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Environmental Surveillance at Los Alamos during 2000

Environmental Surveillance Program:

Air Quality (Group ESH-17)
505-665-8855

Water Quality and Hydrology (Group ESH-18)
505-665-0453

Hazardous and Solid Waste (Group ESH-19)
505-665-9527

Ecology (Group ESH-20)
505-665-8961

Los Alamos
NATIONAL LABORATORY

Los Alamos NM 87545

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APPENDIXES

Environmental Surveillance at Los Alamos reports are prepared annually by the Los Alamos National Laboratory (the Laboratory), Environment, Safety, and Health Division, as required by US Department of Energy Order 5400.1, *General Environmental Protection Program*, and US Department of Energy Order 231.1, *Environment, Safety, and Health Reporting*.

These annual reports summarize environmental data that are used to determine compliance with applicable federal, state, and local environmental laws and regulations, executive orders, and departmental policies. Additional data, beyond the minimum required, are also gathered and reported as part of the Laboratory's efforts to ensure public safety and to monitor environmental quality at and near the Laboratory.

Chapter 1 provides an overview of the Laboratory's major environmental programs. Chapter 2 reports the Laboratory's compliance status for 2000. Chapter 3 provides a summary of the maximum radiological dose a member of the public could have potentially received from Laboratory operations. The environmental data are organized by environmental media (Chapter 4, air; Chapter 5, water; and Chapter 6, soils, foodstuffs, and biota) in a format to meet the needs of a general and scientific audience. A glossary and a list of acronyms and abbreviations are in the back of the report. Appendix A explains the standards for environmental contaminants, Appendix B explains the units of measurements used in this report, and Appendix C describes the Laboratory's technical areas and their associated programs.

We've also enclosed a booklet, *Overview of Environmental Surveillance during 2001*, that briefly explains important concepts, such as radiation, and provides a summary of the environmental programs, monitoring results, and regulatory compliance.

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This report is also available on the World Wide Web at
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Los Alamos National Laboratory (LANL or the Laboratory) is managed by the Regents of the University of California (UC) under a contract that is administered by the National Nuclear Security Administration (NNSA) of the Department of Energy (DOE) through the Los Alamos Area Office (LAAO) and the Albuquerque Operations Office. This report presents environmental data and analyses that characterize environmental performance and addresses compliance with environmental laws at the Laboratory during 2000. Using comparisons with standards and regulations, this report concludes that environmental effects from Laboratory operations are small and did not pose a threat to the public, Laboratory employees, or the environment in 2000. In May 2000, the Cerro Grande fire burned through 7,500 acres of LANL land. The Laboratory carried out special environmental sampling that was designed to evaluate the effects of the fire on environmental conditions. Analysis of the results of this sampling revealed no additional release from Laboratory lands that posed a threat to the public, emergency respondents, employees, or the environment.

Laboratory operations were in compliance with all environmental regulations. All newly proposed activities at the Laboratory that could impact the environment were evaluated through the National Environmental Policy Act (NEPA) to determine potential impacts. In 2000, the Laboratory sent 61 National Environmental Policy Act Environmental Review Forms to DOE for review. We also carried out 68 emergency reviews in support of recovery from the Cerro Grande fire. The Cerro Grande fire interrupted normal operations early in the year and resulted in emergency NEPA work for the duration of 2000. A special edition of the Site-Wide Environmental Impact Statement (SWEIS) Yearbook focussed on wildfire 2000; we also published a Special Environmental Analysis on actions taken in response to the Cerro Grande fire. The Electric Power System Upgrade as well as the Wildfire Hazard Reduction and Forest Health Improvement Program environmental assessments were completed.

The Laboratory is also actively investigating and remediating sites contaminated by past Laboratory operations. Over 600 sites were evaluated after the Cerro Grande fire in order to reduce the possiblity of contaminants moving during post-fire floods.

DOE and LANL continued to plan and develop an Integrated Resources Management Plan in 2000 to integrate existing resource management plans and the development of other management plans with LANL site planning and mission activities.

In this report, we calculate potential radiological doses to members of the public who may be exposed to Laboratory operations. The 2000 Effective Dose Equivalent (EDE) was 0.64 mrem for the air pathway alone. We calculated this dose using Environmental Protection Agency (EPA) -approved methods for air compliance. A maximum off-site dose considering all pathways (not just air) was 0.55 mrem. Maximum calculated dose to a member of the public present on-site was 13 mrem. Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem. We conclude that the doses calculated here, which are in the mrem (one one-thousandth of a rem) or lower range, would cause no adverse human health effects. The total dose from natural background radiation is about 360 mrem in this area and can vary by 10 mrem from year to year.

The Laboratory's air quality compliance program includes the development of air quality permits, calculation of nonradioactive air emissions, and radiological dose assessment. During 2000, the Laboratory performed approximately 300 air quality reviews for new and modified projects, activities, and operations to identify all applicable air quality requirements. A number of projects, some related to Cerro Grande fire recovery, required permits, permit revisions, or administrative notices. Criteria pollutant emissions for 2000 were somewhat less than 1999; however, SO_x emissions increased because of the use of fuel oil at the steam plants during the Cerro Grande fire. The EPA's EDE to any member of the public from radioactive airborne releases from a DOE facility is limited to 10 mrem/yr. The 2000 EDE was 0.64 mrem. As a part of the DOE/Concerned Citizens for Nuclear Safety (CCNS) Consent Decree signed in 1997, during 2000 an independent auditor reviewed the Laboratory's compliance with the EPA 10-mrem standard for Calendar Year 1999. The auditor determined that the Laboratory was in compliance with the 10-mrem standard for CY99.

The Laboratory reports chemical information to EPA, state, and local authorities under the Emergency Planning Community Right-to-Know Act (EPCRA). The EPCRA establishes quantity thresholds for reporting. The Laboratory did not have any spills, releases, or leaks to the environment that required reporting. The Laboratory reported the use of 42 chemicals and explosives. The Laboratory also reported mercury releases: 0.6 pounds air emissions, 0.6 pounds water discharge releases, and approximately 20 pounds of mercury-containing waste shipped off-site for disposal.

Air surveillance at Los Alamos includes monitoring emissions, ambient air quality, direct penetrating radiation, and meteorological parameters to determine the air quality impacts of Laboratory operations. The ambient air quality in and around the Laboratory meets all EPA and DOE standards for protecting the public and workers.

Radioactive materials are an integral part of many activities at the Laboratory, and some of these materials may be vented to the environment through a stack. The Laboratory evaluates these operations to determine impacts on the public and the environment. As of the end of 2000, the Laboratory continuously sampled 30 stacks for the emission of radioactive material to the ambient air. Radioactive air emissions were somewhat higher in 2000 than in 1999. The majority of the increase was from tritium emissions released during cleanup activities at Technical Areas (TAs) -21-209 and -33-86. There were no unplanned releases of radionuclides to the air. Radioactive air emissions were well below the amounts that could result in an off-site individual receiving a dose equal to the regulatory limit of 10 mrem/yr.

Lower ambient air concentrations of plutonium and americium were recorded at TA-54, Area G, during 2000. Radioactive ambient air quality for LANL-derived radionuclides at other locations during 2000 was very similar to 1999. In 2000, the Laboratory investigated several instances of elevated air concentrations. None of these elevated air concentrations exceeded DOE or EPA protective standards for workers or the public.

The Cerro Grande fire produced large amounts of smoke with very high concentrations of particulate matter, carbon monoxide, and nitrogen oxides in the vicinity of the fire. In addition, large amounts of naturally occurring radon decay products were resuspended by the high winds and the burning of vegetation and soils. Therefore, gross alpha and gross beta concentrations at sites impacted by the fire smoke were elevated. Measurements of LANL-derived radionuclides (americium, plutonium, tritium, and uranium) during the fire were consistent with routine measurements and did not demonstrate an elevated impact caused by the fire.

The Laboratory measures levels of external penetrating radiation (the radiation originating from a source outside the body, including x-rays, gamma rays, neutrons, and charged particle contributions from cosmic, terrestrial, and man-made sources) with thermoluminescent dosimeters. Highest doses were measured at locations on-site at TA-54, Area G; the Los Alamos Neutron Science Center; TA-21, Area T; and the Calibration Facility, TA-3-130.

In 2000, 28 gross alpha measurements in water runoff samples exceeded by 5 to 10 times the DOE's derived concentration guidelines (DCG) for radiation protection of the public. One measurement slightly exceeded the DCG for gross beta. Many of these high levels were found upstream of the Laboratory and show the effects of the fire. Most of this radiation is from naturally occurring uranium, thorium, and potassium contained in the high levels of sediment and ash carried by the runoff. When we filtered the runoff to remove the sediment, the concentrations of radionuclides and metals were below all EPA and DOE health-based drinking water standards, except in two samples. The DOE DCGs for public dose are determined assuming that two liters per day of water are consumed each year. This assumption will not be met for runoff, which is present only a few days each year.

The Cerro Grande fire caused major physical changes in watersheds crossing the Laboratory boundary and resulted in large impacts on water chemistry. Burning of trees and organic material on the forest floor removed material that previously absorbed rainfall, leading to increased runoff and erosion. Metals (for example, aluminum, iron, barium, manganese, and calcium) and fallout radionuclides (cesium-137; plutonium-239, -240; and strontium-90) previously bound to forest materials were concentrated in resulting ash and readily moved by runoff.

The Laboratory also monitors groundwater to determine its quality. The regional aquifer beneath Los Alamos is the primary source of drinking water for the Laboratory and the residents of Los Alamos County. Continued testing of water supply wells in 2000 showed that high-explosives constituents are not present in Los Alamos County drinking water. Trace levels of tritium are present in the regional aquifer in a few areas where liquid waste discharges occurred. The tritium levels are less than 1/50th of the drinking water standard. Perchlorate (no drinking water standard) and tritium (at 1/500th of the drinking water standard) were found in water supply well 0-1 in Pueblo Canyon during 2000. Radioactivity measurements in perched alluvial groundwater that exceeded DOE's DCGs for a DOE-operated drinking water system or EPA drinking water standards occurred at locations with current or former radioactive liquid waste discharges: Acid/Pueblo Canyon, DP/Los Alamos Canyon, and Mortandad Canyon. The constituents exceeding drinking water DCGs or maximum contaminant levels were tritium, gross beta, strontium-90, and americium-241. Alluvial groundwater is not used for drinking water.

The long-term trends of water levels in the water supply and test wells in the regional aquifer indicate little depletion of the resource because of pumping for the Los Alamos water supply.

The Laboratory monitors soils both on- and off-site for radionuclides (e.g., tritium, strontium, cesium, uranium, plutonium, and americium), trace elements (e.g., arsenic, beryllium, cadmium, mercury, lead) and organic (e.g., polychlorinated byphenyls [PCBs]), organochlorine pesticides, dioxins, high explosives, polynuclear aromatic hydrocarbons) constituents. Because of public concern about the Cerro Grande fire burning on LANL lands, we also collected soil samples at selected farming locations in northern New Mexico downwind of the Cerro Grande fire, in addition to the samples collected as part of the routine soil (institutional and facility) monitoring program at the Laboratory during the 2000 year. All radionuclide concentrations in soils collected from LANL, perimeter, and regional locations were low; most were nondetectable and indistinguishable from areas a distance away from Laboratory influences (e.g., regional background). Similarly, most trace elements, with the exception of beryllium and lead, in soils from on-site and perimeter areas were within regional background concentrations, and most organic constituents, with the exception of 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin (OCDD) at parts per trillion levels, at all sites were nondetectable. Most mean radionuclide and trace element concentrations in soils collected from LANL and perimeter areas after the Cerro Grande fire were statistically similar to soils collected before the fire in 2000, and the OCDD finding was not related to the fire.

Trend analyses show that radionuclides in soils, particularly tritium, from both on- and off-site areas have been decreasing over time, so that today most radionuclides are approaching background levels.

Foodstuff samples from Laboratory and perimeter locations showed that most radioactivity was attributable to natural sources and/or worldwide fallout, and these samples, for the most part, were statistically indistinguishable from foodstuffs collected in 1999, before the Cerro Grande fire. Produce and fish, in particular, because of the concern for airborne contaminants by smoke and fallout ash and contaminants in runoff, respectively, were not significantly affected. Similarly, all trace elements, including beryllium and lead, in produce from Laboratory and perimeter areas were within regional background concentrations.

Other environmental surveillance (soil, foodstuffs, and biota) program activities conducted in 2000 included the assessment of radionuclide and trace elements in soil, vegetation, bees, raccoons, elk, and deer within and around TA-54, Area G, the Laboratory's primary low-level radioactive waste disposal area, and DARHT, the Laboratory's Dual Axis Radiographic Hydrodynamic Test facility. Special studies included assessing organic biocontaminants in food chains within two canyons at LANL, studying the effects of depleted uranium on amphibians, assessing potential risks from exposure to natural uranium in well water, surveying fire effects and rehabilitation treatments applied after the fire, and estimating soil erosion in forest areas burned during the fire.

1. Introduction

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Abstract

This report presents environmental data that characterize environmental performance and addresses compliance with environmental standards and requirements at Los Alamos National Laboratory (LANL or the Laboratory) during 2000. The Laboratory routinely monitors for radiation and for radioactive and nonradioactive materials at Laboratory sites, as well as at sites in the surrounding region. LANL uses the monitoring results to determine compliance with appropriate standards and to identify potentially undesirable trends. This information is then used for environmental impact analyses, site planning, and annual operational improvements. The Laboratory collected data in 2000 to assess external penetrating radiation and concentrations of chemicals and radionuclides in stack emissions, ambient air, surface waters and groundwaters, the drinking water supply, soils and sediments, foodstuffs, and biota. In addition, the Laboratory conducted extensive sampling following the Cerro Grande fire to determine the effects of smoke and fallout ash on the environment and compared these results with the 1999 results. Using comparisons with standards and regulations, this report concludes that environmental effects from Laboratory operations are small and do not pose a threat to the public, Laboratory employees, or the environment. Laboratory operations were in compliance with all environmental regulations.

A. Laboratory Overview

1. Introduction to Los Alamos National Laboratory

In March 1943, a small group of scientists came to Los Alamos for Project Y of the Manhattan Project. Their goal was to develop the world's first nuclear weapon. Although planners originally expected that the task would be completed by a hundred scientists, by 1945, when the first nuclear bomb was tested at Trinity Site in southern New Mexico, more than 3,000 civilian and military personnel were working at Los Alamos Laboratory. In 1947, Los Alamos Laboratory became Los Alamos Scientific Laboratory, which in turn became Los Alamos National Laboratory (LANL or the Laboratory) in 1981. The Laboratory is managed by the Regents of the University of California (UC) under a contract that is administered by the National Nuclear Security Administration (NNSA) of the Department of Energy (DOE) through the Los Alamos Area Office (LAAO) and the Albuquerque Operations Office.

The Laboratory's original mission to design, develop, and test nuclear weapons has broadened and evolved as technologies, US priorities, and the world community have changed. Los Alamos National Laboratory enhances global security by

- ensuring the safety and reliability of the US nuclear weapons stockpile,
- reducing threats to US security from weapons of mass destruction,
- cleaning up the wastes created from weapons research and development during the Cold War, and
- providing technical solutions to energy, environment, health, infrastructure, and security problems (LANL 1999a).

In its Strategic Plan (1999–2004), Los Alamos National Laboratory expresses its vision as follows:

Los Alamos National Laboratory is a key national resource for the development and integration of leading-edge science and technology to solve problems of national and global security.

The Laboratory will continue its role in defense, particularly in nuclear weapons technology, and will increasingly use its multidisciplinary capabilities to solve important civilian problems, including initiatives in the areas of health, national infrastructure, energy, education, and the environment (LANL 1999a).

2. Geographic Setting

The Laboratory and the associated residential and commercial areas of Los Alamos and White Rock are located in Los Alamos County, in north-central New Mexico, approximately 60 miles north-northeast of Albuquerque and 25 miles northwest of Santa Fe (Figure 1-1). The 43-square-mile Laboratory is situated on the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep east-to-west oriented canyons cut by intermittent streams. Mesa tops range in elevation from approximately 7,800 feet on the flanks of the Jemez Mountains to about 6,200 feet above the Rio Grande Canyon.

Most Laboratory and community developments are confined to mesa tops. The surrounding land is largely undeveloped, and large tracts of land north, west, and south of the Laboratory site are held by the Santa Fe National Forest, Bureau of Land Management, Bandelier National Monument, General Services Administration, and Los Alamos County. San Ildefonso Pueblo borders the Laboratory to the east.

The Laboratory is divided into technical areas (TAs) that are used for building sites, experimental areas, support facilities, roads, and utility rights-of-way (see Appendix C and Figure 1-2). However, these uses account for only a small part of the total land area; much land provides buffer areas for security and safety and is held in reserve for future use.

3. Geology and Hydrology

The Laboratory lies at the western boundary of the Rio Grande Rift, a major North American tectonic feature. Three major local faults constitute the modern rift boundary, and each is potentially seismogenic. Recent studies indicate that the seismic surface rupture hazard associated with these faults is localized (Gardner et al., 1999). Most of the finger-like mesas in the Los Alamos area (Figure 1-3) are formed from Bandelier Tuff, which includes ash fall, ash fall pumice, and rhyolite tuff. The tuff is more than 1,000 feet thick in the western part of the plateau and thins to about 260 feet eastward above the Rio Grande. It was deposited by major eruptions in the Jemez Mountains' volcanic center 1.2 to 1.6 million years ago.

On the western part of the Pajarito Plateau, the Bandelier Tuff overlaps onto the Tschicoma Formation, which consists of older volcanics that form the Jemez Mountains. The tuff is underlain by the conglomerate of the Puye Formation in the central plateau and near the Rio Grande. The Cerros del Rio Basalts interfinger with the conglomerate along the river. These formations overlie the sediments of the Santa Fe Group, which extend across the Rio Grande Valley and are more than 3,300 feet thick.

Surface water in the Los Alamos area occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into upper reaches of some canyons, but the volume is insufficient to maintain surface flows across the Laboratory site before they are depleted by evaporation, transpiration, and infiltration.

Groundwater in the Los Alamos area occurs in three modes: (1) water in shallow alluvium in canyons, (2) perched water (a body of groundwater above a less permeable layer that is separated from the underlying main body of groundwater by an unsaturated zone), and (3) the regional aquifer of the Los Alamos area.

The regional aquifer of the Los Alamos area is the only aquifer in the area capable of serving as a municipal water supply. Water in the regional aquifer is under artesian conditions under the eastern part of the Pajarito Plateau near the Rio Grande (Purtymun and Johansen 1974). The source of most recharge to the aquifer appears to be infiltration of precipitation that falls on the Jemez Mountains. The regional aquifer discharges into the Rio Grande through springs in White Rock Canyon. The 11.5-mile reach of the river in White Rock Canyon between Otowi Bridge and the mouth of Rito de los Frijoles receives an estimated 4,300 to 5,500 acre-feet annually from the aquifer.

4. Biology and Cultural Resources

The Pajarito Plateau is a biologically diverse and archaeologically rich area. This diversity is illustrated by the presence of over 900 species of plants; 57 species of mammals; 200 species of birds, including 112 species known to breed in Los Alamos County; 28 species of reptiles; 9 species of amphibians; over 1,200 species of arthropods; and 12 species of fish (primarily found in the Rio Grande, Cochiti Reservoir, and the Rito de los Frijoles). No fish species have

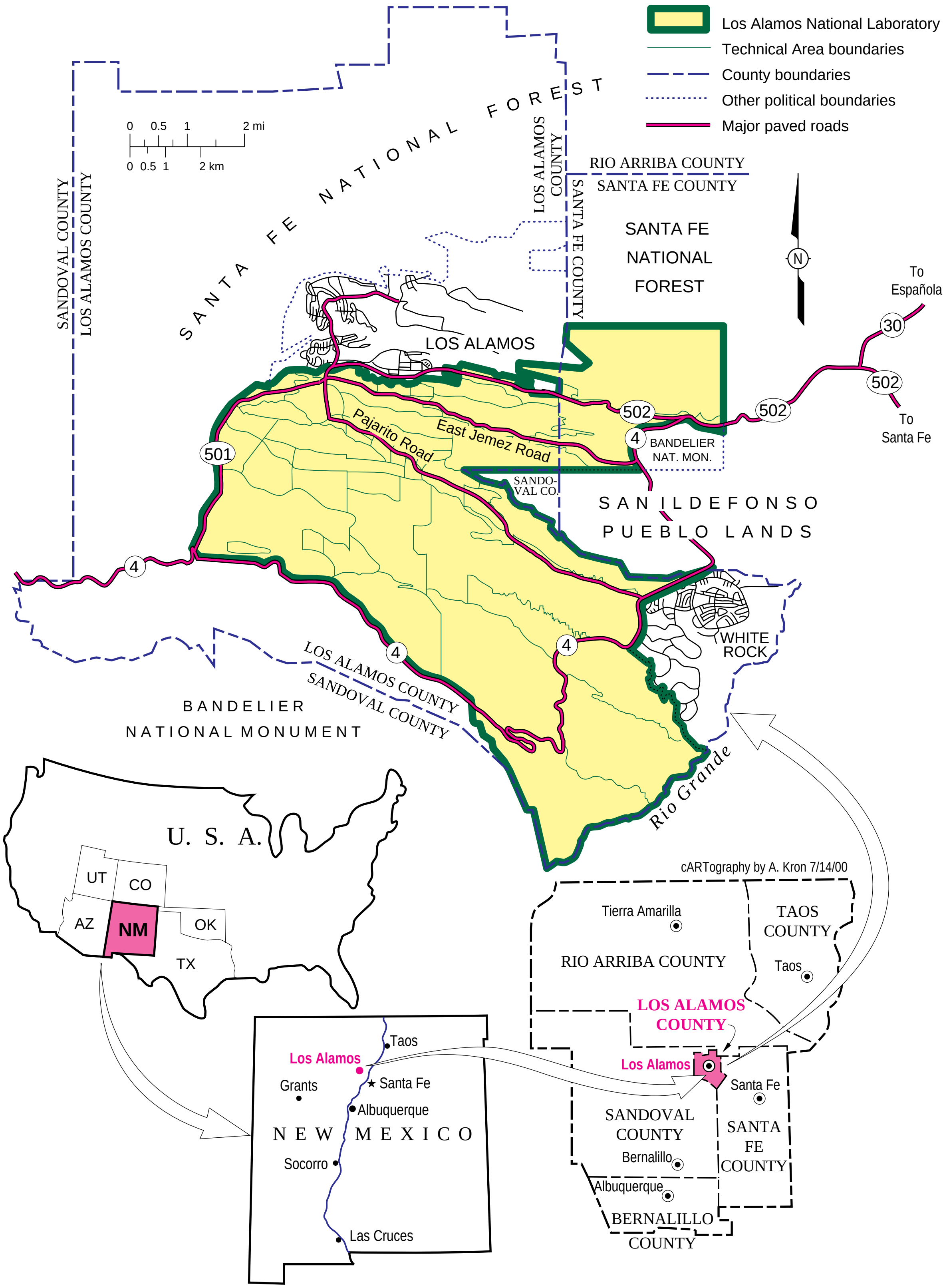

Figure 1-1. Regional location of Los Alamos National Laboratory.

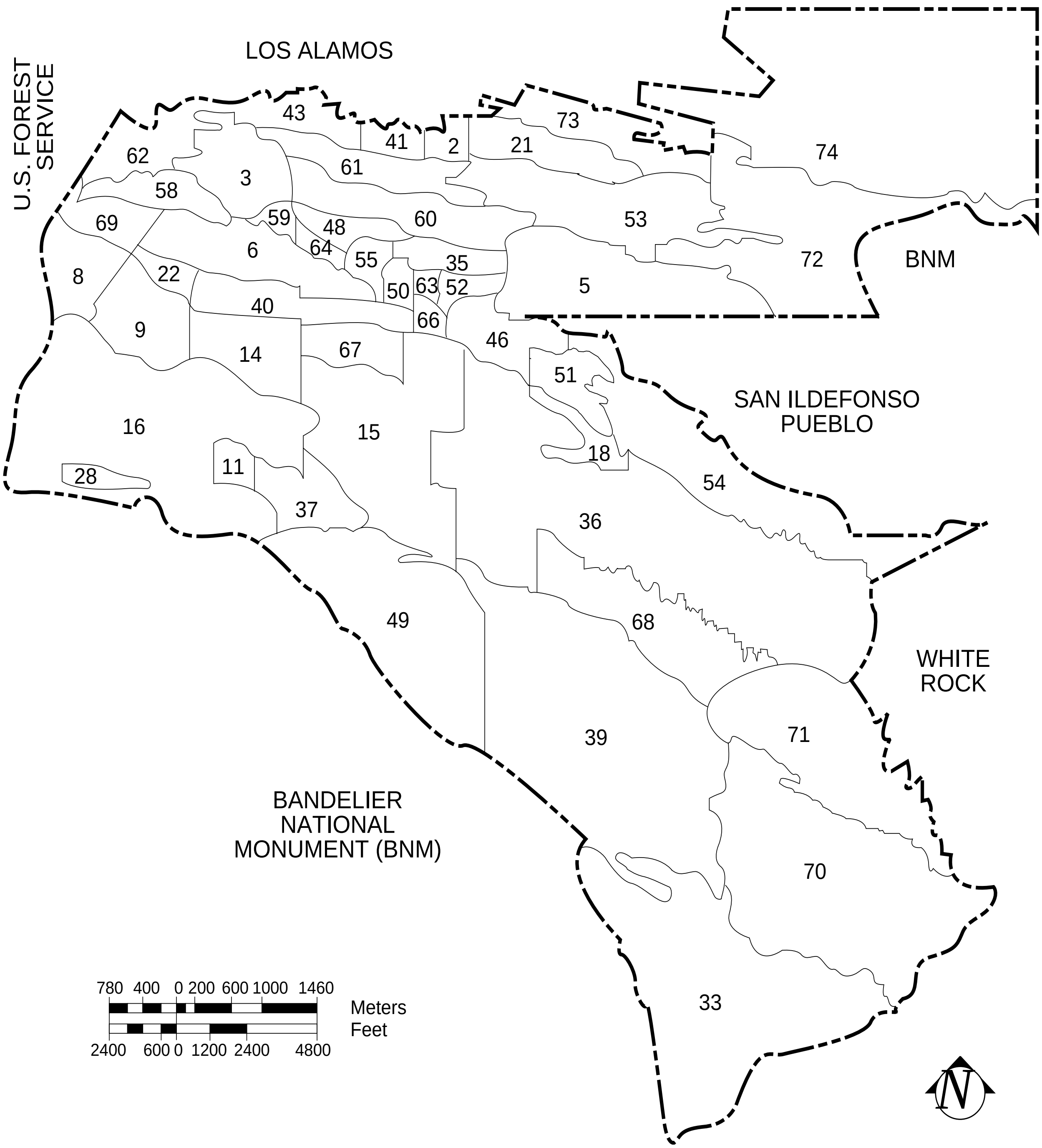

Figure 1-2. Technical Areas of Los Alamos National Laboratory in relation to surrounding landholdings.

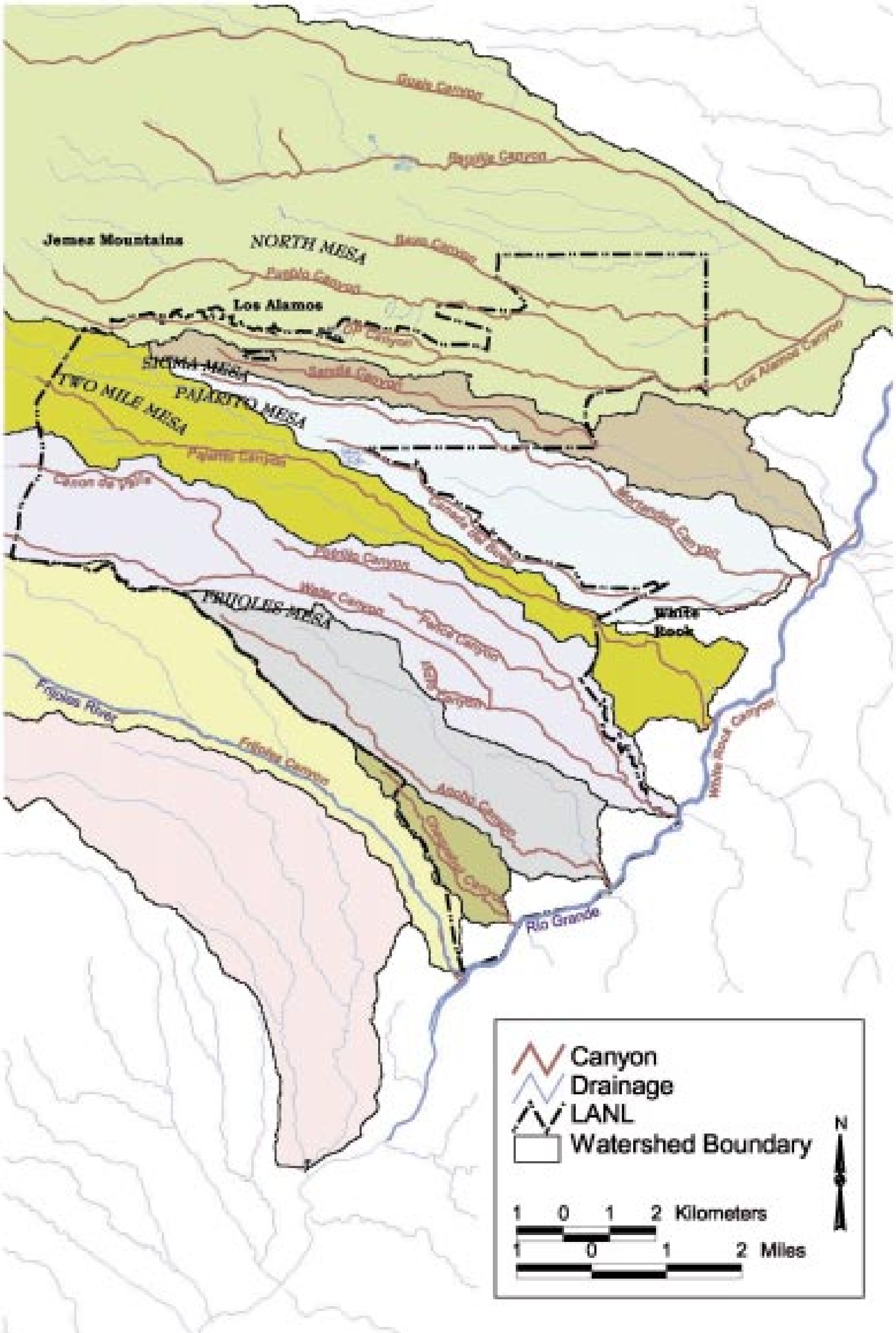

Figure 1-3. Major canyons and mesas.

been found within LANL boundaries. Roughly 20 plant and animal species are designated as threatened species, endangered species, or species of concern at the federal and/or state level.

