3. AFFECTED ENVIRONMENT

> Chapter 3 describes the affected environment at Los Alamos National Laboratory (LANL). This information provides the context for understanding the environmental consequences described in Chapter 4 and serves as a baseline from which any environmental changes brought about by implementing the proposed action can be evaluated. The affected environment at LANL is described for the following impact areas: land use and visual resources; site infrastructure; climate, air quality, and noise; geology and soils; surface and groundwater quality; ecological resources; cultural and paleontological resources; socioeconomics; environmental justice; human health; and waste management and pollution prevention.

3.1 INTRODUCTION

In accordance with the Council on Environmental Quality, National Environmental Policy Act (NEPA) implementing regulations (40 CFR [*Code of Federal Regulations*] 1500 through 1508) for preparing an environmental impact statement (EIS), the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." The affected environment descriptions presented in this chapter provide the context for understanding the environmental consequences described in Chapter 4. They serve as a reference from which any environmental changes brought about by implementing the proposed action can be evaluated; the reference conditions are the currently existing conditions.

The proposed action considered in this *Draft Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at the Los Alamos National Laboratory* (*CMRR EIS*), would place chemistry and metallurgy research (CMR) activities at Technical Area (TA) 3 (the location of the existing CMR Building), TA-6 (the "greenfield" location), or TA-55 (the preferred new location). The affected environment at LANL is described for the following resource areas: land use and visual resources; site infrastructure; climate, air quality, and noise; geology and soils; surface and groundwater quality; ecological resources; cultural and paleontological resources; socioeconomics; environmental justice; human health; and waste management and pollution prevention. The level of detail varies depending on the potential for impacts resulting from each alternative.

The following site-specific and recent project-specific documents were important sources of information in describing the existing environment at LANL. Numerous other sources of site- and resource-related data were also used in the preparation of this chapter and are cited as appropriate:

- *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (LANL SWEIS)* (DOE 1999a)

- *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE 2002e).

The U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA) evaluated the environmental impacts of the proposed action and other alternatives within defined regions of influence. The regions of influence are specific to the type of effect evaluated and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions were assessed for an area within a 50-mile (80-kilometer) radius of the proposed facilities. Economic effects such as job and income changes were evaluated within a socioeconomic region of influence that includes the county in which LANL is located and nearby counties in which substantial portions of the site's workforce reside. Brief descriptions of the regions of influence are given in **Table 3–1**. More detailed descriptions of the regions of influence and the methods used to evaluate impacts are presented in Appendix A.

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

Environmental Resources	***Region of Influence***
Land use and visual resources	LANL and the areas immediately adjacent to it
Site infrastructure	LANL
Air quality	LANL, nearby offsite areas within local air quality control regions where significant air quality impacts may occur, and Class I areas within 62 miles (100 kilometers)
Noise	LANL, nearby offsite areas, access routes to the sites, and the transportation corridors
Geology and soils	LANL and nearby offsite areas
Surface and groundwater quality	LANL and adjacent surface water bodies and groundwater
Ecological resources	LANL and adjacent areas
Cultural and paleontological resources	LANL and adjacent to the site boundary
Socioeconomics	The counties where approximately 90 percent of LANL employees reside
Environmental justice	The minority and low-income populations within 50 miles (80 kilometers) of LANL
Human health	The site and offsite areas within 50 miles (80 kilometers) of LANL
Waste management and pollution prevention	LANL

Reference conditions for each environmental resource area were determined for ongoing operations from information provided in previous environmental studies, relevant laws and regulations, and other Government reports and databases. More detailed information on the affected environment can be found in annual site environmental reports and site NEPA documents. Unless otherwise referenced, the following description of the affected environment at LANL, TA-3, TA-6, and TA-55 are based all or in part on information provided in the *LANL SWEIS* (DOE 1999a), which is incorporated by reference.

3.2 LAND USE AND VISUAL RESOURCES

LANL is located on approximately 25,600 acres (10,360 hectares) of land in north central New Mexico (**Figure 3–1**). The site is located 60 miles (97 kilometers) north-northeast of Albuquerque, 25 miles (40 kilometers) northwest of Santa Fe, and 20 miles (32 kilometers) southwest of Española. LANL is owned by the Federal Government and administered by DOE's

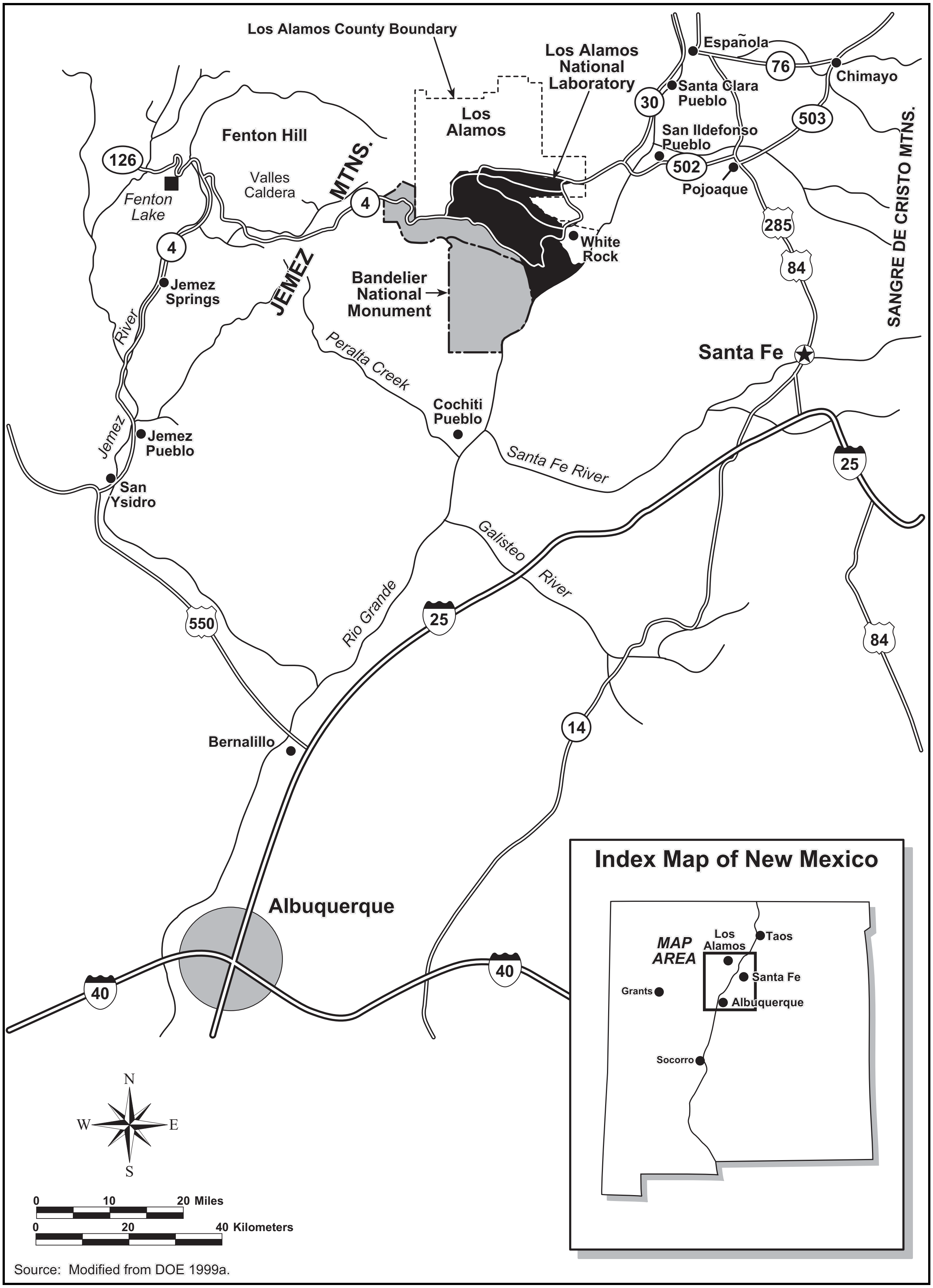

Figure 3–1 Location of LANL

NNSA. It is operated by the University of California under contract to DOE. Portions of LANL are located in Los Alamos and Santa Fe counties. DOE's principal missions are national security, energy resources, environmental quality, and science; each of these missions is supported by activities conducted at LANL. NNSA's national security mission includes maintaining and enhancing the safety, reliability, and performance of the U.S. nuclear weapons stockpile; promoting international nuclear safety and nonproliferation; reducing global danger from weapons of mass destruction; and providing safe and reliable nuclear propulsion plants for the U.S. Navy.

LANL is divided into 49 separate TAs with location and spacing that reflect the site's historical development patterns, regional topography, and functional relationships (**Figure 3–2**). While the exact number of structures changes somewhat with time (for example, as a result of the Cerro Grande Fire; see Section 3.2.1), in 1999 there were 944 permanent structures, 512 temporary structures, and 806 miscellaneous buildings with approximately 5,000,000 square feet (465,000 square meters) that could be occupied. In addition to onsite office space, about 213,300 square feet (19,833 square meters) of space is leased within the Los Alamos town site and White Rock community.

3.2.1 Land Use

Land use in the LANL region is linked to the economy of northern New Mexico, which depends heavily on tourism, recreation (such as skiing and fishing), agriculture, and the state and Federal governments for its economic base. Area communities are generally small, such as the Los Alamos town site with under 12,000 residents, and primarily support urban uses including residential, commercial, lite industrial, and recreational facilities. The region also includes Native American communities; lands of the Pueblo of San Ildefonso shares LANL's eastern border, and other pueblos are located nearby. Major governmental bodies that serve as land stewards and determine land uses within Los Alamos and Santa Fe counties include county governments, DOE, Department of Agriculture (U.S. Forest Service, Santa Fe National Forest), the Department of the Interior (National Park Service, Bandelier National Monument, and the Bureau of Land Management), the State of New Mexico, and several Native American pueblos. Bandelier National Monument and Santa Fe National Forest border LANL primarily to the southwest and northwest, respectively; however, small portions of each also border the site to the northeast (see **Figure 3–3**).

The *LANL SWEIS* used a hazard-based land use approach to characterize land use at LANL. This approach is based on the most hazardous activities in each TA and is organized into six categories.

Support: Includes TAs with only support facilities that do not perform research and development activities and 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 that perform research and development activities with associated chemical and radiological hazards, but that are generally free of explosives hazards; does not include waste disposal sites.

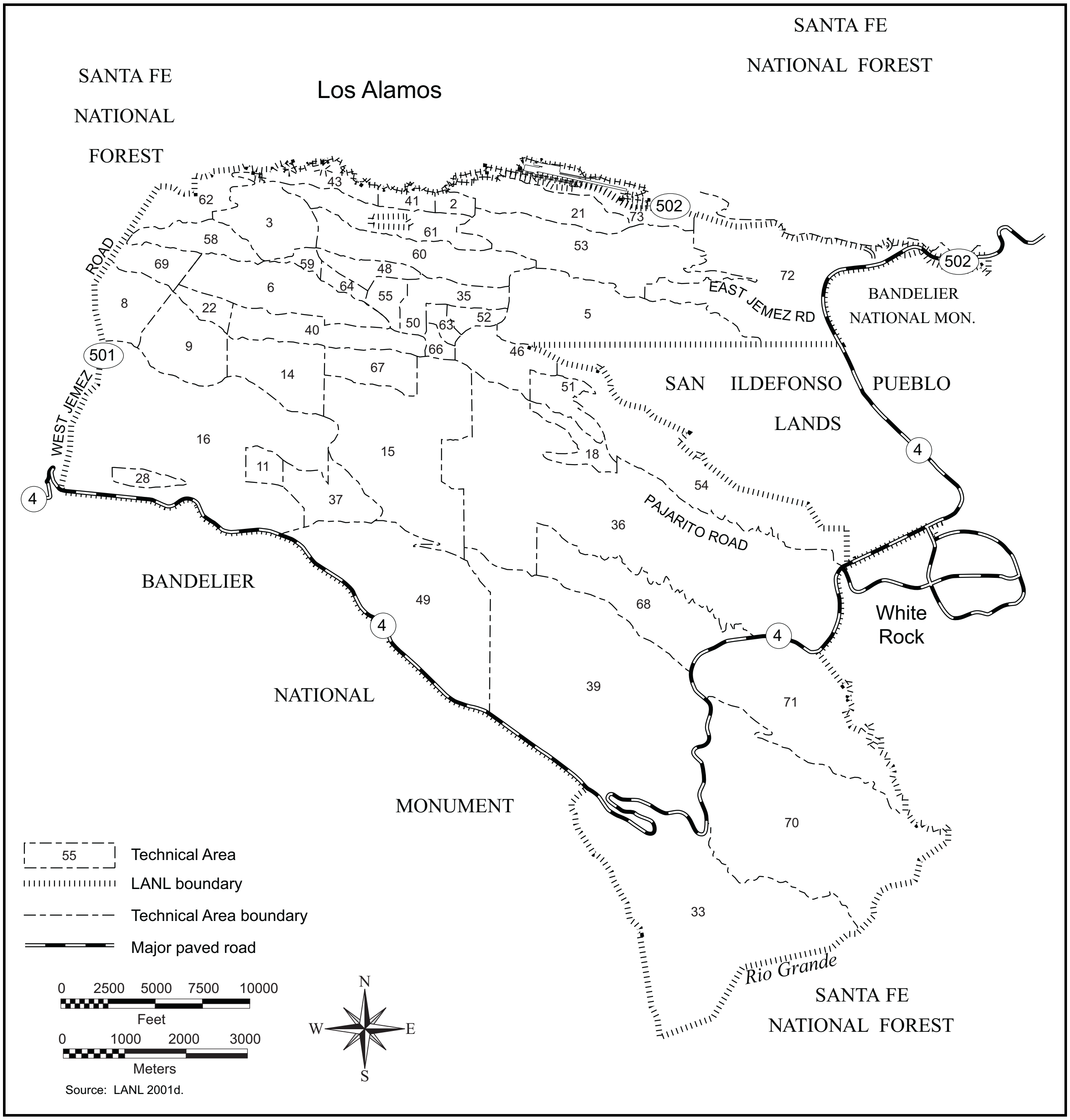

Figure 3–2 Technical Areas of LANL

Research and Development/Waste Disposal: The remaining research and development areas (i.e., those areas that are generally free of explosives hazards and 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 (such as those with existing waste disposal sites).

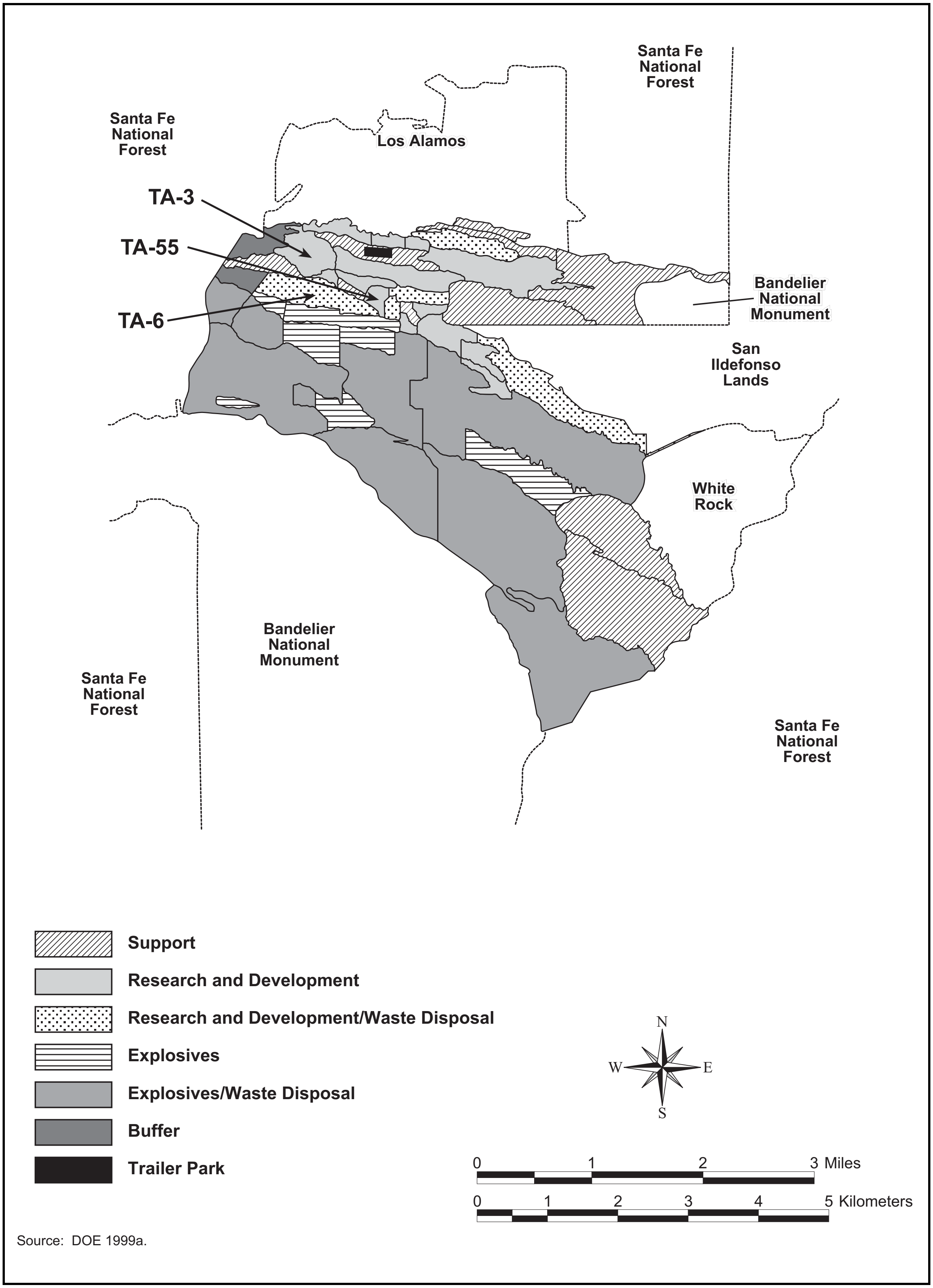

Figure 3–3 Land Use at and Adjacent to LANL

Buffer: Land identified in each of the usage types described above also may serve as a buffer area. This last land use category therefore includes areas that only serve as buffers for the safety or security of other TAs, usually explosives areas.

The *LANL Comprehensive Site Plan* (LANL 2000f) incorporated the *LANL SWEIS* hazard-based land use approach and augmented it by describing and mapping 10 land use categories. The entire Laboratory site is divided into the following land uses: administration, experimental science, high explosives research and development, high explosives testing, nuclear materials research and development, physical/technical support, public/corporate interface, reserve, theoretical/computational science, and waste management.

LANL is divided into TAs that are used for building sites, experimental areas, and waste disposal locations. However, those uses account for only a small part of the total land area of the site. In fact, only 5 percent of the site is estimated to be unavailable to most wildlife (because of security fencing). Most of the site is undeveloped to provide security, safety, and expansion possibilities for future mission-support requirements. There are no agricultural activities present at LANL, nor are there any prime farmlands in the vicinity. In 1977, DOE designated LANL as a National Environmental Research Park for use by the national scientific community as an outdoor laboratory to study the impacts of human activities on piñon-juniper woodland ecosystems (DOE 1996c). In 1999, the White Rock Canyon Reserve was dedicated. It is about 1,000 acres (405 hectares) in size and is located on the southeast perimeter of LANL. The reserve is managed jointly by DOE and the National Park Service for its significant ecological and cultural resources and research potential (LANL 2000e).

Beginning on May 5, 2000, a wildfire known as the Cerro Grande Fire burned across the Los Alamos area. By the time the fire was fully contained on June 6, it had burned a total of 43,150 acres (17,462 hectares), of which 7,684 acres (3,110 hectares) were within the boundaries of LANL (DOE 2002c). In general, impacts of the fire on land use in the region should be temporary. Access and use of certain recreation areas and trails will continue to be restricted over the next year or 2 within at least part of LANL and the surrounding forestlands. Within LANL, 45 structures (trailers, transportable and storage units) were totally destroyed and 67 were damaged. The fire also affected the Los Alamos town site, where about 230 housing units were totally destroyed. The Cerro Grande Fire at times threatened structures at TA-3 and TA-55; however, no permanent buildings were damaged or destroyed. Although the fire burned across TA-6, it did so at a generally low intensity and did not burn any buildings in the area (DOE 2000b, LANL 2000c).

The *Los Alamos County Comprehensive Plan*, which is presently being updated (Los Alamos County 2002), identifies land planning issues and establishes land planning objectives on private and county lands comprising 8,613 acres (3,486 hectares). Twenty-nine percent of this land is located within the Los Alamos town site (inclusive of Royal Crest Trailer Park) and 26 percent is located in the community of White Rock. The remaining 45 percent of the land is undeveloped and is used for recreational activities and open space. LANL, as a Federal Government property, is not addressed in the County Plan. Land-use designations in the Santa Fe County Plan are based on groundwater protection goals. Therefore, this plan designates LANL as "Agricultural and Residential," although, as noted above, there are no agricultural activities on the site, nor are there any residential uses within LANL boundaries (DOE 1996c).

TA-3 is situated in the west-central portion of LANL and is separated from the Los Alamos townsite by Los Alamos Canyon. It is located within the *LANL SWEIS* defined Research and Development land use category (see Figure 3-3) and is an area that has been designated for Experimental Science by the *LANL Comprehensive Site Plan* (LANL 2000f). TA-3 covers 357 acres (144 hectares), of which 69 percent has been developed. Site facilities are located on the top of a mesa between the upper reaches of Sandia and Mortandad Canyons. The administration complex within LANL contains the Director's office, administrative offices, and support facilities. Major facilities within the area include the CMR Building, the Sigma Complex, the Main Shops, and the Materials Science Laboratory. 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, badge office, and the study center. A security fence to aid in physical safeguarding of special nuclear materials (SNM) bounds the CMR Building.

