Carolina

Steven Sholly
University of Vienna
Institute of Rusk Research
Vienna, Austria

Charlotte Lowrey
Women's Leadership Institute
Santa Fe, New Mexico

ORGANIZATIONS

Phil Bove
Acequia Madre
Santa Fe, New Mexico

Maureen Eldredge
Alliance for Nuclear Accountability
Washington, D.C.

Susan Gordon
Alliance for Nuclear Accountability
Seattle, Washington

Erlinda Gonzales
American Business Women's Association
Taos, New Mexico

Bryon Plumley
American Friends Service Committee
Denver, Colorado

Ernie Atencio
Amigos Bravos
Taos, New Mexico

Fred Griego III
Atrisco Land Rights Council
Albuquerque, New Mexico

Joani Berde
Carson Forest Watch
Llano, New Mexico

Rick Nielsen
Citizen Alert
Las Vegas, Nevada

Virginia Sanchez
Citizen Alert Native American Program
Reno, Nevada

Janet Greenwald
Citizens for Alternatives to Radioactive Dumping
Albuquerque, New Mexico

Douglas Doran
Citizens for Alternatives to Radioactive Dumping
Albuquerque, New Mexico

Carmi McLean
Clean Water Action
Denver, Colorado

Jay Coghlan
Concerned Citizens for Nuclear Safety
Santa Fe, New Mexico

David Bodde
U.S. Department of Energy
Environmental Management Advisory Board
Kansas City, Missouri

Douglas Costle
U.S. Department of Energy
Environmental Management Advisory Board
Woodstock, Vermont

Ann Dubois
U.S. Department of Energy
Northern New Mexico Citizens' Advisory Board
Los Alamos, New Mexico

Antonio Delgado
U.S. Department of Energy
Los Alamos National Laboratory Advisory Board
Ranchos de Taos, New Mexico

Tim Frazier
U.S. Department of Energy
Miamisburg, Ohio

Juan Griego
U.S. Department of Energy
Los Alamos, New Mexico

James Hoyal
U.S. Department of Energy
Albuquerque, New Mexico

Lucy Webster
Economists Allied for Arms Reduction
New York, New York

Fred Krupp
Environmental Defense Fund, Inc.
New York, New York

Tom Carpenter
Government Accountability Project
Seattle, Washington

Tom Clements
Greenpeace
Washington, D.C.

Arjun Makhijani
Institute for Energy and Environmental Research
Takoma Park, Maryland

Kevin O'Neill
Institute for Science and International Security
Washington, D.C.

Lorene Willis
Jicarilla Apache Culture Committee
Jicarilla Culture Center
Dulce, New Mexico

Alex Medina
Kiwanis Club
Taos, New Mexico

Sharon Lloyd-O'Connor
League of Women Voters
Washington, D.C.

Greg Mello
Los Alamos Study Group
Santa Fe, New Mexico

Jerilyn Christiansen
Mesa Public Library
Reference Department
Los Alamos, New Mexico

Robert Holden
National Congress of American Indians
Washington, D.C.

David J. Simon
National Parks and Conservation
Albuquerque, New Mexico

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CHAPTER 10.0
GLOSSARY

This glossary lists terms of art or scientific expressions that may not be familiar to some readers of the SWEIS. The terms are defined as they are used in the SWEIS. Statutes or laws are defined and discussed in volume I of the SWEIS, chapter 7, Applicable Laws, Regulation, and Other Requirements.

Absorbed dose: The energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray) (10 CFR 835.2).

Accident: Unexpected or undesirable event that leads to the release of hazardous material within a facility or into the environment, exposing workers or the public to hazardous materials or radiation.

Accord Pueblos: Four Pueblos that have each executed formal accord documents with DOE setting forth the government-to-government relationship between each of the Pueblos and DOE. The four Pueblos are Cochiti, San Ildefonso, Santa Clara, and Jemez.

Actinide: Any of a series of elements with atomic numbers ranging from actinium-89 through lawrencium-103.

Acute exposure: A single or short-term exposure to a toxic substance that may result in health effects.

Advisory Council of Historic Preservation (Council): An independent 19-member federal council created by the *National Historic Preservation Act of 1996*, Title II (16 U.S.C. §470 *et seq.*). The council meets quarterly to review and comment on National Register of Historic Places and Section 106 compliance cases.

Adverse effect: A change produced to an eligible cultural resource that results in demised integrity of location, setting, design, physical condition, materials, workmanship, feeling, or association. When applied to humans or animals, an undesirable health effect.

Air pollutant: Any substance in air that could, if in high enough concentration, harm humans, other animals, or vegetation.

Air quality standards: The level of pollutants in the air prescribed by regulations that may not be exceeded during a specified time in a defined area.

Alpha emitter: A radioactive substance that decays by releasing an alpha particle.

Alpha particle: A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus and has a mass number of 4 and an electrostatic charge of +2. It has low penetrating power and a short range (a few centimeters in air).

Alpha radiation: A strongly ionizing, but weakly penetrating, form of radiation consisting of positively charged alpha particles emitted spontaneously from the nuclei of certain elements during radioactive decay. Alpha radiation is the least penetrating of the four common types of ionizing radiation (alpha, beta, gamma, and neutron). Even the most energetic alpha particle generally fails to penetrate the dead layers of cells covering the skin and can be easily stopped by a sheet of paper. Alpha radiation is most hazardous when an alpha-emitting source resides inside an organism.

Ambient air: That portion of the atmosphere, external to buildings, to which the general public is exposed.

Americium: Americium is a manmade metal that is slightly heavier than lead. Americium-241 is produced by the radioactive decay of plutonium-241; in addition to being an alpha-emitter, it is an emitter of gamma rays. Americium-241 has a half-life of 433 years.

Aquifer: Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to conduct groundwater.

Archaeological sites (resources): Any location where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

Artifact: An object of archaeological or historical interest produced or shaped by human workmanship.

As low as reasonably achievable (ALARA): The approach to manage and control exposures (both individual and collective) to the workforce and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit but a process that has the objective of attaining doses as far below the applicable limits as is reasonably achievable (10 CFR 835.2).

Atomic Energy Commission (AEC): A five-member commission, established by the *Atomic Energy Act of 1946*, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the U.S. Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration. The Energy Research and Development Administration was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

Atomic number: The number of positively charged protons in the nucleus of an atom or the number of electrons on an electrically neutral atom.

Attainment area: An area that the U.S. Environmental Protection Agency has designated as being in compliance with one or more of the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants but not for others.

Authorization/safety basis: Those aspects of the facility design basis and operational requirements relied upon by the DOE as necessary to authorize operation. These aspects are considered to be important to the safety of facility operations. The authorization basis is described in documents such as the facility Safety Analysis Report (SAR) and other safety analyses, hazard classification documents, the technical safety requirements (TSRs), DOE-issued safety evaluation reports, and facility-specific commitments made to comply with DOE orders or policies. Authorization basis is considered to be equivalent to safety basis. Authorization basis also is defined as a combination of authorization/safety basis, the environmental basis, and other regulatory basis documents.