Approximately 70% of DOE land in Los Alamos County has been surveyed for prehistoric and historic cultural resources, and about 1,550 sites have been recorded. More than 85% of the ruins date from the 14th and 15th centuries. Most of the sites are found in the piñon-juniper vegetation zone, with 80% lying between 5,800 and 7,100 feet in elevation. Almost three-quarters of all ruins are found on mesa tops. Buildings and structures from the Manhattan Project and the early Cold War period (1943–1963) are being evaluated for eligibility to the Natural Register of Historic Places.

B. Management of Environment, Safety, and Health

1. Introduction

The Laboratory's environmental, safety, and health (ES&H) goal is to accomplish its mission cost effectively, while striving for an injury-free workplace, protecting worker and public health, minimizing waste streams, and avoiding unnecessary adverse impacts to the environment from its operations.

2. Integrated Safety Management

Throughout the Laboratory, the goal of Integrated Safety Management (ISM) is the systematic integration of ES&H into work practices at all levels. The term “integrated” indicates that the safety management system is a normal and natural element in performing the work. Safety and environmental responsibility involve every worker. Management of ES&H functions and activities is an integral, visible part of the Laboratory's work-planning and work-execution processes.

The Laboratory is committed to achieving excellence in environmental, safety, health, and security performance. Laboratory Director John C. Browne says, “We will never compromise safety or security for programmatic or operational needs.” Zero environmental incidents means complying with all applicable environmental laws and regulations; adopting practicable proactive approaches to achieve environmental excellence (minimizing waste generation, wastewater discharges, air emissions, ecological impacts, cultural impacts, etc.); preventing unnecessary adverse environmental impacts; and enhancing environmental protection (LANL 1999b).

3. Environment, Safety, & Health Division

The Environment, Safety, & Health (ESH) Division is primarily a Laboratory support organization that provides a broad range of technical expertise and assistance in areas such as worker health and safety, environmental protection, facility safety, nuclear safety, hazardous materials response, ES&H training, occurrence investigation and lessons learned, and quality. ESH Division is in charge of performing environmental monitoring, surveillance, and compliance activities to help ensure that Laboratory operations do not adversely affect human health and safety or the environment. The Laboratory conforms to applicable environmental regulatory requirements and reporting requirements of DOE Orders 5400.1 (DOE 1988), 5400.5 (DOE 1990), and 231.1 (DOE 1995).

ESH Division has responsibility and authority for serving as the central point of institutional contact, coordination, and support for interfaces with ESH regulators, stakeholders, and the public, including the DOE, the Defense Nuclear Facilities Safety Board, the New Mexico Environmental Department (NMED), and the Environmental Protection Agency (EPA). ESH Division provides line managers with assistance in preparing and completing environmental documentation such as reports required by the National Environmental Policy Act (NEPA) of 1969 and the federal Resource Conservation and Recovery Act (RCRA) and its state counterpart, the New Mexico Hazardous Waste Act (HWA), as documented in Chapter 2 of this report. With assistance from Laboratory Counsel, ESH Division helps to define and recommend Laboratory policies for applicable federal and state environmental regulations and laws and DOE orders and directives. ESH Division is responsible for communicating environmental policies to Laboratory employees and makes appropriate environmental training programs available. The environmental surveillance program resides in four groups in ESH Division—Air Quality (ESH-17), Water Quality and Hydrology (ESH-18), Hazardous and Solid Waste (ESH-19), and Ecology (ESH-20)—that initiate and promote Laboratory programs for environmental assessment and are responsible for environmental surveillance and regulatory compliance.

Approximately 600 sampling locations are used for routine environmental monitoring. The maps in this report present the general location of monitoring stations. For 2000, over 250,000 routine analyses for chemical and radiochemical constituents were performed on more than 12,000 routine environmental samples. Laboratory personnel collected many additional samples following the Cerro Grande fire. Samples of air particles and gases, water, soils, sediments, foodstuffs, and associated biota are routinely collected at monitoring stations and then analyzed. The results of these analyses help identify impacts of LANL operations on the environment. ESH personnel collect and analyze additional samples to obtain information about particular events, such as major surface water runoff events, nonroutine releases, or special studies. See Chapters 2, 3, 4, 5, and 6 of this report for methods and procedures for acquiring, analyzing, and recording data. Appendix A presents information about environmental standards.

a. Air Quality. ESH-17 personnel assist Laboratory organizations in their efforts to comply with federal and state air quality regulations. ESH-17 personnel report on the Laboratory's compliance with the air quality standards and regulations discussed in Chapter 2 and conduct various environmental surveillance programs to evaluate the potential impact of Laboratory emissions on the local environment and public health. These programs include measuring direct penetrating radiation, meteorological conditions, and stack emissions and sampling for ambient air contaminants. Chapter 4 contains a detailed exploration of the methodologies and results of the ESH-17 air monitoring and surveillance program for 2000. Personnel from ESH-17 monitor meteorological conditions to assess the transport of contaminants in airborne emissions to the environment and to aid in forecasting local weather conditions. Chapter 4 also summarizes meteorological conditions during 2000 and provides a climatological overview of the Pajarito Plateau.

Dose Assessment. ESH-17 personnel calculate the radiation dose assessment described in Chapter 3, including the methodology and assessments for specific pathways to the public.

b. Water Quality and Hydrology. ESH-18 personnel provide environmental monitoring activities to demonstrate regulatory compliance and to help ensure that Laboratory operations do not adversely affect public health or the environment.

ESH-18 provides technical and regulatory support for the Laboratory to achieve compliance with the following major state and federal statutes and regulations: Clean Water Act, including the National Pollutant Discharge Elimination System (NPDES) and Section 404/401 Dredge and Fill Permitting; Safe Drinking Water Act; New Mexico Drinking Water Regulations; New Mexico Water Quality Control Commission Regulations; Federal Insecticide, Fungicide, and Rodenticide Act; and New Mexico Pesticide Control Act. Surveillance programs and activities include groundwater, surface water, and sediments monitoring; water supply reporting for Los Alamos County; and the Groundwater Protection Management Program. Chapter 2 contains documentation on the Laboratory's compliance with state and federal water quality requirements. Chapter 5 summarizes the data ESH-18 personnel collected and analyzed during routine monitoring.

c. Hazardous and Solid Waste. ESH-19 personnel provide services in developing and monitoring permits under hazardous and solid waste rules, RCRA/HWA, Solid Waste Act (SWA), and letters of authorization for landfilling polychlorinated biphenyls (PCB) solids contaminated with radionuclides under the Toxic Substances Control Act (TSCA); providing technical support, regulatory interpretation, and Laboratory policy on hazardous, toxic, and solid waste issues and underground storage tank regulations to Laboratory customers; and documenting conditions at past waste sites. Chapter 2 presents the Laboratory's compliance status with hazardous and solid waste regulations.

d. Ecology. Personnel in ESH-20 investigate and document biological and cultural resources within the Laboratory boundaries; prepare environmental reports, including Environmental Assessments required under NEPA; and monitor the environmental impact of Laboratory operations on soil, foodstuffs, and associated biota. Chapter 2 documents the 2000 work in the areas of NEPA reviews and biological and archaeological reviews of proposed projects at the Laboratory. Chapter 6 contains information on the results and trends of the soil, foodstuff, and biota monitoring programs and related research and development activities.

e. Site-Wide Environmental Impact Statement Project Office. The Site-Wide Environmental Impact Statement (SWEIS) Project Office was established in October 1994 to provide a single point-of-contact to support DOE and its contractor in the agency's preparation of a SWEIS for the Laboratory. Although work on the SWEIS began in 1995, the major accomplishments were primarily in 1997, 1998, and 1999. The effort culminated with the issuance of a final SWEIS in January 1999, a Record of Decision in September 1999, and a Mitigation Action Plan in October 1999.

In 1999, the SWEIS Project Office was renamed the Site-Wide Issues Program Office (SWIPO). The SWIPO functions as the land transfer point-of-contact for LANL to facilitate DOE's compliance with the requirements of Public Law 105-119. During 1999, the SWIPO developed the initial scenarios, costs, and schedules for cleaning up and transferring all 10 tracts of land identified by DOE for transfer within the time frame allocated by Congress. In addition, SWIPO outlined each major step DOE would have to accomplish and provided input to all major deliverables required under Public Law 105-119. See 1.B.5 for more information about Public Law 105-119.

4. Environmental Management Program

a. Waste Management. Waste management activities focus on minimizing the adverse effects of chemical and radioactive wastes on the environment, maintaining compliance with regulations and permits, and ensuring that wastes are managed safely. Wastes generated at the Laboratory are divided into categories based on the radioactive and chemical content. No high-level radioactive wastes are generated at the Laboratory. Major categories of waste managed at the Laboratory are low-level radioactive waste, transuranic (TRU) waste, hazardous waste, mixed low-level waste (waste that is both hazardous and radioactive), and radioactive liquid waste.

The major portion of the inventory of mixed low-level and TRU wastes at the Laboratory was generated before capabilities existed for treatment and disposal of those wastes, and the wastes were placed into storage at TA-54. Treatment and disposal capabilities now exist for most of these wastes, and DOE provides funding specifically to address these so-called "legacy wastes" at LANL.

Mixed Low-Level Waste Work-Off. In 1994, LANL had the equivalent of about 3,000 55-gallon drums of mixed low-level waste in storage because no capability existed at either LANL or other locations in the United States for proper treatment and disposal of the waste. At that time, NMED approved a plan called the Mixed Waste Site Treatment Plan for development and operation of treatment technologies and facilities at LANL. The original estimate called for completing the treatment and disposal of the mixed low-level waste in storage in 2006.

In cooperation with DOE/LAAO, a team worked to evaluate ways to reduce costs and accelerate the schedule. The team identified new treatment capabilities that were being developed commercially and at other DOE sites, and decisions were made to use those capabilities rather than to continue with new facilities at LANL. NMED also approved these efforts. In addition, efforts began to perform extensive characterization of waste that was only suspected of being both hazardous and radioactive. Figure 1-4 shows the progress in treating and disposing of mixed low-level waste. It is expected that this task will be completed in 2003 or 2004, two to three years earlier than originally projected.

Transuranic Waste Inspectable Storage Project. The Transuranic Waste Inspectable Storage Project (TWISP) has been established to retrieve 187 fiberglass-reinforced plywood crates and 16,641 metal drums containing solid-form, TRU waste from three earth-covered storage pads. This waste is being retrieved under a compliance order from NMED because it was not possible to inspect the waste containers as required by the state hazardous waste regulations. After the waste is retrieved, any damaged containers are over-packed in new containers. The containers are vented and have high-efficiency particulate air (HEPA) filters installed in drum lids. The waste containers are then placed in structures where they can be inspected.

After several years of preparation, DOE granted start-up authority for TWISP in March 1997. Retrieval operations have been completed on the first two waste storage pads and were begun on the third pad during 2000. The Cerro Grande fire caused some delay in the start of retrieval on Pad 2, but it is expected that retrieval of containers on the third pad will be completed in about one and one-half years, more than a year earlier than the NMED compliance order.

Decontamination and Volume Reduction System. Large metallic items such as gloveboxes, ventilation ducts, and tanks that are stored within fiberglass-reinforced plywood boxes or other large containers compose about one-third of the legacy TRU waste stored at TA-54. These containers are too large to be shipped for disposal at the Waste Isolation Pilot Plant (WIPP) located east of Carlsbad, New Mexico. Construction has begun at TA-54 on a new facility called the Decontamination and Volume Reduction System or DVRS. The DVRS includes a 13,200-sq-ft containment area with active ventilation and contamination control, instruments for radioassay of waste

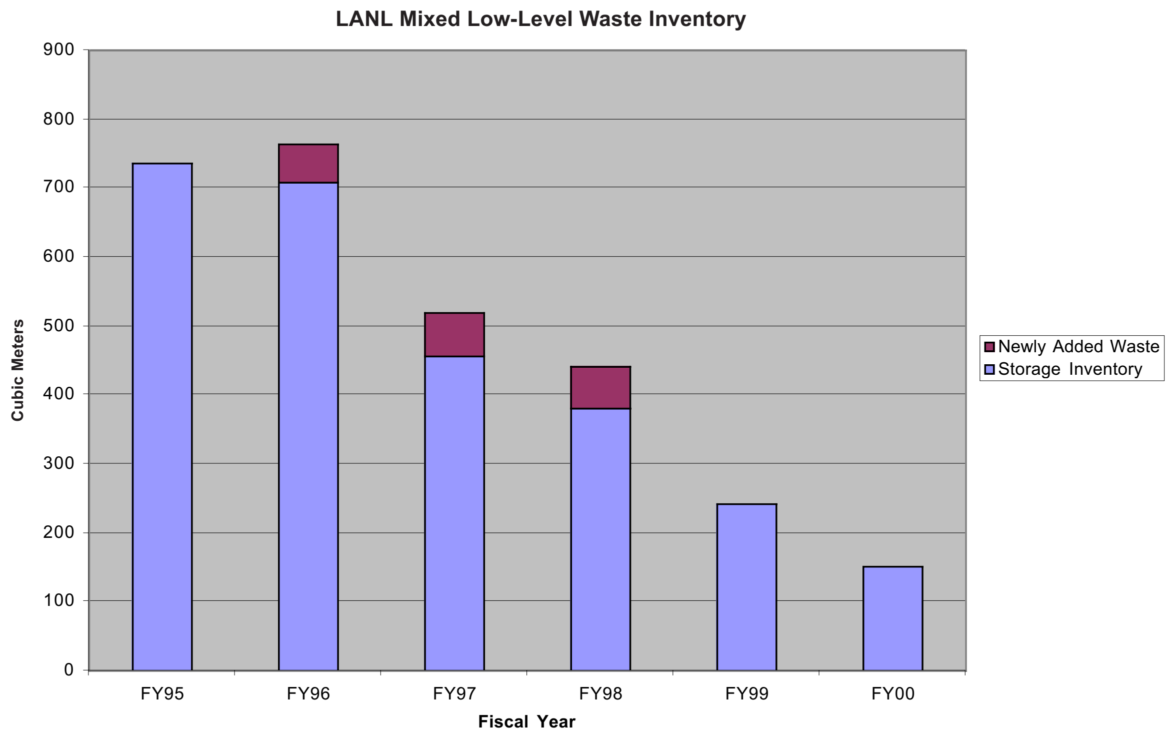

Figure 1-4. Treatment and disposal of mixed low-level waste.

items, several processes for decontamination of metal objects, and a large system to shear and crush large metallic objects into drum-sized items. Oversize metallic waste that can be decontaminated to low-level waste will be disposed on-site at TA-54. Waste that remains TRU waste will be placed into drums that can be shipped for disposal at the WIPP.

Transuranic Waste Characterization, Certification, and Shipment. Shippers must characterize and certify TRU waste to meet the Waste Acceptance Criteria at the WIPP. LANL was the first DOE site to be granted authorization from DOE to certify TRU waste in September 1997 and made the first of 17 shipments of TRU waste to WIPP in March 1999. During 2000, LANL modified all of its characterization and certification procedures to meet new requirements for shipping mixed TRU waste to WIPP under the hazardous waste facility permit granted to the WIPP site by the NMED. DOE completed an audit, but the Laboratory had not received its new authorization from DOE under the permit by the end of 2000. Shipments of TRU waste from LANL to WIPP are expected to resume in 2001.

b. Pollution Prevention. The Laboratory's Environmental Stewardship Office (ESO) manages the Laboratory's pollution prevention program. Section 2.B.1.i provides specific waste minimization accomplishments. See Section 2.E.3 for descriptions of successful pollution prevention projects. Other waste management activities that reduce waste generation include the following:

- continuing financial incentives for waste reduction and innovative pollution prevention ideas and accomplishments such as the annual Pollution Prevention Awards and Generator Set Aside Fee funding;
- developing databases to track waste generation and pollution prevention/recycling projects;
- providing pollution prevention expertise to Laboratory organizations in source reduction, material substitution, internal recycle/reuse, lifetime extension, segregation, external recycle/reuse, volume reduction, and treatment; and
- providing guidance to divisions within the Laboratory for minimizing waste and pollution through application of the Green Zia tools. Green Zia is a pollution prevention program administered by NMED.

In 2000, the ESO published *The Los Alamos National Laboratory 2000 Environmental Stewardship Roadmap*, in accordance with the Hazardous and Solid Waste Amendments Module VIII of the RCRA Hazardous Waste Permit and 40 CFR 264.73. This document is available at *http://emeso.lanl.gov/useful_info/publications/publications.html* on the World Wide Web.

One of the six Laboratory excellence goals has an environmental focus: zero environmental incidents. The roadmap document describes the Laboratory's current operations and the improvements that will eliminate the sources of environmental incidents.

The stewardship solution for zero incidents is to eliminate the incident source. This goal is being accomplished by continuously improving operations to

- reduce waste generation,
- reduce pollutants released,
- reduce natural resources used, and
- reduce natural resources damaged.

c. Environmental Restoration Project. The Environmental Restoration (ER) Project at the Laboratory augments the Laboratory's environmental surveillance program by identifying and characterizing potential threats to human health, the area's ecology, and the environment from past Laboratory operations. The ER Project's mission is to mitigate those threats, where necessary, through cleanup actions that comply with applicable environmental regulations. Corrective actions may include excavating and/or treating the contamination source, capping and containing a source to prevent its migration, and placing controls on future land use. Often these sources are places where wastes were improperly disposed in the past or where the disposal practices of the past would not meet today's standards. As a result, contamination may have spilled or leaked into the environment from such places (called potential release sites or PRSs) over time, with the possibility of causing hazards to human health and/or the environment. The ER Project then must confirm or deny the existence of these hazards and remediate, if deemed necessary.

The ER Project organizes its activities according to the natural watersheds across the Laboratory in which the various PRSs are located. A single watershed comprises one or more mesas and a common canyon drainage. The mesas draining into a common canyon may contain multiple contaminated sites. Each of the eight watersheds in the Los Alamos area is made up of one or more pieces (called aggregates), each containing several PRSs that will be investigated, assessed, and remediated (if necessary) as a group. The specific location of each canyon is shown on Figure 1-3. This watershed approach ensures that drinking water sources and sensitive natural resources will be protected as it accounts for potential cumulative impacts of multiple contaminant sources located on mesa tops and slopes.

An exposure scenario serves as the basis for assessing a site for potential risk to human health and defines the pathways by which receptors are exposed. The ER Project determines human health exposure scenarios based on the current and future land use of the site. Standard land-use scenarios the ER Project uses to determine exposure to human health receptors include

- residential,
- industrial,
- recreational, and
- resource user.

Mirenda and Soholt (1999) fully describe standard land-use scenarios. The Comprehensive Site Plan (LANL 1999c) reflects the status of current facility and land use conditions and future Laboratory needs. Industrial land use affects Laboratory workers and is prescribed by the 30-year planning horizon for the Laboratory's mission and the continued operation of present-day facilities. Buffer zone land use may affect recreational users and is based on present and future access to Laboratory property.

The ER Project is developing and evaluating a set of pathways that would appropriately describe how members of neighboring pueblos use Laboratory lands and environs. The ER Project revised its risk assessment methodology in 1999 to add ecological risk assessments to the human-health risk assessment if warranted by the risk-screening assessment.

The ER Project makes corrective action or cleanup decisions on the basis of ecological risks and risks to the environment, in addition to human-health risks. While human-health risk can be evaluated over a relatively small area, ecological risk assessment requires an understanding of the nature and extent of contamination across much larger areas. Decisions that are protective of water resources in general also require an understanding of the presence and movement of contamination within an entire watershed.

The ER Project at the Laboratory is structured primarily according to the requirements of the Hazardous and Solid Waste Amendments to RCRA, which refer to these cleanup activities as "corrective actions." Module VIII of the Laboratory's Hazardous Waste Facility Permit contains the corrective action provisions. One of the objectives of the ER Project is to complete corrective actions at every site under its purview as necessary. Corrective actions are considered complete when

- the ER Project has demonstrated and documented that the site either poses no risk to human and ecological receptors or that the risk is acceptable—or a final remedy is evaluated, selected, and implemented to reduce or eliminate risk—and
- the administrative authority has concurred.

NMED regulates the Laboratory's corrective action program under RCRA. In addition, the Comprehensive Environmental Response, Compensation, and Liability Act specifies requirements for cleaning up sites that contain certain hazardous substances not regulated by RCRA and for identifying and reporting historical contamination when federal agencies such as DOE transfer surplus property to other agencies or the public. DOE has oversight for those PRSs at the Laboratory that are not subject to RCRA and for the Laboratory's decommissioning program for surplus buildings and facilities.

The ER Project maintains six High-Performing Teams (HPTs) that include members from the DOE, other Laboratory organizations, and the NMED. The teams were formed to accelerate environmental restoration through interagency communication and collaborative decision-making at complex sites. The six teams include: Building 260 Outfall Corrective Measures Study/Corrective Measures Implementation, Airport Landfill, TA-54 RCRA Material Disposal Area Implementation Plan, Ecological Risk, TA-35 Sampling and Analysis Plan, and Permit Modifications. Information about specific HPT activities during 2000 is presented in Section 2.C.2., Environmental Oversight and Monitoring Agreement. The ER Project Installation Work Plan (LANL 2000a) fully documents the watershed approach and the corrective action process. The plan is updated annually as part of the requirements of the RCRA Hazardous Waste Facility permit. See *http://erproject.lanl.gov* on the World Wide Web for additional information about the ER Project. See Chapter 2 for summaries of ER Project activities performed in 2000.

5. Land Conveyance and Transfer Under Public Law 105-119

On November 26, 1997, Congress passed Public Law 105-119. Section 632 of the Act directed the Secretary of Energy to identify parcels of land at or near the Laboratory for conveyance and transfer to one of two entities: either Los Alamos County or the Secretary of the Interior (to be held in trust for San Ildefonso Pueblo). Pursuant to this legislation, DOE determined that an Environmental Impact Statement (EIS) would be required under NEPA to satisfy the requirements for review of environmental impacts of the conveyance or transfer of each of the ten tracts of land (totaling about 4,800 acres) slated for transfer. DOE may retain portions of these tracts because of current or future national security mission needs or the inability to complete restoration and remediation for the intended use within the time frame prescribed in the Act. The Final Conveyance and Transfer (CT) EIS is dated October 1999 (DOE 1999), and a Record of Decision was issued in January 2000.

Public Law 105-119 also required DOE to evaluate those environmental restoration activities that would be necessary to support land conveyance and transfer and to identify how this cleanup could be achieved within the ten-year window established by law. The resultant report, the *Environmental Restoration Report to Support Land Conveyance and Transfer under Public Law 105-119*, was dated August 1999. In addition, Congress required DOE to issue a Combined Data Report that summarized the material contained in the CT EIS and Environmental Restoration Report. The Combined Data Report to Congress was released in January 2000, and the official notification that these documents were available from the EPA appeared in February 2000. DOE is taking various actions to accomplish the conveyance and transfer of the 10 subject tracts, including actions taken with the assistance of the Laboratory, such as regulatory compliance and environmental restoration activities. These actions will continue until all 10 tracts have been transferred or until the end of 2007 as provided for in Public Law 105-119.

6. Cooperative Resource Management

Interagency Wildfire Management Team. The Interagency Wildfire Management Team continues to be a vehicle for addressing wildfire issues of mutual concern to the regional land management agencies. The team collaborates in public outreach activities, establishes lines of authority to go into place during a wildfire, provides cross-disciplinary training, and shares the expertise that is available from agency to agency. The result of this collaboration has been an increased coordination of management activities between agencies and a heightened response capability in wildfire situations. The Interagency Wildfire Management Team has been instrumental in evaluating and guiding the forest thinning activities in the LANL region to minimize the risk and impacts of wildfires. These forest thinning activities were a critical factor in minimizing some of the spread and impacts of the Cerro Grande fire within Los Alamos County, LANL, and US Forest Service lands bordering LANL. In addition to DOE and UC/LANL, regular participants of the Interagency Wildfire Management Team include representatives of the Los Alamos County Fire Department, Santa Fe National Forest, Bandelier National Monument, San Ildefonso Pueblo, NM State Forester's Office, and NMED DOE Oversight Bureau.

East Jemez Resource Council. The East Jemez Resource Council remains a highly effective means of improving interagency communication and cooperation in the management of resources on a regional basis. The council includes the Cultural Resources and the LANL Biological Resources Working Groups. These council working groups give resource specialists a forum for a more detailed and technical assessment of resource-specific issues and solutions. The working groups report on progress and issues during the quarterly council meetings. The council is also providing a forum for soliciting regional agency and stakeholder input during the development of the several resource management documents including the LANL Biological Resources Management Plan, Ecological Risk Assessment Project, and the Comprehensive Site Plan. Council participants include Bandelier National Monument, Santa Fe National Forest, NMED, New Mexico State Forestry Division, US Fish and Wildlife Service, NM Department of Game and Fish, San Ildefonso Pueblo, Santa Clara Pueblo, Cochiti Pueblo, Los Alamos County, Rio Arriba County, DOE, and UC/LANL.

Cochiti Lake Ecological Resources Team. In 2000, the Cochiti Lake Ecological Resources Team assisted the US Army Corps of Engineers in developing a rigorous water quality sampling and monitoring study along the Rio Grande following the Cerro Grande fire. The team supported the study by facilitating interagency communication, advice, and technical reviews. The team also provided the US Army Corps of Engineers with important contact information and water quality data from LANL. Cochiti Lake Ecological Resources Team participants include the US Army Corps of Engineers, Bandelier National Monument, DOE/LAAO, US Geological Survey, US Fish and Wildlife Service, NM Game and Fish, Cochiti Pueblo, US Forest Service, and UC/LANL.

Pajarito Plateau Watershed Partnership. In 2000, the Pajarito Plateau Watershed Partnership continued to develop a multiagency program and plan to identify and resolve the primary regulatory and stakeholder issues affecting water quality in the watersheds of the Pajarito Plateau region. The partnership's mission is to work together to protect, improve, and/or restore the quality of water in the regional watersheds. The partnership completed and submitted a proposal to receive Clean Water Act Section 319 funding from the EPA to improve regional watersheds impacted by the Cerro Grande fire. Partnership members include Bandelier National Monument, San Ildefonso Pueblo, Santa Clara Pueblo, Los Alamos County, NMED, US Forest Service, DOE, and UC/LANL.

7. Community Involvement

The Laboratory continues to encourage public access to information about environmental conditions and the environmental impact of operations at the Laboratory. Although the Community Relations Office has the responsibility to help coordinate activities between the Laboratory and northern New Mexico, many organizations at the Laboratory are actively working with the public. Frequently, these interactions address environmental issues because of the Laboratory's potential impact on local environment, safety, and health. During 2000, considerable resources were expended on responding to the impacts of the Cerro Grande fire in addition to more routine environmental inquiries.

The Communications and Outreach Team of the ER Project works actively with the public. The team coordinates public involvement activities such as public meetings, tours, media, and general outreach activities for issues about the ER Project and the CT EIS. In 1999, the team produced a Web site on the ER Project: *http://erproject.lanl.gov* on the World Wide Web. In 2000, the team developed a "Virtual Library" on the Project's external Web site allowing the public to access ER Project documents online.

Some examples of how the Laboratory distributes and makes environmental information available to the public are described below.

Outreach Centers

During 2000, Community Relations assigned outreach managers to cover Los Alamos, Santa Fe, Española, and Taos. The Los Alamos center includes a reading room with access to Laboratory documents. Approximately 100 people visited the reading room last year. Access to environmental information is available at outreach centers in Los Alamos and Española. In addition to the activities listed below, the office also helps technical organizations coordinate public meetings, tours, speakers, and other outreach activities as needed including assistance with publications.

Bradbury Science Museum

Because many of the Laboratory's facilities are not accessible to the public, the Bradbury Science Museum provides a way for the public to learn about the kinds of work the Laboratory does, whether it is showing how lasers assess air pollution or demonstrating ecological concepts. The attendance of approximately 75,000 in 2000 was lower than in previous years because of the fire-related closures of the Laboratory and the town.

Inquiries

In 2000, the Community Relations Office—with the assistance of a wide variety of Laboratory organizations—responded to literally thousands of questions during the fire from community leaders, employees, and members of the public in addition to the more routine requests for environmental information. These inquiries came to the Community Relations Office by letter, phone, fax, e-mail, and personal visits. During the fire, the office set up special facilities and phone numbers to respond to large numbers of calls from both the employees and the public.

Volunteer recruitment

The Laboratory, through the Community Relations Office, helped recruit Laboratory employees to participate in the environmental restoration efforts after the fire both on and off Laboratory property. Both efforts were a success with volunteers raking, seeding, and mulching as well as cleaning out culverts and installing waddles and other equipment to deter flooding. Hundreds of employees volunteered.

To learn more about the Community Relations Office and the Laboratory's community involvement efforts, you can contact the offices in Los Alamos (505-665-4400, 1-800-508-4400) or Española (505-753-3682) or by e-mail at cro@lanl.gov.

8. Public Meetings

The Laboratory holds public meetings to inform residents of surrounding communities about environmental activities and operations at the Laboratory. During 2000, the Laboratory held two public meetings as part of a continuing series called the "Community Environment, Safety, and Health Meetings." The first of these meetings, titled "Criticality Accidents and Radiation Exposure," was held on March 29, 2000, at the College of Santa Fe. A second meeting, "Wildland Fire 2000: Los Alamos At Risk," took place on April 26, 2000, just days before the Cerro Grande fire began in May 2000.

Immediately following the Cerro Grande fire emergency, the Laboratory established an Emergency Rehabilitation Team (ERT). To assist ERT in communicating with the public, a Public Advisory Group was formed. ERT initially held weekly meetings with the public. In early fall, ERT public meetings were scheduled for once each month.