TA-6 is adjacent to and south of TA-3 and is located on a mesa between Twomile and Pajarito Canyons. It is situated about 0.6 miles (1 kilometer) south of Los Alamos. The area falls within the *LANL SWEIS* defined Research and Development/Waste Disposal land use category (Figure 3-3). Lands within TA-6 are designated in the *LANL Comprehensive Site Plan* for Experimental Science and High-Explosives Research and Development (LANL 2000f). TA-6 encompasses 500 acres (202 hectares) of which only 1 percent is occupied by a gas cylinder staging facility and vacant buildings pending decommissioning.

TA-55 is situated in the west-central portion of LANL approximately 1.1 miles (1.8 kilometers) south of Los Alamos townsite. It is located within the Research and Development land use category as defined in the *LANL SWEIS* (Figure 3–3). The area is designated for Nuclear Materials Research and Development by the *LANL Comprehensive Site Plan* (LANL 2000f). TA-55 encompasses 40 acres (16 hectares) of which 43 percent is developed. The main complex has five connected buildings including the Administration Building, Support Office Building, Support Building, Plutonium Facility, and Warehouse. The Nuclear Materials Storage Facility is separate from the main complex. TA-55 facilities provide research and applications in chemical and metallurgical processes of 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. A security fence to aid in physical safeguarding of SNM bounds the entire site.

3.2.2 Visual Resources

The topography of northern New Mexico is rugged, especially in the vicinity of LANL. Mesa tops are cut by deep canyons, creating sharp angles in the land form. In some cases, slopes are nearly vertical. Often, little vegetation grows on these steep slopes, exposing the geology, with contrasting horizontal planes varying from fairly bright reddish orange to almost white in color. A variety of vegetation occurs in the region, the density and height of which may change over time and can affect the visibility of an area within the LANL viewshed. Undeveloped lands within LANL have a Bureau of Land Management Visual Resource Contrast rating of Classes II and III. Management activities within these classes may be seen but should not dominate the view.

For security reasons, much of the development within LANL, which is generally austere and utilitarian, has occurred out of the public's view. Passing motorists or nearby residents can see only a small fraction of what is actually there. Prior to the Cerro Grande Fire, the view of most LANL property from many stretches of area roadways was that of woodlands and brushy areas. Views from various locations in Los Alamos County and its immediate surroundings have been altered by the Cerro Grande Fire. Although the visual environment is still diverse, interesting, and panoramic, portions of the visual landscape are dramatically stark. Rocky outcrops forming the mountains are now visible through the burned forest areas. The eastern slopes of the Jemez Mountains, instead of presenting a relatively uniform view of dense green forest, are now a mosaic of burned and unburned areas. Grasses and shrubs initially will replace forest stands and will contribute to the visual contrast between the burned and unburned areas for many years. University of California, current LANL Management and Operating contractor (UC at LANL) and neighboring land stewards are in the process of mechanically thinning the forests within LANL and nearby to reduce the existing fuel loads. This effort involves the removal of both burned and live trees. This tree thinning process will increase the visibility of industrial and residential areas within LANL and Los Alamos County. Local effects include reduced visual appeal of trails and recreation areas (DOE 2000b).

The most visible developments at LANL are a limited number of very tall structures, facilities at relatively high, exposed locations, or those beside well-traveled, publicly accessible roads. Developed areas within LANL are consistent with a Class IV Visual Resource Contrast rating, in which management activities dominate the view and are the focus of viewer attention.

At lower elevations, at a distance of several miles away from LANL, the site is primarily distinguishable in the daytime by views of its water storage towers, and white domes at TA-54. Similarly, the Los Alamos town site appears mostly residential in character, with the water storage towers very visible against the backdrop of the Jemez Mountains. At elevations above LANL, along the upper reaches of the Pajarito Plateau rim, the view of LANL is primarily of scattered austere buildings and groupings of several-storied buildings. Similarly, the residential character of the Los Alamos town site is predominantly visible from higher elevation viewpoints. At night, the lights of LANL, the Los Alamos town site, and White Rock are directly visible from various locations across the viewshed as far away as the towns of Española and Santa Fe.

TA-3 is located on a mesa at the base of the Jemez Mountains between the upper reaches of Sandia and Mortandad Canyons. TA-3 is heavily developed and contains numerous buildings that are austere and industrial in appearance. Multi-storied buildings within TA-3 are visible from the Los Alamos town site and from upper elevations of the Pajarito Plateau. The visual resources of TA-3 are consistent with a Class IV Visual Resource Contrast rating, that is, management activities may dominate the view and be the major focus of viewer attention (DOI 1986).

TA-6 is located on a mesa between Twomile and Pajarito Canyons. The area is largely undeveloped; however, it contains a gas cylinder staging facility and vacant buildings pending decommissioning. The heavily wooded area is visible from Pajarito Road and from higher elevations to the west along the upper reaches of the Pajarito Plateau rim. The visual resources of TA-6 are consistent with a Class III Visual Resource Contrast rating, that is, management activities may attract attention but should not dominate the view of the casual observer (DOI 1986).

TA-55 is located on a mesa about 1 mile (1.6 kilometers) southeast of TA-3. While not visible from lower elevations, TA-55 is visible from higher elevations to the west along the upper reaches of the Pajarito Plateau rim, from where it appears as one of several scattered built-up areas among the heavily forested areas of the site. As is the case for TA-3, developed portions of TA-55 would have a Class IV Visual Resource Contrast rating.

3.3 SITE INFRASTRUCTURE

Site infrastructure characteristics for LANL are summarized in **Table 3–2.** Each infrastructure characteristic is further discussed in the following paragraphs.

Table 3–2 LANL Sitewide Infrastructure Characteristics

Resource	*Site Usage* [a]	*Site Capacity*
Transportation		
Roads (miles)	80 [b]	Not applicable
Railroads (miles)	0	Not applicable
Electricity [c]		
Energy (megawatt hours per year)	491,186	963,600
Peak load demand (megawatts)	85.5	110
Fuel		
Natural gas (cubic feet per year)	2,530,000,000 [d]	8,070,000,000 [e]
Water (gallons per year)	344,000,000	542,000,000 [f]

[a] All site usage values are for fiscal year except for water use, which is calendar year.
[b] Includes paved roads and paved parking areas only.
[c] Usage and capacity values are for the entire Los Alamos Power Pool.
[d] Usage value for LANL plus baseline usage for other Los Alamos County users.
[e] Entire service area capacity, which includes LANL and other Los Alamos area users.
[f] Equivalent to DOE's leased water rights.
Sources: DOE 1999a, DOE 1999c, LANL 2002d, LANL 2002e.

3.3.1 Ground Transportation

About 80 miles (130 kilometers) of paved roads and parking surface have been developed at LANL (see Table 3–2). There is no railway service connection at the site. Local and linking regional transportation systems, including roadways, are detailed in Section 3.9.4.

3.3.2 Electricity

Electrical service to LANL is supplied through a cooperative arrangement with Los Alamos County, known as the Los Alamos Power Pool, that was established in 1985. Electric power is supplied to the Power Pool through two existing regional 115-kilovolt electric power lines. The first line (the Norton-Los Alamos line) is administered by DOE and originates from the Norton Substation near White Rock, and the second line (the Reeves Line) is owned by the Public Service Company of New Mexico and originates from the Bernalillo-Algodones Substation. Both transmission substations are owned by the Public Service Company of New Mexico. DOE also operates a gas-fired steam and electrical power generating plant at TA-3 (TA-3 Co-generation Complex) that is used on an as-needed basis, primarily during peak demand periods of LANL operations and during Pool outages. DOE also maintains various low-voltage transformers at LANL facilities and approximately 34 miles (55 kilometers) of 13.8-kilovolt distribution lines (DOE 2000a). Within LANL, DOE also maintains two power distribution substations: the Eastern TA Substation and the TA-3 Substation. In mid-2001, LANL broke ground for construction of the new Western TA Substation as part of a project to provide overall electrical supply reliability across the site and to provide redundant capacity for LANL and the Los Alamos town site in the event of an outage at either of LANL's two existing substations. The Western TA Substation will be serviced by a new 115-kilovolt power transmission line originating at the existing Norton Substation. The new substation's main transformer is rated at 56-megavolt-amperes or about 45 megawatts (DOE 2000a, LANL 2002d).

Recent changes (as of August 1, 2002) in transmission agreements with the Public Service Company of New Mexico have resulted in the removal of contractual restraints on Power Pool resources import capability. Import capacity is now limited only by the physical capability (thermal rating) of the transmission lines. The import capacity is approximately 110 to 120 megawatts from a number of hydroelectric, coal, and natural gas power generators throughout the western United States (LANL 2002e). Onsite electrical generating capability for the Power Pool is limited by the existing TA-3 steam and electric power plant, which is capable of producing up to 20 megawatts of electric power that is shared by the Power Pool under contractual arrangement (DOE 2002g). However, an environmental assessment (DOE 2002g) has been prepared for a project that will support the installation of two new, gas-fired combustion turbine generators within the TA-3 Co-generation Complex and upgrade of the existing steam turbines. Each new unit will have an electric generating capacity of 20 megawatts, with the first unit to be installed in the Fiscal Year 2003 (FY 2003) to FY 2004 timeframe. The second unit is currently not planned for installation until FY 2007 at the earliest (DOE 2002g). Thus, construction and installation of the first combustion turbine generator will boost LANL's onsite electrical generating capacity by 20 megawatts in the near future.

Electricity consumption and peak demands by LANL have historically fluctuated, largely as a result of power demand by the Los Alamos Neutron Science Center. Electric power availability from the Pool (based on a peak load import capacity of 110 megawatts) is 963,600 megawatt-hours per year. In FY 2001, LANL used 375,143 megawatt-hours of electricity. Other Los Alamos County users consumed an additional 116,043 megawatt-hours. The FY 2001 peak load was about 70.9 megawatts for LANL and about 14.6 megawatts for the rest of the county (LANL 2002d). The CMR Building at TA-3 used 12,598 megawatt-hours of electricity in FY 2001, and TA-55 used 14,509 megawatt-hours of electricity in the same period (Johnson Controls 2002). Electricity usage within TA-6 is minimal, as there are no permanently occupied or operated facilities in the area.

3.3.3 Fuel

Natural gas is the primary fuel used in Los Alamos County and at LANL. The natural gas system includes a high-pressure main and distribution system to Los Alamos County and pressure-reducing stations at LANL buildings. In August 1999, DOE sold the 130-mile- (209-kilometer-long) main gas supply line and associated metering stations serving Los Alamos and vicinity to the Public Service Company of New Mexico (LANL 2000d). The county and LANL both have delivery points where gas is monitored and measured. LANL burns natural gas to generate steam to heat buildings and to generate electric power. The natural gas delivery system servicing the Los Alamos area has a contractually-limited capacity of about 8.07 billion cubic feet (229 million cubic meters) per year (DOE 1999c). In FY 2001, LANL used approximately 1.49 billion cubic feet (42.3 million cubic meters) of natural gas (see Table 3–2). Some 90 percent of the natural gas used at LANL is for heating and the remainder for electricity generation to meet peak demands (LANL 2002d). The rest of the service area including Los Alamos County is estimated to use an average of 1.04 billion cubic feet (29.5 million cubic meters) of natural gas annually (DOE 1999c). Relatively small quantities of fuel oil are also stored at LANL as a backup fuel source, but use is negligible. TA-3 and TA-55 use natural gas to fire boilers and for other facility uses. There are no active facilities within TA-6 that consume natural gas. TA-55 is estimated to use approximately 45 million cubic feet (1.3 million cubic meters) of natural gas annually (DOE 2002e).

3.3.4 Water

The Los Alamos water supply system consists of 14 deep wells, 153 miles (246 kilometers) of main distribution lines, pump stations, storage tanks, and 9 chlorination stations. This system supplies potable water to all of the county, LANL, and Bandelier National Monument. On September 8, 1998, DOE transferred operation of the water production system from DOE to Los Alamos County under a lease agreement. Under the lease agreement, DOE retained responsibility for operating the distribution system within LANL boundaries, whereas the county assumed full responsibility for operating the water system, including ensuring compliance with Federal and state drinking water regulations (DOE 2000a, LANL 2002d). On September 5, 2001, DOE completed the transfer of ownership of the water system to the county, along with 70 percent (3,879 acre feet [4.8 million cubic meters] or 1,264 million gallons [4,785 million liters] per annum) of its rights to water. The remaining 30 percent (1,662 acre feet [2.1 million cubic meters] or 542 million gallons [2.05 billion liters] per annum) of the water rights are leased by DOE to the county for 10 years, with the option to renew the lease for 4 additional 10-year terms. A contract with the U.S. Bureau of Reclamation for an additional 1,200 acre feet (1.5 million cubic meters) per year of San Juan-Chama Transmountain Diversion Project water was also transferred to Los Alamos County.

In 2001, LANL used approximately 344 million gallons (1.30 billion liters) of water (LANL 2002d) (see Table 3–2). Potable water is obtained from deep wells located in three well fields (Gauje, Otowi, and Pajarito). Water use at TA-6 is negligible as there are no permanently occupied or operated facilities.

3.4 CLIMATE, AIR QUALITY, AND NOISE

3.4.1 Climate

Los Alamos has a semiarid, 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 town site is not as arid (dry) as that part near the Rio Grande, which is arid continental. 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 are based on observations made at the official Los Alamos meteorological weather station from 1961 to 1990. Normal (30-year mean) minimum and maximum temperatures for the community of Los Alamos range from a mean low of 17.4 degrees Fahrenheit (F) (-8.1 degrees Centigrade [C]) in January to a mean high of 80.6 degrees F (27 degrees C) in July. Normal (30-year mean) minimum and maximum temperatures for the community of White Rock range from a mean low of 14.6 degrees F (-9.7 degrees C) in January to a mean high of 85.6 degrees F (29.8 degrees C) in July. Temperatures in Los Alamos vary with altitude, averaging 5 degrees F (3 degrees C) higher in and near the Rio Grande Valley, which is 6,500 feet (1,981 meters) above sea level, and 5 to 10 degrees F (3 to 5.5 degrees 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 town site temperatures have dropped as low as -18 degrees F (-28 degrees C) and have reached as high as 95 degrees F (35 degrees C). The normal annual precipitation for Los Alamos is 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 town site was 7 inches (17 centimeters) and the highest was 39 inches (100 centimeters).

Thirty-six percent of the annual precipitation for Los Alamos County and LANL results from thunderstorms 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).

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.

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. Wind conditions are discussed further in the *LANL SWEIS* (DOE 1999a).

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 in the 2,727 acres (1,104 hectares) of Bandelier National Monument for the years 1990 through 1994 is 12 per year. 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. No tornadoes are known to have touched the ground in the Los Alamos area.

3.4.2 Air Quality

3.4.2.1 Nonradiological Releases

LANL operations can result in the release of nonradiological air pollutants that may affect the air quality of the surrounding area. LANL is within the Upper Rio Grande Valley Intrastate Air Quality Control Region (#157). The area encompassing LANL and Los Alamos County is classified as an attainment area for all six criteria pollutants (carbon monoxide, nitrogen dioxide, lead, ozone, sulfur dioxide, and particulate matter) (40 CFR 81.332).

In addition to the National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (EPA), the State of New Mexico has established ambient air quality standards for carbon monoxide, nitrogen dioxide, sulfur dioxide, total suspended particulates, hydrogen sulfide, and total reduced sulfur. Additionally, New Mexico has established permitting requirements for new or modified sources of regulated air pollutants. Air quality permits have been obtained from the State Air Quality Bureau for beryllium operations, operation of an air curtain destructor, operation of an asphalt plant, open burning of high-explosive wastes, operation of a rock crusher, the TA-3 power plant and TA-33 generator that were modified or constructed after August 31, 1972. In accordance with Title V of the Clean Air Act, as amended, and New Mexico Administrative Code 20.2.70, UC at LANL and DOE submitted a sitewide operating permit application to the New Mexico Environment Department (NMED) in December 1995. NMED has reviewed the application and issued a Notice of Completeness, but has not yet issued an operating permit. In November 2002, UC at LANL prepared and submitted a comprehensive update and replacement to the December 1995 application. NMED has reviewed the November 2002 application and issued a Notice of Completeness in December 2002, but has not yet issued an approved operating permit.

Criteria pollutants released from LANL operations are emitted primarily from combustion sources such as boilers, emergency generators, and motor vehicles. **Table 3–3** presents information regarding the primary existing sources. In October 2002, UC at LANL installed a flue gas recirculation system on the TA-3 steam plant boilers that will reduce nitrogen oxide (NO_x) emissions by 70 percent (LANL 2002c). LANL's sitewide operating permit application requests voluntary facility-wide emission limits in order to ensure that LANL remains a minor stationary source for the purposes of the Prevention of Significant Deterioration Construction Permit Program and the Clean Air Act Title III requirements for hazardous air pollutants. 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. LANL and DOE have a program to review new and modified operations for their potential to emit air pollutants.

Table 3–3 Air Pollutant Emissions at LANL in 2001

Pollutant	*LANL Sources (tons per year)*	*TA-3 Sources (tons per year)*	*TA-6 Sources (tons per year)*	*TA-55 Sources (tons per year)*
Carbon monoxide	29.1	18.6	(a)	1.65
Nitrogen dioxide	93.8	73.9	(a)	2.88
PM_{10}	5.5	3.59	(a)	0.24
Sulfur dioxide	0.82	0.72	(a)	0.01
Volatile organic compounds	24.1	2.51	(a)	0.1
Hazardous air pollutants	7.4	0.41	(a)	0.67

PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter.
[a] No emission units exist at TA-6.
Source: LANL 2001d, LANL 2002d.

Only limited monitoring of the ambient air has been performed for nonradiological air pollutants within the LANL region. NMED operated an ambient air quality monitoring station adjacent to Bandelier National Monument between 1990 and 1994 to record sulfur dioxide, nitrogen dioxide, ozone, and particulate matter (pm) with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) levels (see **Table 3–4**).

NMED discontinued operation of this station in FY 1995 because recorded values were well below applicable standards. Beryllium monitoring performed in 1999 at 9 onsite stations, 10 perimeter stations, and 6 regional stations showed that beryllium levels were low. The New Mexico beryllium ambient standard has been repealed.

Table 3–4 Nonradiological Ambient Air Monitoring Results

Pollutant	*Averaging Period*	*Most Stringent Standard [a] (micrograms per cubic meter)*	*Ambient Concentration [b] (micrograms per cubic meter)*
Sulfur dioxide	Annual	41 [c]	2
	24 hours	205 [c]	18
	3 hours	1,030 [d]	Not applicable
Nitrogen dioxide	Annual	73.7 [c]	4
	24 hours	147 [c]	9
Ozone	1 hour	185 [d]	138
PM_{10}	Annual	50 [d]	8
	24 hours	150 [d]	29

PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter.
[a] The most stringent of the state and Federal standards are shown.
[b] 1994 ambient concentrations from monitoring site near Bandelier National Monument at TA-49.
[c] State standard.
[d] Federal standard (NAAQS).
Source: DOE 1999a.

Criteria pollutant concentrations attributable to existing LANL activities would be below the concentrations estimated for the Expanded Operations Alternative, which were estimated for the *LANL SWEIS* and are presented in **Table 3–5**.

Table 3–5 Modeled Ambient Air Concentrations from LANL Sources

Pollutant	*Averaging Period*	*Most Stringent Standard* [a] *(micrograms per cubic meter)*	*Maximum Estimated Concentration* [b] *(micrograms per cubic meter)*
Carbon monoxide	8 hours 1 hour	7,800 11,700	1,440 2,710
Lead	Calendar quarter	1.5	0.00007
Nitrogen dioxide	Annual 24 hours	73.7 147	9 90
PM_{10}	Annual 24 hours	50 150	1 9
Sulfur dioxide	Annual 24 hours 3 hours	41 205 1,030	18 130 254
Total suspended particulates	Annual 24 hours	60 150	2 18

PM_{10} = particulate matter less than or equal to 10 microns in aerodynamic diameter.

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. The NAAQS (40 CFR Part 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic PM_{10} mean standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. Standards and monitored values for pollutants other than particulate matter are stated in parts per million (ppm). These values have been converted to micrograms per cubic meter ($\mu g/m^3$) with appropriate corrections for temperature (70 degrees F [21 degrees C]) and pressure (elevation 7,005 feet [2,135 meters]), following New Mexico dispersion modeling guidelines (revised 1998) (NMAQB 1998).

[b] Based on the Expanded Operations Alternative in the *LANL SWEIS*. The annual concentrations were analyzed at locations to which the public has access–the site boundary or nearby sensitive areas. Short-term concentrations were analyzed at the site boundary and at the fence line of certain TAs to which the public has short access.

Source: DOE 1999a.

For toxic air pollutants, a bounding analysis was performed for the *LANL SWEIS*, which indicated that the pollutants of concern for exceeding the guideline values at LANL were emissions from the High Explosives Firing Site operations and emissions that contributed to additive risk from all TAs on receptors near the Los Alamos Medical Center. These combined cancer risks were dominated by chloroform emissions from the Health Research Laboratory. It was shown that pollutants released under the No Action Alternative in the *LANL SWEIS* are not expected to cause air quality impacts that would affect human health and the environment.

As reported in a special environmental analysis for the Cerro Grande Fire in 2000 (DOE 2000b), there could be some temporary increase in suspended particulate matter as a result of removal of vegetation cover, but air quality would be expected to be within the parameters analyzed in the *LANL SWEIS*.