Background radiation: Radiation from: (1) naturally occurring radioactive materials that have not been technologically enhanced, (2) cosmic sources, (3) global fallout as it exists in the environment (such as from the testing of nuclear explosive devices), (4) radon and its progeny in concentrations or levels existing in buildings or the environment that have not been elevated as a result of current or past human activities, and (5) consumer products containing nominal amounts of radioactive material or producing nominal levels of radiation (10 CFR 835.2).

Badged worker: A worker equipped with an individual dosimeter who has the potential to be exposed to radiation.

Baseline: A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement during the performance of an effort; the established plan against which the status of resources and the progress of a project can be measured. For the SWEIS, the environmental baseline is the site environmental conditions that are considered representative for the purpose of projecting future impacts.

Beryllium: An extremely lightweight, strong metal used in weapons systems.

Best available technology (BAT): Economically achievable pollution control methods that will allow point sources to comply with the effluent limitations required by the *Clean Water Act*. Factors to be taken into account in assessing what is the best available technology include the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, environmental impacts other than water quality (including energy requirements), and such other factors as the U.S. Environmental Protection Agency Administrator deems appropriate.

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

Beta emitter: A radioactive substance that decays by releasing a beta particle.

Beta particle: A negatively charged particle emitted during the radioactive decay of many radionuclides. A beta particle is identical with an electron. It has a short range in air and a small ability to penetrate other materials.

Beta radiation: Ionizing radiation consisting of fast moving, positively or negatively charged elementary particles emitted from atomic nuclei during radioactive decay. Beta radiation is more penetrating but less ionizing than alpha radiation. Negatively charged beta particles are identical to electrons; positively charged beta particles are known as positrons. Both are stopped by clothing or a thin sheet of metal.

Biota: Living organisms including plants and animals.

Blast circle: The area wherein fragments from tests may fall and from which humans are excluded during tests.

Bound/bounding: To use simplifying assumptions and analytical methods in an analysis of impacts or risks such that the result overestimates or describes an upper limit on (i.e., "bounds") potential impacts or risks. A bounding analysis is an analysis designed to overestimate or determine an upper limit to potential impacts or risks. A bounding accident is a hypothetical accident for which the calculated consequences equal or exceed the consequences of all other potential accidents for a particular activity or facility.

Byproduct material: Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Byproduct material is exempt from regulation under the *Resource Conservation and Recovery Act*. However, the exemption applies only to the actual radionuclides dispersed or suspended in the waste substance. Any nonradioactive hazardous waste component of the waste is subject to regulation under the *Resource Conservation and Recovery Act*.

Caldera: A large crater formed by the collapse of the central part of a volcano.

Cancer: The name given to a group of diseases characterized by uncontrolled cellular growth with cells having invasive characteristics such that the disease can transfer from one organ to another.

Candidate species: Plants and animals native to the U.S. for which the U.S. Fish and Wildlife Service or the National Marine Fisheries Service has sufficient information on biological vulnerability and threats to justify proposing to add them to the threatened and endangered species list, but cannot do so immediately because other species have a higher priority for listing. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service determine the relative listing priority of candidate taxa in accordance with general listing priority guidelines published in the *Federal Register*.

Canned subassemblies: A component in certain nuclear explosives that may contain natural, depleted, or highly enriched uranium or lithium. The "secondary" in a nuclear weapon.

Capability: The combination of equipment, facilities, infrastructure, and expertise required to undertake types or groups of activities and implement mission element assignments.

Cavate Pueblo: Structure making use of natural rock to form the sides of a single structure or group of buildings, frequently by hollowing out the interior space.

Cesium: A silver-white alkali metal. A radioactive isotope of cesium, cesium-137, is a common fission product.

Characteristic waste: A solid waste defined as hazardous because it exhibits one of the following four characteristics: ignitibility, corrosivity, reactivity, or toxicity.

Cladding: A metal coating bonded onto another metal.

Climatology: The characteristics of the weather over a period of time. The science of climatology addresses the causes, distribution, and effects of weather on the environment and humans.

Code of Federal Regulations (CFR): All federal regulations in force are published in codified form in the Code of Federal Regulations.

Cold War period: The historic period from 1949 to 1989, characterized by international tensions and nuclear armament buildup, especially between the U.S. and the U.S.S.R. The era began approximately at the end of World War II when the *Atomic Energy Act* was passed, establishing the Atomic Energy Commission, and ended with the dissolution of the U.S.S.R. into separate republics and the ending of large-scale nuclear weapons production in the U.S.

Collective dose: The sum of the total effective dose equivalent (TEDE) values of all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert) (10 CFR 835).

Committed dose equivalent (CDE): The dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert) (10 CFR 835.2).

Committed effective dose equivalent (CEDE): The sum of the committed dose equivalents to various tissues of the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert) (10 CFR 835).

Community (biotic): All plants and animals occupying a specific area and their relationships.

Conceptual design: Efforts to develop a project scope that will satisfy program needs; ensure project feasibility and attainable performance levels of the project for congressional consideration; develop project criteria and design parameters for all engineering disciplines; and identify applicable codes and standards, quality assurance requirements, environmental studies, construction materials, space allowances, energy conservation features, health and safety, safeguards, security requirements, and any other features or requirements necessary to describe the project.

Contact-handled waste: Radioactive waste or waste packages with an external dose rate low enough to permit contact handling by humans during normal waste management activities. Contact-handled transuranic waste means transuranic waste with a surface dose rate not greater than 200 millirem per hour.

Container: The metal envelope in a waste package that provides the primary containment function of the waste package and is designed to meet the containment requirements of 10 CFR 60.

Contamination: The deposition or discharge of chemicals, radionuclides, or particulate matter above a given threshold, usually associated with an effects level onto or into environmental media, structures, areas, objects, personnel, or nonhuman organisms.

Cooperating agency: As defined by the Council on Environmental Quality regulations for implementing NEPA, any federal agency other than a lead agency that has jurisdiction by law of special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action. A state or local agency of similar qualifications or, when the effects are on a reservation, an Indian tribe, may by agreement with the lead agency become a cooperating agency (40 CFR 1508.5).

Credible accident: An accident that has a probability of occurrence greater than or equal to once in a million years.

Criteria of effect: Regulations in 36 CFR Parts 800.5(a) and 800.9(b) and Section 106 of the *National Historic Preservation Act* (16 U.S.C. §470 *et seq.*) that provide guidelines for determining the kind and intensity of effect to an eligible cultural resource.