The ER Project also sponsored public meetings, informational briefings, poster sessions, open houses, monthly availability sessions, and tours during 2000. Topics for public meetings included items of interest identified by the public, quarterly status reports on the Project's progress cleaning up sites in the Los Alamos town site and in local canyons, the use of Best Management Practices to stabilize PRSs affected by the Cerro Grande fire, and the cleanup of radioactive sludge from a facility wastewater lagoon at TA-53. The ER Project coordinated a legally mandated meeting on a modification to the Laboratory's RCRA Hazardous Waste Facility Permit. The Communications and Outreach Team staff worked extensively with the Interagency Flood Risk Assessment Team coordinating a public meeting on the impacts of the Cerro Grande fire.

During 2000, the ER Project conducted or coordinated over 30 tours of Laboratory facilities and sites for DOE, EPA, and NMED; the CAB; tribal and local governments and their environmental staffs; and the media. Many of the tours conducted in 2000 dealt with the impact of Cerro Grande fire on ER Project-related sites. The ER Project also sponsored several tours including the Non Traditional In Situ Vitrification Technology demonstrations.

9. Tribal Interactions

During 2000, executive and staff meetings were held with Cochiti Pueblo, Jemez Pueblo, San

Ildefonso Pueblo, Santa Clara Pueblo, and DOE and Laboratory personnel. Subjects for the meetings included DOE-funded environmental programs, such as Environmental Restoration, Environmental Surveillance, Cultural Resource Protection, Emergency Response, and other environmental issues.

The Laboratory's Tribal Relations Team continues to work with tribes on hazardous material shipment through pueblo lands with emphasis on safety issues. The Laboratory provided technical assistance for development of emergency management plans and improvement of procedures for incident notification. The Laboratory signed an Emergency Communications Protocol Agreement with Santa Clara Pueblo in 2000 and is presently working with San Ildefonso on a similar agreement. Additional interactions included

- monthly meetings of the appropriate agencies through the Multiagency Coordinating Group to discuss the progress and needed rehabilitation efforts related to the Cerro Grande fire;
- briefings and tours for tribal officials and staff on the overall flood control measures on Laboratory property that may impact San Ildefonso and other pueblos;
- briefings and tours of cultural sites the Cerro Grande fire affected on a continuing basis with tribal officials and staff; and
- continued monitoring and sampling of the floodwaters for potential contamination conducted independently and jointly by the pueblos and the Laboratory.
- monthly meetings between tribal officials and the ER Project to discuss topics of mutual concern: land conveyance and transfer; risk assessment techniques and specifically the Native American Risk human-health risk assessment technique; and the impact of the Cerro Grande fire on PRSs in the canyons upstream of pueblo lands.

10. A Report for Our Communities

In December 2000, ESH Division published 18,000 copies of the annual report, "For the Seventh Generation: Environment, Safety, and Health at Los Alamos National Laboratory: A Report to Our Communities 1999–2000 Volume IV" (ESH 2000). This report gives the Laboratory, its neighbors, and other stakeholders a snapshot of some of the Laboratory ESH programs and issues.

Feature articles in this volume include issues associated with the Cerro Grande fire aftermath and other ESH issues. Following are some of the article titles:

On the Road to Recovery
The Beauty and the Beast
Smoky Details
First Fire, Now Flood?
Risk Management Makes a Difference
A Message from the Governor of New Mexico
Nuclear Criticality: A Safe Approach to the Dragon
Eliminating Legacy Materials
The Weather Machine
Pueblo Students: Bridging the Gap between Science and Ancient Wisdom

This report is available from the Laboratory's Outreach Centers and reading room. It is also available at *http://lib-www.lanl.gov/la-pubs/00393815.pdf* on the World Wide Web.

11. Citizens' Advisory Board

The Northern New Mexico Citizens' Advisory Board on Environmental Management was formed in 1995 to provide opportunities for effective communications between the diverse multicultural communities of northern New Mexico, the DOE, the Laboratory, and state and federal regulatory agencies on environmental restoration, environmental surveillance, and waste management activities at the Laboratory. ER Project staff participate in the monthly CAB meetings. More information on the CAB is available at *http://www.nnmcab.org* on the World Wide Web.

C. Assessment Programs

1. Overview of Los Alamos National Laboratory Environmental Quality Assurance Programs

Quality is the extent to which an item or activity meets or exceeds requirements. Quality assurance includes all the planned and systematic actions and activities necessary to provide adequate confidence that a facility, structure, system, component, or process will perform satisfactorily. Each monitoring activity ESH Division sponsors has its own Quality Assurance Plan and implementing procedures. These plans and procedures establish policies, requirements, and guidelines to effectively implement regulatory requirements and to meet the requirements for DOE Orders 5400.1 (DOE 1988), 5400.5 (DOE 1990), and 5700.6C (DOE 1991). Each Quality Assurance Plan must address the criteria for management, performance, and assessments.

The ESH groups performing environmental monitoring activities either provide their own quality assurance support staff or can obtain support for quality assurance functions from the Quality Assurance Support Group (ESH-14). ESH-14 personnel perform quality assurance and quality control audits and surveillance of Laboratory and subcontractor activities in accordance with the Quality Assurance Plan for the Laboratory and for specific activities as requested. The Laboratory's Internal Assessment Group (AA-2) manages an independent environmental appraisal and auditing program that verifies implementation of environmental requirements. The Quality and Planning Program Office manages and coordinates the effort to become a customer-focused, unified Laboratory.

2. Overview of University of California/ Department of Energy Performance Assessment Program

During 2000, UC and DOE evaluated the Laboratory based on mutually negotiated ES&H performance measures. The performance measure rating period runs from July to June. The performance measures are linked to the principles and key functions of ISM. The performance assessment program is a process-oriented approach intended to enhance the existing ISM system by identifying performance goals.

Performance measures include the following categories:

- environmental performance;
- radiation protection of workers;
- waste minimization, affirmative procurement, and energy and natural resources conservation;
- management walkarounds;
- hazard analysis and control;
- maintenance of authorization basis; and
- injury/illness prevention.

Specific information on the categories and the assessment scoring can be obtained at *http://drambuie.lanl.gov/~eshiep/* on the World Wide Web.

3. Environment, Safety, & Health Panel of the University of California President's Council on the National Laboratories (UC-ES&H)

The Environment, Safety, and Health Panel of the University of California President's Council on the National Laboratories held its annual meeting August14–16, 2000. The agenda included, among others, the following topics:

- the Cerro Grande fire recovery, rehabilitation, and outreach;
- review of the Laboratory's self-assessment program and leading indicators;
- communications and external relations;
- TA-55 personnel contamination incident; and
- radiation studies.

The panel has not issued a written report summarizing the results of the meeting.

4. Division Review Committee

The ES&H Division Review Committee reviewed ES&H research projects in 2000. The primary purpose of the meeting was to perform the Science & Technology Assessment of ESH Division. The Division Review Committee based its evaluation on the four criteria provided by the UC President's Council on the National Laboratories:

- quality of science and technology,
- relevance to national needs and agency missions,
- support of performance, technical development, and operations at LANL facilities, and
- programmatic performance and planning.

The committee assigned an overall grade of outstanding/excellent to the performance of the division for science and technology. Of the 28 projects evaluated, 18 were truly outstanding or excellent. The projects deemed best in class were

- new tests for beryllium (Be) medical surveillance;
- possible role of exposure to the aerosol physicochemical form of beryllium in development of chronic beryllium disease (CBD);
- detecting emissions of uranium using ambient isotopic measurements;
- utilizing models on multiple scales to enhance

the hydrogeologic characterization of the Pajarito Plateau;

- relationship of ecological variables to Sin Nombre virus antibody seroprevalence in deer mouse populations;
- the effects of fluvalinate residue accumulation on honey bee (*Apis mellifera*) queen and colony performance.

5. Cooperative and Independent Monitoring by Other State and Federal Agencies

The Agreement-in-Principle between DOE and the State of New Mexico for Environmental Oversight and Monitoring provides technical and financial support for state activities in environmental oversight and monitoring. NMED's DOE Oversight Bureau carries out the requirements of the agreement. The Oversight Bureau holds public meetings and publishes reports on its assessments of Laboratory activities. Highlights of the Oversight Bureau's activities are reported in Section 2.C.2 and are available at *http://www.nmenv.state.nm.us/*.

Environmental monitoring at and near the Laboratory involves other state and federal agencies such as the Defense Nuclear Facilities Safety Board, the Agency for Toxic Substances and Disease Registry, the Bureau of Indian Affairs, the US Geological Survey, the US Fish and Wildlife Service, the US Forest Service, and the National Park Service.

6. Cooperative and Independent Monitoring by the Surrounding Pueblos

DOE and UC have signed agreements with the four surrounding pueblos. The main purposes of these agreements are to build more open and participatory relationships, to improve communications, and to cooperate on issues of mutual concern. The agreements allow access to monitoring locations at and near the Laboratory and encourage cooperative sampling activities, improve data sharing, and enhance communications on technical subjects. The agreements also provide frameworks for grant support that allow development and implementation of independent monitoring programs.

D. Cerro Grande Fire

On May 4, 2000, the National Park Service initiated a prescribed burn on the flanks of Cerro Grande Peak within the boundary of Bandelier National Monument (LANL 2000b, DOE 2000). The intended burn was a meadow of about 300 acres, at 10,120 ft, located 3.5 mi. west of the Laboratory boundary at TA-16 (Figure 1-5). This technical area is located near the southwest corner of the Laboratory. The prescribed burn was begun in the evening, but, by 1:00 p.m. of the following day, the burn was declared a wildfire.

ESH-17's meteorological data showed above average temperatures and low humidity for the first ten days of the wildfire. Wind speeds averaged 6 to 17 mph and gusted from 27 to 54 mph during these ten days. Generally, winds tended to be from the southwest to west during this period.

By day five of the wildfire, May 8, spot fires began to occur on Laboratory lands. By May 10, the fire moved into the town site of Los Alamos and was proceeding north and east across the TA-16 mesa top. The fire was moving eastward down Water Canyon, Cañon de Valle, Pajarito Canyon, and Cañada del Buey by May 11. Eventually the fire extended northward on Laboratory lands to Sandia Canyon and eastward down Mortandad Canyon into San Ildefonso Pueblo lands. The wildfire was declared fully contained on June 6, having burned 43,000 acres of land extending to Santa Clara Canyon on Santa Clara Pueblo lands to the north of the town site. In all, approximately 7,500 acres of Laboratory property was covered by wildfire burn.

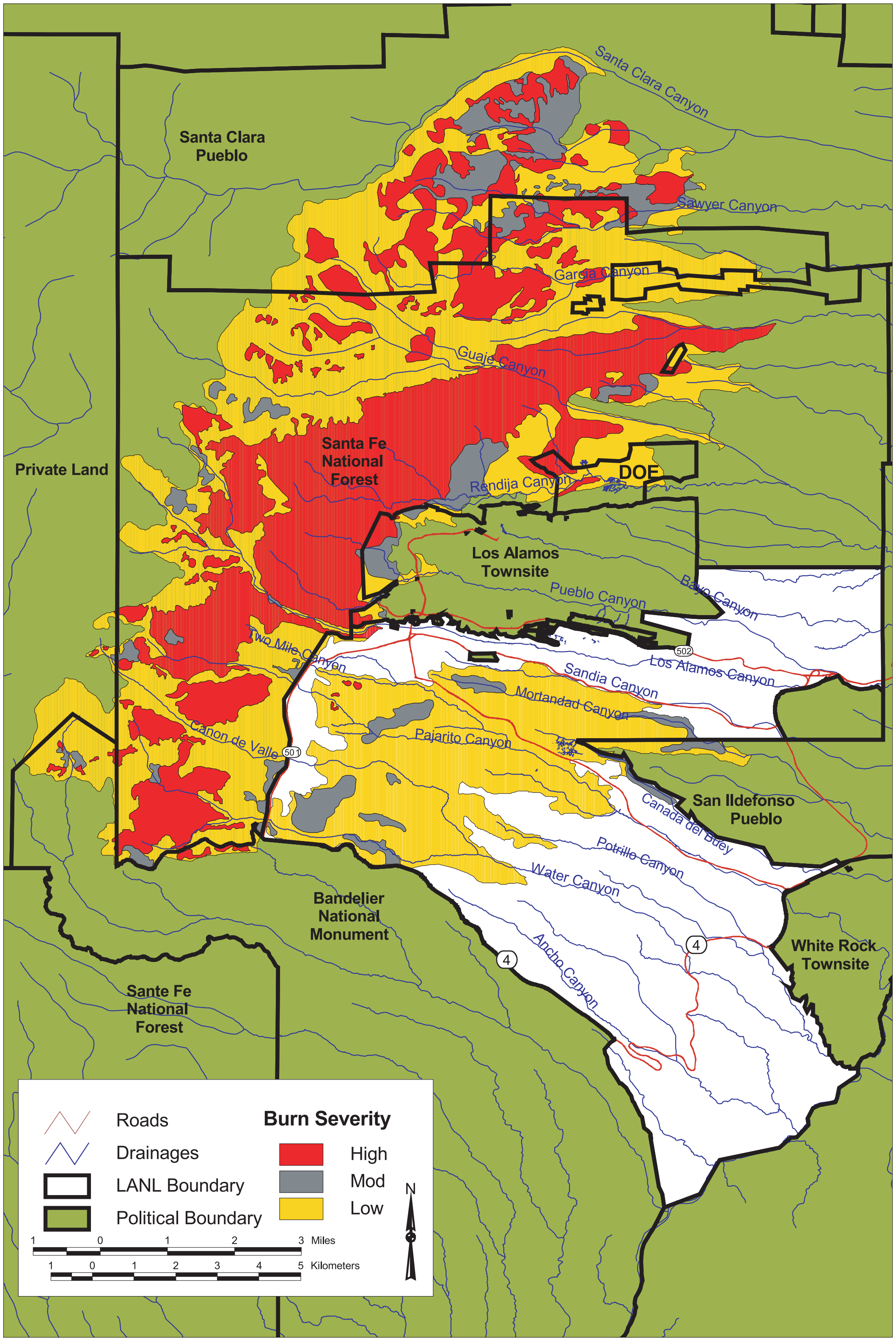

Figure 1-5. Cerro Grande fire burn area.

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2. Compliance Summary

2. Compliance Summary

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Abstract

Los Alamos National Laboratory (LANL or the Laboratory) staff frequently interacted with regulatory personnel during 2000 on Resource Conservation and Recovery Act (RCRA) and New Mexico Hazardous Waste Act requirements and compliance activities. During 2000, the Laboratory continued to work on the application process to renew its Hazardous Waste Facility permit.

The Laboratory's Environmental Restoration (ER) Project originally administered approximately 2,124 potential release sites (PRSs). By the end of 2000, only 880 discrete PRSs remained. High-performing teams made progress on their first corrective measures study/corrective measures implementation project when work began on the cleanup of the Building 260 Outfall area at Technical Area (TA) 16. In addition, a high-performing team completed a RCRA Facility Investigation of material disposal areas at TA-54.

During 2000, the Laboratory performed approximately 300 air quality reviews for new and modified projects, activities, and operations to identify all applicable air quality requirements. A number of projects, some related to Cerro Grande fire recovery, required permits, permit revisions, or administrative notices. Criteria pollutant emissions for 2000 were somewhat less than 1999; however, SO_x emissions increased because of the use of fuel oil at the steam plants during the Cerro Grande fire. The Environmental Protection Agency's (EPA's) effective dose equivalent (EDE) to any member of the public from radioactive airborne releases from a Department of Energy (DOE) facility is limited to 10 mrem/yr. The 2000 EDE was 0.64 mrem. An independent auditor determined that the Laboratory was in compliance with the 10-mrem standard for Calendar Year (CY) 1999. The Laboratory reported mercury on the Toxic Release Inventory Report, under the Emergency Planning and Community Right-to-Know Act. The mercury releases included 0.6 lb air emissions, 0.6 lb water discharge, and approximately 20 lb mercury-containing waste shipped off-site for disposal.

In 2000, the Laboratory was in compliance with its National Pollutant Discharge Elimination System (NPDES) permit liquid discharge requirements in 100% of the samples from its sanitary effluent outfalls and in 100% of the samples from its industrial effluent outfalls. The Laboratory was in compliance with its NPDES permit liquid discharge requirements in 100% of the water quality parameter samples collected in the period from January 1, 2000, through December 31, 2000, at sanitary and industrial outfalls. Concentrations of chemical, microbiological, and radioactive constituents in the drinking water system remained within federal and state drinking water standards.

During 2000, LANL instituted a new National Environmental Protection Act (NEPA), cultural, and biological review process. This Laboratory Implementing Requirement trains division- and program-level reviewers to conduct preliminary NEPA, cultural, and biological compliance screenings, thereby increasing awareness that results in better planning and resource protection. LANL sent 61 NEPA Environmental Review Forms to DOE in 2000 and carried out 68 emergency reviews in support of recovery from the Cerro Grande fire. The Cerro Grande fire interrupted normal operations early in the year and resulted in emergency NEPA work for the duration of 2000. A special edition of the Site-Wide Environmental Impact Statement (SWEIS) Yearbook focussed on wildfire 2000, and a Special Environmental Analysis on actions taken in response to the Cerro Grande fire was also published. The Electric Power System Upgrade and the Wildfire Hazard Reduction and Forest Health Improvement Program environmental assessments were completed. Work continued on SWEIS mitigation action plans, and operations-related mitigation measures for the Dual Axis Radiographic Hydrodynamic Test Facility and the Low-Energy Demonstration Accelerator were implemented.

2. Compliance Summary

Laboratory biologists reviewed 454 proposed activities and projects for potential impact on biological resources including federally listed threatened and endangered species; of these, 60 projects required additional habitat evaluation surveys. In addition, biologists conducted approximately 30 species-specific surveys to determine the presence or absence of a threatened or endangered species at LANL.

A. Introduction

Many activities and operations at Los Alamos National Laboratory (LANL or the Laboratory) use or produce liquids, solids, and gases that may contain nonradioactive hazardous and/or radioactive materials. Laboratory policy implements Department of Energy (DOE) requirements by directing its employees to protect the environment and meet compliance requirements of applicable federal and state environmental protection regulations.

Federal and state environmental laws address handling, transport, release, and disposal of contaminants, pollutants, and wastes; protection of ecological, archaeological, historic, atmospheric, soil, and water resources; and environmental impact analyses. Regulations provide specific requirements and standards to ensure maintenance of environmental qualities. The Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) are the principal administrative authorities for these laws. DOE and its contractors are also subject to DOE-administered requirements for control of radionuclides. Table 2-1 presents the environmental permits or approvals these organizations issued and the specific operations and/or sites affected.

B. Compliance Status

1. Resource Conservation and Recovery Act

a. Introduction. The Laboratory produces a variety of hazardous wastes, most in small quantities relative to industrial facilities of comparable size. The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, creates a comprehensive program to regulate hazardous wastes from generation to ultimate disposal. The HSWA emphasize reducing the volume and toxicity of hazardous waste. The applicable federal regulation, 40 Code of Federal Regulations (CFR) 268, requires treatment of hazardous waste before land disposal.

EPA or an authorized state issues RCRA permits to regulate the storage, treatment, or disposal of hazardous waste and the hazardous component of radioactive mixed waste. A RCRA Part A permit application identifies (1) facility location, (2) owner and operator, (3) hazardous or mixed wastes to be managed, and (4) hazardous waste management methods and units (RCRA hazardous waste management areas). A facility that has submitted a RCRA Part A permit

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 2000

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
RCRA Hazardous Waste Facility	Hazardous and mixed waste storage and treatment permit	November 1989	November 1999 Administratively continued	NMED
	RCRA General Part B renewal application	submitted January 15, 1999		
	RCRA mixed waste Revised Part A application	submitted April 1998	– – –	NMED
	TA-50/TA-54 permit renewal application	submitted January 15, 1999		
HSWA	RCRA Corrective Activities	March 1990	December 1999 Administratively continued	NMED
TSCA[a]	Disposal of PCBs at TA-54, Area G	June 25, 1996	June 25, 2001	EPA
CWA/NPDES[b], Los Alamos	Discharge of industrial and sanitary liquid effluents	August 1, 1994	October 31, 1998[c]	EPA
	Storm water permit for industrial activity	December 23, 2000	October 30, 2005	EPA
Storm Water Permit for Construction Activity	DARHT Facility Project	October 2, 1998	July 7, 2003	EPA
	Guaje Well Field Improvements Project	October 2, 1998	July 7, 2003	EPA
	Fire Protection Improvements Project	October 2, 1998	July 7, 2003	EPA
	Strategic Computing Complex Project	May 21, 1999	July 7, 2003	EPA
	Norton Power Line Project	June 1, 1999	July 7, 2003	EPA
	TA-9 to TA-15 Gas Pipeline Replacement Project	August 22, 1999	July 7, 2003	EPA
	Flood Mitigation Project	July 25, 2000	July 7, 2003	EPA
	Nuclear Materials Safeguards and Security Upgrade Project	February 25, 2000	July 7, 2003	EPA
CWA Sections 404/401 Permits	Sandia Canyon/Survey Activities	March 4, 1998	March 4, 2000	COE[d]/NMED
	Guaje Canyon/Bank Stabilization	March 2, 1998	March 2, 2000	COE/NMED
	Lab-wide Gaging Stations/Sci. Meas. Devices	August 28, 1998	August 28, 2000	COE/NMED
	Norton Transmission Line Replacement	March 4, 1999	March 4, 2001	COE/NMED
	Wetland Characterization	May 25, 1999	May 25, 2001	COE/NMED
	Sewer Line Crossing-Upper Sandia Canyon	May 27, 1999	May 27, 2001	COE/NMED
	Lab-wide Gaging Stations/Sci. Meas. Devices Part 2	June 15, 1999	June 15, 2001	COE/NMED
	TA-9 to TA-15 Natural Gas Line Replacement	June 17, 1999	June 17, 2001	COE/NMED
	TA-48 Wetlands Improvement	July 9, 1999	July 9, 2001	COE/NMED

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 2000 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
CWA Sections 404/401 Permits (Cont.)	TA-72 Firing Range Maintenance	July 13, 1999	July 13, 2001	COE/NMED
	Gas Line Leak Repair-LA Canyon	July 16, 1999	When repair completed	COE/NMED
	Cañon de Valle Filtration Weir	June 25, 1999	June 25, 2001	COE/NMED
	TA-16-260 Interim Corrective Action	December 20, 1999	April 14, 2000	COE/NMED
	Gaging Station Clean-outs	February 22, 2000	February 22, 2002	COE/NMED
	PRV Installation near TA-2	February 23, 2000	February 23, 2002	COE/NMED
	R-7 Well Access Road	March 24, 2000	March 24, 2002	COE/NMED
	TA-11 Erosion Control/Fire Road Project	April 11, 2000	April 11, 2002	COE/NMED
	Sandia Canyon Wetland Characterization	April 13, 2000	April 13, 2002	COE/NMED
	Organic Biocontaminants Study	May 26, 2000	May 26, 2002	COE/NMED
	Cerro Grande Emergency Operations	June 23, 2000	June 23, 2002	COE/NMED
	COE Projects	July 20, 2000	July 20., 2002	COE/NMED
	Pajarito Flood Retention Structure	July 18, 2000	July 18, 2002	COE/NMED
	Los Alamos/Pueblo Low Head Weirs	July 23, 2000	July 23, 2002	COE/NMED
	Gas Line Replacement in Los Alamos Canyon	September 18, 2000	September 18, 2002	COE/NMED
	Martin Spring Filtration Weir	October 31, 2000	October 31, 2002	COE/NMED
	PRS 3-056 (c), PCB Cleanup	November 17, 2000	November 17, 2002	COE/NMED
	PRS 16-020 Photo Processing Cleanup	November 22, 2000	November 22, 2002	COE/NMED
Groundwater Discharge Plan, Fenton Hill	Discharge to groundwater	June 5, 2000	June 5, 2005	NMOCD[e]
Groundwater Discharge Plan, TA-46 SWS Facility[f]	Discharge to groundwater	January 7, 1998	January 7, 2003	NMED
Groundwater Discharge Plan, Sanitary Sewage Sludge Land Application	Land application of dry sanitary sewage sludge	June 30, 1995	June 30, 2000	NMED
Groundwater Discharge Plan, TA-50, Radioactive Liquid Waste Treatment Facility	Discharge to groundwater	submitted August 20, 1996 approval pending		NMED

Table 2-1. Environmental Permits or Approvals under Which the Laboratory Operated during 2000 (Cont.)

Category	Approved Activity	Issue Date	Expiration Date	Administering Agency
Air Quality Operating Permit (20 NMAC[g] 2.70)	LANL air emissions	not yet issued		NMED
Air Quality (20 NMAC 2.72)	Portable Rock Crusher	June 16, 1999	None	NMED
	TA-3 Steam Plant-Flue Gas Recirculation	September 27, 2000	None	NMED
Air Quality (NESHAP)[h]	Beryllium machining at TA-3-39	March 19, 1986	None	NMED
	Beryllium machining at TA-3-102	March 19, 1986	None	NMED
	Beryllium machining at TA-3-141	October 30, 1998	None	NMED
	Beryllium machining at TA-35-213	December 26, 1985	None	NMED
	Beryllium machining at TA-55-4	February 11, 2000	None	NMED
Open Burning (20 NMAC 2.60)	Burning of jet fuel and wood for ordnance testing, TA-11	August 18, 1997	December 31, 2002	NMED
	Burning of HE-contaminated[i] materials, TA-14			
	Burning of HE-contaminated materials, TA-16			
	Burning of scrap wood from experiments, TA-36			
	Fuel Fire Burn of wood or propane, TA-16, Site 1409			
Open Burning (20 NMAC 2.60) Prescribed Burning	Wood pile at TA-16	August 12, 1999	August 12, 2000	NMED

[a] Toxic Substances Control Act.
[b] National Pollutant Discharge Elimination System.
[c] Administratively extended by EPA. A new permit application was submitted to the EPA on May 4, 1998. Approval is pending.
[d] Corps of Engineers.
[e] New Mexico Oil Conservation Division.
[f] Sanitary Wastewater Systems (SWS) Facility.
[g] New Mexico Administrative Code.
[h] National Emission Standards for Hazardous Air Pollutants.
[i] High-explosive.

application for an existing unit manages hazardous or mixed wastes under transitional regulations known as the Interim Status Requirements pending issuance (or denial) of a RCRA Hazardous Waste Facility permit (the RCRA permit). The RCRA Part B permit application consists of a detailed narrative description of all facilities and procedures related to hazardous or mixed waste management, including contingency response, training, and inspection plans. The State of New Mexico issued LANL's current Hazardous Waste Facility Permit to DOE and the University of California (UC) in November 1989.

In 1996, EPA adopted new standards, under the authority of RCRA, as amended, commonly called "Subpart CC" standards. These standards apply to air emissions from certain tanks, containers, less-than-90-day storage facilities, and surface impoundments that manage hazardous waste capable of releasing volatile organic compounds (VOCs) at levels that can harm human health and the environment.

b. Resource Conservation and Recovery Act Permitting Activities. NMED issued the original RCRA Hazardous Waste Facility Permit for the waste management operations at Technical Areas (TAs) 50, 54, and 16 on November 8, 1989. After 10 years, the original permit expired in 1999. In 2000, the permit was administratively continued beyond the expiration date until NMED issues a new permit (as allowed by the permit and by New Mexico Administration Code, Title 20, Chapter 4, Part 1, as revised January 1, 1997 [20 NMAC 4.1], Subpart IX, 270.51), subject to the timely submittal of permit renewal applications.

In past years, the Laboratory has provided (1) a General Part B permit application to serve as a general resource document and as the basis for Laboratory facility-wide portions of the final permit; (2) TA-specific permit applications to provide detail on specific waste management units, resulting in individual chapters of the final permit; and (3) revisions of previously submitted permit applications reflecting the new format. The Laboratory has provided these submittals in response to NMED's guidance on the permit renewal development strategy and the format for the permit renewal applications.

NMED, DOE, and UC initiated a joint Permit Working Group (PWG) in 2000 to facilitate the review of the submitted permit applications and to assist in the development of a draft permit for public review. The Laboratory received four requests for additional or supplemental information (RSIs) from NMED during 2000. LANL developed two RSI responses for the General Part B permit application and submitted them to NMED in July and October. In late 2000, the Laboratory was preparing a third General Part B response for submittal in early 2001. Additional information for the TA-16 permit application was submitted in September 2000.

The PWG received revised draft chapters for the General Part B permit application and for the TA-16 permit application in June 2000. Also in 2000, the PWG arranged informational tours of the waste management units in TA-16, -50, and -54.

The Laboratory requested the removal of several previously proposed waste management units from the permit in 2000 including

- storage pads 137 through 140 at TA-50 that were never built and
- rooms 35, 36, and 38 at Building 1 at TA-50 that had never been used for mixed waste staging after the 1997 permit modifications.

Because of procedure changes, the TA-50, Building 1, Room 60, cementation treatment unit operating under 20.4.1 NMAC Subpart VI standards is now a less-than-90-day accumulation area. On September 19, 2000, the Laboratory also requested approval of the Characterization, High-Activity Processing, and Storage Facility at TA-54, pursuant to 20.4.1 NMAC, Subpart IX, 270.72.

c. Resource Conservation and Recovery Act Corrective Action Activities. Solid waste management units (SWMUs) can be subject to both the HSWA Permit Module VIII corrective action requirements and the closure provisions of RCRA. The corrective action process occurs concurrently with the closure process, thereby satisfying both sets of regulations. See previous LANL environmental reports (ESP 2000, ESP 1999, ESP 1998, ESP 1997, ESP 1996) for the history of RCRA closures and other corrective actions.

Closure Activities. The Laboratory's Environmental Restoration (ER) Project has been working at material disposal area (MDA) P at TA-16 for several years implementing the cleanup of this site under a closure plan approved by NMED. MDA P received burn pad debris and other wastes from the early 1950s until 1984. By December 1997, the Laboratory had excavated test pits, and workers began removing surface debris in October 1998. In February 1999, workers began excavating the landfill itself. In addition to removing equipment contaminated with high explosives (HE) from the World War II-era buildings, workers expected to remove HE residues, barium, and empty drums, bottles, and debris. However, they also found detonable pieces of HE.