In accordance with the Clean Air Act, as amended, and New Mexico regulations, the Bandelier Wilderness Area has been designated as a Class I area (that is, wilderness areas that exceed 10,000 acres [4,047 hectares]), where visibility is considered to be an important value (40 CFR 81 and 20 New Mexico Administrative Code [NMAC] 2.74) and requires protection. Visibility is measured according to a standard visual range (i.e., how far an image is transmitted through the atmosphere to an observer some distance away). Visibility has been officially monitored by the National Park Service at the Bandelier National Monument since 1988. The view distance at Bandelier National Monument has been recorded from approximately 40 to 103 miles (64 to 166 kilometers). The visual range has not deteriorated during the period for which data are available.

3.4.2.2 Radiological Releases

Radiological air emissions in 2001 from all LANL TAs are presented in **Table 3–6**. Radiological air emissions from TA-3, TA-6, and TA-55 are also shown in the table. Plutonium and uranium releases for the year did not change significantly from those experienced in 2000. A single release from TA-16 in January 2001 accounted for 7,600 curies (81 percent) of the tritium released at LANL for the entire year.

Table 3–6 Radiological Airborne Releases to the Environment at LANL in 2001

Radionuclide	*LANL (curies)*	*TA-3 (curies)*	*TA-6 (curies)*	*TA-55 (curies)*
Tritium	9,400	—	—	3.3
Americium-241	2.7×10^{-7}	2.6×10^{-7}	—	6.2×10^{-9}
Plutonium (includes -238, -239, -240)	9.3×10^{-6}	9.2×10^{-6}	—	4.3×10^{-8}
Uranium (includes -234, -235, -238)	7.3×10^{-6}	7.1×10^{-6}	—	1.7×10^{-7}
Thorium	7.7×10^{-7}	5.1×10^{-7}	—	2.7×10^{-7}
Particulates/vapor activation products	1.1	2.7×10^{-7}	—	1.2×10^{-7}
Gaseous/mixed activation products	6,100	—	—	—
Total	15,500	.000017	—	3.3

Note: Dashed lines indicate no measurable releases.
Source: LANL 2002b.

A radiological ambient air sampling network is fielded in Los Alamos, Santa Fe, and Rio Arriba Counties and is designed to measure levels of airborne radionuclides (plutonium, tritium, and uranium) that may be emitted from Laboratory operations. Radionuclides emitted from stacked and/or diffuse sources may be captured. The network comprises more than 50 ambient air sampling stations. Each sampler is equipped with a filter to collect a particulate matter sample (for gross alpha/beta and radiochemical determination) and a silica gel cartridge to collect a water sample (for tritium determination). The average ambient air concentrations calculated from the field and analytical data for the last 5 years by the type of radioactivity and by specific radionuclide are presented in **Table 3–7**.

3.4.3 Noise

Existing LANL-related publicly detectable noise levels are generated by a variety of sources, including construction noise, truck and automobile movements to and from the LANL TAs, high explosives testing, and firearms practice by security guards. Noise levels within Los Alamos County unrelated to LANL are generated predominantly by traffic movements and, to a much lesser degree, other residential-, commercial-, and industrial-related activities. 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.

Table 3–7 Average Background Concentration of Radioactivity in the Regional Atmosphere near LANL [a]

	Units	EPA Concentration limit [b]	1997	1998	1999	2000	2001
Gross Alpha	Ci/m3	Not applicable	0.7	0.8	1.0	1.0	0.8
Gross Beta	Ci/m3	Not applicable	14.1	12.4	13.4	13.0	13.9
Tritium	Ci/m3	1,500	0.7	0.5	0.5	0.8	-0.1
Plutonium 238	Ci/m3	2,100	0.0	0.1	-0.2	0.0	0.0
Plutonium 239, 240	Ci/m3	2,000	-0.2	0.4	0.1	0.0	0.1
Americium-241	Ci/m3	1,900	0.2	0.3	-0.2	0.3	-0.2
Uranium 234	Ci/m3	7,700	14.1	12.9	16.1	17.1	17.9
Uranium 235	Ci/m3	7,100	0.6	0.9	1.2	0.9	1.3
Uranium 238	Ci/m3	8,300	12.2	12.8	15.2	15.9	17.7

[a] Data from regional air sampling stations operated by LANL during the last 5 years. Locations can vary by year.
[b] Each EPA limit equals 10 mrem per year.
Note: negative numbers. Some values in the tables indicate measured negative concentrations, which is physically impossible. However, it is possible for measured concentrations to be negative because the measured concentrations are a sum of the true value and all random errors. As the true value approaches zero, the measured value approaches the total random errors, which can be negative or positive and overwhelm the true value. Arbitrarily discarding negative values when the true value is near zero will result in overestimated ambient concentrations.
Source: LANL 2002c.

Traffic 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.

The standard unit used to report sound pressure levels is the decibel (dB); the A-weighted frequency scale (dBA) is an expression of adjusted pressure levels by frequency that accounts for human perception of loudness. Background noise levels were found to range from 31 to 35 decibels A-weighted (dBA) at the vicinity of the entrance to Bandelier National Monument and New Mexico Route 4 (NM 4). At White Rock, background noise levels range from 38 to 51 dBA (1-hour equivalent sound level); this is slightly higher than was found near Bandelier National Monument, probably due to higher levels of traffic and the presence of a residential neighborhood, as well as the different physical setting. The detonation of high explosives represents the peak noise level generated by LANL operations. The results of these detonations are air blasts and ground vibrations.

The primary source of detonation activities is the high explosives experiments conducted at the LANL Pulsed High-Energy Radiation Machine Emitting X-Rays Facility and surrounding TAs with active firing sites. The Dual Axis Radiographic Hydrodynamic Test Facility has begun operation (followed by a corresponding reduction of Pulsed High-Energy Radiation Machine Emitting X-Rays Facility operations) and is a source of high explosives testing. Explosives detonations were performed in March 1995 for the *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement* (DOE 1995) analysis, and measurements of air blasts and ground vibrations were obtained for representative Pulsed High-Energy Radiation Machine Emitting X-Rays Facility explosives tests.

Air blasts consist of higher-frequency, audible air pressure waves that accompany an explosives detonation. This noise can be heard by both workers and the area public. The lower-frequency air pressure waves are not audible, but may cause secondary and audible noises within a testing structure that may be heard by workers. Air blasts and most LANL-generated ground vibrations result from testing activities involving aboveground explosives research. The effects of vibration from existing activities at LANL are discussed further in the *LANL SWEIS* (DOE 1999a).

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 (reduced) and channeled away from receptors. These regional features are jointly responsible for the lack of 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.

Loss of large forest areas from the Cerro Grande Fire in 2000 has had an adverse effect on the ability of the surrounding environment to absorb noise. However, types of noise and noise levels associated with LANL, and from activities in surrounding communities, have not changed significantly as a result of the fire (DOE 2000b).

Noise generated by LANL operations, together with the audible portions of explosives air blasts, is regulated by worker protection standards and is consistent with the Los Alamos County Code regarding noise generation. 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 (between 7 a.m. and 9 p.m.) 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.

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. Traffic noise from truck and automobile movements around the LANL TAs is excepted under Los Alamos County noise regulations, as is traffic noise generated along public thoroughfares within the county. The vigor and well being of area wildlife and sensitive, Federally-protected bird populations suggest that sound levels at LANL are present within an acceptable tolerance range for most wildlife species and sensitive nesting birds found along the Pajarito Plateau.

3.5 Geology and Soils

LANL is located on the Pajarito Plateau within the Southern Rocky Mountains Physiographic Province. The Pajarito Plateau lies between the Valles Caldera in the Jemez Mountains to the west and the Rio Grande to the east (see **Figure 3–4**). The gently sloping surface of the Pajarito Plateau is divided into multiple narrow east-southeast trending mesas dissected by deep parallel canyons that extend from the Jemez Mountains to the Rio Grande. The major tectonic feature in the region is the Rio Grande Rift that begins in northern Mexico, trends northward across central New Mexico, and ends in central Colorado. The rift is comprised of a complex system of north-trending basins formed from down-faulted blocks of the Earth's crust. In the Los Alamos area, the rift is about 35 miles (56 kilometers) wide and contains the Española Basin. The Sangre de Cristo Mountains border the rift on the east. The Jemez Mountains lie west of the rift and the Pajarito Fault system.

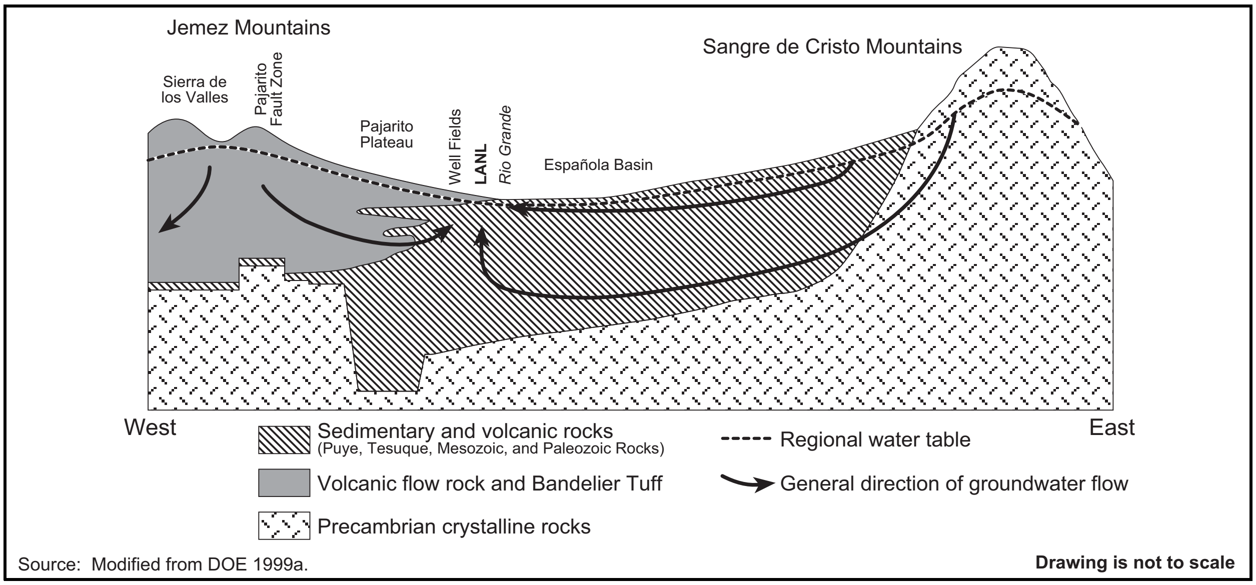

Figure 3–4 Geology and Hydrogeology of the Española Portion of the Northern Rio Grande Basin

Rocks in the LANL region are volcanic in origin, or sedimentary deposits. Volcanic activity began forming the Jemez Mountains about 16.5 million years ago (Gardner et al. 1986) and continued sporadically to the most recent eruptions that produced the El Cajete Pumice Fall about 50,000 to 60,000 years ago (Reneau et al. 1996). Several independent lines of evidence indicate that future volcanic activity in the Jemez Mountains is likely (LANL 1999), but recurrence intervals have not been firmly established.

3.5.1 Geology

3.5.1.1 Surficial Geologic Units

In the LANL area, the youngest surficial geologic units consist of artificial fill due to modern development, colluvium, and alluvium along stream channels in canyons. Extensive areas on the Pajarito Fault escarpment show evidence of mass wasting and land slides. Detailed mapping and trench studies in the Pajarito Fault zone have identified multiple alluvial fan deposits, the youngest of which contained detrital charcoal dated at 9,300 to 9,600 years old. The El Cajete Pumice, which dates from 50,000 to 60,000 years old, is contained within intermediate-aged alluvial fan deposits. Older surficial geologic deposits are remnants from once-extensive alluvial fans predating the incision of the present canyons. These older alluvial deposits contain pumice beds dated at approximately 1.1 million years old (LANL 2001a).

3.5.1.2 Bedrock Units

Bedrock outcrops typically occur on greater than 50 percent of the surface of LANL (DOE 1996c). Forming the Pajarito Plateau, the Bandelier Tuff is the bedrock upon which nearly all LANL facilities are constructed. The Bandelier Tuff consists of the upper Tshirege and lower Otowi Members that were violently erupted about 1.2 and 1.6 million years ago from the Valles and Toledo Calderas, respectively (see Figure 3–1). The Bandelier Tuff is generally thickest to the west near its source and thins eastward across the Pajarito Plateau. Likewise, the Tshirege Member is strongly welded and harder in the west and less welded farther from its source. In the LANL area, the Bandelier Tuff attains a thickness of more than 700 feet (200 meters) and consists of multiple ash-flow deposits of rhyolitic tuff and pumice. In particular, the Tshirege Member consists of multiple cooling units that create nearly horizontal light- and dark-colored strata on canyon walls throughout the LANL area that are visible to motorists. The dark-colored units are harder and more resistant to erosion; they form steep cliffs and cap the mesas. The light-colored softer units form the slopes. This alternating sequence of hard and softer strata creates a stair-step appearance to canyon walls.

Beneath the Bandelier Tuff, older rocks include the 1.7- to 4-million-year-old Puye Formation, which is a complex deposit consisting predominantly of poorly sorted coarse sands to boulders resulting from erosion of the Jemez Mountains. The Puye Formation also includes ash and pumice falls from Jemez Mountain volcanism, inter-bedded basalt flows and debris from the Cerros del Rio volcanic field (2 to 3 million years old), localized deposits of well-rounded cobbles and boulders of crystalline rocks from the ancestral Rio Grande, and fine-grained lake deposits in the eastern portions of the fan. The Tschicoma Formation (2 to 7 million years old) consists of intermediate composition volcanic rocks and forms the bulk of the Jemez Mountains. The Tschicoma Formation inter-fingers with the Puye Formation beneath the western portion of the Plateau. Older still, the Santa Fe Group (4 to 21 million years old) is the thickest and most extensive group of sedimentary deposits in the upper Española Basin. In the vicinity of the Pajarito Plateau, the Santa Fe Group consists of the Tesuque Formation and overlying Chamita Formation; each formation consists of fluvial, slightly consolidated sedimentary rocks derived from erosion of the Sangre de Cristo Mountains to the east. The Santa Fe Group also contains older volcanic tuff deposits and basalt flows, and overlies Precambrian age (greater than 570 million years old) crystalline basement rock.

The Pajarito Fault system defines the western boundary of the Rio Grande Rift. In Los Alamos County, the Pajarito Fault system consists of the Pajarito, Rendija Canyon, and Guaje Mountain Fault zones (see **Figure 3–5**). Of these three fault zones, the Pajarito is the largest and delineates the boundary between the Pajarito Plateau and Jemez Mountains. The Rendija Canyon Fault changes from a single-trace, down-to-the-west displacement in the northern part of Los Alamos

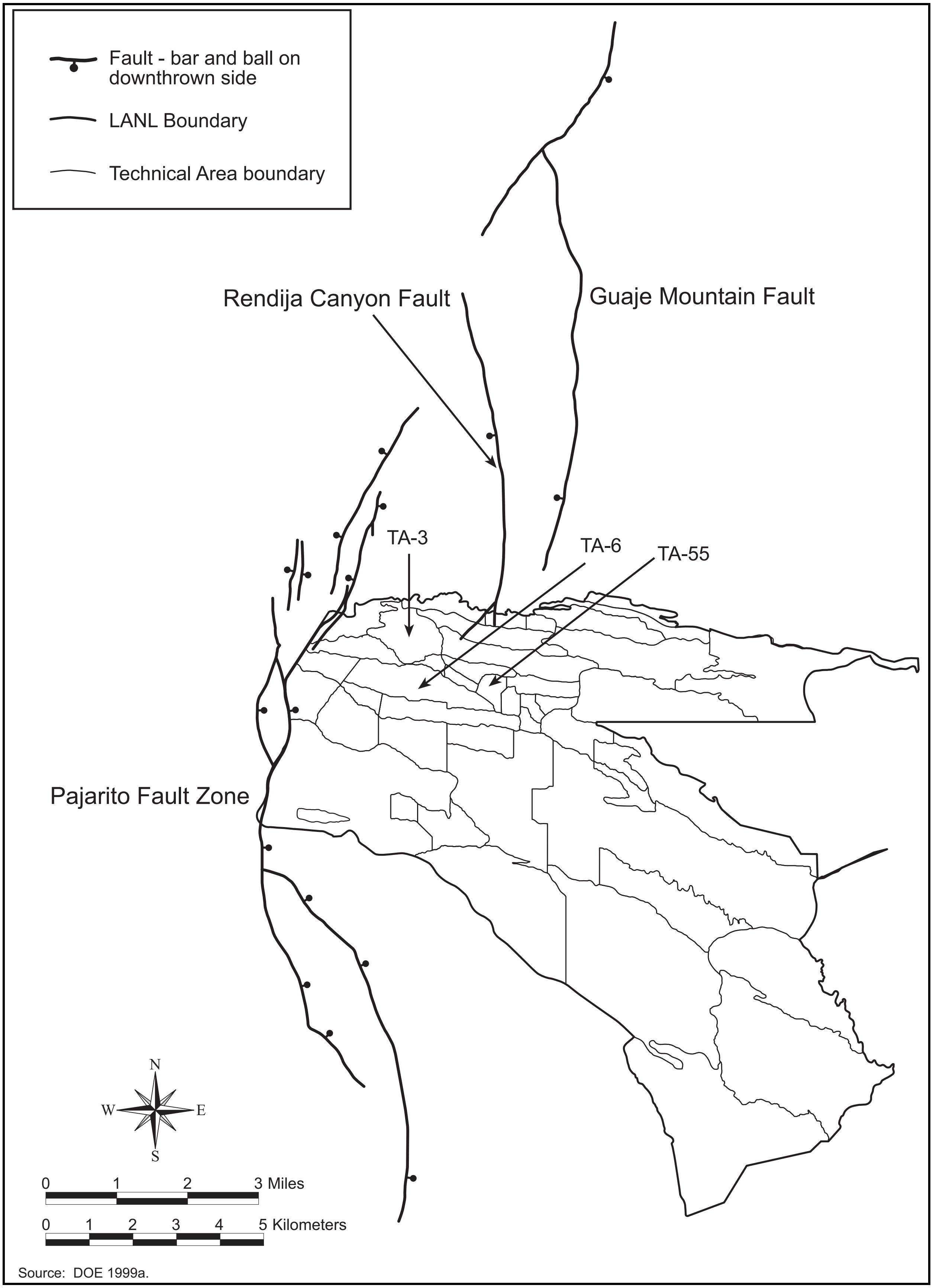

Figure 3–5 Major Faults at LANL

County to a broad zone of smaller faults within LANL property (see Figure 3–5). Locally, the Pajarito and Rendija Canyon Fault zones define a down-faulted block of the Bandelier Tuff that lies beneath the western part of the Los Alamos town site and TA-3. East-southeast trending cross structures define the southern end of the down-faulted block within this structurally complex area (LANL 1999).

The present CMR Building at TA-3 is located within this structurally complex area. Recent core drilling indicated 8 feet (2.4 meters) of high-angle, reverse-fault displacement located at the northeastern edge of the present CMR Building (LANL 1998a). In the same study, interpretation of data from other boreholes suggested that the surface fault trace trends southwest beneath the northern portion of the CMR Building. Based on this investigation, it was concluded that the CMR Building site has, in the past, been impacted by fault rupture. While the probabilistic assessment of the potential for surface rupture indicates that the probability is low (10,000- to 20,000-year recurrence interval), this site would not be considered adequate for a new nuclear facility (DOE 1999a). High-precision geologic mapping has connected the fault displacement at the CMR Building with marker-horizon displacements located 0.25 miles (0.4 kilometers) away in North Twomile Canyon and 0.5 miles (0.8 kilometers) away in Twomile Canyon, southwest of the CMR Building (LANL 1999). A concentration of secondary fault features in the southeast corner of TA-3 is inferred to define the southern end of the Rendija Canyon Fault (DOE 1999a). If the Rendija Canyon Fault zone extends southward along strike beyond its identified position, it would encroach upon TA-6 south of TA-3 (see Figure 3–5). More recent mapping by the LANL Seismic Hazards program, however, suggests that the Rendija Canyon faulting in TA-3 becomes diffuse and ceases in the vicinity of Twomile Canyon (Lewis 2002).

The Rendija Canyon Fault zone lies 0.8 miles (1.3 kilometers) northwest of TA-55 (see Figure 3–5). TA-55 is located within an area of relatively simple structure where virtually no fault deformation can be documented (LANL 1999). Detailed mapping has shown that the closest fault (not shown on Figure 3–5) is located 0.28 miles (0.45 kilometers) west of the Plutonium Facility (DOE 1999a).

As mapped, the Guaye Mountain Fault zone dies out within the Los Alamos town site approximately 2 miles (3.2 kilometers) north-northeast of TA-55; it has not been identified within LANL. Another LANL Seismic Hazards mapping project is ongoing in the central portion of the site (Gardner 2002).

Estimates of the most recent movements along the faults are based on trench studies exposing fault displacements of surficial geologic units. Based on radiocarbon dates obtained from charcoal found in fracture fill, a seismic event caused displacement within the Pajarito Fault zone sometime prior to 8,000 years ago (LANL 2001c). Detailed study in a seismic trench excavated near the new Emergency Operations Center (EOC) in TA-69 (see Figure 3–2) indicates that the most recent paleoseismic event in this area occurred about 8,600 years ago (LANL 2002c). Radiocarbon analyses from faulted and overlying alluvial units indicate that movement on the Guaje Mountain Fault occurred between 4,200 and 6,500 years ago (LANL 1990). The most recent seismic event on the Rendija Canyon Fault is poorly constrained between 8,000 and 23,000 years ago (Wong et al. 1995).

A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years (10 CFR Part 100, Appendix A). Therefore, the three major faults in Los Alamos County are considered active and capable per the U.S. Nuclear Regulatory Commission definition of the term as used for seismic safety.