Criteria pollutant: Six air pollutants for which National Ambient Air Quality Standards are established by the U.S. Environmental Protection Agency: sulfur dioxide, nitric oxides, carbon monoxide, ozone, particulate matter-10 (smaller than 10 microns in diameter), and lead.

Critical habitat: Habitat essential to the conservation of an endangered or threatened species that has been designated as critical by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the *Endangered Species Act* and its implementing regulations (50 CFR 424). The lists of critical habitats can be found in 50 CFR 17.95 (fish and wildlife), 50 CFR 17.96 (plants), and 50 CFR 226 (marine species).

Criticality event or accident: The accidental creation of an uncontrolled, self-sustaining nuclear chain reaction, accompanied by highly damaging external ionizing radiation.

Cultural resources: Any prehistoric or historic sites, buildings, structures, districts, or other places or objects (including biota of importance) considered to be important to a culture, subculture, or community for scientific, traditional, or religious purposes or for any other reason. In the SWEIS, prehistoric cultural resources refer to any material remains and items used or modified by people before the establishment of a European presence in the upper Rio Grande Valley in the early 17th Century; historic cultural resources include all material remains and any other physical alteration of the landscape that has occurred since the arrival of Europeans in the region.

Cultural resource site: The specific place or location of regular human occupation or use, as indicated by one or more forms of physical evidence.

Cultural resources survey: Evaluating the significance of the resources and their eligibility for inclusion in the National Register of Historic Places.

Cumulative impacts: The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal), private industry, or individuals undertake such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time (40 CFR 1508.7).

Curie (Ci): The conventional unit of activity in a sample of radioactive material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie also is a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

Decay (radioactive): The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous transformation of an unstable nuclide into a different nuclide or into a different energy state of the same nuclide; the emission of nuclear radiation (alpha, beta, or gamma radiation) is part of the process.

Decibel (dB): A unit of sound measurement. In general, a sound doubles in loudness for every increase of 10 decibels.

Decibel, A-weighted (dBa): A unit of weighted sound pressure level measured by the use of a metering characteristic and the "A" weighting specified by the American National Standards Institute (S1.4-1971[R176]).

Decommissioning: As used in this SWEIS, the process of decontamination, disassembly, and storage or disposal in a manner and state that assures future exposure of humans and the environment would be at acceptable levels.

Decontamination: The removal or reduction of radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

Depleted uranium (DU): Uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

Deposition: In geology, the laying down of potential rock-forming materials (sedimentation). In atmospheric sciences, the collection and retention of airborne particulates of gases on any solid or liquid surface (called dry deposition), or their removal from the air by precipitation (called wet deposition or precipitation scavenging).

Derived concentration guide (DCG): The concentration of a radionuclide in air or water that, under conditions of continuous exposure for 1 year by one exposure mode (e.g., ingestion of water, submersion in air, or inhalation of air), would result in an effective dose equivalent equal to the annual dose limit for that group exposed. For the public, this would be a dose of 100 millirem to a reference human who inhales 296,000 cubic feet (8,400 cubic meters) of air and ingests 195 gallons (730 liters) of water in a year.

Design basis accident: An accident postulated for the purpose of establishing functional and performance requirements for safety structures, systems, and components.

Design laboratory (or weapons laboratory): DOE facilities involved in the design of nuclear weapons.

Detailed operating procedure (DOP): Approved and authorized procedures for conducting a task.

Detriment: Negative effects from exposure to ionizing radiation. Harmful effects on health are called "health detriment."

Deuterium: A nonradioactive isotope of the element hydrogen with one neutron and one proton in the atomic nucleus.

Direct economic effects: The initial increases in output from different sectors of the economy resulting from some new activity within a predefined geographic region.

Direct effect multiplier: The total change in regional earnings and employment in all related industries as a result of one-dollar changes in earnings and an on-the-job change in a given industry.

Dismantlement: The process of taking apart a nuclear weapon or nuclear weapon component. This process takes place at LANL.

Dispersion: The downwind spreading of a plume by turbulence and meander in wind direction, resulting in a plume of lower concentration over a larger area.

Disposal: The process of placing waste in a final repository.

Disposal cell: Trench for disposal of low-level waste.

Disposition: The ultimate fate or end use of a surplus nuclear material or DOE facility following the transfer of the facility to the Office of the Assistant Secretary for Environmental Waste Management or the Director of the Office of Fissile Materials Disposition.

DOE orders: DOE directives that promulgate requirements and policies to DOE employees and contractors, including requirements to comply with other laws and regulations.

Dose (or radiation dose): The amount of energy deposited in body tissue as a result of radiation exposure. Various technical terms, such as absorbed dose, collective dose, dose equivalent, and effective dose equivalent, are used to evaluate the amount of radiation an exposed person receives. Each of these terms is defined in this glossary.

Dose equivalent: The product of absorbed dose in rad (or gray) in tissue, a quality factor, and other modifying factors. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert) (10 CFR 835.2).

Dosimeter: A device, instrument, or system that measures radiation dose (e.g., film badge or ionization chamber).

Drawdown: The height difference between the natural water level in a formation and the reduced water level in the formation caused by the withdrawal of groundwater.

Drinking-water standards: The prescribed level of constituents or characteristics in a drinking water supply that cannot be exceeded legally.

Ecology: A branch of science dealing with the interrelationships of living organisms with one another and with their nonliving environment.

Ecosystem: Living organisms and their nonliving (abiotic) environment functioning together as a community.

Ecotone: Transition zone between two adjacent distinct plant or animal communities.

Effective dose equivalent (EDE): The summation of the products of the dose equivalent received by specified tissues or organs of the body and the appropriate weighting factor. It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem (or sievert) (10 CFR 835.2).

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

Eligibility: The criteria of significance in American history, architecture, archeology, engineering, and culture. The criteria require integrity and association with lives or events, distinctiveness for any of a variety of reasons, or importance because of information the property does or could hold.

Eligible cultural resource: A cultural resource that has been evaluated and reviewed by an agency and the State Historic Preservation Office(r) and recommended as eligible for inclusion in the National Register of Historic Places, based on the criteria of significance.

Emission standards: Legally enforceable limits on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

Endangered species: Plants and animals that are threatened with extinction, serious depletion, or destruction of critical habitat. Requirements for declaring a species endangered are contained in the *Endangered Species Act*.

Enduring stockpile: The U.S. nuclear stockpile of the future, consisting of fewer than 10 weapon systems (many of them older than their design lifetime), with no new systems added to the stockpile for the foreseeable future.

Energetic material: Generic term for high explosives and propellants.

Enriched uranium: A mixture of uranium isotopes that has greater amounts of the isotope uranium-235 than occur naturally. Naturally occurring uranium is nominally 0.720 percent uranium-235.