After identifying detonable pieces of high explosives, Laboratory workers modified field operations with a remote-handled machine to excavate the landfill in February 1999. They completed the work on May 3, 2000. Excavation of contaminated soil beneath the landfill using nonremote excavating methods resumed after the completion of fire recovery in early July. Activity highlights from 2000 include

- excavating almost 23,000 yd^3 of soil and debris;
- shipping over 19,900 yd^3 of hazardous and industrial wastes and recycled materials for disposal;
- removing approximately 260 lb of HE materials; and
- shipping scrap metal and concrete to recycling facilities; shipping contaminated soils and industrial wastes to off-site solid waste landfills; and disposing of solid wastes that didn't contain hazardous materials on-site at TA-54, MDA J.

Closure activities continued at the TA-16-Open Burn Unit 387 (flash pad) and Open Burn Unit 396 (burn tray) in 2000. Closure of the TA-16 industrial incinerator began in June 2000 and was completed in November 2000.

The ER Project made progress on its first corrective measures study/corrective measures implementation project during 2000 by beginning the cleanup work at Potential Release Site (PRS) 16-021(c)-99. Building 16-260 is the Laboratory's conventional high-explosive machining facility. From 1951 to 1996, 13 sumps discharged high-explosive-contaminated wastewater through the 16-260 outfall. PRS 16-021(c)-99 includes the sumps and drain lines that lead to the outfall, as well as the outfall itself, a pond, and a drainage channel. During the RCRA Facility Investigation (RFI) process, ER Project personnel determined that nearby soils; springs, seeps, and surface and alluvial waters in Cañon de Valle; and groundwater were contaminated with high explosives and barium. During FY2000, ER Project personnel removed the majority of the high-explosive and barium sources at PRS 16-021(c)-99. Workers excavated approximately 1,400 yd^3 of soil and rock from within the outfall area, using both conventional and robotic excavation methods.

Corrective Actions. The ER Project worked on several Voluntary Corrective Actions (VCAs) during 2000. PRS 00-019 is located on property currently owned and used by Los Alamos County. It is the site of the county's former central wastewater treatment plant, which served the town site and Laboratory's sanitary waste needs from 1947 to 1965. The site is located in the eastern part of the town site between Sombrillo Nursing Facility and East Park above Pueblo Canyon. The VCA removed many of the subsurface structures associated with the wastewater treatment plant. Activity highlights for 2000 include the following:

- removed and disposed of approximately 1,500 linear feet of abandoned underground process piping and 4 yd^3 of potentially contaminated soil associated with the outfall areas,
- demolished the pump house and disposed of approximately 300 yd^3 of primarily concrete debris and 1 yd^3 of asbestos-containing waste, and
- recycled two 55-gal. drums of lead and 1 yd^3 of brass.

In addition, the team defined the potential for future risk to human health and/or the environment resulting from past operations at the plant.

PRS 03-56(c) is a storage area located northeast of the Johnson Controls Utility Shop in TA-3. Electrical cable; used and unused dielectric oils; and PCB-containing transformers, capacitors, and oil-filled drums have been stored on the site. The Project completed an expedited cleanup at this site in 1995, removing 1,000 yd^3 of soils. Verification sampling indicated PCBs at concentrations greater than the EPA-prescribed cleanup level of less then 1 ppm. During FY2000, ER Project personnel

- started setup, sampling, and excavation activities at the site; much of the west slope, mesa top, and drainage channels have been excavated and/or vacuumed down to bedrock; and
- excavated approximately 900 yd^3 of PCB-contaminated soil and stored the waste on-site in 142 roll-off bins. Eleven of the bins contained PCBs at concentrations greater than 50 ppm and were shipped to an approved off-site disposal facility. Analytical results are pending from the January 2001 verification sampling.

PRS 00-003-99, the Los Alamos Area Office (LAAO) Land Transfer Site, is part of the work required for transferring the LAAO land transfer parcel from the DOE to Los Alamos County. This area was part of the Western Steam Plant and is adjacent to the parking lot at the current LAAO building. During FY2000, ER Project personnel worked on a VCA that

- removed and disposed of approximately 150 linear ft of vitrified clay pipe,
- removed and recycled an underground process tank from the Western Steam Plant,
- collected supplemental samples to define the nature and extent of contamination, and
- collected confirmatory samples.

ER Project personnel also worked at TA-53 removing radioactive sludge and the liner from within the southern lagoon (PRS 53-002[b]). The lagoon was constructed in 1985 and received excess wastewater from the northern lagoons from 1985 to 1992. It also received radioactive liquid discharges from 1992 to the end of 1998, the year it was taken out of service. During FY2000, ER Project personnel

- removed and disposed of approximately 165 yd^3 of radioactive sludge;
- removed and disposed of approximately 30 yd^3 of the lagoon's liner;
- pumped 5,000 gal. of rain water from the lagoon that is awaiting disposal; and
- drilled 14 boreholes at the bottom of the south lagoon to 15 ft deep and collected samples to determine if contaminants are present below the liner.

High-Performing Teams. The ER Project maintains six High-Performing Teams (HPTs) that include members from the DOE, other Laboratory organizations, and the NMED. The teams were formed to accelerate critical path activities of the ER Project through interagency communication and collaborative decision-making at complex sites. The six teams include Building 260 Outfall Corrective Measures Study/Corrective Measures Implementation, Airport Landfill, TA-54 RCRA Material Disposal Area Implementation Plan, Ecological Risk, TA-35 Integrated Sampling and Analysis Plan, and Permit Modifications. For information about specific HPT activities during 2000, see Section 2.C.2, Environmental Oversight and Monitoring Agreement.

More detailed information on ER Project activities and accomplishments is available at *http://erproject.LANL.gov/documents/virtual.html*, in the FY 2000 Accomplishments Book, and in the Quarterly Technicals Reports.

Responses to the Cerro Grande Fire. Initial assessments indicated that the area burned by the wildfire contained over 600 PRSs. Most of these sites are on Laboratory property, particularly in TA-15 and TA-16 on the west side of the Laboratory. In addition to the impact on PRSs within the burned areas, the ER Project was concerned that runoff and/or flash flooding could impact other PRSs downstream of the burned areas. Runoff could also disturb PRSs on mesa tops and canyon sides and floors where contamination from the early days of Laboratory operations was deposited. Once disturbed, that contamination could potentially flow down the canyons to the Rio Grande.

The ER Project had three immediate tasks:

- Evaluate and stabilize sites touched by fire. The PRS Assessment Team completed PRS assessments on May 23, 2000, and completed best management practices (BMP) installations for 91 PRSs on July 19, 2000 (see Table 2-2). The BMPs diverted water from the PRSs and included contour raking, placement of water barriers, and diversion of stream channels.
- Conduct baseline sampling to characterize post-fire, preflood conditions (i.e., before monsoon season rains) in fire-impacted watersheds. The Contaminant Transport Team developed a Baseline Characterization Sampling Plan on June 24, 2000. ER completed preflood fieldwork, including collection of sediment, surface water, and alluvial groundwater samples, on July 14,

Table 2-2. Number and Location of PRSs Requiring Stablization after the Cerro Grande Fire

No. of PRSs	PRS Location	Start Date	Completion Date
10	TA-11	05/21	05/24
29	TA-6, TA-9, TA-14, TA-15, TA-22, TA-36, TA-40, TA-49	06/14	07/01
34	TA-16, TA-46, TA-14 (R-44)	05/19	07/01
18	TA-4, TA-5, TA-42, TA-48	06/27	07/15

2000. Post-flood fieldwork was carried out in August and September.

- Evaluate, stabilize, or remove sites subject to flooding. The Accelerated Actions Team identified 71 sites in fire-impacted canyons that were potentially vulnerable to post-fire flooding. The majority of these sites were in Los Alamos Canyon (TA-2 and TA-41) and Pajarito Canyon (TA-18 and TA-27) and included outfalls, storm drains, septic systems, and structures associated with the Omega West Reactor at TA-2. The team developed a plan for evaluating each site to determine the type, if any, of accelerated action required. Evaluation criteria included contaminant concentration and inventory, adequacy of existing data, erosion and scouring potential, and residual risk estimates for canyon systems. Status sheets for each of these PRSs are available on the World Wide Web at *http://erproject.LANL.gov/Fire/Data/accelerated.html*.

In addition to the 71 floodplain sites, the ER Accelerated Actions Team identified a flood-impacted sediment deposition area and five fire-impacted sediment deposition areas that could be affected by flooding and required corrective actions to remove debris or contaminated soils. Personnel completed accelerated corrective actions at the following sites:

Los Alamos Canyon, “Garden Plot”: excavation and removal of contaminated soil;

TA-16, MDA R: excavation, waste staging, and waste removal;

TA-36 surface disposal area: debris removal;

TA-15, R-44 firing site surface disposal area: debris removal;

TA-40 surface disposal area: debris removal; and

TA-16 “silver” outfall: removal of contaminated soil, stabilization of drainage channel.

d. Other Resource Conservation and Recovery Act Activities. The Hazardous and Solid Waste Group (ESH-19) began the self-assessment program in 1995 in cooperation with waste management coordinators to assess the Laboratory’s performance in properly storing and handling hazardous and mixed waste to meet federal and state regulations, DOE orders, and Laboratory policy. ESH-19 communicates findings from individual self-assessments to waste generators, waste management coordinators, and management to help line managers implement appropriate corrective actions to ensure continual improvement in LANL’s hazardous waste program. In 2000, ESH-19 completed 1,116 quarterly self-assessments.

e. Resource Conservation and Recovery Act Compliance Inspection. NMED did not conduct an annual hazardous waste compliance inspection at the Laboratory in 2000.

f. Mixed Waste Federal Facility Compliance Order. The Laboratory met all 2000 Site Treatment Plan deadlines and milestones. In October 1995, the State of New Mexico issued a Federal Facility Compliance Order (CO) to both DOE and UC requiring compliance with the Site Treatment Plan. That plan documents the use of off-site facilities for treating mixed waste generated at LANL stored beyond the one-year time frame (Section 3004[j] of RCRA and 40 CFR Section 268.50). The Laboratory treated and disposed of over 650 m^3 of mixed waste through FY2000.

g. Underground Storage Tanks. The Laboratory had two underground storage tanks (USTs) (as defined by 40 CFR Part 280) in operation during 2000. The Laboratory closed (removed or permanently took out of service) all other USTs by December 22, 1998, the EPA upgrade/closure deadline. The two operating USTs are designated as TA-16-197 and TA-15-R312-DARHT.

TA-16-197 is a 10,000-gal. UST for unleaded gasoline at a single-pump fueling station for fueling Laboratory service vehicles located at and around TA-16. TA-15-R312-DARHT is a 10,000-gal. UST that captures and stores any accidental releases from an equipment room located at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility. If a pipe breaks or a leak occurs in the equipment room, all fluids enter floor drains that discharge to the UST. This tank is normally empty and is only used as a secondary containment system during an accidental spill. Substances that could potentially enter the tank are mineral oil and glycol. Both USTs are double-walled with double-wall piping. Both tanks have leak-detection systems. TA-16-197 has a cathodic corrosion protection system. TA-15-R312-DARHT is a fiberglass tank that does not require a corrosion protection system. NMED did not conduct an UST inspection during 2000 (see Table 2-3).

h. Solid Waste Disposal. The Laboratory has a commercial/special-waste landfill located at TA-54, Area J, that is subject to NM Solid Waste Manage-

Table 2-3. Environmental Inspections and Audits Conducted at the Laboratory during 2000

Date	Purpose	Performing Agency
6/1/2000	NESHAP Compliance Audit	RAC[a]
8/15–16/2000	Beryllium Operations Inspection	NMED[b]
10/4/2000 and 7/7/2000	Asbestos Inspections	NMED[b]

[No NPDES Outfall, Stormwater, FIFRA, SDWA, 404/401, Ground Water Discharge Plan, RCRA, PCB, or Underground Storage Tank Inspections were conducted in 2000.]

[a] Risk Assessments Corporation.
[b] New Mexico Environment Department.

ment Regulations (NMSWMR). In December 1998, the NMED Solid Waste Bureau requested a permit for the facility, which has been operating under a Notice of Intent since the NMSWMR were issued in 1995. The Laboratory intends to close Area J and submitted a closure plan to NMED in May 1999. NMED has not yet approved the plan, and no closure activities took place during 2000. Generators of commercial/special waste will individually arrange to ship their wastes off-site to a New Mexico Special Waste landfill when Area J closes.

In 2000, LANL completed the required Solid Waste Facility annual report for 1999. Personnel from the NM Solid Waste Bureau did not inspect Area J during 2000.

LANL also disposes of sanitary solid waste (trash), concrete/rubble, and construction and demolition debris at the Los Alamos County Landfill on East Jemez Road. DOE owns the property and leases it to Los Alamos County under a special-use permit. Los Alamos County owns and operates this landfill and is responsible for obtaining all related permits for this activity from the state. The landfill is registered with the NMED Solid Waste Bureau. The Laboratory contributed 38% (14,237 tons) of the total volume of trash landfilled at this site during 2000, with the residents of Los Alamos County and the City of Española contributing the remaining 62%. Laboratory trash landfilled included 2,380 tons of trash, 10,972 tons of concrete/rubble, and 494 tons of construction and demolition debris. During 2000, the Laboratory also sent 322 tons of brush for composting and 69 tons of metal for recycling to the county landfill.

i. Waste Minimization and Pollution Prevention. To comply with the HSWA Module of the RCRA Hazard Waste Facility permit, RCRA Subtitle A, DOE Order 5400.1, Executive Order (EO) 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, and other regulations, the Laboratory must have a waste minimization and pollution prevention program. A copy of that Laboratory program, the *2000 Environmental Stewardship Roadmap*, is located at *http://emeso.lanl.gov/useful_info/publications/publications.html* on the World Wide Web.

Section 1003 of the Waste Disposal Act cites the minimization of the generation and land disposal of hazardous wastes as a national objective and policy. All hazardous waste must be handled in ways that minimize the present and future threat to human health and the environment. The Waste Disposal Act promotes process substitution; materials recovery, recycling, and reuse; and treatment as alternatives to land disposal of hazardous waste.

The 2000 Annual Report on Waste Generation and Waste Minimization Progress as required by DOE Order 5400.1 provides the amounts of routine, nonroutine, and total RCRA-hazardous, low-level, and mixed low-level wastes Laboratory operations generated during FY2000. See *http://doe2.org/wastemin/default.asp* on the World Wide Web for a copy of this report and additional information about waste minimization. DOE defines routine/normal waste generation at LANL as waste generated from any type of production, operation, analytical, and/or research and development (R&D) laboratory operations; treatment, storage, and disposal (TSD) operations; work for others; or any other periodic and recurring work that is considered ongoing in nature.

Nonroutine/off-normal waste generation is defined as one-time operation waste such as wastes produced from ER Project activities, including primary and secondary wastes associated with removal and remediation operations, and wastes associated with the legacy waste program cleanup and decontamination and decommissioning (D&D) operations.

Source reduction, waste avoidance, and recycling activities reduced FY2000 waste generation by the following amounts when compared with FY1999:

Transuranic (TRU) waste	9.25 m^3
Low-level radioactive waste	812.42 m^3
Mixed low-level radioactive waste	55.6 m^3
Sanitary solid waste	5,074.51 metric tons
Hazardous waste (including RCRA, NM Special, and Toxic Substances Control Act [TSCA] waste)	4,325.6 metric tons

j. Greening of the Government Executive Order. The Laboratory purchases EPA-designated products made with recovered materials in support of EO 13101, “Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition,” signed by President Clinton on September 14, 1998, and to comply with RCRA section 6002. EPA designates the categories of these items, referred to as Affirmative Procurement. Based on past reports, the Laboratory purchases the largest number of items in three categories: paper, toner cartridges, and plastic desktop accessories whenever available. The Laboratory submits a summary report to DOE after each fiscal year end and is required to report quarterly to UC on the Affirmative Procurement Rate.

In April 2001, the DOE will be providing EO 13101 training to Laboratory procurement personnel. Procurement personnel and the Environmental Stewardship Office are working with Laboratory vendors to provide purchasers with a wide variety of recycled content items in the Just-In-Time purchasing system.

k. Resource Conservation and Recovery Act Training. The RCRA training program is a required component of and is described in the RCRA Hazardous Waste Facility Permit. The Laboratory training program is in compliance and, with the exception of refresher courses that undergo annual revisions, experienced only minor modifications and revisions in 2000 to reflect regulatory, organizational, and/or programmatic changes.

During 2000, 97 workers completed RCRA Personnel Training, 482 workers completed RCRA Refresher Training, and 339 workers completed Waste Generation Overview. Of the 482 workers who required RCRA Refresher Training during 2000, 441 met this requirement through completing hazardous waste operations (HAZWOPER) Refresher for Treatment, Storage, and Disposal Workers, a course that includes the RCRA Refresher as part of its eight-hour requirement.

In response to a new Laboratory requirement, the Environment, Safety, and Health Training group (ESH-13) began development of a Waste Generation Overview Refresher course in August 2000. This new course will be available in April 2001, and Laboratory waste generators must take it every three years. The course is web-based and highly interactive and can be taken at the trainee’s computer workstation.

ESH-13 completely revised the following RCRA courses during 2000:

- RCRA Personnel Training
- HAZWOPER: Refresher for Environmental Restoration Workers
- HAZWOPER: Refresher for Treatment, Storage, and Disposal Workers
- Waste Management Coordinator Requirements

ESH-13 updated the following courses during 2000:

- RCRA Refresher Training
- Waste Generator Overview

l. Hazardous and Solid Waste Amendments Compliance Activities. In 2000, the ER Project remained in compliance with Module VIII of the RCRA permit. The Laboratory’s ER Project originally administered approximately 2,124 PRSs, consisting of 1,099 units that were listed on the HSWA module of the Laboratory RCRA permit administered by NMED and 1,025 non-HSWA units administered by DOE. By the end of 2000, only 880 discrete PRSs remained—541 administered by NMED and 339 administered by DOE.

During 2000, a new PRS was identified, and 10 additional PRSs were created when PRS 16-017 was divided. Public comment was pending on no further action recommendations for 30 PRSs, and the Project had recommended 17 additional PRSs for no further action to NMED. The ER Project consolidated 107 HSWA units and 34 non-HSWA units during 2000 during the NMED Annual Unit Audit.

In 2000, the LANL ER Project HSWA compliance activities included remedial site assessments and site cleanups. The assessment portion of the ER Project included submission of 5 RFI reports to NMED and RFI fieldwork on 15 sites.

The ER Project anticipates that the corrective action process for all PRSs will be complete by 2013. Based on the watershed approach, future work will focus on PRSs in the Los Alamos town site at the head of Los Alamos, Pueblo, Guaje, Rendija, Barranca, Bayo, and DP Canyons and work down each canyon to the Rio Grande. Work will then continue southward, watershed by watershed, until work on PRSs in all eight watersheds is completed.

2. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, mandates actions for certain releases of hazardous substances into the environment. The Laboratory is not listed on the EPA's National Priority List, but the ER Project follows some CERCLA guidelines for remediating Laboratory sites that contain certain hazardous substances not covered by RCRA and/or that may not be included in Module VIII of the Laboratory's Hazardous Waste Facility Permit.

DOE fulfills its responsibilities as both a natural resource trustee and lead response agency for ER Project activities at the Laboratory. DOE's policy is to consider CERCLA Natural Resource Damage Assessment (NRDA) issues and, when appropriate, resolve them with other natural resource trustees as part of the ER Project remedy selection process. ER Project cleanup considers integrated resource management activities (e.g., biological resource management, watershed management, and groundwater protection) at the Laboratory. As ER Project cleanup activities progress, natural resource trustees (i.e., Department of Interior, Department of Agriculture Forest Service, Cochiti Pueblo, Jemez Pueblo, San Ildefonso Pueblo, Santa Clara Pueblo, and the State of New Mexico) are invited to participate in the process. DOE initiated its dialogue with the natural resource trustees on ER Project activities in 1997.

3. Emergency Planning and Community Right-to-Know Act

a. Introduction. The Laboratory is required to comply with the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 and Executive Order (EO) 13148.

b. Compliance Activities. In 2000, the Laboratory submitted two annual reports and one updated notification to fulfill its requirements under EPCRA, as shown on Table 2-4 and described below.

Emergency Planning Notification. Title III, Sections 302-303, of EPCRA requires the preparation of emergency plans for more than 360 extremely hazardous substances if stored in amounts above threshold limits. The Laboratory is required to notify state and local emergency planning committees of any changes at the Laboratory that might affect the local emergency plan or if the Laboratory's emergency planning coordinator changes. In 2000, LANL updated the notification to add sodium cyanide to the list of hazardous substances stored on-site.

Emergency Release Notification. Title III, Section 304, of EPCRA requires facilities to provide emergency release notification of leaks, spills, and other releases of listed chemicals over specified reporting quantities into the environment. Releases must be reported immediately to the state and local emergency planning committees and to the National Response Center. No leaks, spills, or other releases of specific chemicals into the environment that required EPCRA reporting occurred during 2000.

Material Safety Data Sheet/Chemical Inventory Reporting. Title III, Sections 311-312, of EPCRA requires facilities to provide an annual inventory of the quantity and location of hazardous chemicals present at the facility above specified thresholds; the inventory includes the material safety data sheet for each chemical. The Laboratory submitted a report to the state emergency response commission and the Los Alamos County Fire and Police Departments listing 42 chemicals and explosives at the Laboratory that exceeded threshold limits during 2000.

Toxic Release Inventory Reporting. EO 13148 requires all federal facilities to comply with Title III, Section 313, of EPCRA. This section requires reporting of total annual releases of listed toxic chemicals that exceed activity thresholds. Starting with reporting year 2000, new and lower

Table 2-4. Compliance with Emergency Planning and Community Right-to-Know Act during 2000

Statute	Brief Description	Compliance
EPCRA Sections 302-303 Planning Notification	Requires emergency planning notification to state and local emergency planning committees.	LANL sent the initial notification to appropriate agencies in 1994 informing officials of the presence of hazardous materials in excess of specific threshold planning quantities and of the current facility emergency coordinator. In 2000, LANL updated the notification to add sodium cyanide to the list.
EPCRA Section 304 Release Notification	Requires reporting of releases of certain hazardous substances over specified thresholds to state and local emergency planning committees and to the National Response Center.	There were no leaks, spills, or other releases of chemicals into the environment that required EPCRA Section 304 reporting during 2000.
EPCRA Sections 311-312 MSDSs and Chemical Inventories	Requires facilities to provide appropriate emergency response personnel with an annual inventory and other specific information for any hazardous materials present at the facility over specified thresholds.	The presence of 42 hazardous materials over specified quantities in 2000 required submittal of a hazardous chemical inventory to the state emergency response commission and the Los Alamos County Fire and Police Department.
EPCRA Section 313 Annual Releases	Requires all federal facilities to report total annual releases of listed toxic chemicals used in quantities above reportable thresholds.	Threshold quantities for mercury were exceeded in 2000 requiring submittal of a Toxic Chemical Release Inventory Reporting Form to the EPA and the state emergency response commission.

chemical activity thresholds are in place for certain persistent, bioaccumulative, and toxic (PBT) chemicals and chemical categories. The thresholds for the PBTs range from 0.1 gram to 100 pounds. Until this change went into affect, the most conservative threshold was 10,000 pounds. LANL exceeded one newly revised PBT threshold in 2000 and therefore was required to report the use and releases. That PBT was mercury with a threshold of 10 pounds. The following releases of mercury were reported: 0.6 pounds of air emissions, 0.6 pounds of water releases, and approximately 20 pounds of mercury-containing waste shipped off-site for disposal.

4. Emergency Planning under DOE Order 151.1.

The Laboratory's Emergency Management Plan is a document that describes the entire process of planning, responding to, and mitigating the potential consequences of an emergency. The most recent revision of the plan, incorporating DOE Order 151.1A, published in March 2000, will be updated in April 2001 and reflect lessons learned during the devastating wildfire that destroyed portions of the Laboratory in 2000. As a result of the Cerro Grande fire, DOE, with funding from Congress, is planning a new Emergency Operations Center (EOC) with enhanced communications, space for multiple agencies, and significantly improved support capabilities. The new EOC has a scheduled completion date during fall 2003. In accordance with DOE Order 151.1A, it remains Laboratory policy to develop and maintain an emergency management system that includes emergency planning, emergency preparedness, and effective response capabilities for responding to and mitigating the consequences of any emergency. In CY2000, 1,162 employees received training as a result of Emergency

Management Plan requirements and the Emergency Management and Response organization's internal training program.

5. Toxic Substances Control Act

Because the Laboratory's activities are research and development and do not involve making chemicals to sell, the polychlorinated biphenyls (PCB) regulations (40 CFR 761) have been the Laboratory's main concern under the TSCA. The PCB regulations govern substances including but not limited to dielectric fluids, contaminated solvents, oils, waste oils, heat-transfer fluids, hydraulic fluids, slurries, soils, sanitary treatment solids from the Sanitary Wastewater Systems (SWS) Facility, and materials contaminated by spills.

During 2000, the Laboratory had 30 off-site shipments of PCB waste. The quantities of waste disposed include 2,714 kg of capacitors; 25 kg of laboratory waste; 52 kg of PCB-contaminated liquids; 162,500 kg of sludge, grit, and screening with PCB removed from the SWS Facility before the waste was delisted in October 2000; and 1,448 kg of fluorescent light ballasts. The amount of PCB-contaminated soil shipped off-site increased from 764 kg to 1,050,192 kg because of an ER Project cleanup in Sandia Canyon. The Laboratory manages all wastes in accordance with 40 CFR 761 manifesting, record keeping, and disposal requirements. PCB wastes are sent to EPA-permitted disposal and treatment facilities. Light ballasts are shipped off-site for recycling.

The Laboratory disposes of nonliquid wastes containing PCB contaminated with radioactive constituents at its TSCA-authorized landfill located at TA-54, Area G. Radioactively contaminated PCB liquid wastes are stored at the TA-54, Area L, TSCA-authorized storage facility. Many of these items have exceeded TSCA's one-year storage limitation and are covered under the Final Rule for the Disposal of PCB, dated August 28, 1998. The primary compliance document related to 40 CFR 761.180 is the annual PCB report that the Laboratory submits to EPA, Region 6. EPA did not conduct an audit of the Laboratory's PCB management program during 2000.

6. Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulates the manufacturing of pesticides, with requirements for registration, labeling, packaging, record keeping, distribution, worker protection, certification, experimental use, and tolerances in foods and feeds. Sections of this act that are applicable to the Laboratory include requirements for certification of workers who apply pesticides. The New Mexico Department of Agriculture (NMDA) has been granted the primary responsibility for pesticide enforcement under the FIFRA. The New Mexico Pesticide Control Act regulates private and public applicators, commercial and noncommercial applicators, pest management consultants, pesticide dealers, pesticide manufacturers, and all activities relating to the distribution and use of pesticides.

For the Laboratory, these regulations apply to the licensing and certification of pesticide applicators, record keeping, pesticide application, equipment inspection, pesticide storage, and disposal of pesticides.

NMDA did not conduct an inspection of the Laboratory's pesticide application program in 2000.

Amount of Pesticides Used during 2000:

TEMPO (insecticide)	234.63 grams
MAX FORCE (ant granules)	24 ounce
FLOREL (growth retardant)	2.5 quarts
STINGER (wasp freeze)	44 ounce
ROUNDUP	14.5 ounce
VELPAR L (herbicide)	11.2 gallons
INSPECTOR	192 ounce
PT110 PYRETHRIN	6 ounce

7. Clean Air Act

NMED or the EPA regulates Laboratory operations and its air emissions. The Air Quality Group's QA Project Plan for the Operating Project, *http://www.esh.lanl.gov/~AirQuality/QA.htm*, presents a complete description of air quality requirements applicable to the Laboratory. A summary of the major aspects of the Laboratory's air quality compliance program is presented below.

a. New Mexico Air Quality Control Act. In December 1995, LANL submitted to NMED an operating permit application as required under Title V of the Clean Air Act (CAA) and Title 20 of the New Mexico Administrative Code, Chapter 2, Part 70-Operating Permits (20 NMAC 2.70). NMED has not yet issued an operating permit. Therefore, LANL currently operates under the terms of its application. When issued, the permit will specify the operational terms and limitations imposed on LANL to continue to ensure that all federal and state air quality standards are being met. LANL will revise and resubmit the application so that a current operating permit application will be available when NMED requests it. LANL updates the application as it adds new emission units and as the regulations change.

LANL is a major source under the Operating Permit Program based on the potential to emit regulated air pollutants. Specifically, LANL is a major source of nitrogen oxides (NO_x), emitted primarily from the TA-3 steam plant boilers. In 2000, LANL continued to implement a project to install flue gas recirculation equipment on the boilers at TA-3 to reduce the NO_x emissions by approximately 70%. Project completion is scheduled for 2001.

LANL reviews plans for new and modified projects, activities, and operations to identify all applicable air quality requirements including the need to revise the operating permit application, to apply for construction permits, or to submit notifications to NMED (20 NMAC 2.72). During 2000, the Laboratory performed approximately 300 air quality reviews. Many of these reviews were performed on activities necessary to respond to damage the Cerro Grande fire caused and to mitigate the threat of flooding after the fire. One of these projects required a construction permit issued under the emergency permit process provisions (20 NMAC 2.72.215). Five other sources/activities (a propane heater and four natural-gas-fired boilers) were exempt from construction permitting but required written notification to NMED. One additional project required an administrative permit revision to reflect the relocation of a diesel generator off-site.

As part of the Operating Permit Program, NMED collects annual fees (20 NMAC 2.71) from sources that are required to obtain an operating permit. For LANL, the fees are based on the allowable emissions from activities and operations as reported in the operating permit application. LANL's fees for 2000 were $12,761.25.