3.5.1.3 Seismicity

Although the LANL region is within an intra-continental rift zone, the area demonstrates low seismicity compared to regions bordering on active continental plate boundaries such as southern California. For example, since 1973 only 6 earthquakes have been recorded within a 62-mile (100-kilometer) radius of TA-3 at LANL (USGS 2002a). In the same period, the San Francisco area experienced 1,161 earthquakes by comparison (USGS 2002b). The LANL-area earthquakes ranged in magnitude from 1.6 to 4.5 while the San Francisco-area earthquakes ranged from 1.0 to 7.1.

From 1873 to the present, 46 earthquakes have occurred within 62 miles (100 kilometers) of TA-3 at LANL (USGS 2002c). Recurrence intervals for these earthquakes ranged from same-day events to a maximum of about 20 years. The closest recorded earthquake to TA-3 occurred on August 17, 1952. The epicenter of this earthquake was located approximately 5 miles (8 kilometers) south-southeast of TA-3. This earthquake predated magnitude determination but had a reported Modified Mercalli Intensity (MMI) of V. For reference, Table A-6 in Appendix A shows the MMI scale of observed earthquake effects and compares it with measures of earthquake magnitude and peak ground acceleration. The largest recorded earthquake within 62 miles (100 kilometers) of TA-3 at LANL was the May 1918 Cerrillos Earthquake. The epicenter of this earthquake was located 31 miles (50 kilometers) southeast of TA-3 and had a reported MMI of VII. The most recent earthquake occurred on December 25, 1988, at a distance of 56 miles (90 kilometers) south-southeast of TA-3. The magnitude was measured at 2.8 (USGS 2002a).

Seismic hazard analysis demonstrates that the highest seismic hazard at LANL would be to a site built atop a trace of the Pajarito Fault (LANL 2001a). Along the Pajarito Fault system, an earthquake with a magnitude greater than or equal to 6 is estimated to have an annual probability of occurrence of once every 4,000 years. An earthquake with a magnitude greater than or equal to 7 is estimated to have an annual probability of occurrence of once every 100,000 years (LANL 1999).

Measures of peak acceleration indicate what an object on the ground would experience during an earthquake. This motion is expressed in units of gravitational acceleration (g). The hazard study of facilities in eight LANL TAs found that earthquakes having an annual probability of occurrence of once in every 10,000 years would cause a horizontal peak ground acceleration ranging from 0.53 g to 0.57 g (Wong et al. 1995). Further, the U.S. Geological Survey has developed seismic hazard metrics and associated maps that are used by the new *International Building Code*. The National Earthquake Hazard Reduction Program maps are based on the estimated natural periods of structural vibration due to earthquake activity and depict maximum considered earthquake (MCE) ground motions of 0.2- and 1.0-second spectral acceleration, respectively, based on a 2 percent probability of exceedance in 50 years (corresponding to an annual probability of occurrence of about 1 in 2,500) (ICC 2000). The three alternative sites for the CMR Building are within a 1.25-mile- (2-kilometer-) wide area. Due to their proximity, calculated MCE ground motion values for the 3 sites are identical and range from 0.19 g for a 1.0-second spectral acceleration to 0.60 g for a 0.2-second spectral acceleration. The calculated peak ground acceleration for the given probability of exceedance at the site is 0.26 g (USGS 2002d). Maintenance and refurbishment activities at LANL are specifically intended to upgrade the seismic performance of older structures. Construction of new facilities must meet DOE Standard 1020-2002 that, in part, implements DOE Order 420.1, as superseded by DOE Order 420.1A. As stated in DOE Order 420.1A, DOE requires that nuclear or nonnuclear facilities be designed, constructed, and operated so that the public, the workers, and the environment are protected from the adverse impacts of natural phenomena hazards, including earthquakes. DOE Order 420.1A, Section 4.4, stipulates the natural phenomena hazards mitigation requirements for DOE facilities and specifically provides for the reevaluation and upgrade of existing DOE facilities when there is a significant degradation in the safety basis for the facility.

During seismic events, facilities near a cliff edge or in a canyon bottom below are potentially susceptible to slope instability, rock falls, and landslides. Slope stability studies have been performed at LANL facilities where a hazard has been identified. As for other geologic hazards due to seismic activity, the potential for land subsidence and soil liquefaction at LANL are considered low and negligible, respectively.

3.5.1.4 Economic Geology

No active mines, mills, pits, or quarries exist in Los Alamos County or at LANL. Rock and mineral resources, however, including sand, gravel, and volcanic pumice are mined throughout the surrounding counties. Sand and gravel are primarily used in construction for road building. Pumice aggregate is used in the textile industry to soften material. Pumice is also used as an abrasive, for building blocks, and in landscaping. The major sand and gravel quarry in the area is located in the lower member of the Puye Formation. The welded and harder units of the Bandelier Tuff are suitable as foundation rocks, structural and ornamental stone, or insulating material. Volcanic tuff has also been used successfully as aggregate in soil-cement subbases for roads.

3.5.2 Soils

Soils in Los Alamos County have developed from decomposition of volcanic and sedimentary rocks within a semi-arid climate and range in texture from clay and clay loam to gravel. Soils that form on mesa tops are well drained and range in thickness from 0 to 40 inches (0 to 102 centimeters). Those that develop in canyon settings can be locally much thicker. Soil erosion rates vary considerably at LANL due to the mesa and canyon topography. The highest erosion rates occur in drainage channels and on steep slopes. Roads, structures, and paved parking lots concentrate runoff. High erosion rates are also caused by past logging practices, livestock grazing, loss of vegetative cover, and decreased precipitation (DOE 1999a). The lowest erosion rates occur at the gently sloping central portions of the mesas away from the drainage channels. Soils at LANL are acceptable for standard construction techniques. No prime farmland soils have been designated in Los Alamos County (DOE 2002e).

In May 2000, the Cerro Grande Fire burned the east-facing slope of the Jemez Mountains immediately upslope of LANL. The fire also burned significant areas within the western and central portions of the site. The loss of ground cover vegetation due to the fire increased the potential for soil erosion in these areas. Following the fire, the U.S. Forest Service Burn Area Emergency Rehabilitation Team found no significant areas of hydrophobic (water repellent) soil conditions within LANL. Due to exposed soils in the Jemez Mountains upslope of LANL, prevention of possible flooding of high-risk LANL facilities during intense precipitation events became a high priority. The possibility for enhanced erosion will likely persist for some 3 to 5 years (DOE 2002e).

3.6 Surface and Groundwater Quality

3.6.1 Surface Water

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams (locally these ordinarily dry stream beds are known as "arroyos"). 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 snowmelt reaches the Rio Grande, the major 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. Major watersheds in the LANL region are shown in **Figure 3–6**. 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 about 41 acre-feet (51,000 cubic meters). The reservoir water was used for recreation, swimming, fishing, and landscape irrigation in the Los Alamos town site until the Cerro Grande Fire occurred in 2000; the reservoir is now used as a floodwater and silt retention structure and is closed to the public (DOE 2000b). 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. Intermittent streams within LANL boundaries are not classified, but are protected by the State of New Mexico for livestock watering and wildlife habitat use (NMAC 20.6.4.10). 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.

Most of LANL effluent is discharged into normally dry arroyos, and this LANL effluent discharge is required to meet effluent limitations under the National Pollutant Discharge Elimination System (NPDES) permit program that requires routine effluent monitoring.

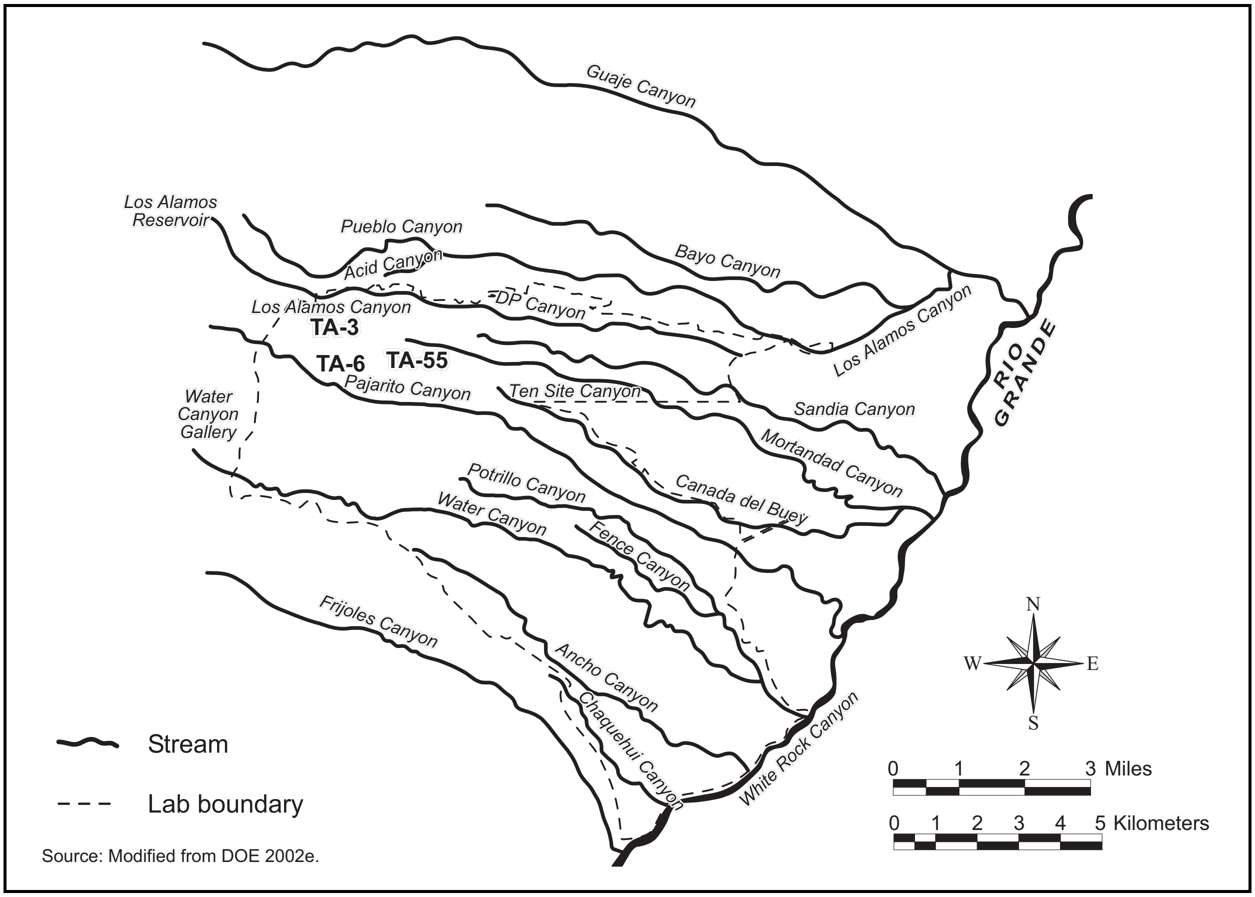

Figure 3–6 Surface Water Features at LANL

Therefore, the water quality of the intermittent streams is more characteristic of the quality of these discharges than of natural runoff, as reflected in the results of 2001 surface water and runoff monitoring. LANL's current NPDES permit (No. NM0028355), which was reissued in December 2000, covers all onsite industrial and sanitary effluent discharges. DOE and UC are co-permittees under the permit. As a result of an outfall reduction program, the number of outfalls requiring monitoring under the permit was reduced from 36 (including one sanitary outfall from the TA-46 Sanitary Wastewater Systems [SWS] Facility and 35 industrial wastewater outfalls) to 21 in the recently reissued permit. This reduction was achieved by removing process flows for seven industrial outfalls and completing the lease transfer of the drinking water system, including nine associated outfalls, to Los Alamos County. During 2001, permit compliance was determined from analysis of 1,085 industrial outfall samples and 134 samples from the SWS Facility (Outfall 13S) for such parameters as metals, radionuclides, and conventional parameters (such as pH and total suspended solids). Monitoring results are submitted to EPA and to the NMED. The NPDES permit compliance rate for all discharge points was nearly 100 percent, with a total of just 4 industrial outfall samples exceeding permit limits. These included one sample from the TA-3 Power Plant outfall (NPDES Outfall 001) in February 2001 that exceeded both the daily maximum and daily average effluent limit for total suspended solids. In addition, one sample from the TA-16 High-Explosive Waste Treatment Facility outfall (NPDES Outfall 05A055) exceeded the upper limit for pH in March 2001, and one sample from the TA-15 DARHT Cooling Tower outfall (NPDES Outfall 03A185) exceeded the water quality-based effluent limitation for selenium in September 2001. In all four cases, the cause of the effluent limitation exceedance was investigated and a corrective action was implemented (LANL 2002c). Industrial and sanitary effluent management is discussed further in Section 3.12.7.

LANL also operated under 11 NPDES stormwater discharge permits in 2001, including 10 issued for specific construction projects and 1 site-wide NPDES Storm Water Multi-Sector General Permit for Industrial Dischargers for which DOE and UC are also co-permittees. As required under this general permit, LANL staff performed stormwater monitoring in 2001 and developed and implemented 20 stormwater pollution prevention plans for its industrial activities (LANL 2002c).

LANL staff monitors surface waters from regional and Pajarito Plateau stations to evaluate the environmental effects of facility operations. Historical activities and resulting effluent discharges have affected water courses and associated sediments particularly in Acid, Pueblo, Los Alamos, and Mortandad Canyons and, consequently, continue to affect surface water and runoff quality in these areas. Surface water grab samples are collected annually from locations where effluent discharges or natural runoff maintains stream flow. Runoff samples are also collected and, since 1996, they have been collected using stream gauging stations, some with automated samplers. Samples are collected when a significant rainfall event causes flow in a monitored portion of a drainage. Many runoff stations are located where drainages cross the LANL boundaries. Detailed information on surface water and stormwater runoff monitoring, including analytical results, are contained in the annual site environmental report (LANL 2002c).

Among the environmental effects produced by the Cerro Grande Fire was an increased potential for stormwater runoff through the canyons that cross LANL property as a result of the loss of vegetation and soil organic matter. It is expected that soil erosion rates and corresponding sediment loads in runoff from denuded watersheds will be much higher than prefire levels for many years resulting in the potential for sediment and debris-laden runoff to reach the Rio Grande. It is also likely that runoff and ambient water quality in canyon drainages will be temporarily reduced by the increase in suspended sediment and by the liberation of organic nitrogen from fire-burned soils, the latter of which can also impact shallow groundwater (DOE 2000b).

UC at LANL has delineated all 100-year floodplains within LANL boundaries, which are generally associated with canyon drainages. 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 lite 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 designated "low hazard" or "no hazard." Overall, most laboratory development is on mesa tops, and development within canyons is light. Nevertheless, for practical purposes, the Cerro Grande Fire increased the extent of all delineated floodplains in and below burned watershed areas (predominantly Los Alamos, Sandia, Mortandad, Pajarito, and Water Canyons) due to vegetation loss. More stormwater runoff reaches the canyon bottoms and could subject LANL facilities located within or near the prefire delineated floodplain areas to increased erosion or sediment and debris deposition (DOE 2000b).

TA-3 is situated on a portion of South Mesa and above the upper reaches of Sandia and Mortandad Canyons that border the area on the east. Twomile Canyon, which converges with Pajarito Canyon south and east of TA-3 near the border of TA-55 with TA-6, abuts TA-3 on the south and west. Los Alamos Canyon borders TA-3 to the north. Since the area is heavily developed, surface drainage primarily occurs as sheet flow runoff from the impervious surfaces within the complex either east toward Sandia and Mortandad Canyons or south and west toward Twomile Canyon. Only a small portion of the northern part of the area drains toward Los Alamos Canyon (USGS 1984). No developed areas of TA-3 lie within the delineated 100-year floodplains associated with Sandia and Mortandad Canyons. The associated 100-year floodplains are mapped as occupying the respective canyon bottom headlands originating in the eastern portion of TA-3 (DOE 2002d). In general, stream flow within the canyons is ephemeral in nature. A short reach of the upper part of Sandia Canyon flows continuously, due in part to discharges from the TA-3 Power Plant outfall (NPDES Outfall 001) that consists of cooling water from the power plant and recycled, treated effluent from the TA-46 SWS Facility. Mortandad Canyon also receives natural runoff as well as effluent from several NPDES outfalls, including from the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50 (DOE 1999a, LANL 2002c). In addition, cooling tower and related effluents are discharged to Sandia Canyon from four TA-3 facility outfalls and to Mortandad Canyon from two TA-3 facility outfalls, including from the CMR Building via NPDES Outfall 03A-021 (EPA 1999a, EPA 2000, LANL 2002d).

TA-6 encompasses a largely undeveloped area of Twomile Mesa situated between Twomile Canyon to the north and the larger Pajarito Canyon to the south (USGS 1984). As such, surface water drainage across TA-6 generally follows the shallow arroyos that convey runoff to the east and southeast to the canyons.

TA-55 is located on a narrow mesa (Mesita del Buey) about 1 mile (1.6 kilometers) southeast of TA-3. The mesa is flanked by Mortandad Canyon to the north and Twomile Canyon to the south (USGS 1984). Like TA-3, the site is largely comprised of a heavily developed facility complex with surface drainage primarily occurring as sheet flow runoff from the impervious surfaces within the complex. No developed portions of the complex are located within a delineated floodplain. One TA-55 facility discharges cooling tower blowdown directly to Mortandad Canyon (via NPDES Outfall 03A181) (EPA 1999b, EPA 2001). The RLWTF at TA-50, as mentioned above, specifically receives and treats plutonium processing and other wastes from TA-55 facilities with effluent discharged via NPDES Outfall 051 to Mortandad Canyon (LANL 2002c, LANL 2002d).

3.6.2 Groundwater

Groundwater in the Los Alamos area occurs as perched groundwater near the surface in shallow canyon bottom alluvium and at deeper levels in the main (regional) aquifer (LANL 2002c). All groundwater underlying LANL and the vicinity having a total dissolved solids concentration of 10,000 milligrams per liter (mg/L) or less is considered a potential source of water supply for domestic or other beneficial use (NMAC 20.6.2.3000). Alluvial groundwater bodies within

LANL boundaries have been primarily characterized by drilling wells on a localized basis where LANL operations are conducted. Wells in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey indicate the presence of continually saturated alluvial groundwater bodies. Intermediate perched groundwater bodies of limited extent are known to occur within the conglomerates and basalts 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, discharged at spring heads; and on the western portion of the Pajarito Plateau (LANL 2002c).

The locations and extent of perched groundwater bodies have not been fully characterized at LANL, but investigations continue, and unidentified perched aquifers may exist. The depth to perched groundwater from the surface ranges from approximately 90 feet (27 meters) in the middle of Pueblo Canyon to about 450 feet (137 meters) in lower Sandia Canyon. The regional aquifer exists in the sedimentary and volcanic rocks of the Española Basin, with a lateral extent from the Jemez Mountains in the west to the Sangre de Cristo Mountains in the east (see Figure 3–4). The hydrostratigraphic (water-bearing) units comprising the regional aquifer include the interconnected Puye Formation and the Tesuque Formation of the Santa Fe Group, with the top of the aquifer originating in the Cerros del Rio Formation, rather than in the Puye Formation, in some locations. Groundwater flow paths are conceptually illustrated in Figure 3–4. Groundwater flow is generally to the east.

The regional aquifer is hydraulically separated for practical purposes from the overlying perched alluvial and intermediate depth perched groundwater bodies by unsaturated volcanic tuff and sedimentary strata, with the regional water table surface lying at a depth that varies from approximately 1,200 feet (366 meters) along the western boundary of the Pajarito Plateau to approximately 600 feet (183 meters) along its eastern edge. Thus, these hydrogeologic conditions tend to insulate the regional aquifer from near-surface waste management activities. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande.

Recharge of the regional aquifer has not been fully characterized and sources are uncertain; data suggest that the regional aquifer of the Española Basin is not strongly interconnected across its extent. Recent investigations further suggest that the majority of water pumped to date has been from storage, with minimal recharge of the regional aquifer. While the regional aquifer is present beneath all watersheds across the LANL region, it is also generally considered to receive negligible recharge from surface water streams in the watersheds. Springs in the LANL area originate from alluvial and intermediate perched groundwater bodies and the regional aquifer and occur in the Guaje, Pueblo, Los Alamos, Pajarito, Frijoles, and White Rock Canyon watersheds. Some 27 springs discharge from the regional aquifer into White Rock Canyon. A perched aquifer yields a relatively high flow to a former potable water supply gallery in Water Canyon (LANL 2002c).

Short-term effects of the Cerro Grande Fire on LANL groundwater resources include a potential increase in the prevalence of perched groundwater and springs. Also, as discussed for surface water, the liberation of organic nitrogen from burned soils could impact shallow groundwater in the perched and alluvial zones, although the effects on deeper groundwater resources are not known (DOE 2000b).

Groundwater monitoring in support of groundwater management and protection efforts is conducted within and near LANL and encompasses the alluvial zone, intermediate perched groundwater zone, regional aquifer, and springs. The groundwater monitoring network for alluvial groundwater consists of shallow observation wells located in Mortandad, Los Alamos, Pueblo, and Pajarito Canyons and in Cañada del Buey. Perched groundwater is monitored from two test wells and one spring (specifically, the Water Canyon Gallery). The monitoring network for the regional aquifer includes 8 deep test wells completed by the U.S. Geological Survey, 12 deep supply wells that are part of the Los Alamos water supply system and produce water for all of LANL and the surrounding communities, and from numerous springs, including those in White Rock Canyon (LANL 2002c).