Environmental assessment (EA): A written environmental analysis that is prepared pursuant to the *National Environmental Policy Act* to determine whether a major federal action could significantly affect the environment and thus require preparation of an environmental impact statement. If the action would not significantly affect the environment, then a Finding of No Significant Impact is issued.

Environmental impact statement (EIS): A document required of federal agencies by the *National Environmental Policy Act* for proposals for legislation or major federal actions significantly affecting the quality of the human environment. A tool for decision making, it describes the positive and negative environmental impacts of the proposed action and alternative actions.

Environmental justice: A requirement of Executive Order 12898 for federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of federal programs, policies, and activities on minority and low-income populations.

Environmental monitoring: The process of sampling and analysis of environmental media in and around a facility being monitored for the purpose of: (1) confirming compliance with performance objectives and (2) early detection of any contamination entering the environment to facilitate timely remedial action.

Environmental Restoration (ER) Program: Program at LANL responsible for investigation and remediation of solid waste management units (SWMUs).

Ephemeral stream: A stream that flows only after a period of heavy precipitation.

Epicenter: The point on the Earth's surface directly above the focus of an earthquake.

Epidemiology: The science concerned with the study of events that determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in defined human populations.

Ethnographic: Information about cultural beliefs and practices.

Exposure limit: The legal limit of accumulated exposure (to ionizing radiation, nonionizing radiation, noise, chemicals, or other hazardous substances).

Exposure pathway: The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a mechanism by which chemicals or physical agents at or originating from a release site reach an individual or population. Each exposure pathway includes a source or release from a source, an exposure route, and an exposure point. If the exposure point differs from the source, a transport/exposure medium such as air or water also is included.

Fabrication: For the purpose of the SWEIS, the terms "fabrication" and "manufacturing" are synonymous. See "manufacturing."

Fault: A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred.

Finding of No Significant Impact (FONSI): A document by a federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant effect on the human environment and will not require an environmental impact statement.

Fissile material: Any material consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. The definition does not apply to unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in a thermal reactor (49 CFR 173.403). DOE Order 5480.3 also includes curium-244 and neptunium-237 as fissile materials.

Fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Fission products: Nuclei formed by the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

Floodplains: The lowlands and relatively flat areas adjoining inland and coastal waters and the flood-prone areas of offshore islands. Floodplains include, at a minimum, that area with at least a 1.0 percent chance of being inundated by a flood in any given year.

The “base floodplain” is defined as the area that has a 1.0 percent or greater chance of being flooded in any given year. Such a flood is known as a 100-year flood.

The “critical action floodplain” is defined as the area that has at least a 0.2 percent chance of being flooded in any given year. Such a flood is known as a 500-year flood. Any activity for which even a slight chance of flooding would be too great (e.g., the storage of highly volatile, toxic, or water reactive materials) should not occur in the critical action floodplain.

Formation: In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

Fugitive emissions: Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Fusion: The combining of two light nuclei (such as hydrogen isotopes or lithium) to form a heavier nucleus. Fusion is accompanied by the release of large amounts of energy.

Gamma radiation: High-energy, short wavelength, electromagnetic radiation emitted from the nucleus of an atom during radioactive decay. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded by dense materials, such as lead or depleted uranium. Gamma rays are similar to, but are usually more energetic than, x-rays.

Genetic effects: Changes in reproductive cells that may result in abnormal offspring of humans or animals (National Council on Radiation Protection [NCRP] 105).

Geology: The science that deals with the Earth: the materials, processes, environments, and history of the planet, including the rocks and their formation and structure.

Glovebox: An airtight box used to work with hazardous material, vented to a closed filtering system, having attached gloves that go into the box permitting work therein.

Groundwater: Water found beneath the Earth’s surface.

Half-life (radiological): The time in which half the atoms of a radioactive substance undergo radioactive decay; this varies for specific radioisotopes from millionths of a second to billions of years.

Hazard analysis: The assessment of hazardous situations potentially associated with a process or activity. It includes the identification of material, system, process, and plant characteristics that can produce undesirable consequences. A safety analysis report hazard analysis examines the complete spectrum of potential accidents that could expose members of the public, on-site workers, facility workers, and the environment to hazardous materials. (See “Safety analysis report.”)

Hazard category: Classification of nuclear facilities and operations for the potential of on-site and off-site effects from accidents. The criteria for distinguishing among hazard categories are found in DOE Order 5480.23, *Nuclear Safety Analysis Reports*.

Hazard index (HI): An indicator of the potential toxicological hazard from exposure to a particular substance; one such HI is the ratio of the estimated exposure to the estimated safe exposure. No toxicological effects would be expected where the HI is less than 1.0.

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

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

Hazardous waste: A solid waste that, because of its quantity, concentration, or physical chemical or infectious characteristics, may significantly contribute to an increase in mortality; or may pose a potential hazard to human health or the environment when improperly treated, stored, or disposed. The *Resource Conservation and Recovery Act of 1980* defines a "solid" waste as including solid, liquid, semisolid, or contained gaseous material (42 U.S.C. 6901 *et seq.*). By definition, hazardous waste has no radioactive components.

Heredity effects: Changes that are passed on to succeeding generation of offspring. See "Genetic effects."

High-efficiency particulate air (HEPA) filter: A throwaway, extended media, dry-type filter with a rigid casing enclosing the full depth of the pleats. The filter exhibits a minimum efficiency of 99.97 percent when tested with an aerosol of essentially monodispersed 0.3 micrometer diameter test aerosol particles.

High explosives (HE): Any chemical compound or mechanical mixture that, when subjected to heat, impact, friction, shock, or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressure in the surrounding medium. Defined by 40 CFR 261.23 as any material that exhibits the characteristic of reactivity.

High explosives fabrication: The ability to fabricate any chemical compound or mechanical mixture that, when subjected to heat, impact, fraction, friction, shock, or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium.

High-level waste (HLW): The highly radioactive waste that results from reprocessing spent nuclear fuel and irradiated targets from reactors and is liquid before it is treated and solidified. LANL has no HLW in its inventory.

Highly enriched uranium (HEU): A mixture of uranium isotopes in which the abundance of the isotope uranium-235 is increased to 20 percent or more by weight, well above normal (naturally occurring) levels.

Historic context: A planning unit that is based on a shared theme, specific time period, and geographical area. Historical contexts are developed for predicting the types of sites and activities that may have taken place and determining how the sites might fit into the context. The evaluation process using the historic context to identify data deficits as criteria for evaluation.

Historic district: A significant concentration, linkage, or continuity of sites, buildings, structures, or objects historically or aesthetically united by plan or physical development and eligible for inclusion in the National Register of Historic Places because of cultural significance.

Hydrodynamic test: High-explosives nonnuclear experiment to investigate hydrodynamic aspects of primary function up to mid to late stages of pit implosion.