LANL reports emissions for the following industrial-type sources: multiple boilers, a water pump, and an asphalt production facility. Table 2-5 shows LANL's calculated air pollutant emissions as reported to NMED for the 2000 emissions inventory (20 NMAC 2.73). LANL's combustion units were the primary point sources of criteria pollutants (NO_x, sulfur oxides [SO_x], particulate matter [PM], and carbon monoxide [CO] emissions). Of all combustion units, the TA-3 steam plant was the largest source of criteria pollutants. In addition to industrial-type sources, LANL reports emissions from a paper shredder, three degreasers, a rock crusher, and from permitted beryllium activities. Smaller sources of air pollutant emissions, such as nonregulated boilers, emergency generators, space heaters, etc., are located throughout the Laboratory. NMED considers them

Table 2-5. Calculated Actual Emissions for Regulated Pollutants (Tons) Reported to NMED

	Pollutants					
Emission Units	**PM**	**CO**	**NO_x**	**SO_x**	**VOC**	**HAP**
Asphalt Plant	0.12	0.7	0.04	0.008	0.014	NA
TA-3 Steam Plant	3.0	15	62	3.9	2.0	NA
TA-16 Boilers	0.068	0.33	0.33	0.005	0.049	NA
TA-21 Steam Plant	0.13	1.4	1.7	0.01	0.09	NA
Water Pump	0.06	2.96	9.26	0.004	0.19	NA
TA-48 Boilers	0.10	1.12	1.336	0.007	0.073	NA
TA-53 Boilers	0.086	0.956	1.138	0.006	0.062	NA
TA-55 Boilers	0.184	2.053	2.751	0.009	0.091	NA
TA-59 Boilers	0.064	0.718	0.85	0.006	0.046	NA
Degreasers	NA	NA	NA	NA	0.039	NA
Paper Shredder	0.0	NA	NA	NA	NA	NA
Rock Crusher	0	0	0	0	0	NA
R & D	NA	NA	NA	NA	10.7	6.5
Total	3.8	25.2	79.4	4.0	13.4	6.5

NA = not applicable.

insignificant sources. These sources are not required to be and were not included in the annual emissions inventory.

LANL calculates air emissions using emission factors from source tests, manufacturer data, and EPA documentation. Calculated emissions for industrial sources are based on actual production rates or fuel consumption rates. These industrial-type sources operated primarily on natural gas. The steam plant boilers at TA-3 and TA-21 are capable of burning diesel as a backup. During 2000, the Laboratory burned approximately 180,000 gallons of fuel oil at the TA-3 steam plant to keep it operational during and immediately following the Cerro Grande fire (6,840 gallons were burned in 1999).

Figure 2-1 provides a comparison among recent emissions inventories reported to NMED with one noteworthy difference from 1999 to 2000. The steam plant at TA-3 emitted greater quantities of SO_x, because it burned fuel oil during the Cerro Grande fire. The rock crusher was not operated in 2000. Therefore, there were no PM emissions from the crushing activities and no combustion products from the rock crusher's diesel-fired engine. Except for SO_x emissions from fuel oil combustion, air emissions from combustion and industrial sources decreased slightly in 2000.

An assessment of the ambient impacts of air pollutant emissions, presented in the Site-Wide Environmental Impact Statement (SWEIS) Yearbook for 2000, indicates that all emissions, except SO_x, are less than the amounts evaluated in the SWEIS. Therefore, no adverse air quality impacts are expected from these emissions. As mentioned above, the burning of fuel oil at the steam plant at TA-3 during the Cerro Grande fire increased SO_x emissions. The impacts of SO_x emissions from the steam plant were evaluated in a CY2000 permit application to install flue gas recirculation equipment. This assessment demonstrates that no SO_2 standards would have been exceeded from the increased CY2000 SO_x emissions.

R&D activities were the primary source of VOC and hazardous air pollutant (HAP) emissions. Detailed analysis of chemical tracking and procurement records indicates that LANL procured approximately 11 tons of VOCs. For a conservative estimate of air emissions, we assumed the total quantity of procured VOCs to be emitted. The VOC emission estimates from R&D

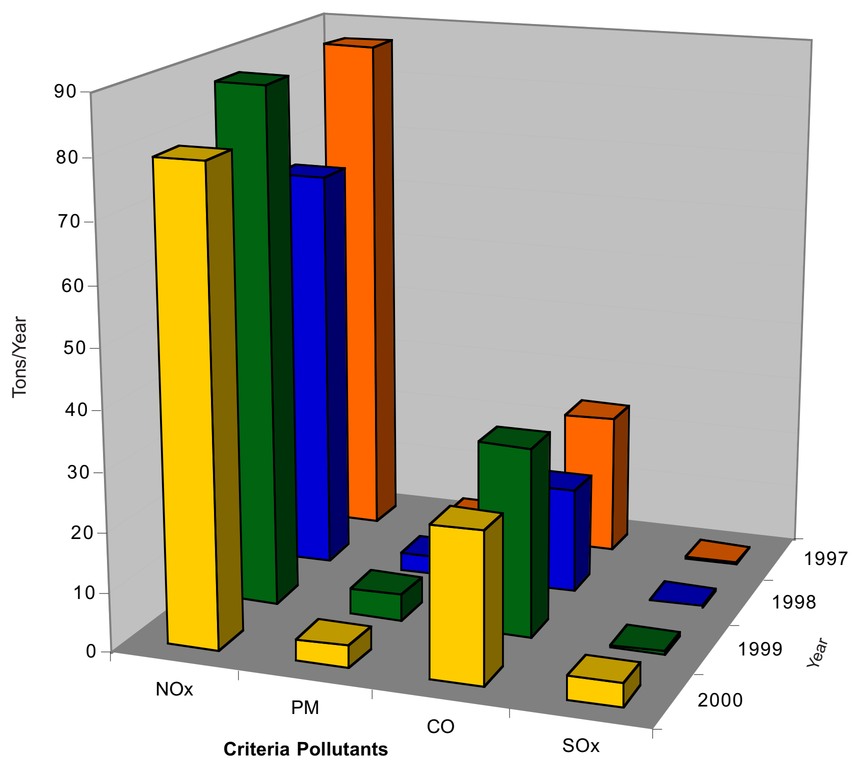

Figure 2-1. Criteria pollutant emissions from LANL.

activities are 45% lower than last year. Factors affecting this reduction include improved chemical management tools and improved quality of chemical procurement data. For the first time, NMED requested, and LANL voluntarily submitted, additional information about HAP emissions. The HAP emissions reported from R&D activities generally reflect the quantities procured during the calendar year. In a few cases, we evaluated procurement values and operational processes in more detail so that actual emissions could be reported in place of the procured value. The total quantity of HAP emissions reported for 2000 was 6.5 tons, down from 13.6 tons in 1999.

Construction Permits. LANL currently operates under the air permits listed in Table 2-1. Table 2-6 summarizes allowable emissions from 20 NMAC 2.72 Construction Permits. In 2000, the Laboratory applied for and received approval from NMED for three permit actions. In February, the Laboratory was issued technical permit revisions to modify beryllium-machining operations at TA-55. The revisions increased operational flexibility within the facility while reducing annual allowable beryllium particulate emissions. In July, the Laboratory assisted Sundt Construction Inc. in receiving an emergency permit to operate a temporary concrete batch plant. The Laboratory used the concrete from this plant to build a flood retention structure to mitigate flood danger in the aftermath of the Cerro Grande fire. The NMED received a closure notice for the concrete batch plant permit in October. In September, the Laboratory received a permit to modify the steam plant at TA-3. The construction permit allows for the installation of flue gas recirculation equipment on the steam plant boilers to reduce NO_x emissions from the boilers up to 70%. The Laboratory also assisted other organizations located on-site with permit notices they submitted to NMED. These actions included an administrative notice of change in ownership of a flash evaporation system, a malfunction notice submitted for upset conditions at the temporary concrete batch plant, and a relocation notice for a contractor-owned and -operated portable rock-crushing facility.

Open Burning. LANL has an open burning permit (20 NMAC 2.60) for operational burns conducted for research projects. All operational burns for 2000 were conducted within the terms specified in the permit. No prescribed burning occurred in 2000. No permits for prescribed burning were requested, and one expired.

Asbestos. The National Emission Standard for Hazardous Air Pollutants for Asbestos (Asbestos NESHAP, 40 CFR 61 Subpart M) requires that LANL provide advance notice to NMED for large renovation jobs involving asbestos and for all demolition projects. The Asbestos NESHAP further requires that all activities involving asbestos be conducted in a manner that mitigates visible airborne emissions and that all asbestos-containing wastes be packaged and disposed properly.

LANL continued to perform renovation and demolition projects in accordance with the requirements of the Asbestos NESHAP. This year, several projects resulted from fire recovery efforts, such as renovating or demolishing buildings damaged during the Cerro Grande fire. The Laboratory submitted a one-time advance notice to the NMED outlining all fire recovery demolition and renovation efforts in June. In addition to fire recovery efforts, other activities included four large renovation jobs and demolition projects for which NMED received advance notice. These projects, combined with fire recovery activities, generated a total 302.4 m^3 of asbestos waste, which was not radioactively contaminated. The Laboratory packaged all asbestos wastes properly and disposed of them at approved landfills.

To ensure compliance, the Laboratory conducted internal inspections of job sites and asbestos packaging approximately monthly. In addition, NMED conducted two inspections during the year and identified no violations. The Air Quality Group's Quality Assurance (QA) Project Plan for the Asbestos Report Project is available at *http://www.esh.lanl.gov/~AirQuality/QA.htm* on the World Wide Web.

Degreasers. The solvent cleaning NESHAP (40CFR 63, Subpart T) requires that all solvent cleaning machines containing any of the six listed halogenated solvents be registered. In 2000, the Laboratory reported the startup of two solvent operations to NMED. As such, the Laboratory currently operates three regulated solvent cleaning machines registered with NMED.

b. Federal Clean Air Act. The State of New Mexico has adopted all of the federal air quality requirements, with a few exceptions: the Stratospheric Ozone Protection (40 CFR 82, Subpart F), the NESHAP for Radionuclides (40 CFR 61, Subpart H), and the Risk Management Program (40 CFR 68).

Ozone-Depleting Substances. Title VI of the CAA contains specific sections establishing regulations and requirements for ozone-depleting substances (ODS) such as halons and refrigerants. The sections applicable to the Laboratory include Section 608,

Table 2-6. Allowable Air Emissions (20 NMAC 2.72)

Source	Condition	Regulated Pollutant	Allowable Emissions
Beryllium Machining at TA-3-39	NA	Beryllium	0.008 lb/yr
		Beryllium	4.0E-06 lb/hr
Beryllium Machining at TA-3-102	NA	Beryllium	0.00014 lb/yr
		Beryllium	4.0E-07 lb/hr
Beryllium Machining at TA-3-141	NA	Beryllium	0.0004 lb/yr
		Beryllium	3.0E-06 lb/hr
Beryllium Machining at TA-35-213	NA	Beryllium	0.0008 lb/yr
		Beryllium	4.0E-07 lb/hr
Beryllium Activities at TA-55-4	Machining	Beryllium	0.0066 lb/yr
		Beryllium	2.6E-04 lb/24-hr
		Aluminum	0.0066 lb/yr
		Aluminum	2.6E-04 lb/24-hr
Beryllium Activities at TA-55-4	Foundry	Beryllium	1.9E-06 lb/yr
		Beryllium	7.7E-08 lb/24-hr
		Aluminum	1.9E-06 lb/yr
		Aluminum	7.7E-08 lb/24-hr
Beryllium Activities at TA-55-4	Combined	Beryllium	0.0066 lb/yr
		Beryllium	2.6E-04 lb/24-hr
		Aluminum	0.0066 lb/yr
		Aluminum	2.6E-04 lb/24-hr
Rock Crusher	NA	Particulate Matter	Limited[a]
		Nitrogen Dioxide	6.4 tons/yr
		Nitrogen Dioxide	6.2 lb/hr
		Carbon Monoxide	1.4 tons/yr
		Carbon Monoxide	1.3 lb/hr
		Volatile Organic Compounds	0.5 tons/yr
		Volatile Organic Compounds	0.5 lb/hr
		Sulfur Dioxide	0.4 tons/yr
		Sulfur Dioxide	0.4 lb/hr
TA-3 Steam Plant-Flue Gas Recirculation	Per Boiler Burning Natural Gas[b]	Particulate Matter	1.4 lb/hr
		Nitrogen Oxides	9.0 lb/hr
		Carbon Monoxide	7.4 lb/hr
		Volatile Organic Compounds	1.0 lb/hr
		Sulfur Oxides	2.6 lb/hr
TA-3 Steam Plant-Flue Gas Recirculation	Per Boiler Burning Fuel Oil[b]	Particulate Matter	2.7 lb/hr
		Nitrogen Oxides	9.9 lb/hr
		Carbon Monoxide	6.8 lb/hr
		Volatile Organic Compounds	0.3 lb/hr
		Sulfur Oxides	68.7 lb/hr
TA-3 Steam Plant-Flue Gas Recirculation	Combined Fuel Use for all Three Boilers	Particulate Matter	15.7 tons/yr
		Nitrogen Oxides	99.6 tons/yr
		Carbon Monoxide	81.3 tons/yr
		Volatile Organic Compounds	11.1 tons/yr
		Sulfur Oxides	36.9 tons/yr

[a] Fugitive particulate matter emissions from transfer points, belt conveyors, screens, feed bins, and from stockpiles shall not exhibit greater than 10% opacity. Fugitive particulate matter emissions from the rock crusher shall not exhibit greater than 15% opacity. Opacity is the degree to which emissions reduce the transmission of light and obscure the view of a background object.

[b] The TA-3 Steam Plant has three boilers.

National Recycling and Emission Reduction Program, and Section 609, Servicing of Motor Vehicle Air Conditioners. Section 608 prohibits individuals from knowingly venting ODS into the atmosphere during maintenance, repair, service, or disposal of halon fire-suppression systems and air conditioning or refrigeration equipment. All technicians who work on refrigerant systems have to be EPA certified and use certified recovery equipment. The Laboratory is required to maintain records on all work involving refrigerants as well as the purchase, usage, and disposal of refrigerants and must perform all work in accordance with EPA requirements and Laboratory standards. The Laboratory's standards for refrigeration work are covered under Criterion 408, "EPA Compliance for Refrigeration Equipment," of the Operations and Maintenance manual. Section 609 includes standards and requirements for recycling equipment that services motor vehicle air conditioners and for training and certification of maintenance and repair technicians. LANL contracts with Johnson Controls Northern New Mexico (JCNNM) and other vendors to maintain, service, repair, and dispose of halon fire-suppression systems and air conditioning and refrigeration equipment. LANL contracts automotive repair work, including motor vehicle air-conditioning work, to JCNNM and to qualified local automotive repair shops.

Radionuclides. Under the National Emission Standard for Hazardous Air Pollutants for Radionuclides (Rad NESHAP), EPA limits the effective dose equivalent (EDE) to any member of the public from radioactive airborne releases from a DOE facility, such as LANL, to 10 mrem/yr. The 2000 EDE (as calculated using EPA-approved methods) was 0.64 mrem. The location of the highest dose was at East Gate. The principal contributor to the dose was operations from the Los Alamos Neutron Science Center. The Air Quality Group's QA Project Plan for the Rad NESHAP Compliance Project is available at *http://www.esh.lanl.gov/~AirQuality/QA.htm* on the World Wide Web. In addition, air quality reports on the radionuclide air emissions are available at *http://www.esh.lanl.gov/~AirQuality/AirReports.htm* on the World Wide Web.

LANL reviews plans for new and modified projects, activities, and operations to identify the need for emissions monitoring or prior approval from EPA. During 2000, approximately 100 reviews involved the evaluation of air quality requirements associated with the use of radioactive materials. None of these projects required EPA prior approval.

In 2000, independent auditors completed a report of LANL's 1999 compliance status. The independent audit found that the Laboratory was in compliance with the Rad NESHAP requirements of the CAA in 1999. Section 2.D., Consent Decree, provides more information.

Risk Management Program. The 1990 Clean Air Act Amendments (1990 CAA) included Section 112(r), Prevention of Accidental Releases. Section 112(r) required the EPA to establish a risk management program (RMP) to prevent accidental releases of flammable and toxic substances to the environment and to minimize the consequences of a release. The 112(r) program provides lists of toxic and flammable substances with their associated threshold quantities (TQ). Any process or storage facility that uses any listed substance in quantities exceeding its TQ is subject to EPA's RMP. Under the 112(r) program, threshold determinations are based on the quantity of substance present at a particular location or in a particular process at any point in time (i.e., what is the potential for release during an accident). Threshold determinations are not based on cumulative usage.

EPA established the requirements for the RMP in 40 CFR 68. Facilities that are subject to the RMP were required to register with EPA and submit a facility-specific risk management plan by June 21, 1999. LANL has not exceeded any TQ between the effective date (June 21, 1999) and the present date. Therefore, LANL is not subject to the RMP and is not required to register with EPA. LANL will continue to evaluate chemical procurements, new sources, and processes containing regulated substances to determine any change in the applicability status of the RMP.

8. Clean Water Act

a. National Pollutant Discharge Elimination System Outfall Program. The primary goal of the Clean Water Act (CWA) (33 U.S.C. 1251 et seq.) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The act established the requirements for National Pollutant Discharge Elimination System (NPDES) permits for point-source effluent discharges to the nation's waters. The NPDES outfall permit establishes specific chemical, physical, and biological criteria that an effluent must meet before it is discharged. Although most of the Laboratory's effluent is discharged to normally dry arroyos, the Laboratory is required to meet effluent limitations under the NPDES permit program.

UC and DOE are co-permittees of the NPDES permit covering Laboratory operations. EPA Region 6 in Dallas, Texas, issues and enforces the permit. However, NMED certifies the EPA-issued permit and performs some compliance evaluation inspections and monitoring for EPA through a Section 106 water quality grant.

The Laboratory's NPDES Permit, No. NM0028355, expired October 31, 1998, but was administratively continued by EPA until a new permit is issued. As required by the NPDES regulations, on May 4, 1998, 180 days before permit expiration, the Laboratory submitted an application to EPA for renewal of the NPDES permit. On December 29, 2000, the EPA issued the Public Notice of Final Permit Decision for NPDES Permit No. NM0028355. The new NPDES Permit has an effective date of February 1, 2001, and contains 21 permitted outfalls.

Each year, the number of permitted outfalls at the Laboratory had been decreasing in response to the success of the Waste Stream Characterization Program and Corrections Project and the NPDES Outfall Reduction Program. Since 1995, the Laboratory has deleted 120 outfalls. As of January 1, 2000, the Laboratory's NPDES permit had 20 outfalls, which included one sanitary outfall and 19 industrial outfalls. However, as of December 31, 2000, one industrial outfall, 03A199, was added to the new Permit bringing the total number of NPDES-permitted outfalls to 21.

Over the years, the Laboratory has achieved a reduction in outfalls by removing process flows at industrial outfalls and completing the lease transfer of the drinking water system to Los Alamos County. Future activities will further reduce the number of permitted outfalls at the Laboratory. Nine additional outfalls are currently targeted for elimination. These include NPDES Outfalls 02A129, 03A024, 03A027, 03A028, 03A047, 03A048, 03A130, 03A158, and 05A097. Completing equipment upgrades to treatment facilities, decontamination and decommissioning of nonessential facilities, combining of process flows, installation of closed-loop cooling systems, containerization of wastewater, and removal of experimental processes will eliminate these outfalls. Additionally, long-term objectives of the NPDES Outfall Reduction Program will require that outfall owners evaluate outfalls for continued operation and that new construction designs and modifications to existing facilities provide for reduced or no-flow effluent discharge systems.

Under the Laboratory's NPDES outfall permit, samples for effluent quality limits are collected for analysis weekly, monthly, and quarterly depending on the outfall category. The Laboratory also collects water quality samples for analysis annually at all outfalls. The Laboratory reports results to EPA and NMED at the end of the monitoring period for each respective outfall category. During CY2000, none of the 1,121 samples collected from the industrial outfalls exceeded effluent limits (Table 2-7). No effluent limit exceedances occurred in the 200 samples collected from the SWS Facility Outfall 13S. See Table A-4 for a summary of these outfalls and a listing of the permit's monitoring requirements.

b. National Pollutant Discharge Elimination System Sanitary Sewage Sludge Management Program. In July 1997, the Laboratory requested approval from the EPA Region 6 to make a formal change in its sewage sludge disposal practices from land application under 40 CFR Part 503 regulations to landfill disposal as a 50-499 ppm PCB-contaminated TSCA waste, as authorized under 40 CFR 761. This change was necessary because of the repeated detection of low-level PCBs (less than 5 ppm) in the SWS Facility's sewage sludge. The EPA approved the Laboratory's request in September 1997.

Following this change, the Laboratory began an investigation to determine the source of the PCBs found in the SWS Facility's sludge. The investigation's findings led the Laboratory to believe that the PCBs appearing at the SWS Facility might have originated from the remnants of old PCB spills in sewer lines. Subsequently, the Laboratory undertook a program of testing and cleaning sewer lines. Based upon the analytical data obtained from testing sludge, grit, and screenings, the Laboratory believed that it could begin to safely dispose of the sanitary treatment solids as a non-TSCA waste. In September 2000, the Laboratory notified the EPA Region 6 that it intended to change its disposal practice for sewage sludge, grit, and screenings to disposal as a non-TSCA waste (total PCB concentration less than 50 ppm), as authorized under 40 CFR 761.20(a)(4). After September 2000, the Laboratory began disposing of all SWS Facility sludge with less than 50 ppm PCBs as a New Mexico Special Waste.

During 2000, the SWS Facility generated approximately 23.5 dry tons (47,060 dry lb) of sewage sludge. All of this sludge was disposed of after September 2000 as <50 ppm non-TSCA waste at a landfill authorized to accept this material.

c. National Pollutant Discharge Elimination System Permit Compliance Evaluation Inspection. The NMED did not conduct a NPDES Outfall Compliance Evaluation Inspection during 2000 (see Table 2-7).

Table 2-7. National Pollutant Discharge Elimination System Permit Monitoring of Effluent Quality and Water Quality Parameters at Industrial Outfalls: Exceedances during 2000

Date	Purpose	Performing Agency
	[No NPDES exceedances occurred 2000.]	

d. National Pollutant Discharge Elimination System Storm Water Program. The NPDES permit program also regulates storm water discharges from identified industrial activities. During 2000, the Laboratory had nine active NPDES permits for its storm water discharges (see Table 2-1). Under the EPA's NPDES Storm Water Multi-Sector General Permit for Industrial Discharges, the Laboratory is covered by one overall active permit. Under the EPA Region 6 NPDES Storm Water Construction permit, eight Laboratory projects were permitted and active: DARHT Facility Construction Project, Guaje Well Improvements Project, the Fire Protection Improvements Project, the Norton Power Line Project, the Strategic Computing Complex (SCC) Project, TA-9-15 Gas Pipeline Replacement Project, the Cerro Grande fire Mitigation Project, and the Nuclear Materials Safeguards and Security Upgrades (NMSSUP) Project.

UC and DOE are co-permittees under the NPDES Multi-Sector General Permit (MSGP-2000) for the Laboratory. The MSGP-2000 regulates storm water discharges from the following Laboratory industrial activities: hazardous waste treatment, storage, and disposal facilities operating under interim status or a permit under Subtitle C of RCRA (this category includes SWMUs); landfills, land application sites, and open dumps including those that are subject to regulation under Subtitle D of RCRA; steam electric power generating facilities; asphalt paving operations; scrap recycling facilities; vehicle maintenance activities; primary metal activities; and chemical and allied products manufacturing activities.

Since 1992, the MSGP-2000 is the third general permit published by EPA to regulate storm water discharges from industrial activities at the Laboratory. This permit expires October 30, 2005.

As with the 1992 Baseline General Permit and 1995 Multi-Sector General Permit, the MSGP-2000 requires the development and implementation of a Storm Water Pollution Prevention Plan. During 2000, the Laboratory maintained and implemented 19 Storm Water Pollution Prevention Plans for its industrial activities.

The Multi-Sector General Permit requires monitoring of the storm water discharges from all identified industrial activities. The Laboratory collected approximately 96 samples (as compared with approximately 70 samples in 1999) during the summer of 2000 and has submitted this data to EPA in accordance with the Permit's requirements. The increase in the number of samples submitted was largely due to the Laboratory's efforts to sample and characterize storm water runoff from Laboratory property impacted during the Cerro Grande fire.

To meet the monitoring requirements of the MSGP-2000 and other monitoring programs, the Laboratory is operating 69 stream monitoring and partial record storm water monitoring stations on the canyons entering and leaving the Laboratory. Samples are collected at the confluence of these major canyons and in certain segments of these canyons as well as at a number of site-specific facilities. "Surface Water Data at Los Alamos National Laboratory: 2000 Water Year" (Shaull et al., 2001) reports the discharge information for 2000.

e. National Pollutant Discharge Elimination System Storm Water Program Inspection. The Laboratory corrected deficiencies noted during a July 12, 1999, Region 6, compliance inspection of the Laboratory's Storm Water Program. To this date, all deficiencies have been addressed.

f. Spill Prevention Control and Countermeasures Program. The Laboratory's Spill Prevention Control and Countermeasures (SPCC) Plans, as required by the CWA in accordance with 40 CFR 112, are comprehensive plans developed to meet EPA requirements that regulate water pollution from oil spills. The Laboratory has SPCC Plans for the 28 aboveground oil storage tanks that operated during 2000.

g. Dredge and Fill Permit Program. Section 404 of the CWA requires the Laboratory to obtain permits from the US Corps of Engineers (COE) to perform work within perennial, intermittent, or ephemeral watercourses. Projects involving excavation or fill below the normal high-water mark must be conducted with attention to the water quality and riparian habitat preservation requirements of the Act.

COE has issued a number of nationwide permits that cover specific activities. Each nationwide permit contains conditions to protect water quality. Section 401 of the CWA requires states to certify that Section 404 permits issued by COE will not prevent attainment of state-mandated stream standards. NMED reviews Section 404/401 joint permit applications and issues separate Section 401 certification letters, which include additional permit requirements to meet state stream standards for individual projects at the Laboratory.

Table 2-1 lists all of the Laboratory's Section 404/401 permits during 2000. Projects permitted include utility lines, road crossings, headwaters and isolated waters, and wetland/riparian areas.

On June 8, 2000, a copy of the joint Section 404/401 application and supplemental information for the Los Alamos National Laboratory's "Emergency Control Measures To Reduce The Potential For Flooding And Soil Erosion On LANL Property Due To The Cerro Grande Wildfire Project" was submitted to COE and the New Mexico Environment Department's Surface Water Quality Bureau (NMED-SWQB). The Laboratory's Emergency Rehabilitation Team, in cooperation with the Cerro Grande Burned Area Emergency Rehabilitation (BAER) Team, made recommendations to reduce the potential for flooding and erosion expected with the start of the summer monsoon season. The project was necessary to control sediment transport from storm events, to help reduce flooding, and to reduce further fire threats. On June 23, 2000, COE assigned Action No. 2000-00420 to this activity and authorized the work under Nationwide Permit (NWP) No. 37, which encompasses work done by or funded by the Natural Resources Conservation Service qualifying as an "exigency" situation (requiring immediate action) under its Emergency Watershed Protection Program (7 CFR 624) and work done or funded by the Forest Service under its Burned Area Emergency Rehabilitation Handbook (FSH 509.13), provided the District Engineer is notified in accordance with the "Notification" general condition. Additionally, on the same day, NMED-SWQB conditionally certified the Laboratory's activities under NWP No. 37 pursuant to Section 401 of the Clean Water Act.

On August 2, 2000, COE, NMED, and Laboratory personnel met to review and discuss all Section 404/401 dredge and fill activities at the Laboratory conducted during the emergency operations. The objective of the meeting was to review each dredge and fill activity and assign the most appropriate Section 404 permit. Approximately 81 dredge and fill projects were reviewed that were originally covered by NWP No. 37. Eighteen of these project activities did not require Section 404 dredge and fill permits because the work was either located outside of the waterways or did not involve the placement of dredged or fill material below the ordinary high-water (OHW) mark of the waterway. Twelve of the projects were never implemented, and one dredge and fill project (i. e., landfill culvert improvement at Diamond Drive) was a COE/Los Alamos County Project. The remaining fifty projects were covered under additional NWPs. COE requires the Laboratory to certify that the work authorized under the above-referenced permits has been completed in accordance with the specified terms and conditions. The Laboratory is currently reviewing all Section 404 projects conducted under the emergency operations resulting from the Cerro Grande wildfire for compliance with the NWPs and final closure.

9. Safe Drinking Water Act

a. Introduction. On September 8, 1998, DOE transferred operation of the Los Alamos Water Supply System from the Laboratory to Los Alamos County under a lease agreement. Under this agreement, the Laboratory retained responsibility for operating the distribution system within the Laboratory's boundaries, whereas the county assumed full responsibility for operating the water system, including ensuring compliance with the requirements of the federal Safe Drinking Water Act (SDWA) (40 CFR 141) and the New Mexico Drinking Water Regulations (NMEIB 1995). The SDWA requires Los Alamos County to collect samples from various points in the Laboratory's, Los Alamos County's, and Bandelier National Monument's water distribution systems and from the water supply wellheads to demonstrate compliance with SDWA maximum contaminant levels (MCLs). The EPA has established MCLs for microbiological organisms, organic and inorganic constituents, and radioactivity in drinking water. The state has adopted these standards and has included them in the New Mexico Drinking Water Regulations. The EPA has authorized NMED to administer and enforce federal drinking water regulations and standards in New Mexico.

During 2000, the Laboratory sampled all of the water supply wells in operation at the time of sampling for quality assurance purposes. The Laboratory's quality assurance drinking water program provides additional assurance during the transition period following transfer of the water system to Los Alamos County. The Laboratory's monitoring results are not for SDWA compliance purposes; Los Alamos County's SDWA sampling program determines SDWA compliance. This report presents the results from both the quality assurance monitoring the Laboratory conducted (noncompliance results) and the SDWA compliance monitoring Los Alamos County conducted (compliance results).

In 2000, the monitoring network for Los Alamos County's SDWA compliance sampling program consisted of the following three location groups:

(1) wellhead sampling from the water supply wells in operation at the time of sampling (Guaje wells G1A, G2A, G3A, and G4A; Pajarito Mesa wells PM1, PM2, PM3, PM4, and PM5; and Otowi wells O1 and O4);

(2) the 6 total trihalomethane (TTHM) sampling locations within the distribution system; and

(3) the 41 microbiological sampling sites located throughout the Laboratory, Los Alamos County, and Bandelier National Monument.

Staff from NMED's Drinking Water Bureau performed all chemical and radiological sampling for Los Alamos County with the exception of TTHM sample collection, which JCNNM and Los Alamos County staff conducted. The New Mexico Health Department's Scientific Laboratory Division in Albuquerque and the New Mexico State University's Soil and Water Testing Laboratory in Las Cruces received samples for analysis. The JCNNM Health and Environmental (HENV) laboratory performs microbiological sampling and analysis. NMED has certified the HENV laboratory for microbiological compliance analysis. Certification requirements include proficiency samples, maintenance of an approved quality assurance/quality control program, and periodic NMED audits.