Effluent discharges have affected canyon bottom perched alluvial groundwater in Pueblo, Los Alamos, and Mortandad Canyons. Most notably, radionuclide constituents in effluents discharged to Mortandad Canyon from the RLWTF at TA-50 have often exceeded the DOE Derived Concentration Guides (DCGs) for public dose from drinking water. Nitrate also contained in the effluent has caused alluvial groundwater concentrations to exceed the New Mexico groundwater standard and EPA Maximum Contaminant Level (MCL) of 10 (mg/L). The nitrate source is nitric acid from plutonium processing at TA-55 that enters the TA-50 waste stream. A reverse osmosis and ultrafiltration treatment system that removes additional radionuclides and nitrate from the effluent began operation in April 1999. As a result, effluent discharges from the RLWTF now meet the DOE DCGs for public dose and drinking water standards for nitrate; the RLWTF effluent has met DOE DCGs continuously since December 10, 1999 (LANL 2002c).

Groundwater monitoring results for perched alluvial and intermediate-depth groundwater in 2001 were similar to previous years with groundwater near the location of current or historic liquid waste discharges showing elevated contaminant levels, including in Los Alamos and Mortandad Canyons. In past years, the levels of tritium, strontium-90, and gross beta in alluvial groundwater in Mortandad Canyon have usually exceeded EPA drinking water criteria. In 2001, strontium-90 exceeded the EPA MCL in two alluvial monitoring wells in Mortandad Canyon and was also detected in surface water in the canyon. None of the other monitored radiochemical parameters exceeded either the DOE DCGs or EPA MCLs. During 2001, nitrate concentrations in alluvial groundwater were below the New Mexico groundwater standard and EPA MCL, except for one downstream well in Mortandad Canyon. Two wells in Mortandad Canyon also exceeded the New Mexico standard of 1.6 mg/L for fluoride. Perchlorate, a nonradiological contaminant (with a provisional drinking water standard of 0.018 mg/L) was detected in groundwater in every alluvial groundwater well sampled in Mortandad Canyon, with a maximum concentration of 0.22 mg/L. The perchlorate source is the RLWTF effluent; however, a treatment system was installed in 2001 at the RLWTF to remove perchlorate from the facility's effluent (LANL 2002c).

For regional aquifer samples from wells and springs in 2001, the radiochemical results were generally below the DOE drinking water DCGs and the EPA or New Mexico standards applicable to a drinking water system, with most results near or below the analytical detection limit. This excludes relatively high detections of uranium isotopes and gross alpha emitters due to naturally occurring uranium. The only radionuclide consistently detected in samples from production wells or test wells within the regional aquifer is tritium, particularly beneath Los Alamos, Pueblo, and Mortandad Canyons. In 2001, groundwater samples taken from supply well O-1 had tritium concentrations averaging 31.6 pCi/L (maximum 40.2 pCi/L). While higher than background concentrations in the regional aquifer around LANL, maximum observed concentrations are about 500 times smaller than the EPA MCL (20,000 pCi/L). Tritium was either not detected or was found at background levels in other water supply wells. No high-explosive compounds or degradation products were detected in the regional aquifer in 2001, although LANL, along with regulatory agencies, continues to investigate detections of high-explosive constituents above EPA Health Advisory guidance values that were found beneath TA-16 in 1998 during drilling of characterization well R-25. Perchlorate was detected during 2001 from the O-1 water supply well at concentrations of 2 and 5 micrograms per liter (μg/L), depending on analytical method. The source of the perchlorate might be residual perchlorate from the now decommissioned radioactive liquid waste treatment plants that discharged effluents into upper Pueblo Canyon until 1964. Otherwise, no supply wells had any concentrations of nonradiochemical constituents exceeding drinking water limits (LANL 2002c). Additional information on groundwater monitoring, including analytical results, is presented in the annual site environmental report (LANL 2002c).

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 Los Alamos County, LANL, and Bandelier National Monument comes from the main aquifer. Water use is detailed in Section 3.3.4.

The depth to the top of the main aquifer is about 1,000 feet (300 meters) beneath the mesa tops in the central part of the Pajarito Plateau, which encompasses TA-3 and TA-6 (DOE 2002d). Groundwater within the main aquifer beneath the central plateau is expected to flow to the east and southeast. The depth to groundwater beneath TA-55 is approximately 1,280 feet (390 meters) and the flow direction is inferred as east and southeast (DOE 2002e). As discussed above, radioactive effluents from TA-3 and TA-55 are conveyed through RLWTF at the TA-50 wastewater treatment facility and then discharged to Mortandad Canyon. No industrial or radioactive effluents are generated at TA-6.

3.7 ECOLOGICAL RESOURCES

3.7.1 Terrestrial Resources

LANL lies within the Colorado Plateau Province. Ecosystems within the laboratory site itself are quite diverse, due partly to the increasing temperature and decreasing moisture along the approximately 12-mile (19-kilometer) wide, 5,000-foot (1,525-meter) elevational gradient from the peaks of the Jemez Mountains to the Rio Grande. Only a small portion of the total land area at LANL has been developed. In fact, only five percent of the site is estimated to be unavailable to most wildlife (because of security fencing). The remaining land has been classified into four major vegetation zones that are defined by the dominant plants present and occur within specific elevational zones. These include mixed juniper savannah (5,200 to 6,200 feet [1,600 to

1,900 meters]), piñon-juniper woodland (6,200 to 6,900 feet [1,900 to 2,100 meters]), ponderosa pine forest (6,900 to 7,500 feet [2,100 to 2,300 meters]), and mixed conifer forest (7,500 to 9,500 feet [2,300 to 2,900 meters]) (see **Figure 3–7**). The vegetative communities on and near LANL are very diverse, with over 900 species of vascular plants identified in the area. As noted in Section 3.2.1, the 1,000-acre (405-hectare) White Rock Canyon Reserve, located in the southeast portion of LANL, was dedicated in 1999 because of its ecological and cultural resources and research potential. DOE will continue to own and control access to the property. The National Park Service will cooperatively manage the reserve to enhance and ensure protection of habitat and wildlife (DOE 1999c).

Terrestrial animals associated with vegetation zones in the LANL area include 57 species of mammals, 200 species of birds, 28 species of reptiles, and 9 species of amphibians. Common animals found on LANL include the black-headed grosbeak (*Pheuclicus melanocephalus*), western bluebird (*Sialia mexicana*), elk (*Cervus elaphus*), and raccoon (*Procyon lotor*). The most important and prevalent big game species at LANL are mule deer (*Odocoileus hemionus*) and elk. Elk populations have increased in the area from 86 animals introduced in 1948 and 1964 to an estimated population of over 10,000 animals. Hunting is not permitted onsite. Numerous raptors, such as the red-tailed hawk (*Buteo jamaicensis*) and great-horned owl (*Bubo virginianus*), and carnivores, such as the black bear (*Ursus americanus*) and bobcat (*Lynx rufus*), are also found on LANL (DOE 1999c). A variety of migratory birds have been recorded at the site and are protected under the Migratory Bird Treaty Act.

In May 2000, the Cerro Grande Fire burned across 7,684 acres (3,110 hectares) of forest area within LANL (DOE 2002c). Fire suppression activities resulted in the clearing of an additional 130 acres (52 hectares). Depending on fire intensity, vegetation will either be replaced by new species or recover in a relatively short period. Where the fire intensity was high, it is likely that recolonization will be by other than the original species, with the possibility that exotic plants may predominantly occur in areas previously dominated by native species (DOE 2000b).

Throughout LANL's history, developments within various TAs have caused significant alterations in the terrain and the general landscape of the Pajarito Plateau. These alterations have resulted in significant changes in land use by most groups of wildlife, particularly birds and large mammals that have large seasonal and daily ranges. Certain projects required the segregation of large areas such as mesa tops and, in some cases, project areas were secured by fences around their perimeters. These alterations have undoubtedly caused some species of wildlife, such as elk and mule deer, to alter their land-use patterns by cutting off or changing seasonal or daily travel corridors to wintering areas, breeding and foraging habitats, and bedding areas (DOE 1996c). The Cerro Grande Fire dramatically altered the habitat of many animals. While initially eliminating or fragmenting the habitats of many animals (such as reptiles, amphibians, small mammals, and birds), the habitat for other species (such as large mammals) will increase or improve by the newly created foraging areas. During the fire, individuals of many species died. Population recovery is expected within the next several breeding seasons. Elk and mule deer populations are expected to increase in response to the additional foraging areas resulting from postfire vegetation regrowth (DOE 2000b).

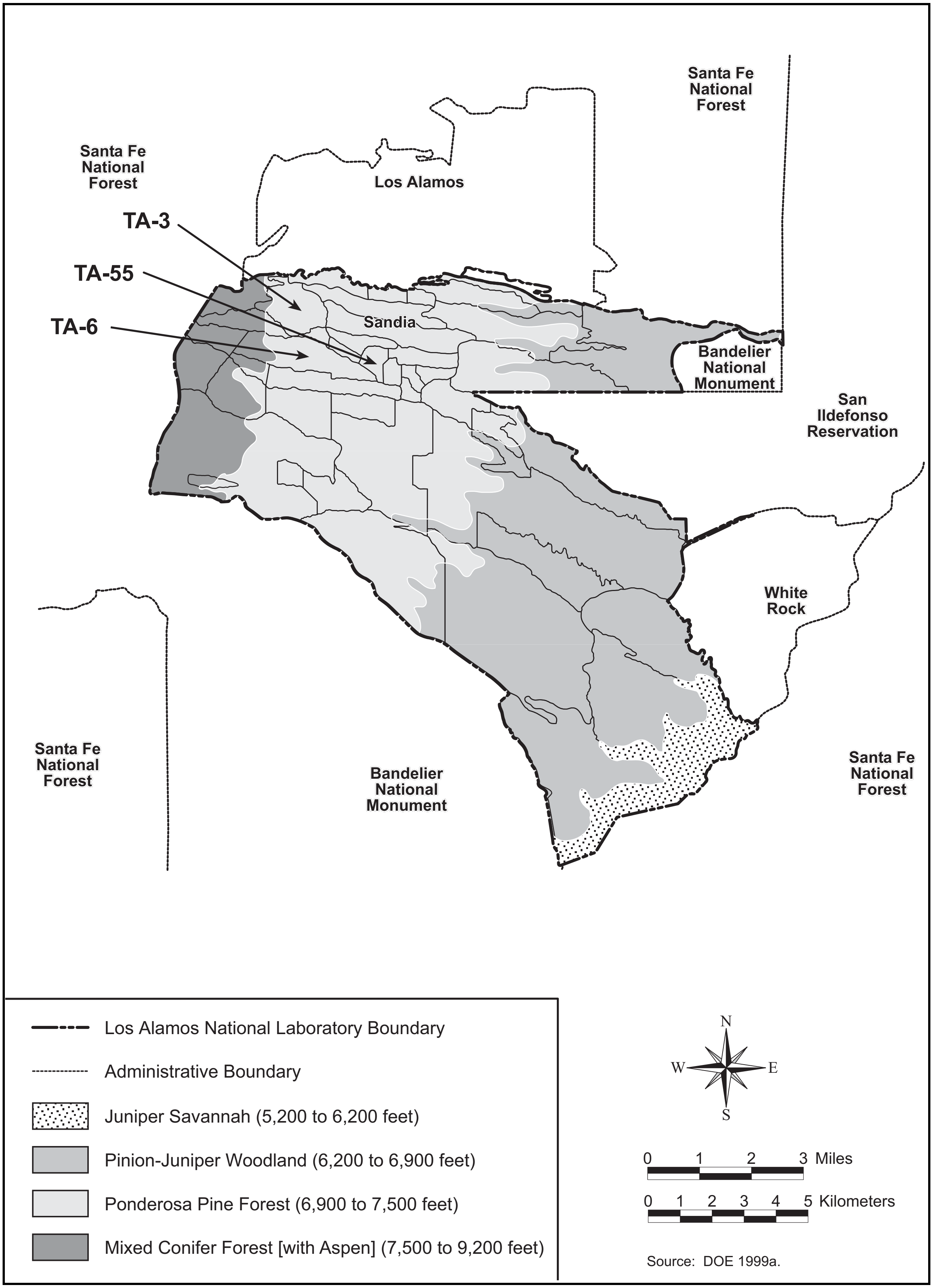

Figure 3–7 LANL Vegetation Zones

LANL recently proposed a Wildfire Hazard Reduction Project that would involve treating 250 acres (100 hectares) of mixed conifer, 6,150 acres (2,490 hectares) of ponderosa pine, and 3,600 acres (1,457 hectares) of piñon-juniper habitat in order to reduce future fire hazards (Marsh 2001). While the project would typically use both heavy equipment and hand tools, heavy equipment would not be used on slopes greater than 30 percent.

TA-3 is primarily located in the ponderosa pine forest vegetation zone, although the western-most portion of the area lies within the mixed conifer forest vegetation zone. Approximately 69 percent of the 357-acre (144-hectare) site is developed. Wildlife likely to be present in the area include elk, mule deer, raccoon, deer mouse (*Peromyscus maniculatus*), American robin (*Turdus migratorius*), Steller's jay (*Cyanocitta stelleri*), white breasted nuthatch (*Sitta carolinensis*), western bluebird (*Sialia mexicana*), and prairie lizard. Due to the presence of security fencing, no large animals are likely to be found within fenced portions of TA-3.

The eastern portion (approximately 80 percent) of TA-6 is located within the ponderosa pine forest vegetation zone, while the western portion falls within the mixed conifer forest vegetation zone. TA-6 encompasses 500 acres (202 hectares) of which only 1 percent is developed. Wildlife species found within TA-6 would be similar to those noted above for TA-3. Due to the undeveloped nature of the area, wildlife are free to migrate across the site.

TA-55 is located in the ponderosa pine forest vegetation zone; however, 43 percent of the 40-acre (16-hectare) site is developed. Animal species likely to be present in the area would be similar to those noted above for TA-3. Due to the presence of security fencing, no large animals would be found within developed portions of TA-55.

3.7.2 Wetlands

Wetlands in the LANL region provide habitat for reptiles, amphibians, and invertebrates (e.g., insects), and potentially contribute to the overall habitat requirements of a number of Federal- and State-listed species. The majority of the wetlands in the area are associated with canyon stream channels or are present on mountains or mesas as isolated meadows often in association with springs or seeps. There are also some springs bordering the Rio Grande within White Rock Canyon. Cochiti Lake, located downstream from LANL, supports lake-associated wetlands.

Wetlands occurring at LANL were identified in 1990 as part of the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory and subsequently as part of ongoing environmental work at the site. Twenty-seven wetlands totaling 77 acres (31 hectares) have been identified on the site with more than 95 percent of these located in the Sandia, Mortandad, Pajarito, and Water Canyon watersheds (DOE 2002c).

About 13 acres (5 hectares) of wetlands within LANL boundaries are caused or enhanced by process effluent wastewater from 21 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 stormwater and process water, contributed

108 million gallons (407 million liters) to wetlands within LANL boundaries. Nearly half of the outfalls are probable sources of drinking water for large mammals.

During the Cerro Grande Fire, 16 acres (6.5 hectares), or 20 percent of the wetlands occurring at LANL, were burned at a low or moderate intensity. No wetlands within LANL were severely burned. Secondary effects from the fire to wetlands may also occur as a result of increased runoff due to the loss of vegetation. Wetlands were not disturbed by fire suppression activities; however, a number of projects were undertaken after the Cerro Grande Fire to control runoff and erosion. Two projects involving the enlargement of culverts in lower Pajarito Canyon, one about 0.25 miles (0.4 kilometers) downstream from TA-18 and the other at State Road 4, resulted in removal of about 1.5 acres (0.6 hectares) of wetland vegetation composed primarily of willow (*Salix* spp.) trees. Wetland vegetation is likely to regenerate over the next several years if the area is not silted in or scoured away by flood waters (DOE 2000b).

There are 8 wetlands located within TA-3 that total 1.1 acres (0.44 hectares). This includes Sandia wetlands, LANL's largest wetlands, located within both TA-3 and TA-60. Vegetation associated within the area wetlands is characterized by the presence of species such as rush (*Juncus* spp.), willow, and broad-leafed cattail (*Typha latifolia* L). Wildlife associated with these wetlands include raccoon, red-winged black birds (*Agelauis phoenixe*), ravens (*Corvus corvax*), marsh wrens (*Cistothorus palustris*), song sparrows (*Melospiza melodia*), many-lined skinks (*Eumeces multivirgatus*), and canyon tree frogs (*Hyla arenicolor*).

There are no wetlands located within TA-6. However, there is a narrow band of riparian vegetation located along portions of the stream channel of Two Mile Canyon. Vegetation found along the stream includes coyote willow (*Salix exigua* Nutt.), water birch (*Betula occidentalis* Hook.), and inland rush (*Juncus interior* Wiegand). Animal species present are similar to those noted above for TA-3.

Three wetlands are located within TA-55, totaling 1.02 acres (0.41 hectares), all of which result from natural sources. Vegetation associated with these wetlands includes rush, willow, and broad-leafed cattail. Wildlife species using these areas are similar to those noted above for TA-3.

3.7.3 Aquatic Resources

While the Rito de Los Frijoles in Bandelier National Monument (located to the south of LANL) and the Rio Grande are the only truly perennial streams in the region, several of the canyon floors on LANL contain reaches of perennial surface water. Examples of perennial streams occur in lower Pajarito and Ancho Canyons, which flow to the Rio Grande. 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 (*Populus deltoides* Bartr. ex. Marsh, ssp. *wislizeni*, [S. Wats.] Eckenwalder), willow, and other water-loving plants are present in scattered locations at LANL, as well as along the Rio Grande in White Rock Canyon. The springs and streams at LANL do not support fish populations; however, many other species utilize these waters (DOE 1999c). For example, terrestrial wildlife use onsite streams for drinking and associated riparian habitat for nesting and feeding.

Aquatic habitat present within TA-3 and TA-55 is minimal and is associated with ponding within wetland areas. Animal species using these areas would be similar to those noted in Section 3.7.2. No aquatic areas exist within TA-6.

3.7.4 Threatened and Endangered Species

The USFWS is responsible for listing Federally-protected plants and animals as endangered, threatened, and candidate, under provisions of the Endangered Species Act of 1973, as amended, and for designating critical habitat necessary for their survival. Species previously listed as Category 2 candidate species (i.e., those for which listing was possibly appropriate) are now listed as species of concern. The state separates the regulatory authority for plants and animals between the New Mexico State Forestry Division and the New Mexico Game and Fish Department, respectively. The Forestry Division lists plants as endangered, sensitive, and review, while the Game and Fish Department designates animals as endangered and threatened. The U.S. Forest Service lists species for special management consideration on lands under their jurisdiction and protects these species under the authority of the Endangered Species Act of 1973. Only Federal and state threatened and endangered species are legally protected. Plants and animals receiving other designations do not receive legal protection, but should be considered during project planning.

A number of Federal and state protected and sensitive (rare or declining) species have been documented in the LANL region (see **Table 3–8**). These consist of two Federal endangered species (the black-footed ferret [*Mustela nigripes*], and southwestern willow flycatcher [*Empidonax traillii extimus*]), two Federal threatened species (the bald eagle [*Haliaeetus leucocephalus*] and Mexican spotted owl [*Strix occidentalis lucida*]), and 20 species of concern. Species listed as endangered, threatened, sensitive, or review by the State of New Mexico are also included in Table 3–8. No Federal critical habitat has been designated at LANL. However, areas of the Santa Fe National Forest near LANL have been designated as critical habitat for the Mexican spotted owl.

The results of the Cerro Grande Fire likely will not cause a long-term change to the overall number of Federally-listed threatened and endangered species inhabiting the region. However, the results of the fire likely will change the distribution and movement of various species, including the Mexican spotted owl. The areas off LANL that have been proposed as critical habitat suffered heavy damage during the Cerro Grande Fire. Specifically, two primary areas considered as critical habitat for the Mexican spotted owl located on Forest Service land near LANL suffered almost 100 percent vegetation mortality. The fire may also have long-term effects on the habitat of several State-listed species, including the Jemez Mountain salamander. As noted in Section 3.7.2, two projects undertaken after the fire to enlarge culverts in the lower Pajarito Canyon disturbed about 1.5 acres (0.6 hectares) of wetland vegetation composed primarily of willow trees. This wetland was potential habitat for the southwestern willow flycatcher at LANL; however, it was not a confirmed nesting or roosting habitat and was of marginal quality (DOE 2000b).