Hydrodynamics: The study of the motion of a fluid and of the interactions of the fluid with its boundaries, especially in the case of an incompressible inviscid fluid.

Hydrology: The science dealing with the properties, distribution, and circulation of water on and below the Earth's surface and in the atmosphere.

Implosion: Sudden inward compression and reduction in volume.

Incident-free risk: The risk of effects during normal conditions, not including the additional risk posed by incidents and accidents.

Index: A selected recent data set that is considered representative of current conditions and serves as a baseline for projecting future changes.

Indirect economic effects: Indirect effects result from the need to supply industries experiencing direct economic effects with additional outputs to allow them to increase their production. The additional output from each directly affected industry requires inputs from other industries within a region (i.e., purchases of goods and services). This results in a multiplier effect to show the change in total economic activity resulting from a new activity in a region.

Inertial confinement fusion (ICF): A laser-initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.

Infrastructure: The basic services, facilities and equipment needed for the functioning and growth of an area.

Interim (permit) status: Period during which treatment, storage, and disposal facilities coming under the *Resource Conservation and Recovery Act of 1980* are temporarily permitted to operate while awaiting denial or issuance of a permanent permit.

Intersite: Transportation or other activities involving other sites.

Intrasite: Transportation or activities occurring solely within the boundaries of a facility.

Ion: An atom or molecule that has gained or lost one or more electrons to become electrically charged.

Ion exchange: A unit physiochemical process that removes ions, including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

Ionizing radiation: Radiation with sufficient energy to displace electrons from atoms or molecules, thereby producing ions.

Isolated find: A single artifact with no verifiable association with other cultural resources or other elements that would enlarge the historic information it contains.

Isotope: Nuclei of the same element with different numbers of neutrons are isotopes of the element. Isotopes have the same chemical properties but may have different radioactive properties.

Joint test assembly: A nonnuclear test configuration, with diagnostic instrumentation, of a warhead or bomb.

Key facility: Certain LANL facilities that were selected for special attention in the SWEIS. Selection criteria for key facilities are discussed in volume I, section 2.2.2 of the SWEIS.

Kiva: In this SWEIS, one of the remote-controlled critical assembly buildings associated with the Los Alamos Critical Experiment Facility (LACEF).

Laser: A device that produces a beam of monochromatic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little scattering and has a high concentration of energy per unit area.

Latent cancer fatality (LCF): Death from cancer resulting from, and occurring some years after, exposure to excess ionizing radiation or other carcinogens.

Limiting condition for operation (LCO): The lowest functional capability or performance levels of safety-related structures, systems, components, and their support systems required for normal, safe operation of the facility.

Lithic scatter: Concentrations of stones showing evidence of human manufacturing of stone tools, including finished artifacts, roughly formed artifacts, the cores of stone from which they were made, and the waste flakes from the tool manufacturing process.

Low-income population: Community in which 25 percent or more of the population is characterized as living in poverty. The SWEIS uses the U.S. Bureau of the Census 1990 data to establish poverty thresholds; the 1990 poverty threshold for unrelated individuals was a 1989 income of $6,451 for those under age 65; $5,947 for those age 65 and older; and $12,674 for a family of four.

Low-level radioactive mixed waste (LLMW): Waste that contains both hazardous and low-level radioactive components. The hazardous component in LLMW is subject to regulation under the *Resource Conservation and Recovery Act of 1980*.

Low-level radioactive waste (LLW): All radioactive waste that is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material" as defined by DOE Order 5820.2A, *Radioactive Waste Management*. Byproduct material includes the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as LLW, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

Manufacturing: For the purpose of the SWEIS, the terms "fabrication" and "manufacturing" are synonymous. LANL has an existing capability to fabricate or manufacture plutonium parts. That is, the equipment, knowledge, supporting infrastructure, and administration procedures and controls exist at LANL to create plutonium metallic shapes to precise specifications. This capability is currently used in support of existing missions for research and development and to build prototypes of parts.

Maximally exposed individual (MEI): A hypothetical person whose location and habits result in the highest concentration or exposure and who takes no protective actions to lessen his or her exposure.

Maximum contaminant level (MCL): The MCL is the maximum permissible level of a contaminant in water that is delivered to any user of a public water system, as measured within the system or at entry points, depending upon the contaminant (40 CFR 141).

Megawatt (MW): A unit of power equal to 1 million watts. Megawatt thermal is commonly used to define heat produced, while megawatt electric defines electricity produced.

Meteorology: The science dealing with the atmosphere and its phenomena, especially as relating to weather.

Migration: The natural movement of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.

***Migratory Bird Treaty Act*:** This act states that it is unlawful to pursue, take, attempt to take, capture, possess, or kill any migratory bird, or any part, nest, or egg of any such bird other than permitted activities.

Minority population: Area where minority individuals comprise 25 percent or more of the population. Minority refers to people who classified themselves in the 1990 U.S. Census as African Americans, Asian or Pacific Islanders, American Indians, Hispanics of any race or origin, or other non-White races.

Mitigation: The alleviation of adverse impacts on resources by avoidance, by limiting the degree or magnitude of an action, by repair or restoration, by preservation and maintenance that reduces or eliminates the impact, or by replacing or providing substitute resources or environments.

Mixed oxide (MOX): A physical blend of uranium oxide and plutonium oxide that can be used as fuel in a nuclear reactor.

Mixed waste: See low-level radioactive mixed waste.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act*, as amended. The primary NAAQS are intended to protect the public health with an adequate margin of safety, and the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAP): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These standards were implemented in the *Clean Air Act Amendments of 1977*.

National Environmental Research Park (NERP): An outdoor laboratory set aside for ecological research to study the environmental impacts of energy developments. NERPs were established by DOE to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology development and use.

National Pollutant Discharge Elimination System (NPDES): Federal permitting system required for hazardous effluents regulated through the *Clean Water Act,* as amended.

National Pollutant Discharge Elimination System Permit: Federal regulation (40 CFR Parts 122 and 125) requires permits for the discharge of pollutants from any point source into the waters of the U.S. regulated through the *Clean Water Act*, as amended.

National Register of Historic Places (NRHP): A list of districts, sites, buildings, structures, and objects of prehistoric or historic local, state, or national significance maintained by the Secretary of the Interior. The list is expanded as authorized by Section 2(b) of the *Historic Sites Act of 1935* (16 U.S.C. §462) and Section 101(a)(1)(A) of the *National Historic Preservation Act of 1966*, as amended.

Native American: A tribe, people, or culture that is indigenous to the U.S. Also referred to as American Indians.

Natural phenomena accidents: Accidents that are initiated by events such as earthquakes, tornadoes, floods, etc.

Neutron: An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1. A free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

Neutron flux: The product of neutron number density and velocity (energy) giving an apparent number of neutrons flowing through a unit area per unit time.