In 2000, the Laboratory's monitoring network for quality assurance sampling consisted of the following: wellhead sampling from the 10 water supply wells in operation at the time of sampling (Guaje wells G1A, G2A, G3A, G4A; Pajarito Mesa wells PM1, PM2, PM3, PM5; and Otowi wells O1, O4). Sampling locations, frequencies, preservation, handling, and analyses follow the requirements specified in federal and state regulations. Laboratory staff performed chemical and radiological sampling and submitted the samples for analysis to the New Mexico Health Department's Scientific Laboratory Division in Albuquerque. The Water Quality and Hydrology Group (ESH-18) has certified staff to perform drinking water sampling. ESH-18 maintains both electronic and hard copy files of all data collected from quality assurance testing.

b. Radiochemical Analytical Results. In 2000, Los Alamos County collected drinking water samples from four water supply wells to determine the radiological quality of the drinking water. As shown in Table 2-8, the concentrations of gross alpha and gross beta activity were less than the EPA screening levels. When gross alpha and beta activity measurements are below the screening levels, Los Alamos County does not need to perform further isotopic analyses or perform dose calculations under the SDWA program. However, it should be noted that ESH-18 also conducts comprehensive monitoring of the water supply wells for radiochemical constituents (see Table 5-27).

Radon is a naturally occurring radionuclide produced during the decay of geological sources of uranium. In 2000, Los Alamos County conducted radon sampling at seven water supply wells. As shown in Table 2-9, the concentrations ranged from 235 to 685 pCi of radon per liter of water. On August 6, 1996, EPA withdrew the proposed MCL of 300 pCi of radon per liter of water and issued a new proposed rule for radon that sets the following regulatory standards for radon: an MCL of 300 pCi/L and an Alternative Maximum Contaminant Level (AMCL) of 4,000 pCi/L. The AMCL applies to those states that implement an EPA-approved Multi-Media Mitigation (MMM) program for reducing radon levels in indoor air. The State of New Mexico has announced that it intends to develop a MMM program. The EPA is scheduled to publish the final rule by August 2001.

In 2000, the Laboratory collected quality assurance drinking water samples at 10 water supply wells to determine the radiological quality of the drinking water. As shown in Table 2-10, the concentrations of gross alpha and gross beta activity were less than the EPA screening levels.

c. Nonradiological Analytical Results. In 2000, Los Alamos County collected TTHM samples during each quarter from six locations in the Laboratory and Los Alamos County water distribution systems. As shown in Table 2-11, the annual average for samples in 2000 was 4.15 µg of TTHM per liter of water, less than the SDWA MCL of 100 µg of TTHM per liter of water. In 2000, Los Alamos County collected samples

Table 2-8. Radioactivity in Drinking Water (pCi/L) during 2000 by LANL

	Gross Alpha			Gross Beta		
Sample Location	**Calibration Std.**	**Value**	**(Uncertainty)**	**Calibration Std.**	**Value**	**(Uncertainty)** [a]
Wellheads:						
Pajarito Well-PM1	^{241}Am	1.2	(0.4)	^{137}Cs	3.3	(0.7)
	Natural U	1.6	(0.6)	^{90}Sr, ^{90}Y	3.0	(0.7)
Pajarito Well-PM2	^{241}Am	0.2	(0.2)	^{137}Cs	1.7	(0.7)
	Natural U	0.2	(0.3)	^{90}Sr, ^{90}Y	1.6	(0.7)
Pajarito Well-PM3	^{241}Am	0.6	(0.3)	^{137}Cs	3.5	(0.8)
	Natural U	0.9	(0.4)	^{90}Sr, ^{90}Y	3.3	(0.7)
Pajarito Well-PM5	^{241}Am	0.5	(0.3)	^{137}Cs	3.0	(0.7)
	Natural U	0.7	(0.4)	^{90}Sr, ^{90}Y	2.8	(0.6)
Guaje Well-G1A	^{241}Am	0.3	(0.2)	^{137}Cs	1.8	(0.9)
	Natural U	0.4	(0.3)	^{90}Sr, ^{90}Y	1.7	(0.8)
Guaje Well-G2A	^{241}Am	0.3	(0.2)	^{137}Cs	2.2	(0.8)
	Natural U	0.4	(0.3)	^{90}Sr, ^{90}Y	2.1	(0.8)
Guaje Well-G3A	^{241}Am	0.6	(0.3)	^{137}Cs	1.1	(0.6)
	Natural U	0.8	(0.3)	^{90}Sr, ^{90}Y	1.1	(0.6)
Guaje Well-G4A	^{241}Am	1.1	(0.3)	^{137}Cs	0.7	(0.6)
	Natural U	1.4	(0.4)	^{90}Sr, ^{90}Y	0.7	(0.6)
Guaje Well-O1	^{241}Am	1.0	(0.3)	^{137}Cs	2.2	(0.7)
	Natural U	1.3	(0.4)	^{90}Sr, ^{90}Y	2.1	(0.6)
Otowi Well-O4	^{241}Am	0.7	(0.3)	^{137}Cs	3.5	(0.7)
	Natural U	0.9	(0.4)	^{90}Sr, ^{90}Y	3.3	(0.6)
EPA Maximum Contaminant Level		15			NA	
EPA Screening Level		5			50	

[a] Uncertainties, sigmas, are expressed as ± one standard deviation (i.e., one standard error).

for nitrate (as nitrogen) in drinking water at the 11 water supply wells in operation at the time of sampling. As shown in Table 2-12, nitrate concentrations at all locations were less than the SDWA MCL. In 2000, Los Alamos County collected samples for inorganic constituents in drinking water at three water supply wells. As shown in Table 2-12, inorganic constituents at all locations were less than the SDWA MCLs.

In 2000, Los Alamos County collected four quarterly samples for VOCs from the following three water supply wells: G2A, G3A, and G4A. As shown Table 2-13, no VOCs were detected at any of the sampling locations with the exception of MEK (2-butanone) at G2A (5.2 µg/L) and G3A (6.1 µg/L) and chloroform at G2A (1.0 µg/L). All third quarter samples, collected on August 23, 2000, were lost during analysis because of a malfunctioning analytical instrument. The SDWA provides no MCL for chloroform, so we use the SDWA MCL for total trihalomethanes (a group of compounds that includes chloroform), which is 100 µg per liter of water. Chloroform is a byproduct of chlorine disinfection. It is believed that the source of the chloroform found in the samples was the chlorine used in disinfecting the wells. LANL's quality assurance sampling of wells G2A, G3A, and G4A in September 2000 did not detect MEK or chloroform in the samples at concentrations greater than the analytical laboratory's sample detection limit.

In 2000, Los Alamos County collected synthetic organic compound (SOC) samples from the following six water supply wells: PM3, PM4, O1, G2A, G3A, and G4A. No SOCs were detected at any of the sampling locations at concentrations greater than the analytical laboratory's sample detection limit.

In 2000, LANL also collected quality assurance samples for inorganic constituents in drinking water at

Table 2-9. Radon in Drinking Water (pCi/L) during 2000 by LA County for Compliance Purposes

Sample Location	Value	(Uncertainty)[a]
Wellheads:		
Pajarito Well Field-PM1	274	(13)
Pajarito Well Field-PM2	685	(38)
Pajarito Well Field-PM3	295	(20)
Pajarito Well Field-PM4	452	(27)
Pajarito Well Field-PM5	457	(27)
Otowi Well Field-O1	235	(17)
Otowi Well Field-O4	461	(28)
EPA Maximum Contaminant Level	300 pCi/L	
EPA Alternative Maximum Contaminant Level	4000 pCi/L	

[a]Uncertainties are expressed as one standard deviation
Note: The AMCL applies to those states that implement an EPA-approved Multi-Media Mitigation (MMM) program for reducing Radon levels in indoor air.

the 10 water supply wells in operation at the time of sampling. As shown in Table 2-14, all inorganic constituents at all locations were less than the SDWA MCLs.

In 2000, LANL also collected quality assurance VOC samples from the 10 water supply wells in operation at the time of sampling. No VOCs were detected at any of the sampling locations at concentrations greater than the analytical laboratory's sample detection limit.

d. Microbiological Analyses of Drinking Water. Each month during 2000, Los Alamos County collected an average of 48 samples from the Laboratory's, Los Alamos County's, and Bandelier National Monument's water distribution systems to determine the free chlorine residual available for disinfection and the microbiological quality of the drinking water. Of the 577 samples analyzed during 2000, none indicated the presence of total or fecal coliforms. Noncoliform bacteria were present in 46 of the microbiological samples. Noncoliform bacteria are not regulated, but their repeated presence in samples may serve as an indicator of stagnation and biofilm growth in water pipes. Table 2-15 presents a summary of the monthly analytical data.

In the days following the Cerro Grande fire, personnel from both HENV and the NMED Drinking Water Bureau collected 81 microbiological samples to assess drinking water quality. While all samples demonstrated compliance with the SDWA, more than

Table 2-10. Radioactivity in Drinking Water (pCi/L) during 2000 by LA County for Compliance Purposes

	Gross Alpha			Gross Beta		
Sample Location	Calibration Std.	Value	(Uncertainty)[a]	Calibration Std.	Value	(Uncertainty)[a]
Entry Points:						
Pajarito Well Field-PM1	^{241}Am	1.80	(0.40)	^{137}Cs	3.80	(0.60)
	Natural U	2.30	(0.50)	^{90}Sr, ^{90}Y	3.70	(0.60)
Pajarito Well Field-PM3	^{241}Am	0.30	(0.20)	^{137}Cs	2.20	(0.50)
	Natural U	0.40	(0.30)	^{90}Sr, ^{90}Y	2.10	(0.50)
Pajarito Well Field-PM4	^{241}Am	0.80	(0.40)	^{137}Cs	4.30	(0.60)
	Natural U	1.10	(0.50)	^{90}Sr, ^{90}Y	4.10	(0.60)
Otowi Well Field-O1	^{241}Am	1.20	(0.30)	^{137}Cs	4.70	(0.60)
	Natural U	1.50	(0.40)	^{90}Sr, ^{90}Y	4.60	(0.60)
EPA Maximum Contaminant Level		15			NA	
EPA Screening Level		5			50	

[a]Uncertainties are expressed as one standard deviation.

Table 2-11. Total Trihalomethanes in Drinking Water (μg/L) during 2000 by LA County for Compliance Purposes

	2000 Quarters			
Sample Location	**First**	**Second**	**Third**	**Fourth**
Distribution Sites:				
Los Alamos Airport	4.7	6.4	8.6	5.3
White Rock Fire Station	<0.5	<0.5	<0.5	<0.5
North Community Fire Station	1.9	1.0	1.0	3.0
S-Site Fire Station	2.2	2.9	4.2	6.3
Barranca Mesa School	0.6	2.1	5.1	1.8
TA-39, Bldg. 02	12.3	9.0	9.5	9.7
2000 Average of 4.15 μg/L				
EPA Maximum Contaminant Level			100.0	
Sample Detection Limit			0.5	

half of the samples demonstrated little or no chlorine residual because chlorine cylinders were removed from technical areas threatened by the fire. The Laboratory would like to acknowledge the efforts of the HENV and NMED. The Cerro Grande fire posed a significant threat to the Los Alamos drinking water system, and these efforts provided an important level of assurance to the residents of Los Alamos County and workers at the Laboratory.

e. Long-Term Trends. The Los Alamos water system has never incurred a violation for an SDWA-regulated chemical or radiological contaminant. The water supply wells have, on occasion, exceeded the proposed SDWA MCL for radon because of its natural occurrence in the main aquifer.

f. Drinking Water Inspection. The NMED did not conduct an inspection of the drinking water system during 2000.

10. Groundwater

a. Groundwater Protection Compliance Issues. Groundwater monitoring and protection efforts at the Laboratory have evolved from programs initiated by the US Geological Survey in the 1940s to present efforts. The major regulations, orders, and policies pertaining to groundwater are as follows.

DOE Order 5400.1 requires the Laboratory to prepare a Groundwater Protection Management Program Plan that focuses on protection of groundwater resources in and around the Los Alamos area and ensures that all groundwater-related activities comply with the applicable federal and state regulations.

Task III of Module VIII of the RCRA Hazardous Waste Facility Permit, the HSWA Module, requires the Laboratory to collect information about the environmental setting at the facility and to collect data on groundwater contamination. Task III, Section A.1, requires the Laboratory to conduct a program to evaluate hydrogeologic conditions. Task III, Section C.1, requires the Laboratory to conduct a groundwater investigation to characterize any contamination at the facility.

In March 1998, NMED approved a comprehensive hydrogeologic characterization work plan for the Laboratory. The Hydrogeologic Workplan (LANL 1998a) was developed partially in response to NMED's denial of the Laboratory's RCRA groundwater monitoring waiver demonstrations. The plan proposes a multiyear drilling and hydrogeologic analysis program to characterize the Pajarito Plateau and to assess the potential for groundwater contamination from waste disposal operations. The goal of the project is to develop greater understanding of the geology, groundwater flow, and geochemistry beneath the 43-square-mile Laboratory area and to assess any impacts that Laboratory activities may have had on groundwater quality. The Hydrogeologic Workplan will result in an enhanced understanding of the Laboratory's groundwater setting and an improved ability to ensure adequate groundwater monitoring.

Table 2-12. Inorganic Constituents in Drinking Water (mg/L) during 2000 by LA County for Compliance Purposes

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl
Wellheads:													
Pajarito Well Field-PM1										0.50			
Pajarito Well Field-PM2										0.32			
Pajarito Well Field-PM3	0.0016	0.049	<0.0002	<0.0001	0.0055	0.31	<0.02	<0.0002	0.00095	0.48	<0.001	<0.0004	<0.00003
Pajarito Well Field-PM4	0.0008	0.023	<0.0002	<0.0001	0.0056	0.29	<0.02	<0.0002	0.0005	0.32	<0.001	<0.0004	<0.00003
Pajarito Well Field-PM5										0.49			
Otowi Well Field-O1	0.0026	0.025	<0.0002	<0.0001	0.0067	0.40	<0.02	<0.0002	0.0008	1.00	<0.001	<0.0004	<0.00003
Otowi Well Field-O4										0.42			
Guaje Well Field-G1A										0.45			
Guaje Well Field-G2A										0.45			
Guaje Well Field-G3A										0.57			
Guaje Well Field-G4A										0.53			
EPA Maximum Contaminant Levels (MCLs)	0.05	2.0	0.004	0.005	0.10	4.0	0.20	0.002	0.1	10.0	0.05	0.006	0.002

Table 2-13. Volatile Organic Compounds in Drinking Water (mg/L) during 2000 by LA County for Compliance Purposes

Sample Location	VOC Group I Compounds	Sample Date
Wellheads:		
Guaje Well Field-G2A	5.2 mg/L MEK[a]	03/28
Guaje Well Field-G2A	1.0 mg/L Chloroform[b]	04/26
Guaje Well Field-G2A	Lost[c]	08/23
Guaje Well Field-G2A	U	11/15
Guaje Well Field-G3A	6.1 mg/L MEK[a]	03/28
Guaje Well Field-G3A	U	04/26
Guaje Well Field-G3A	Lost[c]	08/23
Guaje Well Field-G3A	U	11/15
Guaje Well Field-G4A	U	03/28
Guaje Well Field-G4A	U	04/26
Guaje Well Field-G4A	Lost[c]	08/23
Guaje Well Field-G4A	U	11/15

[a] Methyl Ethyl Ketone(2-Butanone). No drinking water maximum contaminant level has been established for MEK.
[b] No drinking water maximum contaminant level (MCL) has been established specifically for Chloroform. Chloroform is regulated as a total trihalomethane, which has an MCL of 100 µg per liter of water.
[c] Sample volume was lost because of instrument failure during analysis.
U = None detected above the Sample Detection Limit (SDL).

We anticipate completion of the Hydrogeologic Workplan in 2005.

New Mexico Water Quality Control Commission (NMWQCC) regulations control liquid discharges onto or below the ground surface to protect all groundwater in the State of New Mexico. Under the regulations, when required by NMED, a facility must submit a groundwater discharge plan and obtain NMED approval (or approval from the Oil Conservation Division for energy/mineral extraction activities). Subsequent discharges must be consistent with the terms and conditions of the discharge plan.

The Laboratory has three approved groundwater discharge plans to meet NMWQCC regulations (Table 2-1): one for TA-57 (Fenton Hill); one for the SWS Facility; and one for the land application of dried sanitary sewage sludge from the SWS Facility. On August 20, 1996, the Laboratory submitted a groundwater discharge plan application for the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50. As of December 31, 2000, NMED approval of the plan was still pending.

b. Compliance Activities. The Laboratory continued an ongoing study of the hydrogeology and stratigraphy of the region, as required by the HSWA Module of the RCRA Hazardous Waste Facility Permit, DOE Order 5400.1, and the Hydrogeologic Workplan (LANL 1998a). The Groundwater Protection Management Program Plan that ESH-18 administers integrates studies by several Laboratory programs. The Laboratory's Groundwater Annual Status Summary Report (Nylander et al., 2001) provides more detailed information on newly collected groundwater data. Drilling progress for the Hydrogeologic Workplan (LANL 1998a) during 2000 included work on the following wells. Some key highlights for 2000 are noted.

- Four regional aquifer characterization wells (R-12, R-19, R-22, R-31), one regional aquifer contamination delineation well (CDV-15-3),

Table 2-14. Inorganic Constituents in Drinking Water (mg/L) during 2000 by LANL

Sample Location	As	Ba	Be	Cd	Cr	F	CN	Hg	Ni	NO_3 (as N)	Se	Sb	Tl
Wellheads:													
Pajarito Well-PM1	0.001	<0.1	<0.001	<0.001	0.003	0.26	<0.005	<0.0002	<0.01	0.47	<0.005	<0.001	<0.001
Pajarito Well-PM2	0.001	<0.1	<0.001	<0.001	0.004	0.27	<0.005	<0.0002	<0.01	0.32	<0.005	<0.001	<0.001
Pajarito Well-PM3	0.002	<0.1	<0.001	<0.001	0.003	0.32	<0.005	<0.0002	<0.01	0.45	<0.005	<0.001	<0.001
Pajarito Well-PM5	0.001	<0.1	<0.001	<0.001	0.004	0.28	<0.005	<0.0002	<0.01	0.30	<0.005	<0.001	<0.001
Guaje Well-G1A	0.010	<0.1	<0.001	<0.001	0.006	0.54	<0.005	<0.0002	<0.01	0.44	<0.005	<0.001	<0.001
Guaje Well-G2A	0.009	<0.1	<0.001	<0.001	0.004	0.35	<0.005	<0.0002	<0.01	0.43	<0.005	<0.001	<0.001
Guaje Well-G3A	0.004	<0.1	<0.001	<0.001	0.003	0.33	<0.005	<0.0002	<0.01	0.60	<0.005	<0.001	<0.001
Guaje Well-G4A	0.002	<0.1	<0.001	<0.001	0.002	0.26	<0.005	<0.0002	<0.01	0.51	<0.005	<0.001	<0.001
Otowi Well-O4	0.002	<0.1	<0.001	<0.001	0.003	0.30	<0.005	<0.0002	<0.01	0.39	<0.005	<0.001	<0.001
Otowi Well-O1	0.003	<0.1	<0.001	<0.001	0.002	0.44	<0.005	<0.0002	<0.01	1.44	<0.005	<0.001	<0.001
EPA Maximum Contaminant Levels	0.05[a]	2.0	0.004	0.005	0.1	4.0	0.2	0.002	0.1	10.0	0.05	0.006	0.002

[a] Proposed SDWA Primary Drinking Water Standard.

Table 2-15. Bacteria in Drinking Water at Distribution System Taps during 2000 by LA County for Compliance Purposes

Month	No. of Samples Collected	No. of Positive Tests		
		Coliform	Fecal Coliform	Noncoliform
January	46	0	0	1
February	46	0	0	0
March	45	0	0	2
April	45	0	0	3
May	72	0	0	6
June	47	0	0	8
July	45	0	0	7
August	46	0	0	4
September	48	0	0	5
October	46	0	0	6
November	45	0	0	3
December	46	0	0	1
Total 2000	577	0	0	46
Maximum Contaminant Level (MCL)		[a]	[b]	[c]

[a] The MCL for coliforms is positive samples not to exceed 5% of the monthly total.
[b] The MCL for fecal coliforms is no coliform positive repeat samples following a fecal coliform positive sample.
[c] There is no MCL for noncoliforms.

and one intermediate-depth perched groundwater characterization well (R-9i) were installed during CY2000. Three other partially completed regional aquifer characterization wells were finished during the year (R-9, R-15, R-25).

- Quarterly groundwater characterization sampling began during CY2000 at wells R-9, R-9i, R-12, R-15, and R-19. Each characterization well was developed, and aquifer testing was conducted before groundwater sampling. Groundwater samples were analyzed for inorganic, organic, and radiological constituents. The ER Project is validating analytical results, and partial results are available (ER 2001).
- R-12 is located at the Laboratory's eastern boundary in Sandia Canyon. In the first quarterly sampling results, we find no values exceeding EPA primary drinking water MCLs or New Mexico groundwater standards.
- R-15 is located in Mortandad Canyon approximately one mile from the Laboratory's eastern boundary. None of the first quarterly sampling results exceed EPA primary drinking water or New Mexico groundwater standards. The organic compound Bis(2-ethylhexyl)phthalate is reported at 5.9 µg/L (compared with a drinking water MCL of 6 µg/L). Whether this is a real groundwater contaminant or is due to analytical laboratory contamination must still be determined.
- R-22 is located on the mesa above Pajarito Canyon and Cañada del Buey, immediately east of the solid low-level radioactive waste disposal site MDA G. During the drilling, we found tritium in the regional aquifer at approximately 100 pCi/L. Quarterly water quality characterization of this well will start in 2001.
- R-31 is located in Ancho Canyon west of State Road 4. We completed the first phase of drilling in 1999, and well construction was complete in March 2000. Analytical results are pending.
- R-19 was installed near TA-36 on the mesa above Threemile and Potrillo canyons and is equipped to monitor perched zones and the regional aquifer. It is located between the HE activities at TA-16 and municipal supply well

PM-2. Samples indicate no HE in the upper four screened intervals. In a water sample collected from a perched zone at 833 ft during drilling, we found HE degradation products in very low concentrations (<0.5 µg/L). It is uncertain if the products are true groundwater contaminants or are associated with the drilling fluids. Other groundwater samples from a perched zone and the regional aquifer did not show any HE compounds. Quarterly sampling of the finished well will evaluate the contaminant levels and distribution.

- CDV-15-3 was drilled as part of the ER Project corrective measures study in the western portion of the Laboratory to delineate the extent of HE groundwater contamination downgradient of TA-16, Building 260 outfall (Hickmott 2000). During drilling, we collected six groundwater samples from two perched zones and from the regional aquifer. We observed HE degradation products near the analytical detection limit in only one out of the six samples. The presence of HE must be confirmed through regular quarterly sampling.
- R-9 is a regional aquifer characterization well located near the eastern boundary in lower Los Alamos Canyon. In the quarterly sampling results, we find no values exceeding EPA primary drinking water MCLs or New Mexico groundwater standards. The regional aquifer tritium level in the second quarterly sampling was 4.8 pCi/L.
- R-9i is an intermediate-depth well located immediately adjacent to regional well R-9 that was completed in March. It is used to evaluate the quality of water in two perched intermediate zones. During the drilling of R-9, we found uranium levels of approximately 40 µg/L in the second perched zone. After we sampled the finished well, however, uranium levels in this same zone appear to be <2 µg/L. Tritium values less than 100 pCi/L in both zones are consistent with the earlier borehole samples.

11. National Environmental Policy Act

a. Introduction. The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4331 et seq.) requires federal agencies to consider the environmental impacts of proposed actions before making decisions. NEPA also requires a decision-making process open to public participation. All activities that DOE or the Laboratory proposes are subject to NEPA review. DOE is the sponsoring agency for most LANL activities. DOE must comply with the regulations for implementing NEPA published by the Council on Environmental Quality (CEQ) at 40 CFR Parts 1500–1508 and its own NEPA Implementing Procedures as published at 10 CFR Part 1021. Under these regulations and DOE Order 451.B, DOE reviews proposed LANL activities and determines whether the activity is categorically excluded from the need to prepare further NEPA documentation based on previous agency experience and analysis or whether to prepare one of the following:

- An Environmental Assessment (EA), which should briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI) for the proposed action, or
- An EIS, which is a detailed written statement of impacts with a subsequent Record of Decision (ROD).

If an EA or an EIS is required, DOE is responsible for its preparation. In some situations, a LANL project may require an EA or EIS; but, because the project is connected to another larger action that requires an EIS (such as the LANL Site-Wide EIS [SWEIS] or a programmatic EIS done at the nationwide level), the LANL project may be included in the larger EIS. The LANL project is then analyzed in the larger action or analysis or may later tier off the final programmatic EIS after a ROD is issued.

LANL project personnel initiate NEPA reviews by completing environment, safety, and health identification documents. These documents create the basis of a DOE NEPA Environmental Review Form, formerly known as a DOE Environmental Checklist. The LANL Ecology Group (ESH-20) prepares these documents using the streamlined format as specified by DOE/LAAO.

During 2000, LANL instituted a new NEPA, cultural, and biological (NCB) review process known as the NCB Laboratory Implementing Requirement (LIR) that trains reviewers in line organizations to conduct preliminary NCB screenings to ensure compliance with applicable NCB requirements. A DOE audit performed in 2000 found the NCB LIR review process to be “Perhaps the most noteworthy practice...This process places more responsibility for NEPA, cultural resources and biological resources reviews on the division and program directors that own the action. This ownership should result in an increased awareness of NCB issues and consequently, better planning and resource protection." (LAAO 2000).

b. Compliance Activities. In 2000, LANL sent 61 NEPA Environmental Review Forms to DOE compared with 159 in 1999. DOE categorically excluded 23 new actions and amended the categorical exclusion for another 23 approved actions. DOE made other NEPA determinations on 15 actions. Two EA determinations resulted in a FONSI. Twenty-two actions were unresolved in 2000. LANL applied DOE "umbrella" categorical exclusion determinations for 209 actions in 2000, compared with 161 in 1999.

c. Environmental Impact Statements, Supplement Analyses, and Special Environmental Analyses.

Site-Wide Environmental Impact Statement. DOE completed a new SWEIS for LANL (DOE 1999) in January 1999; the associated ROD was signed on September 13, 1999. NEPA documents at LANL are tiered from or reference this SWEIS until the DOE determines that a new SWEIS is needed. An annual report that identifies how LANL's operations track against the projections made in the SWEIS, the SWEIS 1999 Yearbook, is available at *http://lib-www.lanl.gov/la-pubs/00393813.pdf*. The yearbook is published annually. A Special Edition of the SWEIS Yearbook: Wildfire 2000 is also available at *http://lib-www.lanl.gov/la-pubs/00393627.pdf* on the World Wide Web.

In 2000, DOE prepared a Supplement Analysis (SA) to determine if the SWEIS adequately addressed the environmental effects of a proposal for modifying current methods for receiving and managing certain off-site unwanted radioactive sealed sources at LANL or if additional documentation under NEPA was needed. The SA specifically compared key impact assessment parameters in the SWEIS with the revised management approaches described in the SA. On October 10, 2000, DOE determined that the proposal did not constitute new circumstances or information or substantial changes to measures contained in the SWEIS relevant to environmental concerns and that no further NEPA documentation was required.

Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico (DOE/SEA-03). This report, issued in September 2000, documents the DOE/National Nuclear Security Administration (NNSA) assessment of impacts from the Laboratory's emergency activities responding to the major disaster conditions in the wake of the Cerro Grande fire. This document did not analyze the effects of the fire per se. DOE, in consultation with the CEQ, invoked "alternative arrangements" pursuant to 40 CFR 1506.11 and 10 CFR 1021.343 to replace the normal EIS process. Sixty-eight emergency reviews were carried out at the Laboratory in support of the Cerro Grande fire recovery efforts. Actions covered by the Special Environmental Assessment (SEA) encompassed a wide range of activities from fire suppression to major post-fire construction. The projects had a series of adverse effects primarily resulting from soil and vegetation removal. Beneficial impacts included the protection of cultural resources, of substantial floodplains and wetlands, and of government, tribal, and private property. The SEA mitigation plan includes monitoring and evaluating flood and erosion control structures, monitoring treated and restored areas, stabilizing cultural resource sites within burned areas, contaminant monitoring, and the reassessing of natural and cultural resource management plans. The Special Environmental Assessment is available at *http://tis.eh.doe.gov/nepa/docs/seas/sea03/sea03.html* on the World Wide Web.

d. Environmental Assessments Completed during 2000. The status of EA-level NEPA documentation at the Laboratory and project descriptions follow.

Electric Power System Upgrade (DOE-EA-1247). This EA looked at six alternatives for upgrading electric power delivery to Los Alamos National Laboratory. The proposed action consists of constructing and operating a 19.5-mi electric power transmission line from the Norton Station west across the Rio Grande to locations within TA-3 and TA-5. Three segments would be built to 345 kV specifications and the fourth segment to 115 kV specifications; the whole line would be operated at 115 kV. The project includes the construction of associated electric substations at the Laboratory, as well as the construction of two short line segments that would uncross a portion of two existing power lines. Additionally, the project includes a fiber-optic communications line as part of the required grounding conductor for the power line. Four alternatives to the Proposed Action were considered. Alternative 1 is similar to the Proposed Action except that the first three right-of-way segments would be constructed and operated at 345 kV and an additional substation would need to be constructed. Alternative 2 is similar to the Proposed Action except that the entire length of the corridor would be constructed and operated at 115 kV. Alternative 3 is the same as the Proposed Action through the first three right-of-way segments; the last right-of-way segment would follow an alternative route through a more northerly right-of-way and parallel to another 115-kV power line within LANL. Alternative 4 is the same as the Proposed Action through the first three right-of-way segments; the last right-of-way segment generally would follow a more southerly right-of-way mostly adjacent to New Mexico Highways 4 and 501. This last segment would also parallel an existing 13.8-kV power line for most of its length. In the final No Action Alternative, no changes would be made to the existing electrical power supply system. DOE issued a FONSI on March 9, 2000, in support of the Proposed Action. This EA is available at *http://nepa.eh.doe.gov/ea/ea1247/ea1247.pdf* on the World Wide Web.