Table 3–8 Threatened, Endangered, and Other Sensitive Species of LANL

Common Name	*Scientific Name*	*Federal Status* [a]	*State Status*	*Potential to Occur* [b]
Mammals				
Black-footed ferret	*Mustela nigripes*	FE	-	Low
Spotted bat	*Euderma maculatum*	-	T	High
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*	-	T	Moderate
Western small-footed myotis bat	*Myotis ciliolabrum melanorhinus*	SOC	SOC	High
Little brown occult bat	*Myotis lucifugus occultus*	SOC	SOC	Moderate
Little brown bat	*Myotis lucifugus carissima*	SOC	SOC	Moderate
Fringed bat	*Myotis thysanodes thysanodes*	SOC	SOC	High
Yuma bat	*Myotis yumanensis yumanensis*	SOC	SOC	High
Long-legged bat	*Myotis volans interior*	SOC	SOC	High
Long-eared bat	*Myotis evotis evotis*	SOC	SOC	High
Townsend's pale big-eared bat	*Plecotus townsendii pallescens*	SOC	SOC	High
Big free-tailed bat	*Nyctinomops macrotis*	SOC	SOC	Moderate
Ringtail	*Bassariscus astutus*	SOC	SOC	High
Western spotted skunk	*Spilogale gracilis*	SOC	SOC	Moderate
Red fox	*Vulpes vulpes*	SOC	SOC	Moderate
Goat peak pika	*Ochotona princeps nigrescens*	SOC	SOC	Low
American marten	*Martes americana origenes*	SOC	SOC	Low
Birds				
Southwestern willow flycatcher	*Empidonax trailii extimus*	FE	E	Moderate
Bald eagle	*Haliaeetus leucocephalus*	FT	T	Moderate
Mexican spotted owl	*Strix occidentalis lucida*	FT	-	Moderate
Mountain plover	*Charadrius montanus*	PT	-	Low
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	C	-	Moderate
Baird's sparrow	*Ammodramus bairdii*	-	T	Low
Northern goshawk	*Accipiter gentilis*	SOC	SOC	Low
Loggerhead shrike	*Lanius ludovicianus*	SOC	SOC	Moderate
Gray vireo	*Vireo vicinior*	SOC	SOC	Moderate
Black swift	*Cypseloides niger borealis*	SOC	SOC	Low
Amphibians				
Western boreal toad	*Bufo boreas boreas*	C	E	Low
Jemez mountain salamander	*Plethodon neomexicanus*	-	T	Moderate
Fish				
Flathead chub	*Hybopsis gracilis*	SOC	SOC	Low
Invertebrates				
Pearly checkerspot butterfly	*Charidryas acastus acastus*	SOC	SOC	Low

Common Name	***Scientific Name***	***Federal Status*** [a]	***State Status***	***Potential to Occur*** [b]
Plants				
Mountain lily	*Lilium philadelphicum*	-	E	Moderate
Yellow lady's slipper orchid	*Cypripedium parviflorum* var. *pubescens*	-	E	Moderate
Heleborine orchid	*Epipactis gigantea*	-	S	Moderate
Checker-lily	*Fritillaria atropurpurea*	-	R	Moderate

[a] **Codes for Legal Status:**
FE = Federally endangered, species for which a final rule has been published in the *Federal Register* (FR) to list the species as endangered.
SOC = Species of Concern, species that have been proposed for listing in the past or could potentially be listed in the lifetime of the project. These species do not receive legal protection.
FE (Ex) = Federally endangered, but New Mexico population is an experimental nonessential population.
FT = Federally threatened, species for which a final rule has been published in the FR to list the species as threatened.
P = Proposed for listing.
T (State, animal) = Threatened, any animals species or subspecies that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico.
C = Candidate for listing, substantial information exists on biological vulnerability to support proposals to list as endangered or threatened.
E (State, animal) = Endangered, any animal species or subspecies whose prospects of survival or recruitment in New Mexico are in jeopardy.
E (State, plant) = Endangered, any plant species whose prospects of survival within the state are in jeopardy or are likely, within the foreseeable future, to become jeopardized.
S = Sensitive, any plant taxon that is considered to be rare because of restricted distribution or low numerical density.
R = Review, any plant taxon about which more information is needed. The species is either taxonomically questionable or poorly understood as to distribution or endangerment.

[b] **Potential to Occur**
High = The species is known to exist at LANL.
Moderate = Some species habitat components exist at LANL.
Low = Species habitat components do not exist at LANL.

Sources: Keller 2002, NMNHP 2002.

Habitat that is either occupied by Federally-protected species or that is potentially suitable for use by these species in the future has been delineated within LANL. The LANL Habitat Management Plan, implemented in 1998, identifies areas of environmental interest (AEI) for various Federally-listed threatened or endangered species. In general, an AEI consists of a core area that contains important breeding or wintering habitat for a specific species and a buffer area around the core area. The buffer protects the core area from disturbances that would degrade its value. The Plan defines the types and levels of activities that may be conducted within these areas. AEIs at LANL are managed and protected by DOE and UC because of their significance to biological or other resources. AEIs have been established for the Mexican spotted owl, bald eagle, and southwestern willow flycatcher (LANL 1998b). They have not been established for the whooping crane and black-footed ferret since suitable habitat for these species does not occur at LANL (LANL 2000b).

Although core and buffer AEIs for the Mexican spotted owl have been established within the northern half of TA-3, surveys have not identified this species as actually occurring within the area. The existing CMR Building does not fall within the AEI for the spotted owl. AEIs for the bald eagle and southwestern willow flycatcher do not coincide with TA-3.

Core and buffer areas for the Mexican spotted owl occur in the southern and eastern portions of TA-6. Surveys of these areas have not located any spotted owls. The CMRR Project facilities would be located within the central section of the site, which is outside of the designated

Mexican spotted owl AEI. AEIs for the bald eagle and southwestern willow flycatcher do not coincide with TA-6.

TA-55 falls completely within core and buffer AEIs for the Mexican spotted owl; however, as is the case for TA-3 and TA-6, surveys have not identified any owls within the area. The location of the proposed CMRR Facility within TA-55 falls within both core and buffer areas for this species. AEIs for the bald eagle and southwestern willow flycatcher do not coincide with TA-55.

3.8 Cultural and Paleontological Resources

3.8.1 Prehistoric Resources

Prehistoric resources at LANL 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. Archaeological surveys have been conducted of approximately 90 percent of the land within LANL (with 85 percent of the area surveyed receiving 100 percent coverage) to identify the cultural resources. The majority of these surveys emphasized prehistoric Native American archaeological sites, including pueblos, rock shelters, rock art, water control features, trails, and game traps. A total of 1,777 prehistoric sites have been recorded at LANL, of which 439 have been assessed for potential nomination to the National Register of Historic Places. Of these, 379 sites were determined to be eligible, 60 sites ineligible, and two of undetermined status. The remaining 1,338 sites, which have not been assessed for nomination to the National Register of Historic Places, are assumed to be eligible until assessed. Three areas in the vicinity of LANL have been established as National Register of Historic Places sites or districts: Bandelier National Monument, Puye Cliffs Historic Ruins, and the Los Alamos Scientific Laboratory National Historic District. The latter is the location of former TA-1 in downtown Los Alamos, which includes Fuller Lodge, the Bathtub Row Houses, and the Ice House Monument at Ashley Pond.

The Cerro Grande Fire directly impacted 215 prehistoric sites. Effects to cultural resource sites included effects originating from burned-out tree root systems forming conduits for modern debris and water to mix with subsurface archaeological deposits and for entry by burrowing animals. Also, snags or dead or dying trees have fallen and uprooted artifacts (DOE 2000b). Additionally, the leveling of a staging area in TA-49 during the fire destroyed one and damaged two other prehistoric sites. Areas at LANL burned by the Cerro Grande Fire have been surveyed for impacts and mitigation measures have been implemented.

TA-3 contains two prehistoric lithic scatter sires. The New Mexico State Historic Preservation Office has concurred that the sites are eligible for the National Register of Historic Places.

TA-6 contains one prehistoric one- to three-room structure. This site has yet to be assessed for eligibility status with regard to the National Register of Historic Places.

TA-55 contains no prehistoric sites. Within TA-48, a short distance from the TA-55 boundary (about 300 feet [100 meters]), there is a prehistoric site eligible for listing on the National Register of Historic Places.

3.8.2 Historic Resources

In April 2000, the DOE, NNSA entered into a programmatic agreement with the New Mexico State Historic Preservation Office concerning the management of LANL's historic properties (MOU DE-GM32-00AL77152). Historic resources present within LANL boundaries and on the Pajarito Plateau can be attributed to nine locally defined Periods: U.S. Territorial, Statehood, Homestead, Post Homestead, Historic Pueblo, Undetermined historic, Manhattan Project, Early Cold War, and Late Cold War. The number of sites identified from each period are as follows: 1 from the U.S. Territorial Period, 9 from the Statehood Period, 71 from the Homestead Period, 5 from the Post Homestead Period, 1 from the Historic Pueblo Period, 36 from the Undetermined Historic Period, 56 from the Manhattan Project Period, and 527 from the Early and Late Cold War Periods. Thus, a total of 706 historic sites have been identified at LANL.

The Cerro Grande Fire directly impacted 11 historic buildings and 56 historic sites. Structures and artifacts form the Homestead Period, Manhattan Project Period, and Cold War Period were adversely affected. The fire destroyed virtually all-wooden buildings associated with the Homestead Period, and the burned properties were largely reduced to rubble. V-Site, one of the last vestiges of the Manhattan Project Period remaining at Los Alamos, was the location where work was conducted on the Trinity device. This important historical site was partially destroyed by the fire. Also, a historic structure and building at TA-2 were adversely impacted by post-fire activities (DOE 2000b).

TA-3 contains 43 historic resources. The New Mexico State Historic Preservation Office has determined that two of these resources are eligible for the National Register of Historic Places. The remaining 41 have yet to be assessed for eligibility status. Under the programmatic agreement with the New Mexico State Historic Preservation Office, the CMR Building is part of a subset of LANL's buildings and structures dating from 1942 to 1963 (Manhattan Project and early Cold War Era to the signing of the Limited Test Ban Treaty) that will be identified and evaluated for effects from proposed LANL undertakings. Based on the historical importance of CMR Building operations, it is anticipated that the CMR Building will be determined eligible for listing on the National Register of Historic Places.

TA-6 contains 20 historic resources. The New Mexico State Historic Preservation Office has concurred that four of these resources are eligible and two are not eligible for the National Register of Historic Places. The remaining 14 have yet to be assessed for eligibility status.

TA-55 contains 11 historic resources, 1 of which the New Mexico State Historic Preservation Office has concurred with the determination that it is eligible for the National Register of Historic Places, and 2 have been determined to be not eligible. The remaining eight have yet to be assessed.

3.8.3 Traditional Cultural Properties

Consultations to identify traditional cultural properties were conducted with 19 Native American tribes in connection with the preparation of the *LANL SWEIS*. Two Hispanic communities were also contacted. These consultations identified 15 ceremonial and archaeological sites, 14 natural features, 10 ethnobotanical sites, 7 artisan material sites, and 8 subsistence features at LANL. 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. Additional consultations regarding traditional cultural properties are ongoing for LANL and other New Mexico properties administered by NNSA and DOE.

3.8.4 Paleontological Resources

A single paleontological artifact has been discovered at a site within LANL boundaries; however, in general the near-surface stratigraphy is not conducive to preserving plant and animal remains. The near-surface materials at LANL are volcanic ash and pumice that were extremely hot when deposited; most carbon-based materials (such as bones or plant remains) would likely have been vaporized or burned if present. No palentological resources have been identified in the close vicinity of TA-3, -6, or -55.

3.9 SOCIOECONOMICS

Statistics for population, housing, community services, and local transportation are presented for the region of influence, a three-county area in New Mexico made up of Los Alamos, Santa Fe, and Rio Arriba counties **(Figure 3–8)**. The majority (89.7 percent) of all LANL employees reside in the Tri-County area (see **Table 3–9**).

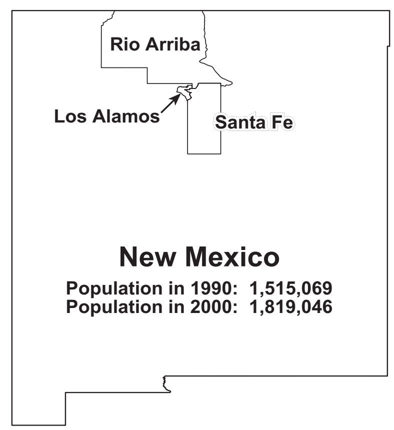

Figure 3–8 Counties in the LANL Region of Influence

3.9.1 Regional Economic Characteristics

Between 1990 and 1999, the civilian labor force in the Tri-County area increased 14.4 percent to 92,189. In 1999, the annual unemployment average in the region of influence was 3.7 percent, which was less than the annual unemployment average of 5.6 percent for New Mexico (DOL 2000).

In 1997, government agencies and enterprises represented the largest sector of employment in the Tri-County area (35.6 percent). This was followed by service activities (29.5 percent) and retail (20.7 percent). The totals for these employment sectors in New Mexico were 25.1 percent, 27.5 percent, and 23.7 percent, respectively (NMDL 1998).

Table 3–9 Distribution of Employees by Place of Residence in the LANL Region of Influence in 1996

County	*Number of Employees* [a]	*Total Site Employment (percent)*
Los Alamos	5,381	50.8
Rio Arriba	2,149	20.3
Santa Fe	1,967	18.6
Region of influence total	9,497	89.7

[a] Data not available for nontechnical contractors or consultants.
Source: DOE 1999a.

3.9.2 Demographic Characteristics

The 2000 demographic profile of the region of influence population and income information is included in **Table 3–10**. Persons self-designated as minority individuals comprise 57.9 percent of the total population. This minority population is composed largely of Hispanic or Latino and American Indian residents. The Pueblos of San Ildefonso, Santa Clara, San Juan, Nambe, Pojoaque, Tesuque, and part of the Jicarilla Apache Indian Reservation are included in the region of influence.

Table 3–10 Demographic Profile of the Population in the LANL Region of Influence

	Los Alamos County	*Rio Arriba County*	*Santa Fe County*	*Region of Influence*
Population				
2000 population	18,343	41,190	129,292	188,825
1990 population	18,115	34,365	98,928	151,408
Percent change from 1990 to 2000	1.3	19.9	30.7	24.7
Race (2000) (percent of total population)				
White	90.3	56.6	73.5	71.5
Black or African American	0.4	0.3	0.6	0.5
American Indian and Alaska Native	0.6	13.9	3.1	5.2
Asian	3.8	0.1	0.9	1.0
Native Hawaiian & Other Pacific Islander	0.0	0.1	0.1	0.1
Some other race	2.7	25.6	17.7	18.0
Two or more races	2.3	3.3	4.1	3.7
Percent minority	17.9	86.4	54.5	57.9
Ethnicity (2000)				
Hispanic or Latino	2,155	30,025	63,405	95,585
Percent of total population	11.7	72.9	49.0	50.6

Source: DOC 2001.

Income information for the LANL region of influence is included in **Table 3–11**. There are significant differences in the income levels among the three counties, especially between Rio Arriba County, at the low end, and Los Alamos County, at the upper end. The median household income in Los Alamos County is over double that of the New Mexico State average, while the median household income of Rio Arriba County is below the state average. In 1999, only 2.9 percent of the population in Los Alamos County was below the official poverty level, while in Rio Arriba County, 20.3 percent of the population was below the poverty level (DOC 2003).

Table 3–11 Income Information for the LANL Region of Influence

	Los Alamos County	*Rio Arriba County*	*Santa Fe County*	*New Mexico*
Median household income 1999 ($)	78,993	29,429	42,207	34,133
Percent of persons below poverty line (1999)	2.9	20.3	12.0	18.4

Source: DOC 2003.

3.9.3 Housing and Community Services

Table 3–12 lists the total number of occupied housing units and vacancy rates in the region of influence. In 1990, the Tri-County area contained 63,386 housing units, of which 56,514 were occupied. The median value of owner-occupied units was $125,100 in Los Alamos County, which is higher than the other two counties and over twice the median value of units in Rio Arriba County. The vacancy rate was lowest in Los Alamos County (4.7 percent) and highest in Rio Arriba County (20.2 percent). During the Cerro Grande Fire in 2000, approximately 230 housing units were destroyed or damaged in northern portions of Los Alamos County (DOE 2000b). As a result, vacancy rates have decreased.

Community services include public education and healthcare (including hospitals, hospital beds, and doctors). In 1998, student enrollment totaled 26,290 in the region of influence and the average student-to-teacher ratio was 17:1 (Department of Education 2000). In 1998, three hospitals served the Tri-County area, with a hospital bed-to-population ratio of 1.9 hospital beds per 1,000 persons. The average region of influence's physician-to-population ratio was 2.7 physicians per 1,000 persons (Gaquin and DeBrandt 2000).

Table 3–12 Housing and Community Services in the LANL Region of Influence

	Los Alamos County	*Rio Arriba County*	*Santa Fe County*	*Region of Influence*
Housing (1990) [a]				
Total units	7,565	14,357	41,464	63,386
Occupied housing units	7,213	11,461	37,840	56,514
Vacant units	352	2,896	3,624	6,872
Vacancy rate (percent)	4.7	20.2	8.7	10.8
Median value ($)	125,100	57,900	103,300	Not available
Public Education (1998) [b]				
Total enrollment	3,674	6,917	15,699	26,290
Student-to-teacher ratio	14.8:1	18:1	17.2:1	17:1
Community Healthcare (1998) [c]				
Hospitals	1	1	1	3
Hospital beds per 1,000 persons	2.9	2.1	1.7	1.9
Physicians per 1,000 persons	2.6	0.9	3.3	2.7

Sources:
[a] DOE 1999a.
[b] Department of Education 2000.
[c] Gaquin and DeBrandt 2000.

3.9.4 Local Transportation

Motor vehicles are the primary means of transportation to LANL. Regional transportation route(s) to LANL include: Albuquerque and Santa Fe – I-25 to U.S. 84/285 to NM 502; from Española – NM 30 to NM 502; and from Jemez Springs and western communities – NM 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to NM 4 to NM 502 (see Figure 3–1). 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.

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 Española. The nearest commercial rail connection is at Lamy, New Mexico, 52 miles (83 kilometers) southeast of LANL. LANL 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 under a lease agreement. The airport is located parallel to East Road at the southern edge of the Los Alamos community. Until January 1996, the airport provided regular passenger and cargo service through specialized contract carriers such as Ross Aviation, which were under contract to DOE to provide passenger and cargo air service to Los Alamos County and LANL. DOE continues to negotiate with various companies to provide for service to the Los Alamos Airport.

3.10 ENVIRONMENTAL JUSTICE

Under Executive Order 12898, DOE is responsible for identifying and addressing disproportionately high and adverse impacts on minority or low-income populations. As discussed in Appendix D, minority persons are those who identify themselves as Hispanic or Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, or multi-racial (with at least one race designated as a minority race under Council on Environmental Quality (CEQ) Guidelines (CEQ 1997)). Persons whose income is below the Federal poverty threshold are designated as low income.

There are three locations at LANL being considered for the continued operation of CMR activities. These are TA-3, TA-6, and TA-55 (see Section 1.4). **Figure 3–9** shows locations for these activities. The location for the new CMRR Facility at TA-55 is approximately 1.2 miles (1.9 kilometers) southeast of the existing CMR Building. The location for the new CMRR Facility at TA-6 is approximately 0.5 miles (0.8 kilometers) south of the existing CMR Building.

Populations at risk include persons who live within 50 miles (80 kilometers) of the existing CMR Building or the proposed locations for CMRR Facilities at TA-55 or TA-6. As indicated in **Figure 3–10**, eight counties are included or partially included in the potentially affected areas surrounding these locations: Bernalillo, Los Alamos, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe, and Taos.

Figure 3–10 shows the minority and non-minority populations by county living within the potentially affected area surrounding the existing CMR Building in the year 2000. Because CMRR Facility locations are relatively close to one another, the minority and non-minority populations living in potentially affected areas surrounding the TA-6 and TA-55 sites differ from those surrounding the existing CMR Building at TA-3 by less than three percent. Minorities living in the 8 counties comprised approximately 53 percent of the total population at risk. Nearly 70 percent of the total and minority populations at risk lived in Sandoval and Santa Fe counties.