Noise: Unwanted or undesirable sound, usually characterized as being so loud as to interfere with, or be inappropriate to, normal activities such as communication, sleep, study, or recreation.

Noncriteria pollutant: A pollutant with an effects screening level guideline. Some noncriteria pollutants have a state standard as well.

Nonattainment area: An air quality control region (or portion thereof) in which the U.S. Environmental Protection Agency has determined that ambient air concentrations exceed National Ambient Air Quality Standards for one or more criteria pollutants.

Nondestructive evaluation: Test method that does not involve damage to or destruction of the test sample; this includes the use of ultrasonics, radiography, magnetic flux, and other techniques.

Nonnuclear component: Any one of the parts of a nuclear weapon that do not contain radioactive or fissile material.

Nonnuclear fabrication: Ability to fabricate nonnuclear components and perform nonnuclear component surveillance.

Nonproliferation: Preventing the spread of nuclear weapons, nuclear weapon materials, and nuclear weapon technology.

Nonproliferation Treaty: A treaty with the aim of controlling the spread of nuclear weapons technologies, limiting the number of nuclear weapons states, and pursuing, in good faith, effective measures relating to the cessation of the nuclear arms race. The treaty does not invoke stockpile reductions by nuclear states, and it does not address actions of nuclear states in maintaining their stockpiles.

Nuclear component: A part of a nuclear weapon that contains fissionable or fusionable material.

Nuclear facility: A facility with operations that involve radioactive materials in such form and quantity that a nuclear hazard potentially exists to the employees or the general public. Included are facilities that: produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium; conduct separations operations; or conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations. Incidental use of radioactive materials in a facility operation (e.g., check sources, radioactive sources, and x-ray machines) does not necessarily require a facility to be included in this definition.

Nuclear warhead: A warhead that contains fissionable and fusionable material; the nuclear assembly and nonnuclear components packaged as a deliverable weapon.

Nuclear weapons complex: The set of interrelated federal sites and government-owned/contractor-operated facilities supporting the research, development, design, manufacture, testing, and maintenance of the nation’s nuclear weapons and the subsequent dismantlement of retired weapons.

Off site (also off-site): As used in the SWEIS, the term denotes a location, facility, or activity occurring outside of the boundary of the entire LANL site.

On site (also on-site): As used in the SWEIS, the term denotes a location or activity occurring somewhere within the boundary of the LANL site.

Operable unit (OU): A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration or eliminates or mitigates a release, threat of release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units.

Outfall: The discharge point of a drain, sewer, or pipe as it empties into a body of water.

Packaging: The assembly of components necessary to ensure compliance with federal transportation regulations. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.

Paleontology: A science dealing with life of past geological periods as known from fossil remains.

Paleontological resources: Fossils including those of microbial, plant, or animal origin.

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

Perched aquifer: Groundwater separated from the underlying main body of groundwater, or aquifer, by unsaturated rock.

Perched groundwater: A body of groundwater of small lateral dimensions lying above a more extensive aquifer.

Performance assessment (PA): An analysis that predicts the behavior of a system or system component under a given set of conditions. In the context of "waste management activities," a systematic analysis of the potential risks posed by waste management systems to the public and environment, and a comparison of those risks to established performance objectives.

Permeability: The degree to which, or rate at which a fluid or gas can pass through a substance.

Perennial: Acting or lasting throughout the year or through many years (perpetual).

Person-rem: A redundancy meaning a dose of 1 rem. When used with a collective dose or population dose, it is a unit for expressing the dose when integrated across all people in the population.

Physical setting: The land and water form, vegetation, and structures that compose the landscape.

Pit: An assembly at the center of a nuclear device containing a subcritical mass of fissionable material.

Plume: The elongated pattern of contaminated air or water originating at a point source, such as a smokestack or a hazardous waste disposal site.

Plutonium: A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

Pollution prevention: Involves recycling or reduction of any hazardous substance, pollutant, or contaminate before generation, along with practices that protect natural resources through conservation or more efficient use.

Population dose: See "collective dose."

Potable: Suitable for drinking.

Pounds per square inch (psi): A measure of pressure. Atmospheric pressure is about 14.7 psi.

Prehistoric: Of, relating to, or existing in times antedating written history. In this SWEIS, prehistoric cultural resources refer to any material remains and items used or modified by people before the establishment of a European presence in the upper Rio Grande Valley in the early 17th Century.

Production: Fabrication or manufacturing of a relatively large quantity of items (as compared to the research and development and prototype capability). Production usually implies an effort to optimize material flows and improve efficiency and yield as well as the reliability of both the product and the process.

Programmatic environmental impact statement (PEIS): A broad-scope EIS prepared in accordance with the requirements of 102(2)(C) of NEPA that analyzes the environmental impacts of proposed federal policies or programs that involve multiple decisions potentially affecting the environment at one or more sites.

Project-specific environmental impact statement: An EIS prepared in accordance with the requirements of 102(2)(C) of NEPA that evaluates the environmental impacts of a single proposed action. See "Environmental impact statement."

Protected area: An area encompassed by physical barriers, subject to access controls, surrounding material access areas, and meeting the standards of DOE Order 5632.1C, *Protection and Control of Safeguards and Security Interests*.

Pueblo: The communal dwelling of an Indian village of Arizona, New Mexico, or adjacent areas consisting of contiguous flat-roofed stone or adobe houses in groups, sometimes several stories high; an Indian village of the southwestern U.S.; a member of a group of Indian peoples of the southwestern U.S.

Rad: See "Radiation absorbed dose."

Radiation: As used in the SWEIS, means ionizing radiation. The emitted particles or photons from the nuclei of radioactive atoms.

Radiation absorbed dose (rad): The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.

Radioactive: The state of emitting radiation energy in forms of waves (rays) or particles.

Radioactive waste: Materials from nuclear operations that are radioactive or are contaminated with radioactive materials, and for which use, reuse, or recovery are impractical.

Radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

Radioisotopes: See "Isotope."

Radionuclide: Any radioactive element.

Radon: A heavy gaseous, radioactive element with a half life of about 4 days from the decay of radium.

RADTRAN: A computer code combining user-determined meteorological, demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.

Raptor: Birds of prey including various types of hawks, falcons, eagles, vultures, and owls.

Recharge: Replenishment of water to an aquifer.

Record of Decision (ROD): A document prepared in accordance with the requirements of 40 CFR 1505.2 that provides a concise public record of DOE's decision on a proposed action for which an EIS was prepared. A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), factors balanced by DOE in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not.

Region of influence (ROI): Region in which the principal direct and indirect socioeconomic effects of actions are likely to occur and are expected to be of consequence for local jurisdictions.

Reliability: The ability of a nuclear weapon, weapon system, or weapon component to perform its required function under stated conditions for a specified period of time (essentially equivalent to performance).