Environmental Assessment for the Wildfire Hazard Reduction and Forest Health Improvement Program at Los Alamos National Laboratory, Los Alamos, New Mexico (DOE-EA-1329). Five major wildfires have ignited within the local area outside the boundaries of the Laboratory over the past 50 years. This EA analyzed four alternatives to reduce the wildfire threat to LANL and the surrounding region. The proposed alternative—an ecosystem-based approach—was selected. It will implement a Wildfire Hazard Reduction and Forest Health Improvement Program at LANL that would not use fire as a treatment measure but would initially include individual, small-scale projects using mechanical and manual thinning over about 10 years with ongoing, long-term maintenance projects conducted thereafter. The Limited Burn Alternative would have allowed limited burning for slash pile disposal with burns conducted only under controlled weather conditions and with strict on-site suppression. The Burn Alternative would have used carefully controlled burns to reduce ground fuels and to burn slash waste piles produced by tree thinning treatments. Under the No Action Alternative, there would have been very limited mechanical and manual tree cutting next to structures, roads, and parking facilities with minimal associated slash disposal by chipping. Fuels would continue to increase unless and until consumed in a wildfire or decayed in place. The analysis indicated that the Proposed Action would have a long-term beneficial effect on a variety of resources at LANL, while the No Action Alternative would not reduce the risk of catastrophic wildfire that could have a serious adverse local or cumulative effect on resources at or in the vicinity of LANL. DOE determined that the proposed action would not significantly affect the quality of the human environment, completed the EA, and issued a FONSI on August 10, 2000. This EA is available at *http://nepa.eh.doe.gov/ea/ea1329/ea1329.pdf* on the World Wide Web.

e. Environmental Assessments in Progress during 2000. The Cerro Grande fire interrupted normal operations early in the year and resulted in emergency NEPA work for the duration of 2000. No Environmental Assessments were in progress during 2000.

f. Mitigation Action Plans. As part of the implementation requirements under NEPA, DOE prepares and is responsible for implementing Mitigation Action Plans (MAPs) (10 CFR 1021, Section 331 [a] July 9, 1996). MAPs may apply to individual or site-wide projects and are generally project specific and are designed to (1) document potentially adverse environmental impacts of a proposed action, (2) identify impact mitigation commitments made in the final NEPA documents (FONSIs or RODs), and (3) establish action plans to carry out each commitment. The MAP Annual Report (MAPAR) reports the implementation status of each MAP to the public. ESH-20 coordinates the implementation of the following DOE MAPs at the Laboratory.

Site-Wide Environmental Impact Statement. DOE issued this MAP in September 1999. The MAP provides details about the mitigation actions found in the ROD and tasks LANL with preparation of a project plan to implement them. Mitigations include specific measures to further minimize the impacts identified in the SWEIS as a result of operations (e.g., electrical power and water supply, waste management, and wildfire) and measures to enhance existing programs to improve operational efficiency and minimize future potential impacts from LANL operations (e.g., cultural resources, traditional cultural properties, and natural resources management). The Laboratory expects to complete specific measures by FY2006, and the enhancement of existing programs should be implemented by FY2003. A MAPAR is prepared annually.

Dual Axis Radiographic Hydrodynamic Test Facility Mitigation Action Plan. DOE issued this MAP in 1995. On January 14, 1999, the DARHT MAPAR for 1998 was released to the public for review and comment. During 2000, all operations-related mitigation measures were implemented. The construction-related mitigation measures were completed in 1999. The scope of operational-related mitigation measures includes ongoing environmental chemistry baseline monitoring, ongoing monitoring of the Nake'muu cultural resources site, and human health and safety mitigations for operations. The DARHT MAPAR for 1999 was distributed to DOE public reading rooms on January 18, 2000.

Low-Energy Demonstration Accelerator Mitigation Action Plan. DOE issued this MAP in 1996. On January 18, 2000, the LEDA MAPAR for 1999 was released to the public for review and comment. All MAP commitments for preventing soil erosion and monitoring industrial NPDES outfalls and potential wetlands formation in and around the LEDA facility are being implemented and are on schedule.

Lease of Land for the Development of a Research Park at LANL Mitigation Action Plan. DOE issued this MAP in October 1997. Implementation of the MAP was contingent on the completion and approval of the formal lease agreement between DOE and the lessee. The lease agreement is complete, and Congress approved it in February 1999. In 2000, based on a review of the completed lease agreement and Research Park Site Development Plan, DOE made the decision to terminate the MAP and implement the required mitigations through the provisions and requirements of the lease agreement.

12. Integrated Resources Management

DOE and LANL continued to develop the Integrated Resources Management Plan (IRMP) that was initiated in 1999. The development and implementation of the IRMP is mandated under the ROD and MAP for the LANL SWEIS. The final IRMP will be completed, and Laboratory-wide implementation initiated, in 2002.

The IRMP involves DOE and multiple LANL organizations and is being developed as a mission-oriented tool for integrating facility and land use planning activities with the management of natural and cultural resources. In 2000, significant progress was made in developing a draft IRMP. In addition, several special studies were funded to gather data and develop procedures needed for future IRMP implementation. The IRMP development process was carefully evaluated to identify issues and schedule modifications resulting from the Cerro Grande fire in May 2000. The scope and schedule were modified as needed to address the influence of the fire while ensuring compliance with the SWEIS ROD and MAP. All necessary scope and schedule modifications were formally submitted to DOE/LAAO and documented in the SWEIS MAP Tracking System. As part of the IRMP, LANL continued to develop several resource-specific management plans during 2000.

13. Cultural Resources

a. Introduction. The ESH-20 Cultural Resources Team is responsible for developing the CRMP (see Section 12), building and maintaining a database of all cultural resources found on DOE land, supporting DOE's compliance with the requirements applicable to cultural resource legislation as listed below, and providing appropriate information to the public on cultural resource management issues. Cultural resources are defined as archaeological materials and sites dating to the prehistoric, historic, or European contact period that are currently located on or beneath the ground; standing structures that are over 50 years old or are important because they represent a major historical theme or era; cultural and natural places, select natural resources, sacred objects and sites that have importance to American Indians; and American folklife traditions and arts.

b. Compliance Overview. Section 106 of the National Historic Preservation Act, Public Law 89-665, implemented by 36 CFR 800, requires federal agencies to evaluate the impact of all proposed actions on cultural resources. Federal agencies must also consult with the State Historic Preservation Officer (SHPO) and/or the Advisory Council on Historic Preservation about possible adverse effects on National Register of Historic Places eligible resources.

During 2000, Laboratory Cultural Resources Team (ESH-20) evaluated 1,111 Laboratory proposed actions and conducted 13 new field surveys to identify cultural resources. DOE sent 11 survey results to the SHPO for concurrence in findings of effects and determinations of eligibility for National Register inclusion of cultural resources located during the survey. The Governors of San Ildefonso, Santa Clara, Cochiti, and Jemez Pueblos and the President of the Mescalero Apache Tribe received for comment copies of six reports to identify any traditional cultural properties that a proposed action could affect. ESH-20 identified no adverse effects to cultural resources in 2000.

The American Indian Religious Freedom Act of 1978 (Public Law 95-341) stipulates that it is federal policy to protect and preserve the right of American Indians to practice their traditional religions. Tribal groups must receive notification of possible alteration of traditional and sacred places. The Native American Grave Protection and Repatriation Act of 1990 (Public Law 101-601) states that if burials or cultural objects are inadvertently disturbed by federal activities, work must stop in that location for 30 days, and the closest lineal descendant must be consulted for disposition of the remains. No discoveries of burials or cultural objects occurred in 2000.

The Archaeological Resources Protection Act (ARPA) of 1979 (Public Law 96-95) provides protection of cultural resources and sets penalties for their damage or removal from federal land without a permit. No ARPA violations were recorded on DOE land in 2000.

c. Compliance Activities.

Nake'muu. As part of the DARHT MAP, the Cultural Resource Team is conducting a long-term monitoring program at the ancestral pueblo of Nake'muu. The team is implementing the program to assess the impact of LANL mission projects on cultural resources. Nake'muu is the only pueblo at the Laboratory that still contains its original standing walls. It dates from circa 1200–1325 A. D. and contains 55 rooms with walls standing up to 6 feet high. As such, it represents one of the best-preserved ruins on the Pajarito Plateau. In 2000, preliminary results from the monitoring program indicate that 1.2% of the chinking stones and 0.4% of the masonry blocks are falling out of the walls on an annual basis. Projecting this rate of failure over the next 10 to 15 years indicates that substantial changes to the site can be expected. At this early stage in the monitoring program, it is unclear what the causes of the observed deterioration are; however, it appears to be related to natural freeze-thaw cycles because north-facing walls are suffering higher rates of collapse. The site is ancestral to the people from San Ildefonso Pueblo who refer to it in their oral histories and songs. They are invited for annual visits to Nake'muu to personally view the ruins and consult on the long-term status of the site and possible stabilization options.

Traditional Cultural Properties Consultation Comprehensive Plan. In 2000, the Cultural Resources Team assisted DOE/LAAO in finalizing a Traditional Cultural Properties Consultation Comprehensive Plan. This plan provides the framework to open government-to-government consultations between DOE/LAAO and interested Native American tribal organizations on identifying, protecting, and gaining access to traditional cultural properties and sacred places. The comprehensive plan is part of the mitigation actions described in the ROD for the SWEIS for the Continued Operation of the Los Alamos National Laboratory. The plan provides the basis for traditional cultural properties protection and access agreements with participating tribal organizations. It also describes methods and procedures for maintaining confidentiality of sensitive information. The comprehensive plan was distributed for tribal comment in the summer of 2000. The next phase of the consultation process will include visits to tribal governments and organizations interested in participating in the consultation process. The first visits are scheduled for the spring of 2001.

Land Conveyance and Transfer. Public Law 105-119, November 1997, directs the Department of Energy to convey and transfer parcels of DOE land in the vicinity of the Laboratory to the County of Los Alamos, New Mexico, and to the Secretary of the Interior, in trust for the San Ildefonso Pueblo. In support of this effort, the Cultural Resources Team conducted historic property inventories and evaluations, as required under Section 106 of the National Historic Preservation Act, in preparation for the eventual transfer of lands out of federal ownership. This effort has included the archaeological survey of 4,700 acres of Laboratory lands and the inventory and evaluation of 47 buildings and structures located on the transfer parcels. Final cultural resources reports received New Mexico State Historic Preservation Officer concurrence in the summer of 2000.

Cerro Grande Fire Recovery. The Cultural Resources Team is conducting fire damage assessments of approximately 7,500 acres of LANL property burned during the May 2000 Cerro Grande fire. It is estimated that 519 historic properties will be visited during the ongoing assessment activities. The assessments include photography, evaluation of fire impacts, global positioning system (GPS) recording of site locations, site rehabilitation, and long-term monitoring. Preliminary results of the first phase of assessments indicate that the fire damaged the Homestead Period wooden structures most severely, completely destroying a number of homestead cabins. Reassessments of National Register of Historic Places eligibility will be required at these sites.

14. Biological Resources including Floodplain and Wetland Protection

a. Introduction. The DOE and the Laboratory comply with the Endangered Species Act; the Migratory Bird Treaty Act; the Bald Eagle Protection Act; Presidential Executive Order 11988, Floodplain Management; Presidential Executive Order 11990, Protection of Wetlands (Corps 1989); and Section 404 of the Clean Water Act. The Laboratory also protects plant and animal species listed by the New Mexico Conservation Act and the New Mexico Endangered Species Act.

b. Compliance Activities. During 2000, the ESH-20 Biology Team reviewed 454 proposed Laboratory activities and projects for potential impact on biological resources, including federally listed threatened and endangered (T&E) species. These reviews evaluate the amount of previous development or disturbance at the site, determine the presence of wetlands or floodplains in the project area, and determine whether habitat evaluations or species-specific surveys are needed. Of the 454 reviews, the Biology Team identified 60 projects that required habitat evaluation surveys to assess whether the appropriate habitat types and parameters were present to support any threatened or endangered species; this work included two floodplain and wetlands assessments. As part of the standard surveys associated with the Threatened and Endangered Species Habitat Management Plan, the Biology Team conducted approximately 30 species-specific surveys to determine the presence or absence of a threatened or endangered species at LANL. The Laboratory adhered to protocols set by the US Fish and Wildlife Service and to permit requirements of the New Mexico State Game and Fish Department.

c. Biological Resource Compliance Documents. In 2000, the Biology Team prepared several biological resource documents, such as biological assessments, biological evaluations, and other compliance documents. These documents included, among others, a biological assessment of TA-53 cooling tower replacement (Loftin 2000) and the Central Health Physics Calibration Facility (Keller 2000). DOE determined that these projects may affect, but are not likely to adversely affect, individuals of threatened and endangered species or their critical habitat; the US Fish and Wildlife Service concurred with these determinations.

The Biology Team contributed to the continued implementation of the Threatened And Endangered Species Habitat Management Plan (HMP) (LANL 1998b). Site plans were successfully used to further evaluate and manage the threatened and endangered species occupying DOE/Laboratory property (see Section 6.C.5).

d. Effects of the Cerro Grande Fire. During 2000, the greatest impact to ecological resources was the Cerro Grande fire. The Cerro Grande fire burned approximately 43,150 ac (17,261 ha). Preliminary results indicate that about 34% of the acres were burned with low severity (burn severity relates to the fire's impact on soil features), 8% with moderate severity, and about 58% with high severity. The fire created a habitat mosaic that is dynamic and will offer changing opportunities for plant and animal communities.

The results of the Cerro Grande fire will likely not cause a long-term change to the overall number of federally listed T&E species inhabiting the region, but the fire will likely change the distribution and movement of various species, including the Mexican spotted owl. However, it is estimated that 91% of the LANL Mexican spotted owl habitat remains suitable. The fire may also have long-term effects to the habitat of several state-listed species, including the Jemez Mountains salamander. Following the fire, LANL continued operating under the current HMP guidelines. During 2001, we plan to modify the HMP to reflect post-fire habitat changes.

In 2000, the Laboratory completed several contaminant studies and continued risk assessment studies on the food chain for threatened and endangered species habituating Laboratory lands, including potential impacts from the fire. These studies included an assessment of organic chemical contamination in the food chain for selected endangered species and a study monitoring PCBs and organochlorine pesticides (OCPs) in fish of the Rio Grande (see Chapter 6).

C. Current Issues and Actions

1. Compliance Agreements

a. New Mexico Hazardous Waste Management Regulations Compliance Orders. On June 25, 1998, the Laboratory received CO-98-02 that alleged two violations of the NM Hazardous Waste Management Regulations for the storage of gas cylinders at TA-21. NMED proposed civil penalties of over $950,000. The Laboratory filed its answer to the CO on August 10, 1998, meeting the compliance schedule by demonstrating that all gas cylinders had been disposed of properly. Efforts to resolve this CO continued during 2000.

On December 21, 1999, the Laboratory received CO-99-03. It covered the alleged deficiencies the NMED Hazardous and Radioactive Materials Bureau discovered during a five-month inspection that took place in 1997. The inspection was called "wall-to-wall" because NMED personnel walked every space at the Laboratory—storage areas, laboratories, hallways, stairwells, and the areas around buildings—looking for improperly stored hazardous chemicals. In past inspections, only designated storage areas were included. Twenty-nine deficiencies were alleged with over $1 million in proposed penalties. The Laboratory prepared and submitted its response to the CO and requested a hearing during 2000.

The Laboratory received CO-99-01 on December 28, 1999, in response to the NMED inspection conducted between August 10 and September 18, 1998. The inspection team visited approximately 544 sites at the Laboratory. Thirty violations were alleged in the CO. Total penalties proposed were almost $850,000. The Laboratory prepared and submitted its response to the CO and requested a hearing during 2000.

The full text of the COs received during 1999, as well as status updates for 2000, is available at *http://drambuie.lanl.gov/~esh19/* on the World Wide Web.

2. Environmental Oversight and Monitoring Agreement

The Agreement-in-Principle between DOE and the State of New Mexico for Environmental Oversight and Monitoring provides financial support for state activities in environmental oversight and monitoring. The NMED's DOE Oversight Bureau (DOB) carries out the requirements of the agreement. Highlights of the Oversight Bureau's activities are presented below.

Gamma Radiation and Air Particulate Monitoring. The DOB measured gamma radiation at 12 locations. Radiation measurements were consistent with and slightly lower than the Laboratory's and were within the range of background. The DOB measured airborne radionuclides at five locations, also on or near the facility boundary. The results were consistent with the Laboratory's results, with low values for plutonium and americium and slightly higher values for uranium. All values were well below applicable standards. Tritium was measured at the same five locations. Levels increased at one station because of a release of tritium from the TA-21 facility. The Laboratory measured comparable levels after the release. The other stations showed background levels.

During the Cerro Grande fire, the DOB collected samples of ash fall particulates on smooth surfaces using small swatches or swipes of filter media. The swipes were collected from Cochiti Reservoir to Okay Owingeh and counted for alpha radiation. The swipes initially showed elevated alpha counts rates, which declined rapidly to normal levels. Based on the isotopic analysis of air monitoring filters and the rapid drop in activity of the swipes, the elevated readings appear to have been the result of naturally occurring, short-lived radionuclides.

Soil, Sediment, and Biota. The Bureau continued its ongoing environmental surveillance data collection and evaluation. It collected samples of soil, storm water, fish, and macroinvertebrates to evaluate levels of persistent environmental contaminants, particularly mercury, dioxins, and PCBs. The Laboratory's ESH-20 helped the Bureau collect samples of fish from Cochiti and Abiquiu Reservoirs.

Analytical results showed concentrations of mercury greater than 1 mg/kg in fish from Cochiti Reservoir (2.2 ppm in a walleye pike), with an average concentration in 10 fish samples of 0.4 ppm. Dioxins were either not detected or were found near the detection limit. Using high-resolution analytical techniques that are not approved by EPA for compliance purposes, the Bureau found total PCBs at higher concentrations in Cochiti fish than in Abiquiu fish, although levels of dioxin-like PCBs were similar. Samples of dragonflies and damselflies collected in Upper Sandia Canyon showed elevated levels of total and dioxin-like PCBs.

After the Cerro Grande fire, the DOB expanded its monitoring program to evaluate possible environmental impacts. It collected samples of ash and soil in the forested areas burned by the fire, samples of soils and produce from farms in the path of the smoke cloud, and storm water and sediments derived from ash deposits. Analytical results showed that the concentrations of radionuclides and other chemicals were below levels that pose a short-term or acute threat to human health. Some of the ash, sediment, and soil samples had radionuclides and metals at concentrations in excess of EPA and NMED screening levels designed to be protective of human health for long-term exposures.

In general, samples of ash from the burned areas and stream-course sediments below the fire contained higher levels of radionuclides and metals than are typical of soils and sediments from the area. This increase is probably the result of the concentration of these materials by the combustion process. Samples of ash-laden sediments along the Rio Grande in White Rock Canyon also had higher levels than typical for area sediments, but these were lower than levels measured in sediments closer to the burned areas. Post-fire concentrations in farm soils were found to be similar to those measured before the fire.

The DOB sampled post-fire sediments deposited along the Rio Grande in White Rock Canyon. The samples were analyzed for radionuclides, metals, and cyanide and other persistent organic compounds. The results indicated that concentrations of most analytes in the White Rock Canyon sediment deposits were lower than the concentrations of these analytes in sediments from canyons directly below the Cerro Grande fire.

Storm Water. The DOB collected 33 storm water samples from canyons potentially affected by the Cerro Grande fire. Six additional samples were collected in canyons that were not impacted by the fire. The US Geological Service collected six samples for the DOB in the Rio Grande. More than two-thirds of the samples were collected during two storms in October. Samples were collected of storm water flowing in canyons including South Fork Acid, Acid, Pueblo, Los Alamos, Guaje, Pajarito, Water, Potrillo, Sandia, Mortandad, and Cañada del Buey and from the Rio Grande.

The DOB found that the analytical results indicated that concentrations of metals and radionuclides were generally elevated in the suspended sediment fraction of storm water. Levels of radionuclides in suspended sediment separated from storm water were higher than those levels found in sediment deposited in the canyons. Some storm water samples contained radionuclides (strontium-90, uranium, potassium-40, and ruthenium-106) at levels that exceed EPA radionuclide screening levels for drinking water. However, these levels are for drinking water continuously over the long term (several decades) and are not regulatively applicable to periodic storm water events.

Using a high-resolution analytical technique that is not an EPA-approved method for compliance purposes, the DOB measured PCBs in water in three canyons on Laboratory property and one draining the Los Alamos town site. Using an EPA-approved method for compliance, PCBs were not measured above detectable limits by the Laboratory. The highest levels were found in Pueblo Canyon and Pueblo North tributary, which drains the North Community of Los Alamos, and are unlikely to be the result of a Laboratory impact.

Environmental Restoration. Representatives of the DOB worked on High-Performing Teams (HPTs) that included members from the DOE, Los Alamos National Laboratory, and the Environment Department. The teams are intended to accelerate critical path environmental restoration activities through interagency communication and collaborative decision-making.

The Building 260 Outfall team determined how to best classify the “blending” of contaminated and uncontaminated soil removed from a contaminated drainage and how to categorize and manage the different waste streams created during the soil removal. The team also made decisions about the on-site treatment of waste. The Ecorisk team also participated with the Building 260 Outfall effort.

The Airport Landfill team agreed on the regulatory and technical approaches to remediation of the landfill. The team agreed that additional soil, water, and soil gas samples should be collected to fill some data gaps, the landfill should be capped with a cover designed for municipal waste, and the drainages on the hillside below the landfill should be remediated by removing refuse and disposing of it at a designated off-site landfill or recycling it.

The MDA team concluded that the Laboratory needed to perform a corrective measures study at MDA H because although contaminants at the site do not present a current or near-term risk, they may present an unacceptable threat to humans and the environment over the lifetime of the waste. The team also agreed that further investigation needed to fill data gaps should be done concurrently with the corrective measures study.

The Work-off/Annual Unit Audit/Permit modification HPT assessed sites that were previously proposed for no further action (NFA) before NMED had regulatory authority. Sites were reevaluated against current regulatory criteria to determine if they still met the NFA criteria. As a result of the HPT, 30 SWMUs were removed from the permit in 2000. The team also completed a consolidation effort that combined sites to support an Annual Unit Audit of HSWA units required by NMED.

The Laboratory’s ER Project removed contaminated stream sediments in Sandia Canyon below a PCB-contaminated site, 3-056(c). During the removal, DOB investigators collected samples of water upstream and downstream of the removal area and of sediments that remained on-site. Analytical results indicated that total PCBs in the water were higher downstream than upstream of the removal, probably because of a sudden release of effluent water from the power plant in TA-3.

After the Cerro Grande fire, Bureau staff worked with DOE and the ER Project to identify contaminated sites that had been burned by the fire. Approximately 315 sites were identified. The team evaluated the sites to determine which were at high risk for erosion and contaminant transport. The DOB is monitoring these erosion controls to assure that they are effective in limiting the migration of contamination and reducing erosion.

D. Consent Decree

1. Clean Air Act Consent Decree/Settlement Agreement

During 1997, DOE and the Laboratory Director entered into a Consent Decree and a Settlement Agreement to resolve a lawsuit that the Concerned Citizens for Nuclear Safety filed. The lawsuit, filed in 1994, alleged that the Laboratory was not in full compliance with the CAA Radionuclide NESHAP, 40 CFR 61, Subpart H. The decree and agreement require actions that will continue through 2002 and, depending upon the results of the independent audits, may continue through 2004. All of the provisions of the decree and agreement were met during 2000 and are described in detail at *http://www.air-quality.lanl.gov/ConsentDecree.htm* on the World Wide Web.

Risk Assessment Corporation (RAC) completed the second independent audit of the Laboratory's Radionuclide NESHAP program during 2000. The final report for this second audit was issued on December 13, 2000. According to the report, the audit team determined that the Laboratory was in compliance with 40 CFR 61, Subpart H, for the audit year 1999. The auditors commended the Laboratory for addressing the findings of the first audit and also for the concerted effort put forth during the audit to make it an open, thorough, and responsive process. The audit team noted the positive interaction between the audit team, LANL, Concerned Citizens for Nuclear Safety, and the Institute for Energy and Environmental Research. The auditors also commended the parties' professionalism and dedication to the audit process, given the unusually difficult circumstances created by the Cerro Grande fire and the critical issues with regard to security at LANL.The Laboratory submitted RAC's final audit report to DOE, and DOE provided copies to EPA Region 6, NMED, and the Laboratory's Community Reading Room. The third audit of the Radionuclide NESHAP Program will begin in June 2002.

A full copy of the audit report is available at *http://www.air-quality.LANL.gov/ConsentDecree.htm* on the World Wide Web.

E. Significant Accomplishments

1. RCRA Facility Investigation for TA-54

During 2000, ER Project personnel completed a draft RFI report on the material disposal areas at TA-54. TA-54 is located in the east-central portion of the Laboratory on Mesita del Buey, between Pajarito Canyon to the south and Cañada del Buey to the north. The site is divided into four MDAs:

- MDA G has been used since 1957 for permanent land disposal of radioactive solid waste and is now used for disposal of low-level radioactive waste and storage of mixed and transuranic wastes.
- MDA H was used between 1960 and 1989 for permanent land disposal of classified or sensitive wastes, some of which were contaminated with radioactive, hazardous, or explosive constituents.
- MDA J was used between 1961 and 1999 for disposal of administrative controlled wastes.
- MDA L was used between 1959 and 1986 for permanent land disposal of chemical waste and is now used for storage of hazardous and mixed liquid wastes.

MDAs G, H, and L have associated PRSs that are subject to postclosure corrective action under RCRA; the RFI addresses releases of contaminants and risks associated with the wastes disposed of at these PRSs before July 24, 1990, when the EPA granted RCRA authority to the State of New Mexico. MDA J is currently being closed under the New Mexico Solid Waste Management Regulations; it was not evaluated in this RFI. Section 2.B. Solid Waste Disposal in this chapter contains additional information about MDA J.

The principal conclusion of the draft RFI report, based on the interpretation of the results of the risk assessments, is that sufficient information is available to evaluate and optimize corrective measures for controlling potential future risks posed by potential long-term releases at TA-54.

The present-day human health risk assessment in the draft RFI concluded that current levels of contamination in air, surface soil, and sediment do not exceed applicable risk thresholds established by EPA. The present-day ecological screening assessment detected concentrations of Aroclor-1260 (a PCB) in surface soils at MDA G below levels that require cleanup to protect ecological receptors.

2. TA-21 Nontraditional In Situ Vitrification Hot Demonstration

In April 2000, members of the ER Project, in conjunction with the DOE/LAAO; the DOE's Environmental Management Office of Science and Technology; MSE Technology Applications, Inc.; and Geosafe Corporation executed a second demonstration of a nontraditional in situ (in place) vitrification (heating to extremely high temperatures sufficient to melt the waste) (called NTISV) technology on an area north of MDA V in TA-21. The purpose of the project was to demonstrate whether in situ vitrification could provide an environmentally sound, safe, and cost-effective solution for treating and stabilizing soils contaminated with chemical and radioactive wastes. The NTISV technology uses heat from electricity to convert earth into an inert, environmentally benign glass-like monolith. The conversion occurs below the ground surface. This demonstration was a "hot" demonstration because it involved radioactive constituents. The "cold" demonstration (involving no radioactive materials) was conducted during April 1999.

During the hot demonstration, the team vitrified the central section of an absorption bed, an area approximately 20 ft long by 30 ft wide by 22 ft deep. To vitrify the mass of cobble, gravel, soil, and contaminants, the team inserted four electrodes into the ground. Power was gradually increased to more than 3 million watts, raising the temperature of the material to between 2200º and 2550º C. With increasing temperatures, the underground melt area slowly increased in width and depth. As the material melted, virtually all of the organic chemicals would have broken down and been released as gases. The gases were filtered from the air by treatment systems. Only filtered air was discharged into the atmosphere during the demonstration. The inorganic chemicals and radionuclides were contained within the glass block that will be left in place when the melted mass cools and solidifies. The vitrified glass should be cool enough to obtain samples from in about a year, allowing the team to evaluate whether the project was successful in immobilizing the inorganic chemicals and radionuclides found at MDA V.

3. Pollution Prevention

In 2000, seven Laboratory organizations received recognition from the New Mexico Green Zia Environmental Excellence program for their noteworthy environmental performance. The governor presented the awards for winners from across the state at a special ceremony in October.

Laboratory Achievement Award winners included

- Environmental Science and Waste Technology (E) Division,
- High-Explosive Science and Technology Group (DX-2), and
- Weapons Component Technology (NMT-5).

LANL's Commitment Award winners included

- Business Operations (BUS),
- Human Resources (HR),
- Facility and Waste Operations-Distributed Facilities (FWO-DF), and
- Transition Manufacturing and Safety Equipment (TMSW) project.

Recognition at the Commitment Level indicates that independent program examiners and judges believe the organization's management has made a strong commitment to pollution prevention and the organization is establishing a basic, systematic pollution prevention program. Recognition at the Achievement Level shows that examiners and judges believe the organization has developed its pollution prevention program into a prevention-based environmental management system and can demonstrate measurable results.

The Laboratory recognized 29 outstanding individual and team pollution prevention accomplishments during 2000 with cash awards and recognition in a ceremony held April 26, 2001. Brief descriptions of the award-winning efforts are available at *http://emeso.LANL.gov/eso_projects/p2_awards/winners_2001.htms* on the World Wide Web.

The Environmental Science and Waste Technology Division's Environmental Stewardship Office will receive a 2000 Piñon Award from Quality New Mexico. The Piñon Award identifies organizations that have made a serious commitment to using quality principles.

4. NPDES Team

On January 29, 2000, the EPA provided public notice of the Laboratory's proposed NPDES Permit. The notice allowed a 30-day public comment period. In response to the public notice, the Laboratory's ESH-18, in coordination with Laboratory Facility Managers, operating groups, outfall contacts, legal counsel, and representatives from DOE/LAAO, reviewed the proposed NPDES Permit and the Fact Sheet, which explains the basis for permit conditions. On February 28, 2000, the Laboratory and DOE provided written comments on the proposed NPDES Permit to ensure consistency with existing NPDES Permit requirements and new state water quality standards. The Laboratory and DOE also requested that the EPA re-issue for review a draft permit and fact sheet that incorporated recent changes to the New Mexico water quality standards.