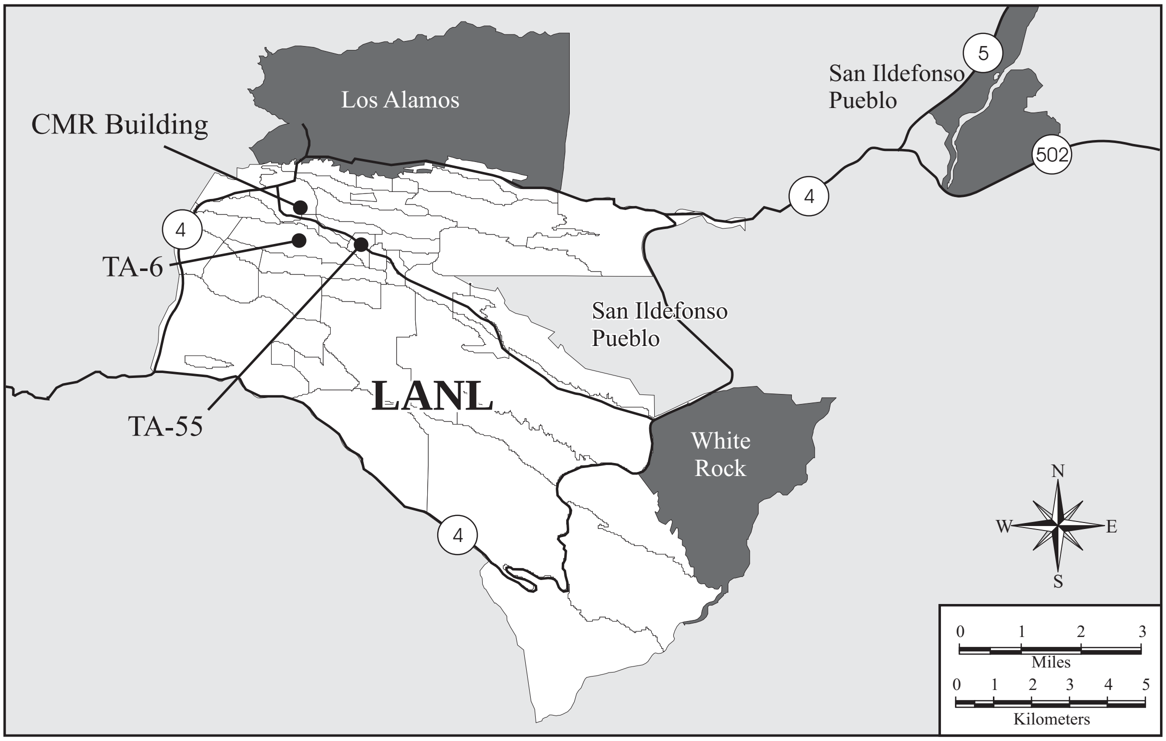

Figure 3–9 CMR Building and Sites for the New CMRR Facility

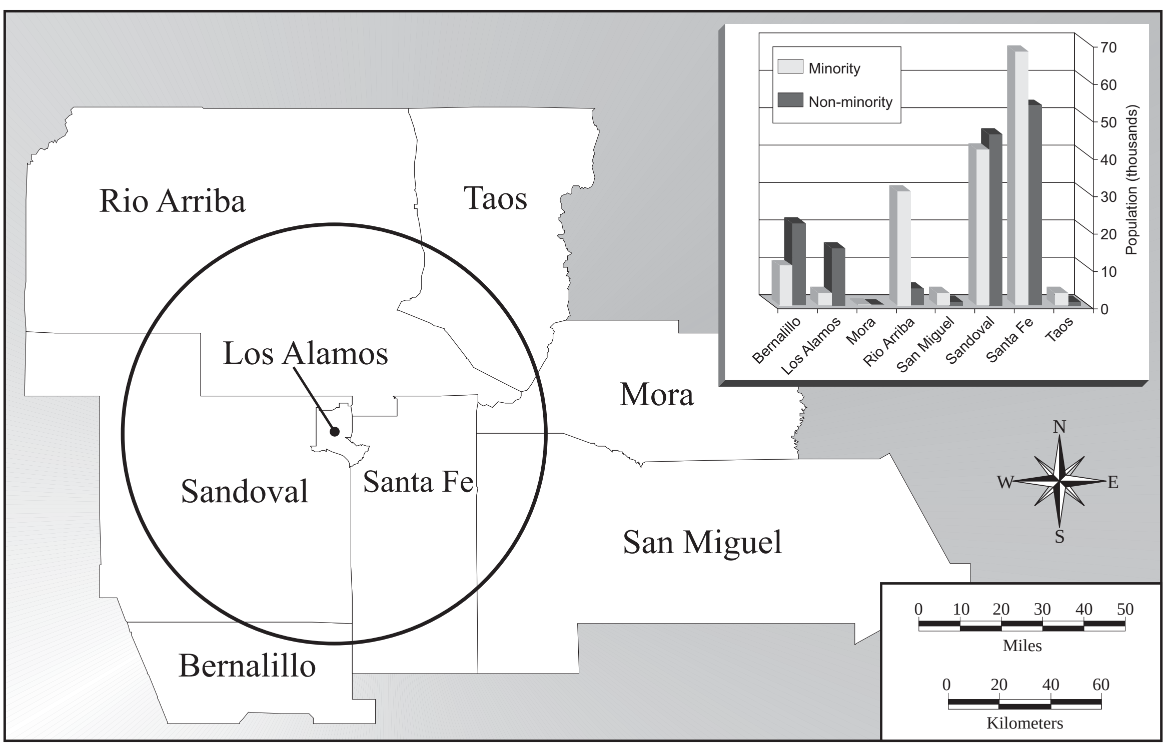

Figure 3–10 Minority and Non-Minority Populations by County Living in the Potentially Affected Area

Figure 3–11 shows cumulative minority populations as a function of distance from TA-3, TA-6, and TA-55. Values along the vertical axis of Figure 3–11 show the minority population (in thousands) residing within a given distance from these technical areas. Moving outward from locations, the cumulative populations increase sharply in the Española, Santa Fe, and Albuquerque areas. Nearly 40 percent of the potentially affected minority population lived in the Santa Fe area in 2000. Cumulative minority populations surrounding TA-3 and TA-6 are almost identical as a function of distance from the site. Because the CMRR Facility could be located in TA-55, it would be approximately 1 mile (1.6 kilometers) closer to the Santa Fe area. The surge in minority population resulting from minority residents of Santa Fe occurs at a distance that is approximately 1 mile (1.6 kilometers) less than the corresponding distance for TA-3 and TA-6.

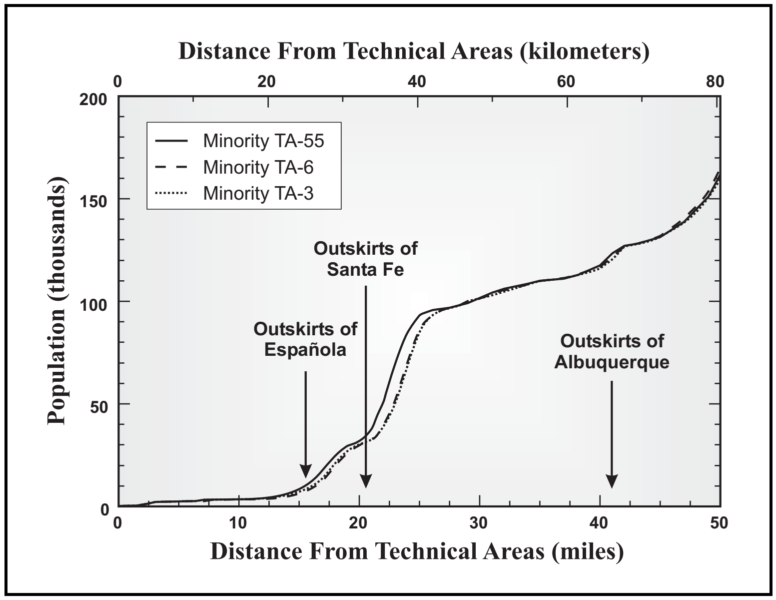

Figure 3–11 Minority Populations as a Function of Distance from TA-3, TA-6, and TA-55

Figure 3–12 shows the composition of the potentially affected minority population surrounding TA-55. Hispanics and American Indians comprised approximately 94 percent of the potentially affected minority population. Nearly one-half of the potentially affected Hispanic and American Indian populations lived in the Santa Fe area in 2000. The racial and Hispanic composition in the potentially affected area is reasonably representative of that for the State of New Mexico. Hispanics comprised approximately 76 percent of New Mexico's minority population in 2000, and American Indians comprised nearly 16 percent of the State's minority population. Among the 50 states, New Mexico has the second largest percentage minority population (55 percent). Only the State of Hawaii has a larger percentage minority population (77 percent).

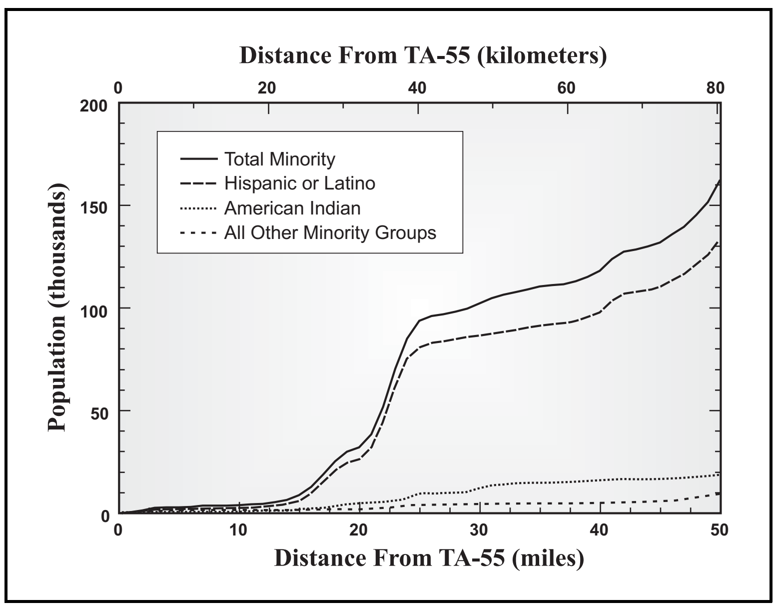

Figure 3–12 Minority Groups TA-55

As indicated in **Figure 3–13** the largest potentially affected low-income populations reside in Sandoval and Santa Fe counties. Approximately 70 percent of the total potentially affected low-income population lived in these two counties in 2000. Low-income persons comprised approximately 13 percent of the total potentially affected population.

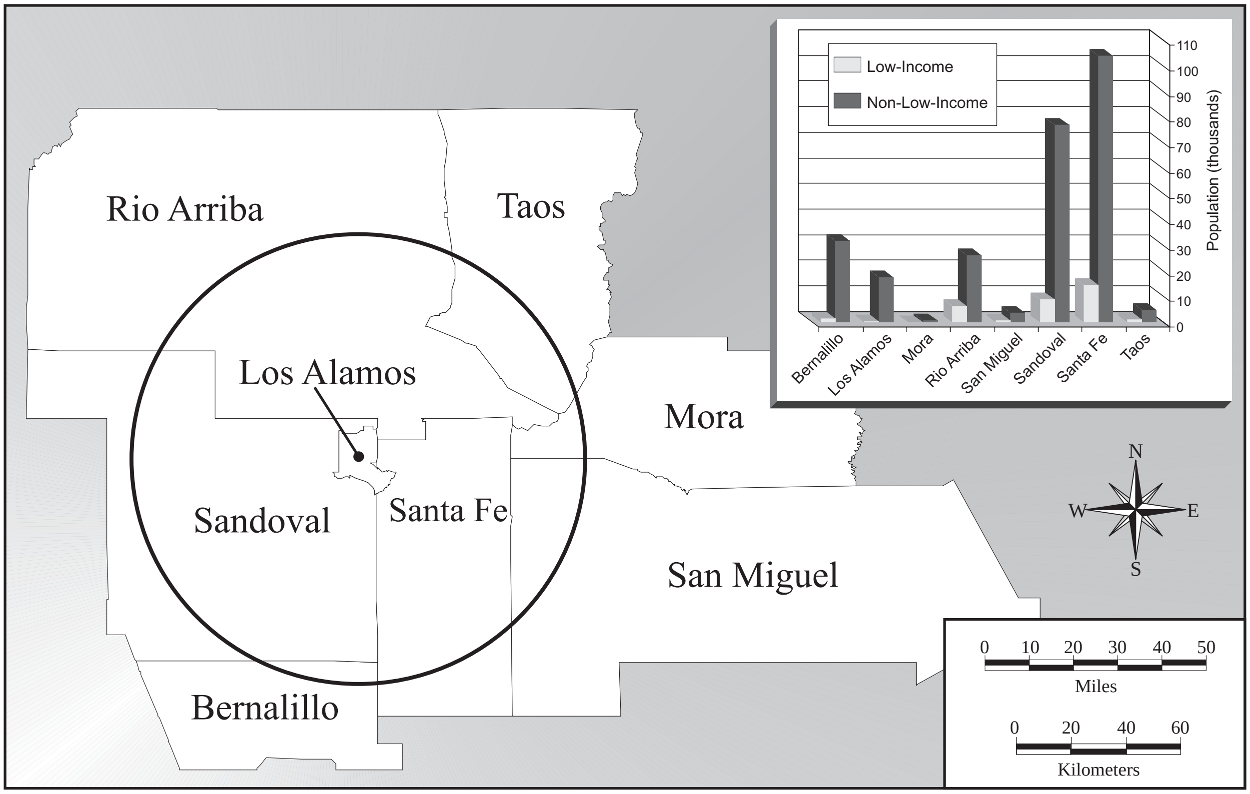

Figure 3–13 Low-Income and Non-Low-Income Populations by County Living in the Potentially Affected Area

Figure 3–14 shows the cumulative low-income population as a function of distance from TA-3, TA-6, and TA-55. The overall shape of these curves is similar to those shown in Figures 3–11 and 3–12. Low-income populations surrounding TA-3, TA-6, and TA-55 are concentrated in the Española, Santa Fe, and Albuquerque areas. Nearly 40 percent of the potentially affected low-income population lived in the Santa Fe area in 2000.

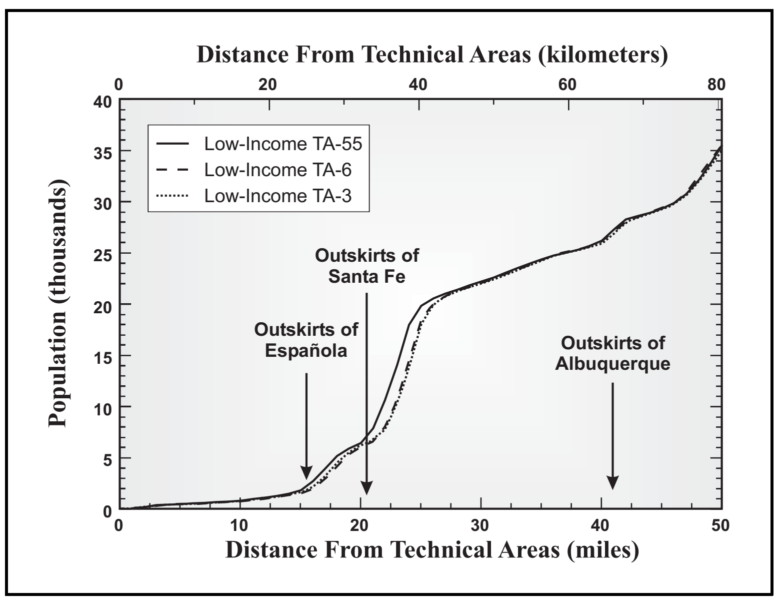

Figure 3–14 Cumulative Low-Income Population as a Function of Distance from TA-3, TA-6, and TA-55

At the public scoping meetings on the CMRR EIS held in Pojoaque, New Mexico, on August 13, 2002 (see Section 1.7), the Director of Environmental and Cultural Preservation for the Pueblo San Ildefonso identified environmental justice concerns over the implementation of the Preferred Alternative. Pueblo of San Ildefonso land is located adjacent to the boundary of LANL TA-54. While no one resides on this land, members of the Pueblo use it for hunting, gathering, and ceremonial and cultural purposes. Residents of Pueblo San Ildefonso expressed concern that pollution resulting from implementation of the Preferred Alternative could contaminate Mortandad Canyon, which in turn drains onto Pueblo land and sacred areas. At the scoping meetings, the representative of the Pueblo San Ildefonso requested that this EIS evaluate alternatives that would locate the CMRR Facility farther away from their lands. Also, a former Governor of the Pueblo of Acoma expressed concern that implementation of the Preferred Alternative could contaminate areas surrounding LANL, and that LANL's record of compliance with environmental regulations was not satisfactory.

3.11 HUMAN HEALTH

Public and occupational health and safety issues include the determination of potential adverse effects on human health that could result from acute and chronic exposure to ionizing radiation and hazardous chemicals. The following subsections include a discussion of radiation exposure and chemical exposure and the associated human health risks from each.

3.11.1 Radiation Exposure and Risk

Major sources and levels of background radiation exposure to individuals in the vicinity of LANL are shown in **Table 3–13**. Annual background radiation doses to individuals are expected to remain constant over time. Background radiation doses are unrelated to LANL operations.

Table 3–13 Sources of Radiation Exposure to Individuals in the LANL Vicinity Unrelated to LANL Operations

Source	*Effective Dose Equivalent (millirem per year)*
Natural Background Radiation	
External cosmic [a]	50 to 90
External terrestrial [b]	50 to 150
Internal terrestrial and global cosmogenic	40
Radon (in homes)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	50
Weapons test fallout	<1
Consumer and industrial products	10
Total	400 to 500

[a] Cosmic radiation doses are lower in the lower elevations and higher in the mountains.
[b] Variation in the external terrestrial dose is a function of the variability in the amount of naturally occurring uranium, thorium, and potassium in the soil.
Source: LANL 2001a.

Normal operational releases of radionuclides to the environment from LANL operations provide another source of radiation exposure to individuals in the vicinity of LANL. Types and quantities of radionuclides released from LANL operations in 2001 are listed in *Environmental Surveillance at Los Alamos During 2001* (LANL 2002c), and are presented in Section 3.4.2.2.

The annual population dose for the public resulting from these releases is 1.6 person-rem, which corresponds to an average annual individual dose of 0.006 millirem for individuals residing within 50 miles (80 kilometers) of the LANL site. (The estimated population for this region in 2001 was 277,000.) The dose to the offsite public is almost exclusively the result of airborne releases from LANL. The annual dose to the maximally exposed offsite individual was calculated to be 1.9 millirem. A calculation for a maximally exposed onsite individual was also made. This individual was assumed to be a member of the public who traveled along Pajarito Road on a relatively frequent basis and was therefore susceptible to a dose from the operation of facilities at TA-18 higher than that received by the general offsite public. The annual dose to this maximally exposed onsite individual was calculated to be 4.2 millirem (LANL 2002c). These doses fall within the radiological limits (individual dose limit of 10 millirem per year from airborne emissions and 100 millirem per year from all sources) given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, and are much lower than those from background radiation.

Using a risk estimator of one latent cancer death per 2,000 rem dose (see Appendix B), the estimated probability of this maximally exposed person developing a latent fatal cancer from radiation exposure associated with 1 year of LANL operations is less than one in one million (1×10^{-6}). According to the same risk estimator, 0.0008 excess latent fatal cancers are projected in the population living within 50 miles (80 kilometers) of LANL from 1 year of normal LANL operations. To place this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The mortality rate associated with cancer for the entire U.S. population is 0.2 percent per year. Based on this mortality rate, the number of fatal cancers expected during 2001 from all causes in the population of 277,000 living within 50 miles (80 kilometers) of LANL was 554. This expected number of fatal cancers is much higher than the 0.0008 latent fatal cancers estimated from LANL operations in 2001.

LANL workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at LANL from operations in 2001 are presented in **Table 3–14**. These doses fall within the radiological limits established by 10 CFR 835, *Occupational Radiation Protection*. Using a risk estimator of one latent fatal cancer per 2,500 person-rem among workers (see Appendix B) and a total workers' dose of 113 person-rem, the number of estimated latent fatal cancers among LANL workers from normal operations in 2001 is 0.045. The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

Table 3–14 Radiation Doses to Workers from Normal LANL Operations in 2001 (total effective dose equivalent)

Occupational Personnel	*Onsite Releases and Direct Radiation*	
	Standard	*Actual*
Average radiation worker (millirem)	(a)	85
Total workers (person-rem) [b]	None	113

[a] The radiological limit for an individual worker is 5,000 millirem per year (10 CFR 835). However, DOE's goal is to maintain radiological exposure as low as reasonably achievable. Therefore, DOE has recommended an administrative control level of 500 millirem per year (DOE 1999b); the site must make reasonable attempts to maintain individual worker doses below this level.
[b] There were 1,330 workers with measurable doses in 2001.
Source: DOE 2002h.

External radiation doses have been measured in areas of TA-3, TA-6, and TA-55 that may contain radiological sources for comparison with offsite natural background radiation levels. Measurements taken in 2001 showed doses within TA-3 (excluding some restricted locations within the area) to be between 110 and 129 millirem, within TA-6 to be 132 millirem, and within TA-55 to be between 142 and 150 millirem. Offsite doses from background radiation were measured to be as high as 144 millirem (LANL 2002c).

In 2001, the average concentration in air of plutonium-239, gross alpha, and gross beta radiation on the LANL site were measured to be 1×10^{-18} curies per cubic meter, 8×10^{-16} curies per cubic meter, and 1.4×10^{-14} curies per cubic meter, respectively. The concentration of plutonium-239 was about twice that measured at offsite regional locations; the concentrations of gross alpha and gross beta radiation were about the same as measured regionally (LANL 2002c). No specific measurements were reported for the TAs, but the concentrations would be expected to be similar to the average site values.

3.11.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (such as soil through direct contact or via the food pathway).

Adverse health impacts to the public are minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public could occur during normal operations at LANL via inhalation of air containing hazardous chemicals released to the atmosphere by LANL operations. Risks to public health from ingestion of contaminated drinking water or direct exposure are also potential pathways.

Baseline air emission concentrations for air pollutants and their applicable standards are presented in Section 3.4.2.1. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are compared with applicable guidelines and regulations.

Chemical exposure pathways to LANL workers during normal operations could include inhaling the workplace atmosphere, drinking LANL potable water, and possible other contact with hazardous materials associated with work assignments. Workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. LANL workers are also protected by adherence to the Occupational Safety and Health Administration and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals used in the operation processes, ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at LANL are substantially better than required by standards.

3.11.3 Health Effects Studies

Numerous epidemiological studies have been conducted in the LANL area. These studies have been summarized in the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (SSM PEIS)* (DOE 1996b). One study conducted by the New Mexico Department of Health reported elevations in brain cancer incidence during the mid to late 1980s, compared to state and national reference populations, but random fluctuation could not be ruled out. Breast cancer incidence rates in Los Alamos from 1970 to 1990 remained level, but higher than New Mexico rates. Reproductive and demographic factors known to increase the risk of breast cancer have been prevalent in the county. Ovarian cancer incidence in the county from 1986 to 1990 was approximately twofold greater than that observed in a New Mexico State reference population. In the mid to late-1980s, a twofold excess risk of melanoma was observed in Los Alamos County compared with a New Mexico State reference population. A more recent study observed a fourfold increase in thyroid cancer incidence during the late 1980s and early 1990s compared with the state as a whole, but the rate began to decline in 1994 and 1995. No statistically significant excess cancers were reported for male workers exposed to plutonium. However, statistically significant excesses in kidney cancer and lymphomatic leukemia were observed in male workers exposed to external radiation. For more detailed descriptions of studies reviewed and the findings, refer to Appendix Section D.1.2 of the *LANL SWEIS* (DOE 1999a) and to Appendix Section E.4.6 of the *SSM PEIS* (DOE 1996b).

3.11.4 Accident History

Unanticipated incidents have occurred at the CMR Building that had the potential for impacts to workers and the public. However, the consequences of most of the incidents were minor, and none resulted in fatal worker injuries. In most of these incidents, no inhalation of radioactive material occurred, and it was possible to decontaminate the workers and areas near where the contamination occurred. The following is a list of historical incidents that are pertinent to this EIS:

- In 1981, a radiological incident occurred in Wing 3 of the CMR Building. Plutonium-238 heat source material was accidently spilled. As a result, there was widespread wing contamination and 15 laboratory employees, a public worker, and two residential houses in Santa Fe were contaminated.

- In 1971, an incident in Wing 9 involved an uptake of plutonium-238 during work on a heat source in an argon-purged atmosphere. The airborne radioactive material was released through a puncture in a boot around a manipulator in the operating area. Several personnel in the area received intake exposures. Intensive decontamination efforts were required to clean up the wing.