Rem (roentgen equivalent man): The conventional unit or radiation dose equivalent. A unit of individual dose of absorbed ionizing radiation used to measure the effect on human tissue. The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma-ray exposure.

Remediation: The decontamination of facilities or sites to an acceptable level of contamination suitable for general or specified use.

Remote-handled waste: In general, refers to radioactive waste that must be handled at a distance to protect workers from unnecessary exposure. "Remote-handled transuranic waste" means transuranic waste with a dose rate of 200 millirem per hour or more at the surface of the waste package.

Risk: A quantitative or qualitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.

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

Roentgen: A unit of exposure to ionizing x-ray or gamma radiation equal to 2.58×10^{-4} coulomb per kilogram. (A coulomb is a unit of electrical charge.) A roentgen is approximately equal to 1 rad.

Roentgen Equivalent Man (rem): See "Rem."

Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and may eventually enter streams.

Safety analysis report (SAR): A safety document providing a concise but complete description and safety evaluation of a site, design, normal and emergency operation, potential accidents, predicted consequences of such accidents, and the means proposed to prevent such accidents or mitigate their consequences. A safety analysis report is designated as final when it is based on final design information; otherwise, it is designated as preliminary.

Safe secure transport (SST): A specially designed trailer, used for transporting nuclear weapons or nuclear weapon components.

Safeguards and security: Program or actions with the express goal of elimination or minimizing the likelihood of unauthorized access to or loss of custody of a nuclear weapon or weapon system, nuclear materials, or sensitive or classified information.

Sanitary wastes: Liquid or solid (includes sludge) wastes that are not hazardous or radioactive and that are generated by industrial, commercial, mining, or agricultural operations or from community activities.

Scope: In a document prepared pursuant to the *National Environmental Policy Act of 1969*, the range of actions, alternatives, and impacts to be considered.

Scoping: Involves the solicitation of comments from interested people, groups, and agencies at public meetings, public workshops, in writing, electronically, or via fax to assist DOE in defining the proposed action, identifying alternatives, and developing preliminary issues to be addressed in an environmental impact statement.

Secondary (assembly): The component of a nuclear weapon that contains elements needed to initiate the fusion reaction in a thermonuclear reaction.

Section 106 process: A *National Historic Preservation Act* (16 U.S.C. §470 *et seq.*) review process used to identify, evaluate, and protect cultural resources eligible for nomination to the National Register of Historic Places that may be affected by federal actions or undertakings.

Sedimentation: The settling out of soil and mineral solids from suspensions under the force of gravity.

Seismic: Pertaining to any earth vibration, especially an earthquake.

Seismic zone: Geographic region that is assumed to possess uniform earthquake potential throughout.

Seismicity: Occurrence of earthquakes in space and time.

Setting: The physical environment of a property.

Severe accident: An accident with a frequency rate of less then 10^{-6} per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, off-site consequences, or both.

Sewage: The total of organic waste and wastewater generated by an industrial establishment or a community.

Shielding: A material placed between a radiation source and a receptor that absorbs the radiation, thus reducing the exposure to the receptor.

Short-lived nuclides: Radioactive isotopes with half-lives no greater than about 30 years (e.g., cesium-137 and strontium-90).

Site-wide environmental impact statement (SWEIS): A type of programmatic EIS that analyzes the environmental impacts of all or selected functions at a DOE site. As part of its regulations for implementation of NEPA, DOE prepares site-wide EISs for certain large, multiple-facility DOE sites; it may prepare EISs or EAs for other sites to assess the impacts of all or selected functions at those sites (10 CFR 1021.330 [c]).

Socioeconomics: The social and economic condition in the study area.

Solid waste management unit (SWMU): Any unit from which hazardous constituents may migrate, as defined by the *Resource Conservation and Recovery Act.* A designated area that is or is suspected to be the source of a release of hazardous material into the environment that will require investigation and/ or corrective action.

Source material: In general, material from which special nuclear material can be derived. Under the *Atomic Energy Act* and U.S. Nuclear Regulatory Commission regulations, "source material" means uranium and thorium in any physical or chemical form, as well as ores that contain 1/20 of 1 percent (0.05 percent) or more by weight of uranium or thorium.

Source term: The quantity of material released and parameters such as exhaust temperature that determine the downwind concentration, given a specific meteorological dispersion condition.

Special nuclear material (SNM): As defined in Section 11 of the *Atomic Energy Act of 1954*, special nuclear material means (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material or (2) any material artificially enriched by any of the foregoing.

Species of concern: Includes species that are considered to be potential candidates for addition to the List of Endangered Species (50 CFR 17) by the federal agency responsible for *Endangered Species Act* compliance oversight, the U.S. Fish and Wildlife Service. These are primarily species for which there is insufficient information on biological vulnerability and threat to warrant legal protection.

Stabilization: Actions taken to further confine or reduce the hazards associated with residues as necessary for safe management and responsible storage.

START I and II: Strategic Arms Reduction Talks (also Treaty) (START) refer to negotiations between the U.S. and the U.S.S.R. (the former Soviet Union during START I negotiations) aimed at limiting and reducing nuclear arms. START I discussions began in 1982 and eventually led to a ratified treaty in 1988. START II discussions, which are now in progress, will attempt to further reduce the acceptable levels of nuclear weapons ratified in START I.

State Historic Preservation Office(r) (SHPO): A position in each U.S. state that coordinates state participation in the implementation of the *National Historic Preservation Act* (16 U.S.C. §470 *et seq.*). The SHPO is a key participant in the Section 106 process, assisting in the steps of identification of eligible resources, evaluating effects of undertakings, and developing mitigation measures or management plans to reduce any adverse effects to eligible cultural resources.

Stockpile management: Operations associated with producing, maintaining, refurbishing, surveilling, and dismantling the nuclear weapons stockpile.

Stockpile stewardship: Activities associated with research, design, development, and testing of nuclear weapons and the assessment and certification of their safety and reliability.

Stockpile surveillance: Routine and periodic examination, evaluation, and testing of stockpile weapons and weapon components to ensure that they conform to performance specifications and to identify and evaluate the effect of unexpected or age-related requirements.

Strike: The direction or trend that a structural surface (e.g., a bedding or fault plane) takes as it intersects the horizontal.

Surface water: Water on the Earth's surface, as distinguished from water in the ground (groundwater).

Technical safety requirements (TSRs): Those requirements that define the conditions, the safe boundaries, and the management or administrative controls necessary to ensure the safe operation of a nuclear facility and to reduce the potential risk to the public and facility workers from uncontrolled releases of radioactive materials or from radiation exposures due to inadvertent criticality. TSRs consist of safety limits, operating limits, surveillance requirements, administrative controls, use and application instructions, and the basis thereof. TSRs were formerly known as "operational safety requirements" for nonreactor nuclear facilities and "technical specifications" for reactor facilities.