- There have been at least nine, and perhaps many more spills of radioactive materials during operations within ventilated hoods and operations outside of containment boxes. One typical spill occurred when a worker in a ventilated hood was splashed with a radioactive solution spilled inside the hood. Another spill occurred when a worker dropped a glass vial containing 140 micrograms of dried plutonium-238 residue.

- Several incidents occurred in the time period from 1992 through 1997 that caused contamination outside of the facility. These incidents were the result of stack releases in excess of DOE guidelines and of contaminated material sent to the Los Alamos landfill. Four other environmental contamination incidents occurred outside the CMR Building prior to this period. During 1995, there were two releases at the CMR Building involving 116 micro curies of uranium-235 from Wing 4 and 1.24 micro curies of plutonium-239 from Wing 3. Also, in this time period, a hot-cell manipulator seal leak and glove tear in Wing 9 resulted in both a stack release of 55 curies of plutonium-238 to the environment and an individual exposure of 15 rem in the lungs.

- Three incidents of small fires occurred in the time interval from 1996 through 1997. One fire was a result of the ignition of a container of isopropyl alcohol and potassium hydroxide. The incident occurred either by spontaneous ignition of the bath or the evolution of vapors that were ignited by an external source. A second fire occurred in Wing 5 involving an unattended electric oven that was being used to dry a potentially contaminated mop head. A third fire occurred in Wing 9 as a result of an explosion.

Investigations of these and other occurrences were conducted to determine root causes, implement corrective actions, evaluate trends, and communicate lessons learned. A review of incidents at the CMR Building verifies that accidents occur both during laboratory processes and during activities to operate and maintain the facility.

3.11.5 Emergency Preparedness and Security

Each DOE site has established an emergency management program that is activated in the event of an accident. This program has been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, training, preparedness, and response.

NNSA maintains equipment and procedures to respond to situations where human health or the environment is 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 assistance teams (DOE Order 151.1, *Comprehensive Emergency Management System*). These programs also provide for notification of local governments whose constituencies may be threatened. Broad ranges of exercises are run to ensure the systems are working properly, from facility-specific exercises to regional responses. In addition, DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997.

The current EOC is located within TA-59 near TA-3. A new EOC is under construction within TA-69 near TA-8. The move to the new, state-of-the-art facility is expected to occur in early 2004. The new EOC incorporates many of the lessons learned from operation of the existing EOC during, and for 3 months following, the Cerro Grande Fire in 2000. The new EOC is planned as a multi-agency user facility that is capable of accommodating a large number of emergency responders simultaneously. The facility will also routinely accommodate 911 emergency workers of Los Alamos County, as well as LANL's emergency responder staff.

3.12 WASTE MANAGEMENT AND POLLUTION PREVENTION

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage, and disposal technologies, and in compliance with all applicable Federal and state statutes and DOE Orders. The following types of waste are managed at LANL: transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Each of these waste types is generated by CMR activities. Section 3.12.1 discusses general waste inventories and the activities involved in their management. The following subsections discuss each waste type in greater detail.

3.12.1 Waste Inventories and Activities

CMR operations in the existing CMR Building generate transuranic waste, mixed transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste. Transuranic waste, mixed transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste are treated, stored, and disposed of in accordance with current LANL waste management practices. No high-level radioactive waste is generated from the CMR activities conducted at the CMR Building.

In accordance with the Records of Decision for the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (Waste Management PEIS)* (DOE/EIS-0200-F, May 1997), waste could be treated and disposed of onsite at LANL or at other DOE sites or commercial facilities. Based on the Record of Decision for hazardous waste published on August 5,1998 (63 FR 41810), nonwastewater hazardous waste will continue to be treated and disposed of at offsite commercial facilities. Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste published on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed at all sites, and to the extent practicable, onsite disposal of low-level radioactive waste will continue. Hanford and Nevada Test Site (NTS) will be made available to all DOE sites for disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management PEIS* will be treated at Hanford, the Idaho National Engineering and Environmental Laboratory (INEEL), the Oak Ridge Reservation and the Savannah River Site (SRS), and will be disposed of at Hanford and NTS. Based on the Record of Decision for transuranic waste (63 FR 3629), DOE has decided to treat LANL's transuranic waste onsite prior to disposal at an offsite facility. DOE is in the process of developing a policy for the management of mixed transuranic waste.

The existing CMR Building has established several capabilities for managing waste, including analyzing, packaging, storing, and transporting low-level, transuranic, and hazardous waste generated from programmatic operations. All liquid radioactive and inorganic chemical wastes meet LANL's waste acceptance criteria before the waste is sent via the industrial waste line to LANL's RLWTF at TA-50 for processing. Because the volume of liquid organic chemical wastes is very low, these wastes are collected in small containers in temporary holding areas, packaged, and transported from the CMR Building to TA-50 by truck. Low-level radioactive wastes in a solid physical state are also packaged in the CMR Building, where care is taken to avoid combining hazardous wastes with radioactive wastes to form mixed wastes. These low-level solid wastes and hazardous solid wastes are stored separately in temporary locations until they are shipped to waste storage and disposal locations at TA-54.

Waste generation rates from CMR activities are provided in **Table 3–15**; also included for comparison are total waste generation rates for all LANL activities. Selected waste management facilities at LANL are summarized in **Table 3–16**.

Although not listed on the National Priorities List, LANL adheres to Comprehensive Environmental Response, Compensation, and Liability Act guidelines for environmental restoration projects that involve certain hazardous substances not covered by the Resource Conservation and Recovery Act (RCRA). LANL's environmental restoration program originally consisted of approximately 2,100 potential release sites (DOE 1999d). At the end of 1999, there remained 1,206 potential release sites requiring investigation or remediation and 118 buildings awaiting decontamination and decommissioning.

Based on a review by LANL's Environmental Restoration Program, the boundary of Potential Release Site 48-001 overlaps a small area in the corner of the proposed relocation site at TA-55. This area of overlap involves possible surface soil contamination from TA-48 stack emissions. Further investigation and any necessary remediation of this site will be completed under LANL's Environmental Restoration Program (LANL 2001d) and in accordance with LANL's Hazardous Waste Facility Permit. More information on regulatory requirements for waste disposal is provided in Chapter 5.

Table 3–15 Selected Waste Generation Rates from CMR and LANL Activities

Waste Type	*Units*	*CMR Generation Rate*	*LANL Generation Rate*
Transuranic	Cubic yards per year	19.5 [a]	169 [a]
Mixed transuranic	Cubic yards per year	8.5 [a]	41.2 [a]
Low-level radioactive	Cubic yards per year	1,217 [a,b]	3,714 [a]
Mixed low-level radioactive	Cubic yards per year	6.7 [a]	128 [a]
Hazardous	Pounds per year	10,494 [a]	1,897,304 [a,c]
Nonhazardous			
Liquid	Cubic yards per year	Not available	906,188 [d]
Solid	Cubic yards per year	Not available	7,132 [d]

a LANL SWEIS, Table 4.9.3.3-1.
b Volumes of low-level radioactive waste includes solid waste generated by the treatment of liquid low-level radioactive waste generated by CMR operations.
c This waste type also includes biomedical waste.
d DOE 1999d.
Note: The generation rates are attributed to facility operations and do not include the waste generated from environmental restoration actions.

Table 3–16 Selected Waste Management Facilities at LANL

			Applicable Waste Type					
Facility Name/Description	*Capacity*	*Status*	*TRU*	*Mixed TRU*	*LLW*	*MLLW*	*HAZ*	*NHAZ*
Treatment Facility (cubic yards per year unless otherwise indicated)								
Transuranic waste volume reduction	1,413	Online	X	X				
RAMROD and RANT facilities	1,373	Online	X	X				
Low-level radioactive waste compaction	99	Online			X			
Sanitary wastewater treatment	1,386,456	Online						X
Radioactive Liquid Waste Treatment Facility	9,240,000 gallons [b]	Online			X			
Storage Facility (cubic yards)								
Low-level radioactive waste storage	867	Online			X			
Mixed low-level radioactive waste storage	763	Online				X		
Hazardous waste storage	2,438	Online					X	
Disposal Facility								
TA-54, Area G low-level radioactive waste disposal (cubic yards)	330,245 [a]	Online			X			
Sanitary tile fields (cubic yards per year)	742,560	Online						X

a Current inventory of 326,975 cubic yards. Capacity will be expanded as part of the implementation of the *LANL SWEIS* Record of Decision.
b The RLWTF (9.24 million gallons [35 million liters]) is the amount of radioactive liquid waste projected to be treated under the Expanded Operations Alternative, see *LANL SWEIS*, page 3-29.
TRU = transuranic waste, LLW = low-level radioactive waste, MLLW = mixed low-level radioactive waste, HAZ = hazardous waste, NHAZ = non-hazardous waste, RAMROD = Radioactive Materials Research, Operations, and Demonstration; RANT = Radioactive Assay and Nondestructive Test.
Source: DOE 1999a, DOE 1999d.

3.12.2 Transuranic Waste

Transuranic waste is generated by analytical, processing, and fabrication activities in the CMR Building at LANL. All projects generating transuranic waste are required to implement waste minimization (64 FR 50797).

As part of the implementation of the Record of Decision for Transuranic Waste (TRU) Waste Treatment and Storage, part of the *Waste Management Programmatic Environmental Impact Statement* (DOE 1997b), LANL will treat transuranic waste onsite. Most transuranic waste will be disposed at the Waste Isolation Pilot Plant (WIPP) in New Mexico. However, WIPP commenced TRU waste disposal operations in March 1999, and the preferred alternative in the *WIPP Disposal Phase Final Supplemental Environmental Impact Statement (SEIS)* (DOE 1997c) included a 35-year operating period. The WIPP disposal phase is, therefore, assumed to end in 2034. Several DOE sites, including LANL, expect to generate transuranic waste beyond 2034 as a result of ongoing missions. The National Transuranic Waste Management Plan classifies transuranic waste generated after 2034 as waste having no current plan for disposal.

The CMRR Facility would start operations in 2010 with full operations planned for 2012. The operating life of the CMRR Facility is at least 50 years. To accommodate all projected transuranic waste from the CMRR Facility and other ongoing operations, DOE would need to extend the disposal phase for the WIPP repository or develop a new transuranic waste repository similar to the WIPP. Because sufficient lead time exists to develop such a repository, and given the fact that DOE has successfully demonstrated the capability of disposing transuranic waste, this EIS assumes that a transuranic waste repository similar to the WIPP would be available.

The total volume of transuranic waste currently managed by DOE (stored and projected) is estimated to be 249,949 cubic yards (191,100 cubic meters) of which 244,194 cubic yards (186,700 cubic meters) is contact handled transuranic and 5,755 cubic yards (4,400 cubic meters) is remote handled transuranic waste. A portion of this waste will be treated or repackaged prior to disposal, and the reported volumes may change depending on the selected processing or repackaging methodology. The estimated volume to be disposed of at WIPP is 151,853 cubic yards (116,100 cubic meters), of which 148,191 cubic yards (113,300 cubic meters) is contact handled transuranic (of which about 4,185 cubic yards [3,200 cubic meters] has already been disposed), and 3,662 cubic yards (2,800 cubic meters) is remote handled transuranic waste (DOE 2002b).

WIPP's total capacity for both contact handled and remote handled transuranic waste is set at 229,676 cubic yards (175,600 cubic meters) by the *WIPP Land Withdrawal Act*. The Consultation and Cooperation Agreement restricts the quantity of remote handled transuranic waste to only 5 percent by volume. Thus, the total volume of remote handled transuranic waste cannot exceed 9,260 cubic yards (7,080 cubic meters). If the maximum allowable remote handled transuranic waste volume were disposed, the available capacity for contact handled transuranic waste would be 220,416 cubic yards (168,520 cubic meters). CMR operations at LANL are expected to generate 61 cubic yards (47 cubic meters) per year of contact handled transuranic waste. Over a 50-year time period, this would result in a total of about 3,050 cubic yards (2,350 cubic meters) of contact handled transuranic waste. Based on current transuranic waste forecasts, the available contact handled transuranic waste disposal capacity at WIPP is about 72,225 cubic yards (55,220 cubic meters). The available capacity or new capacity would be sufficient to accommodate the estimated volumes of transuranic waste from future LANL CMR operations.

3.12.3 Mixed Transuranic Waste

Transuranic waste that also contains hazardous components regulated under RCRA is managed as mixed transuranic waste. Once generated, the mixed transuranic waste generally is transferred to a satellite storage area at the existing CMR Building. Subsequent storage, bulking, and transportation operations are performed according to hazardous waste management and U.S. Department of Transportation (DOT) regulations and DOE directives. The storage, bulking, and transportation preparation activities take place at TA-54. Most mixed transuranic waste will be disposed at WIPP or a similar facility.

3.12.4 Low-Level Radioactive Waste

Radioactive wastes that contain less than 100nCi/g of transuranic radionuclides are managed as low-level waste. Solid low-level radioactive waste generated by LANL's operating divisions is characterized and packaged for disposal at the onsite low-level radioactive waste disposal facility at TA-54, Area G, or sent to off-site licensed commercial facilities for disposal. Low-level radioactive waste minimization strategies are intended to reduce the environmental impact associated with low-level radioactive waste operations and waste disposal by reducing the amount of low-level radioactive waste generated or minimizing the volume of low-level radioactive waste that will require storage or disposal onsite. A 1998 analysis of the low-level radioactive waste landfill at TA-54, Area G, indicated that at previously planned rates of disposal, the disposal capacity would be exhausted in a few years. Reduction in low-level radioactive waste generation has extended this time to approximately 5 years; however, potentially large volumes of waste from planned construction upgrades and demolition activities at LANL could rapidly fill the remaining capacity (LANL 2000a).

As part of the implementation of the Record of Decision in the *LANL SWEIS*, DOE will continue onsite disposal of LANL-generated low-level radioactive waste using the existing footprint at the Area G low-level waste disposal area and will expand disposal capacity into Zones 4 and 6 at Area G. This expansion would cover up to 72 acres (29 hectares). Additional sites for low-level radioactive waste disposal at Area G would provide onsite disposal for an additional 50 to 100 years (64 FR 50797, LANL 2000a).

The primary sources of liquid low-level radioactive waste at the CMR Building are laboratory sinks, duct wash-down systems, and overflows and blowdowns from circulating chilled-water systems, generating approximately 10,400 gallons per day (LANL 2002f) (Internal Memorandum, Estimate of CMR Flows, Prepared by Pete Worland, LANL FWO-WFM, September 25, 2002). The liquid radioactive waste is transferred through a system of pipes and by tanker trucks to the RLWTF at TA-50, Building 1. The radioactive components are treated and the resulting solids are then disposed of as solid low-level radioactive waste at TA-54, Area G. The remaining liquid is discharged through a permitted outfall that empties into

| Mortandad Canyon (LANL 2000a). Discharges of effluent through permitted outfalls must meet stringent discharge parameters and are sampled to verify the attainment of these parameters on a frequent basis. The RLWTF has been upgraded and modified in the past and additional upgrades and changes to the facility are being comtemplated. The premise of the CMRR EIS analysis is that the RLWTF or a similar treatment capability would be available to treat LANL liquid low-level radioactive wastes.

3.12.5 Mixed Low-Level Radioactive Waste

There are seven major mixed low-level radioactive waste streams at LANL: circuit boards, gloveboxes, lead parts, research and development chemicals, personal protective equipment, fluorescent tubes, and waste generated from spills and spill cleanup. Typically, mixed low-level radioactive waste is transferred to a satellite storage area once generated. Whenever possible, mixed low-level materials are surveyed to confirm the radiological contamination levels, and if decontamination will eliminate either the radiological or the hazardous component, materials are decontaminated and removed from the mixed low-level radioactive waste category (LANL 2000a).

Proper waste management and DOT documentation are provided for solid waste operations at TA-54, Area G or Area L, to process remaining mixed low-level radioactive waste for storage, bulking, and transportation. RCRA waste management operations at Area G involve storage of mixed low-level radioactive waste in above-grade container areas including buildings, sheds, and domes. There are currently no hazardous or mixed waste disposal operations at Area G. The storage units have operated under the LANL hazardous waste facility permit (expired 1999) and interim status. All the storage units will be included in the pending renewal of the permit. The renewed permit will also include provisions for final remediation of the past disposal operations. As part of the renewal process, NMED has recently requested a closure and post-closure plan to include groundwater monitoring for historic hazardous waste disposal units and an extensive information document regarding further details of Area G waste management operations. From TA-54, mixed low-level radioactive waste is sent to commercial and DOE treatment and disposal facilities. The waste is treated/disposed of by various processes (such as segregation of hazardous components, macroencapsulation, or incineration) (LANL 2000a).

In October 1995, the State of New Mexico issued a Federal Facility Compliance Order to both DOE and LANL requiring compliance with the site treatment plan. That plan documents the development of treatment capacities and technologies or use of offsite facilities for treating mixed waste generated at LANL that is stored beyond the 1-year timeframe (LANL 2000e). LANL has met, and continues to meet, the treatment goals of the plan without further milestones.

3.12.6 Hazardous Waste

Hazardous waste commonly generated at LANL includes many types of laboratory research chemicals, solvents, acids, bases, carcinogens, compressed gases, metals, and other solid waste contaminated with hazardous waste. This may include equipment, containers, structures, and other items intended for disposal and contaminated with hazardous waste (such as compressed gas cylinders). After the hazardous waste is collected, it is sorted and segregated. Some materials are reused within LANL, and others are decontaminated for reuse. Those materials that cannot be decontaminated or recycled are packaged and shipped to offsite RCRA-permitted treatment and disposal facilities (LANL 2000a).

3.12.7 Nonhazardous Waste

Both LANL and Los Alamos County use the same landfill located within LANL boundaries. The landfill is operated under a special permit by Los Alamos County. The Los Alamos County Landfill received about 22,013 tons (20 million kilograms) of solid waste from all sources during the period July 1995 through June 1996, with LANL contributing about 22 percent of the solid waste. After the Cerro Grande Fire, the generation of wastes from community and LANL cleanup activities increased several fold. The Los Alamos County landfill is scheduled for closure in 2007. A replacement facility, which could be located either at LANL or offsite, would then be used by LANL for nonhazardous waste disposal. It is currently anticipated that, if located offsite, the replacement facility would be located within 100 miles (160 kilometers) of LANL. Both LANL and Los Alamos County could need to transport their wastes to the new facility.

Sanitary liquid waste is delivered by dedicated pipelines to the SWS Facility at TA-46. The plant has a design capacity of 600,000 gallons (2.27 million liters) per day, and in 2000 processed a maximum of about 250,000 gallons (950,000 liters) per day. Some septic tank pumpings are delivered periodically to the plant via tanker truck for treatment. Sanitary waste is treated by an aerobic digestion process. 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 SWS Facility and are applied as fertilizer as authorized by the existing NPDES permit.

3.12.8 Waste Minimization

LANL's Environmental Stewardship Office manages LANL's pollution prevention program. This is accomplished by eliminating waste through source reduction or material substitution; recycling potential waste materials that cannot be minimized or eliminated; and treating all waste that is generated to reduce its volume, toxicity, or mobility prior to storage or disposal. The achievements and progress have been updated at least annually. Implementing pollution prevention projects reduced the total amount of waste generated at LANL in 1999 by approximately 3,216 cubic yards (2,459 cubic meters). Examples of pollution prevention projects completed in 1999 at LANL include reduction of low-level radioactive waste and mixed low-level radioactive waste by 152 cubic yards (116 cubic meters), by decontaminating waste metal and reduction of transuranic waste by 4 cubic yards (3 cubic meters), and by using improved nondestructive assay instrumentation, which enabled the measurement and characterization of waste as either transuranic or low-level radioactive waste (DOE 2000c).

3.12.9 Waste Management PEIS Records of Decision

The *Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*Waste Management PEIS*) resulted in several Records of Decision affecting waste management actions at LANL (**Table 3–17**). Decisions on the various waste types were announced in a series of Records of Decision published in the *Waste Management PEIS* (DOE 1997b). The hazardous waste Record of Decision was published on August 5, 1998 (63 FR 41810), and the low-level radioactive and mixed low-level radioactive waste Record of Decision was published on February 18, 2000 (65 FR 10061). The hazardous waste Record of Decision states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with the Oak Ridge Reservation and the SRS continuing to treat some of their own nonwastewater hazardous waste onsite in existing facilities, where it is economically feasible. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that, for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, onsite at INEEL, LANL, the Oak Ridge Reservation, and the SRS. In addition, Hanford and NTS will be available to all DOE sites for low-level radioactive waste disposal. Mixed low-level radioactive waste will be treated at Hanford, INEEL, the Oak Ridge Reservation, and the SRS and disposed of at Hanford and NTS. More detailed information concerning DOE's decisions for the future configuration of waste management facilities at LANL is presented in the hazardous waste and low-level radioactive and mixed low-level radioactive waste Records of Decision.

Table 3–17 Waste Management PEIS Records of Decision Affecting LANL

Waste Type	*Preferred Action*
Transuranic	DOE has decided to treat LANL's transuranic waste onsite prior to disposal at an offsite facility. [c]
Low-level radioactive	DOE has decided to treat LANL's low-level radioactive waste onsite and continue onsite disposal. [a]
Mixed low-level radioactive	DOE has decided to regionalize treatment of mixed low-level radioactive waste at the Hanford Site, INEEL, the Oak Ridge Reservation, and the SRS. DOE has decided to ship LANL's mixed low-level radioactive waste to either the Hanford Site or NTS for disposal. [a]
Hazardous	DOE has decided to continue to use commercial facilities for treatment of most of LANL's nonwastewater hazardous waste. [b]

[a] From the Record of Decision for low-level radioactive and mixed low-level radioactive waste (65 FR 10061).
[b] From the Record of Decision for hazardous waste (63 FR 41810).
[c] From the Record of Decision for transuranic waste (63 FR 3629).