Threatened and endangered (T&E) species: Animals, birds, fish, plants, or other living organisms threatened with extinction by human-produced or natural changes in their environment. Requirements for declaring species threatened or endangered are contained in the *Endangered Species Act of 1973*.

Total effective dose equivalent (TEDE): The sum of the effective dose equivalent from external exposures and the committed effective dose equivalent from internal exposures (10 CFR 835).

Toxic waste: Individual chemical wastes (liquid or solid), such as polychlorinated biphenyls or asbestos, that are regulated by the *Toxic Substances Control Act*.

Transuranic (TRU) waste: Waste, without regard to source or form, that is contaminated with alpha-emitting radionuclides of atomic number greater than 92 (uranium) and with half-lives greater than 20 years in concentrations greater than 100 nanocuries per gram.

Traditional cultural property (TCP): A significant place or object associated with historical and cultural practices or beliefs of a living community that is rooted in that community's history and is important in maintaining the continuing cultural identity of the community.

Tritium: A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H–3 and T.

Unreviewed safety question: A proposed change, test, or experiment is considered to involve an unreviewed safety question if: (1) the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety evaluated previously by safety analyses will be significantly increased or (2) a possibility for an accident or malfunction of a different type than any evaluated previously by safety analyses will be created that will result in significant safety consequences.

Uranium: A heavy, silvery-white metallic element (atomic number 92) with many radioactive isotopes. Uranium-235 is most commonly used as a fuel for nuclear fission. Another isotope, uranium-238, can be transformed into fissionable plutonium-239 by its capture of a neutron in a nuclear reactor.

Volatile organic compounds (VOCs): A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, chloroform, and methyl alcohol.

War reserve: Operational weapons and materials designated as essential for national security needs.

Waste acceptance criteria (WAC): Requirements established by treatment, storage, and disposal facilities for the acceptance of waste into a facility.

Waste characterization: The identification of waste composition and properties by reviewing process knowledge, nondestructive examination, nondestructive assay, or sampling and analysis. Characterization provides the basis for determining appropriate storage, treatment, handling, transportation, and disposal requirements.

Waste generator: For the purpose of the SWEIS, any individual or group of individuals who generate radioactive, mixed, hazardous, or other types of wastes at LANL.

Waste Isolation Pilot Plant (WIPP): A DOE facility designed and authorized to permanently dispose of transuranic radioactive waste in a mined underground facility in deep geologic salt beds. It is located in southeastern New Mexico, 26 miles (42 kilometers) east of the City of Carlsbad.

Waste management: The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated pollution prevention, surveillance, and maintenance activities.

Waste minimization: Actions that economically avoid or reduce the generation of waste by source reduction, by reducing the toxicity of hazardous waste, by improving energy usage, or by recycling.

Watershed: For the purposes of the SWEIS, a watershed was defined as that region contributing water to major identified stream channels, which ultimately become tributaries or drain into tributaries to an 11-mile (18-kilometer) segment of the Rio Grande between Otowi Bridge and Frijoles Canyon.

Weapon component: An item in a nuclear weapon that can be either an assembly or individual subset of an assembly. The word "component" can be used interchangeably with "part" or "subassembly."

Weapons laboratories: Colloquial term for the three DOE national laboratories—Los Alamos, Lawrence Livermore, and Sandia—that are responsible for the design, development, and stewardship of U.S. nuclear weapons.

Weapon system: Collective term for the nuclear assembly and nonnuclear components, subsystems, and systems that compose a nuclear weapon.

Wetland: Land or areas exhibiting hydric (requiring considerable moisture) soil concentrations, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

Whole-body dose: Dose resulting from the uniform exposure of all organs and tissues in a human body.

Wind rose: A depiction of wind speed and direction frequency for a given period of time.

X-rays: Penetrating electromagnetic radiation having a wavelength much shorter than that of visible light. X-rays are identical to gamma rays, but originate outside the nucleus, either when the inner orbital electrons of an excited atom return to their normal state or when a metal target is bombarded with high-speed electrons.

CHAPTER 11.0
CONTRACTOR DISCLOSURE STATEMENTS

DE-AC04-94AL85382

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE LANL SWEIS FOR DOE NUCLEAR WEAPONS COMPLEX MODERNIZATION

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked *Questions Concerning CEQ's National Environmental Policy Act Regulations*", 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)". See 46 FR 18026-18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) and list financial or other interest if (b) is checked).

(a) ☒ Contractor has no financial or other interest in the outcome of the project.

(b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interest

1. NA
2.
3.

Certified by:

Daniel M. Schwendenman
Signature

Daniel M. Schwendenman
Name

Project Manager, EASI
Title

November 26, 1997
Date

Enterprise Advisory Services, Inc. Disclosure Statement

DE-AC0495AL99975

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE LANL SWEIS FOR DOE NUCLEAR
WEAPONS COMPLEX MODERNIZATION

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Financial or Other Interest

1.

2.

3.

Certified by: Thomas E. Magette

Signature

THOMAS E. MAGETTE

Name

VICE PRESIDENT

Title

8·25·97

Date

Tetra Tech, Inc. Disclosure Statement

DE-AC0495AL99975

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE LANL SWEIS FOR DOE NUCLEAR
WEAPONS COMPLEX MODERNIZATION

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(b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interest

1.

2.

3.

Certified by:

Signature

William R. Rhyne
Name

Vice President
Title

August 13, 1997
Date

H&R Technical Associates Disclosure Statement

DE-ACO495AL99975

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE LANL SWEIS FOR DOE NUCLEAR
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Financial or Other Interest

1.

2.

3.

Certified by:

SIGNATURE

Krishan K. Wahi
NAME

President
TITLE

October 10, 1995
DATE

GRAM, Inc. Disclosure Statement

DE-ACO495AL99975

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
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Financial or Other Interest

1.

2.

3.

Certified by:

[signature]
SIGNATURE

Evaristo J. Bonano
NAME

President and CEO
TITLE

October 10, 1995
DATE

BETA Corporation Disclosure Statement

DE-ACO495AL99975

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
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Financial or Other Interest

1.

2.

3.

Certified by:

R. Lee Norland

SIGNATURE

R. LEE NORLAND

NAME

GENERAL MGR. DOE PROGRAMS

TITLE

10/11/95

DATE

Dames & Moore Disclosure Statement

DE-ACO495AL99975

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE LANL SWEIS FOR DOE NUCLEAR
WEAPONS COMPLEX MODERNIZATION

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Financial or Other Interest

1.

2.

3.

Certified by: David B Winsor
SIGNATURE

David B. Winsor
NAME

Vice President
TITLE

24 Oct 95
DATE

Parsons Brinckerhoff Energy Services, Inc Disclosure Statement

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