On March 21, 2000, the EPA requested that the Laboratory prepare a biological evaluation (BE) to support the EPA's consultation with the US Fish and Wildlife Service (USFWS) on the direct, indirect, and cumulative effects of the proposed NPDES permit on federally listed T&E species in the Los Alamos area. ESH-20, on behalf of DOE and UC who are co-permittees for the Laboratory's NPDES permit No. NM0028355, completed the biological evaluation report on June 8, 2000.

The EPA requested USFWS concurrence with the Laboratory's evaluation. On December 14, 2000, the USFWS agreed that the proposed action would not adversely affect listed species or their habitat and that the EPA effect determination for bald eagle and southwestern willow flycatcher should be modified from "no affect" to "may affect, not likely to adversely affect." The USFWS based this modification on information presented in the BE about risk analysis and other protective measures the proposed permit included to minimize possible adverse effects to the bald eagle and southwestern willow flycatcher. The USFWS provided the Laboratory with a copy of their letter to the EPA, dated December 18, 2000.

An assessment of the Laboratory's 20 NPDES outfalls following the Cerro Grande fire revealed no fire-related impacts to any outfall piping. NPDES monitoring and reporting requirements were completed on schedule. Potential future impacts include likely increases in storm water runoff in the canyons that transect Laboratory property and the potential for increase of contaminant transport across Laboratory property. Laboratory scientists are heavily involved in post-fire contaminant monitoring programs and will continue these activities into the future to document and actively mitigate against increases in contaminant transport within the Laboratory's property, including within T&E species habitat. The Laboratory provided data updates to the EPA when new information developed.

On December 29, 2000, the EPA issued a public notice of the Agency's final permit decision, a summary of the EPA's response to earlier comments, and a copy of the final NPDES Permit. On January 19, 2001, a copy of the Laboratory's new NPDES Permit was hand-carried to each operating group and facility management unit with NPDES outfalls under their management. The NPDES Outfall Team collaborated with operating groups and facility management staff to prepare written comments on the new permit that went to the EPA on January 31, 2001.

The comments the EPA received included specific concerns with the new permit requirements. Substantial changes in the new NPDES permit were the following:

- more stringent effluent limits based on new water quality standards;
- compliance schedules for treated cooling water outfalls. The Laboratory must meet the new Total Residual Chlorine limit (11 ppb) by January 31, 2003, for these outfalls, which will require dechlorination treatment units;
- requirement to identify accelerator-produced isotopes entering the TA-50 RLWTF;
- new limits for RDX and TNT added to the permit at NPDES outfalls 05A055 (TA-16 High-Explosive Wastewater Treatment Facility [HEWTF]) and 05A097 (TA-11 Drop Tower). The TA-11 Drop Tower outfall will need to be modified or shut down if effluent limits cannot be met;
- increased sampling frequencies; and
- additional monitoring and reporting requirements.

The Laboratory's new NPDES permit was effective February 1, 2001. The EPA issues NPDES permits, and NMED certifies them for a period of five years.

F. Significant Events

1. Cerro Grande Fire

a. Monitoring and Surveillance. This year was exceptionally challenging when compared with all previous years because of the impact of the Cerro Grande fire (Chapter 1.D) on the Laboratory's priorities and needs for environmental monitoring and surveillance of storm water. The Laboratory's surveillance programs shifted to address the following concerns:

- off-site movement of Laboratory contaminants during fire by airborne transport to downwind receptors in the general public,
- exposure of emergency personnel to wildfire smoke during the fire, and
- transport of contaminants by storm water flooding of Laboratory lands down canyons to off-site lands and the Rio Grande.

Fire recovery operations became the Laboratory's first priority. Results of the special surveillance sampling efforts are presented in subsequent chapters for air and water quality, soil and foodstuffs, and dose assessment.

b. Emergency Rehabilitation Team. The Laboratory's Emergency Rehabilitation Team (ERT) completed initial assessments and land rehabilitation treatments of the burned areas on Laboratory property following the Cerro Grande fire. The Facility and Waste Operations Division (FWO), ESH-18, ESH-20, ER, and contract rehabilitation crews worked together throughout the summer to identify and complete rehabilitation treatments using BAER methods and specifications for reducing erosion and potential flooding on LANL property. The ERT's goal was to address potential impacts of increased runoff resulting from the fire and to identify potential long-term erosion and restoration issues. After addressing the immediate threat of erosion from the seasonal monsoon season following the fire, the team shifted its focus to monitoring, maintaining, and, in some cases, improving our rehabilitation treatments and techniques.

The ER Project's PRS Assessment Team completed burned area assessments and installed rehabilitation practices and erosion controls for 91 PRSs (Table 2-2). PRS field assessments started on May 16, 2000, and general field rehabilitation activities began on June 9, 2000.

Laboratory personnel conducted on-the-ground evaluations of burned areas to ground truth burned area maps to determine the nature and extent of the restoration activity required. ESH-18 directed International Technology Corporation, JCNNM, Los Alamos Technical Associates, Washington Group, Greyback Forestry Crews, and four sawyers on rehabilitation techniques and locations for work.

The rehabilitation effort on LANL property lasted for approximately 10 weeks. The completed land treatments follow the BAER Team Cerro Grande fire specifications:

- aerial seeding,
- hydromulching (aerial and truck), and
- hand rehabilitation, including
  - removal of hazard trees,
  - contour raking,
  - hand seeding,
  - straw wattles on contours,
  - log structures,
  - rock check dams,
  - run-on diversion trenches,
  - contour tree felling, and
  - straw mulching.

Aerial and hand seeding used the BAER recommended seed mixture, which contained both annual and perennial seed (30% annual rye grass, 30% mountain brome, 30% slender wheat grass, and 10% barley). Specified canyon walls in Pajarito, Cañada del Buey, and Water Canyons and areas that were steep and inaccessible by road were hydromulched from the air. Steep areas that had road access were mulched from trucks. The mulch was a mixture of fertilizer, seed, shredded wood, water, and a tackifier. The mulch (hydro or straw) covered the raked and seeded areas to provide a place for seed germination. Land rehabilitation treatments such as tree felling, raking, wattle placement, log structures, and rock check dams used contours to decrease erosion caused by water runoff. Table 2-16 includes the approximate coverage for each of the treatments cited above.

Laboratory personnel will monitor these treatments over the next few years. They will maintain existing treatment and apply additional treatment on other areas, as needed.

2. Plutonium-239, -240 in Acid Canyon

During 2000, the ER Project continued its work in Acid Canyon, a tributary to upper Pueblo Canyon, part of the Los Alamos/Pueblo watershed. Former TA-45 was located at the top of the South Fork of Acid Canyon; a wastewater treatment plant for radioactive liquid wastes and a vehicle decontamination facility were located there during the 1950s and early 60s. Decontamination and decommissioning of the main structures, associated waste lines, and wastewater outfalls began in October 1966.

In 1967, Los Alamos County assumed title to the property and used the site for storing and staging

Table 2-16. Estimated Acreage of Land Treated Following Cerro Grande Fire

Treatment	Acres	Amount (lbs/acre)	Total (lbs)
Truck Hydromulching	125		
– hydromulch		2,000	250,000
– tacifier		240	30,000
– seed		35	43,750
Rehabilitation by Hand	950		
– hand seeding	400	35	
– wattles	736	188,700 lin. ft	188,700 lin. ft
– contour falling	886	NA	NA
– raking	736	NA	NA
– mulching (straw)	736	160 bales	5,000

Note: The acreage listed above is per unit treated. Several of the units required a combination of treatments.

equipment and supplies for the Utility Department. After the Utility Department moved to its current site on Trinity Drive, the county built a skate park on the site in 1997. Investigation and cleanup activities have continued at former TA-45 and in Acid Canyon since 1945; the cleanups met the cleanup standards in place at the time.

In 1999, ER Project personnel took sediment samples to confirm the results of previous studies. The sampling used a geomorphic approach that targeted specific sediment deposits resulting from past wastewater treatment effluent releases. The sampling was designed to find the areas that might contain the highest contamination levels and involved detailed mapping of sediment deposits and intensive radiation surveys with field instruments.

Results of the investigation showed plutonium-239, -240 levels from 2 to 1,880 piC/g in sediment. The 1,880 piC/g value is three times higher than any previous sample analyzed from Acid Canyon. The Laboratory performed additional field studies, collecting 35 new sediment samples in November 1999 to further characterize plutonium concentrations and evaluate risks associated with these concentrations.

During FY2000, ER Project personnel

- Prepared detailed geomorphic maps and conducted field characterization of 700 meters of Acid Canyon, extending to the confluence with Pueblo Canyon,
- Collected 96 sediment samples for analysis at off-site laboratories, and
- Reached agreement with NMED, EPA, and DOE on an appropriate dose assessment approach for the South Fork of Acid Canyon where radionuclide concentrations are highest.

ER Project personnel prepared an interim report on sediment contamination in the South Fork of Acid Canyon, which concluded that reasonable maximum exposures for a conservative “child exposure” scenario are below the cleanup level of 15 mrem/yr recommended by the EPA and DOE.

G. Awards

1. Solid and Hazardous Waste

A member of ESH-19 received a Los Alamos Achievement Award for her outstanding research and development as recognized by the ESH Division Review Committee in April 2000 and for improved ES&H protection of the public as a result of the study “Utilizing Models on Multiple Scales to Enhance the Hydrogeologic Characterization of the Pajarito Plateau.”

2. Environmental Restoration Project

The ER Project’s Baseline Development Team won a Laboratory Distinguished Performance Award for a

Large Team for developing a lifecycle baseline (beginning with FY2000) for the ER Project. The lifecycle baseline is extremely complex, addressing the Laboratory's potentially contaminated sites and consolidating them into units related to eight major watersheds. Within these consolidated units, the baseline team prioritized the sites for investigation, assessment, stabilization, and remediation, placing high-risk work first. The team's finished baseline is 21 volumes that detail the project planning, resources, and scheduling necessary to complete the ER Project. The baseline was able to reduce the ER Project's completion date by three years and its total cost by about $2.6 billion. The baseline exceeded DOE's expectations and helped Los Alamos achieve an "Excellent" rating on the FY99 University of California Appendix F Performance Measures.

Three Project personnel received Los Alamos Achievement Awards in 2000. The first award was for outstanding achievement during the Project's efforts to consolidate PRSs on the Laboratory's HSWA Module of the RCRA Hazardous Waste Facility permit and for using knowledge of the PRSs during the Cerro Grande fire to protect the surface water natural resource and minimize any potential contaminant release from the Laboratory. The second award was granted for individual achievement during the lifecycle baseline efforts. The third award was for outstanding achievement in staffing the Project Office that resulted in significant cost savings.

3. ESH-17 Uranium Air Sampling

The ESH Division Review committee recognized an ESH-17 team for its outstanding research and development work on uranium air sampling. This research and development work has allowed the routine air monitoring network to be used to determine if uranium air concentrations are from Laboratory operations or are from naturally occurring sources of uranium. The work has also assisted the Laboratory in responding to public concerns about depleted uranium.

4. NPDES Team Pollution Prevention Award

A member of the NPDES team received a Pollution Prevention Award in April 2000 for his work on HEWTF Waste and Contaminant Reduction. The HEWTF now circulates wastewater continuously, which reduces the need to change the activated carbon as frequently, saving approximately $30,000 per year and decreasing the possibility of the facility exceeding NPDES limits.

5. Storm Water Team Pollution Prevention Award.

Members of the Storm Water Team received a Pollution Prevention Award in April 2000 for work on developing storm water Pollution Prevention Plans for the Laboratory.

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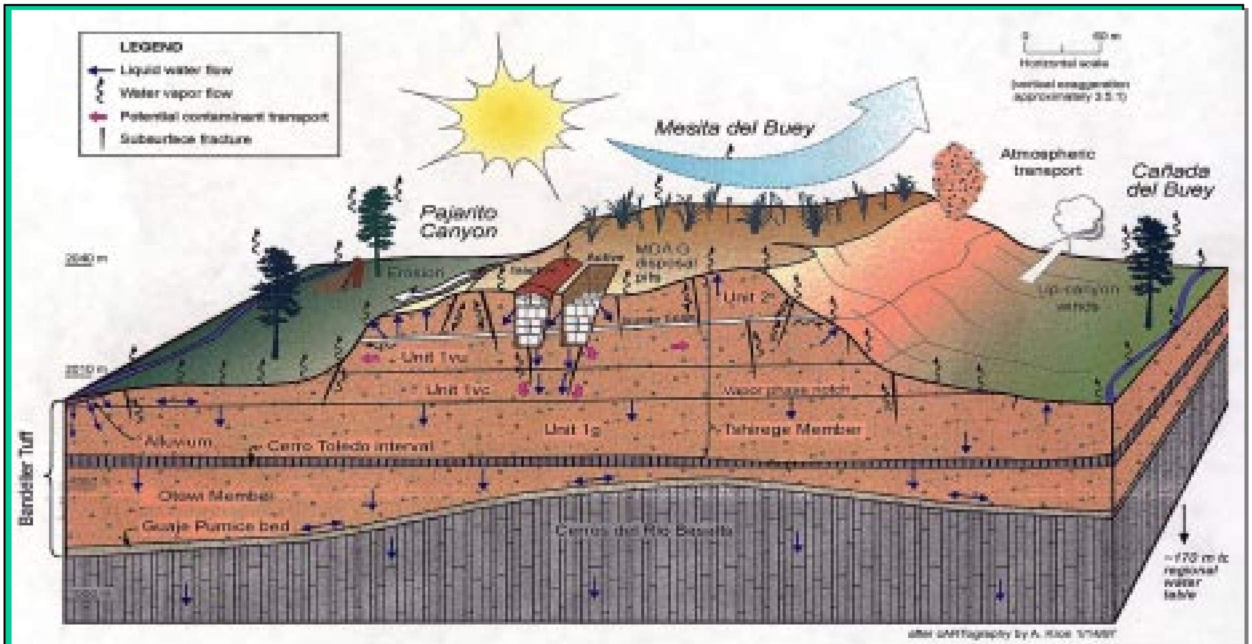
3. Environmental Radiological Dose Assessment



Pathways for movement of contaminants to receptors in the Los Alamos area.

3. Environmental Radiological Dose Assessment

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Abstract

We calculate potential radiological doses to members of the public who may be exposed to Los Alamos National Laboratory (LANL or the Laboratory) operations. To fully understand potential radiological impacts, we calculate the doses to the population nearby, to potentially maximally exposed individuals on- and off-site, and to "average" residents of Los Alamos and White Rock. The population and individual doses include consideration of all potential exposure pathways (primarily inhalation, ingestion, and direct exposure). Our calculations indicate the population within 80 km of LANL received a dose of 1.0 person-rem, which is consistent with most years' doses (person-rem is the quantity used to describe population dose). The calculated maximum off-site radiation dose to a member of the public from Laboratory sources was at East Gate and was 0.55 mrem, which is less than 1% of the Department of Energy (DOE) dose limit of 100 mrem and also well below the level at which health effects are known to occur. This dose is calculated using all exposure pathways to satisfy DOE requirements and is different from the dose presented in Chapter 2, which is calculated for compliance with National Emission Standards for Hazardous Air Pollutants and considers only the dose from the air pathway. The calculated maximum on-site individual exposure to a member of the public is 13 mrem, which compares with 3 mrem in 1999, when the dose was calculated at a different location. This member of the public is a hypothetical individual who walks daily near Technical Area (TA) -3-130, the Calibration Facility at the corner of Pajarito Road and Diamond Drive. This dose would be from direct radiation for which the applicable dose limit is 100 mrem, the allowed dose from all pathways. No health effects would be expected from this exposure. Doses were calculated for ingestion of unit quantities of produce, fish, eggs, deer, elk, and other locally grown or gathered foods. Based on local food growing and consuming habits, there was no significant dose contribution for consuming locally grown/gathered foods during 2000. In fact, the only food products that showed statistically significant radionuclides were nongame fish from reservoirs upstream of potential LANL influence and the bone of elk from a regional background location. Based on sampling of local and regional tap waters, we also concluded that there was no significant dose related to LANL activities from ingesting the tap water in Los Alamos or White Rock.

Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem at high dose rates. We conclude that the doses calculated here, which are in the mrem (one one-thousandth of a rem) range, would cause no human health effects. They are also smaller than or similar to typical variations in the background radiation dose. The total dose from background radiation, greater than 99% of which is from natural sources, is about 360 mrem in this area and can vary by 10 mrem from year to year.

There were public concerns about potential fire-induced exposure to LANL contaminants, during and after the fire. We calculated inhalation doses for several potentially exposed hypothetical individuals during the fire. The fire-related dose increment in each case was small and was caused by increased airborne concentration of natural radionuclides, primarily from the radon decay series. Elevated air concentrations of uranium isotopes of LANL origin were indicated at one AIRNET station in Mortandad Canyon. The dose a worker might have received from this exposure was very small, and the toxicological effects were also calculated to be insignificant. After the fire, exposure pathways besides inhalation may have developed as potentially contaminated sediments could be mobilized by post-fire runoff and redeposited in other areas where human exposures could occur. We evaluated scenarios including residences in canyons downstream of known LANL contamination and for users of the Rio Grande including irrigation, swimming, fishing, and cattle watering. In each case, the doses calculated were small. In fact, the impacts in the Rio Grande appear to be caused by the expected aftereffects of fire, such as ash mobilization and transport, and were not related to LANL operations and legacy wastes in canyons. In other words, most of

the effects we calculated for downstream users would have occurred following a large fire whether LANL had existed or not.

To Read About . . . **Turn to Page . . .**

A. Overview of Radiological Dose Equivalents

Radiological dose equivalents presented here are calculated doses received by individuals exposed to radioactivity or radioactive materials. Radiation can damage living cells because of its ability to deposit energy as it passes through living matter. Energy deposited in the cell can result in cell damage, cell death, and, rarely, cell mutations that survive and can cause cancer. Because energy deposition is how radiation causes cell damage, radiation doses are measured in the quantity of radiation energy deposited per unit mass in the body. Different types of radiation carry different amounts of energy and are multiplied by adjustment factors for the type of radiation absorbed. Radiation affects different parts of the body with different degrees of effectiveness, but we need to report the "effective" dose the whole body has received. The term "effective dose equivalent" (EDE), referred to here as dose, is the "effective" dose calculated to have been received by the whole body, generally from an external radiation source. To calculate this dose, we sum the doses to individual organs or tissues.

Long-lived radionuclides that a body inhales or ingests continue to deposit energy in the body and give doses for a long time after their intake. To account for this extended dose period, we also calculated a "committed effective dose equivalent" (CEDE), also referred to in this report as "dose." The CEDE gives the total dose, integrated over 50 years, that would result from radionuclides taken into the body from short-term exposures. In this report, we calculate CEDEs for radionuclides taken into the body during 2000. The doses we report below include the contributions from internally deposited radionuclides (CEDE) and from radiation exposures received from sources outside the body (EDE) all under the general term "dose."

Federal government standards limit the dose that the public may receive from Los Alamos National Laboratory (LANL or the Laboratory) operations. The Department of Energy (DOE 1990) public dose limit to any individual is 100 mrem per year received from all pathways (i.e., all ways in which people can be exposed to radiation, such as inhalation, ingestion, and direct exposure). The dose received from airborne emissions of radionuclides is further restricted by the dose standard of the Environmental Protection Agency (EPA) of 10 mrem per year, which is codified in the Code of Federal Regulations (40 CFR 61); see Appendix A. These doses are in addition to exposures from normal background, consumer products, and medical sources. Doses from public water supplies are also limited according to the Clean Water Act (EPA 2000). Chapter 2 presents dose calculations performed to comply with 40 CFR 61 (EPA 1986) that are based on different pathways and use different modeling programs than those performed for DOE requirements, which are presented here in Chapter 3.

This chapter reports calculations of potential radiological doses to members of the public. Therefore, we don't present worker doses in this report. Information on LANL worker radiation doses is published quarterly in the report "Los Alamos National Laboratory, Radiological Protection Program, Performance Indicators for Radiation Protection," which can be found in the Community Reading Room (505-665-4400).

B. Public Dose Calculations

1. Scope

The objective of our dose calculations is to calculate and report incremental (above background) doses caused by LANL operations. Therefore, we don't include dose contributions from radionuclides present in our natural environment or from radioactive fallout unless we identify LANL as the direct source for these radionuclides. Our assessments are intended to be realistic but conservative enough to demonstrate with a high degree of certainty that larger doses did not occur. Annual radiation doses to the public are evaluated for three principal exposure pathways: inhalation, ingestion, and external (also referred to as direct) exposure. We calculate doses that the population as a whole within 80 km may have received and also doses to specific hypothetical individuals within that population as shown below.

(1) *The entire population within 80 km of the Laboratory.* We base this modeled dose on all significant sources of radioactive air emissions at LANL. The modeling includes direct exposure to the radioactive material as it passes, inhalation of radioactive material, and ingestion of material that is deposited on or incorporated into vegetation and animal products such as poultry, eggs, and beef.

(2) *The maximally exposed individual (MEI) who is not on LANL/DOE property (referred to as the off-site MEI).* For this calculation, we use the definition of location in 40 CFR 61, which defines the receptor as someone who lives or works at the off-site location. Any school, residence, place of worship, or non-LANL workplace would be considered a potential location for the off-site MEI. Please note that although the definition for the location of this hypothetical individual is taken from 40 CFR 61, the dose calculation we perform here is more comprehensive than the one required for compliance with 40 CFR 61 (as presented in Chapter 2). The calculated dose to the off-site MEI we present here is an "all-pathway" assessment, which includes contributions from air emissions from stack and diffuse sources at LANL, ingestion of food gathered locally, drinking local tap water, exposure to soils in the Los Alamos/White Rock area, and any other significant exposure route.

(3) *The on-site MEI is defined as someone who is in transit through LANL/DOE property but not necessarily employed by LANL.* DOE-owned roads are generally open to public travel. We calculate this dose for a hypothetical member of the public who is exposed while on or near LANL/DOE property.

(4) *An "average" resident of Los Alamos and White Rock.* We used average air concentrations from LANL's Air Monitoring Network (AIRNET) in Los Alamos and White Rock to calculate these doses. To these calculated doses, we add the contributions from other potentially significant sources, which may include the Los Alamos Neutron Science Center (LANSCE) and Technical Area (TA) 18 (LANSCE and TA-18 emissions are not measurable by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in local soils.

(5) *Ingestion doses for various population locations in northern New Mexico from ingestion of food grown (fruits and vegetables) or harvested (deer, elk, beef, and fish) locally.* Because not all food products are available everywhere within the 80-km radius, we do not have a uniform set of ingestion data on which to calculate doses. We report doses for all locations from which food was gathered.

(6) *Special Scenarios.* Each year, we look at a number of special situations that could result in the exposure of a member of the public. This year the Cerro Grande fire necessitated dose calculations for effects that may have been experienced during the fire and also those that may have occurred afterward. We report doses calculated for

- doses during the Cerro Grande fire when inhalation was the important pathway and
- doses related to the Cerro Grande fire, but that were received after it occurred, during the remainder of 2000.

Other scenarios, which we analyzed and reported in previous reports (ESP 1996, 1997, 1998, and 1999), have not changed since that time, and, therefore, were not reanalyzed. For example, in previous reports (ESP 1996, 1997), we modeled potential doses from contaminated sediments in Mortandad, Los Alamos, and Acid Canyons. For previous calculations of potential doses from exposure to contaminated sediments in Mortandad, Los Alamos, or Acid Canyon, please see Chapter 3 of the surveillance reports from the last three years.

2. General Methodology

Our radiological dose calculations follow methodologies recommended by federal agencies to determine radiation doses (DOE 1991, NRC 1977) where possible. However, where our calculations do not lend themselves easily to standard methodologies, we have developed appropriate methods described below. The general process for calculating doses from ingestion or inhalation is to multiply the concentration of each radionuclide in the food product, water, or air by the amount of food or water ingested or air inhaled to calculate the amount of radioactivity taken into the body. Then, we multiply this amount by factors specific to each radionuclide (DOE 1988b) to calculate the dose from each radionuclide. We sum these amounts to give the total dose from each pathway, such as ingestion and inhalation, throughout the year. Where local concentrations are not known but source amounts (amounts released from stacks or from diffuse emission sources) are known, we can calculate the doses at receptor locations using a model. The model combines source-term information with meteorological data to estimate where the radioactive material went. By determining air concentrations in all directions around the source, the model can then calculate doses at any location. The models are also capable of calculating how much of the airborne radioactive material finds its way into nearby vegetation and animal material. We use the Generation II (GENII) model for all dispersion evaluations (Napier et al., 1988) because this is the model DOE has accepted for dose calculation. The following sections provide some of the specifics of the modeling.

The method for calculating direct doses from radiation sources is dependent upon a number of variables including the source of the penetrating radiation, the distribution of source material, the method and parameters of exposure, etc. For example, the exposure rate from direct radiation to a person swimming in contaminated water or "immersed" in contaminated air can be calculated by multiplying the water or air concentration by the appropriate exposure factor(s) for each radionuclide (DOE 1988a). Exposure to radioactive material in soil may be evaluated by performing RESRAD runs based on average radionuclide concentrations in soil. Or, we can perform a calculation to evaluate the exposure rate at a certain distance above the soil (DOE 1988a), or, finally, simplifying equations or exposure factors may be used to evaluate the exposure rates. We can base exposures from a stationary Laboratory source of radiation, such as the Calibration Facility at TA-3-130, on measurements of exposure rates at the point of interest (at the location of a potential receptor). Or, we can evaluate them by using integrating dosimeters such as environmental thermoluminescent dosimeters (TLDs) and environmental neutron dosimeters that are located where a receptor might spend time.

a. Changes/Developments in Ingestion Calculations for 2000. We implemented two significant developments in our ingestion dose calculation process for 2000. We conducted a survey to evaluate local habits for ingestion of food grown or gathered locally, and we collected tap water samples from Los Alamos, White Rock, and surrounding communities to evaluate potential LANL contribution to water ingestion dose near LANL. These changes are described below.

Ingestion of Locally Grown/Gathered Food Products. The Foodstuffs Program of the Ecology Group (ESH-20) collects and analyzes many food products. They present the data annually in these surveillance reports. However, incorporating these data into annual ingestion dose calculations is problematic for several reasons. Among the issues that create difficulty are the following:

- The same foods are not collected each year from a consistent set of locations; therefore, using the full set of foods collected each year would give inconsistent results from year to year.
- To be consistent from year to year, we should assume the same ingestion rates for each food type each year. But, there is much variability of ingestion habits among our varied local populations.
- "Average" local ingestion habits may be quite different from tabulated values.
- Ingestion values are not available for some of the foods collected locally.

We are required to include all significant dose contributors in the all-pathway dose calculations presented below. Therefore, we needed to assess which of the locally grown/gathered food types might be a significant part of the local average diet and, if contamination were present in these foods, would be a significant dose contributor.

During 2000, we conducted a survey to ascertain how much of local people's diet was of foods that were grown or gathered locally. By locally, we mean within the presumed range of influence of LANL operations, past and present. Our survey was distributed to all members of the Air Quality Group (ESH-17) and ESH-20, and we compiled the responses from 34 completed surveys. We believe the responses are representative of the Los Alamos/White Rock populace and plan to do additional surveys to broaden our data base. We asked questions about fruit, garden produce, deer/elk, fish, honey, eggs, milk, chicken, and wild foods such as mushrooms and berries. Our two objectives were to determine how much of these food types were produced locally and how much of the average resident's diet was made up of these locally grown or gathered foods.

Following are our conclusions for each food type:

Fruit—About 70% of local residents reported having fruit trees that provide them fruit at some time. Estimates based on individual habits, on the frequency of fruiting, and on the duration over which fruit is consumed during a year that fruit is obtained indicate that about 10% of the fruit consumed locally is grown locally.

Produce—We found that about 50% of the survey respondents raised gardens and that about 10% of the produce local residents consumed was raised in their gardens.

Deer/Elk—About 10% of the respondents reported consuming deer or elk that were hunted within 10 miles of LANL. They hunt successfully about once in three years, and when they have deer or elk available, it is a large proportion of the red meat they consume. However, because of the small percentage of local residents that consume their own locally gathered deer or elk, such deer and elk appear to make up only about 2% of the average local diet of red meat.

Fish—Less than 1% of the fish consumed locally were collected from the Rio Grande or Cochiti Reservoir.

Honey—Less than 20% of the respondents indicated that they eat local honey. However, consumers of local honey do not tend to supplement that with honey purchased elsewhere. About 15% of the honey consumed locally is derived from local hives.

Eggs/Milk/Chicken—Well under 10% of the locally ingested eggs, milk, and chickens were produced locally.

Wild Foods—These are foods that can be collected within this area and include nuts, berries, currants, mushrooms, etc. About 5% of the total local ingestion of these types of foods is collected locally.

We believe that a food type represents a potentially significant exposure pathway to an average resident only if it is detected above background concentrations, if a significant fraction of the local residents consume that locally grown/gathered food (as opposed to purchased from stores or out-of-area merchants), and if the annual dose from ingesting that food type at average rates was greater than 0.1 mrem. If foods met these criteria, we would have calculated a dose based on average ingestion rates and added it to the total doses for appropriate receptors. Based on our survey, we concluded that locally grown or gathered food products don't constitute a significant fraction (we used 30% as the significance cutoff) of the local diet. Because of the small percentages of foods consumed from local sources and the very small radionuclide content of these foods, there was a not a significant dose contribution to average residents from ingestion of these foods in 2000.

Water Ingestion Evaluation. Before 2000, our evaluation of the dose from drinking water relied on samples from the deep production wells. To make the sampling more representative of water actually consumed, we led a sampling effort during 2000 to collect tap water samples from residences and public places in Los Alamos, White Rock, and regional locations. We used the regional values to assess whether local water had higher concentrations of radionuclides of LANL origin so that we could calculate doses based on any elevated concentrations. We collected tap water samples from ten locations each in Los Alamos, White Rock, and surrounding communities (Pojoaque, Chimayo, Española, Jemez, Santa Fe, and El Rito). Detection limits were low enough to be able to assess any concentrations that could provide a significant dose (we define significant as greater than or equal to 0.1 mrem). We found that the concentrations of radionuclides besides uranium are the same in Los Alamos, White Rock, and regional locations down to the levels of detection we were using. We concluded that there is negligible radiological dose impact from any of these radionuclides. Uranium concentrations were low in Los Alamos, White Rock, and El Rito but were elevated at several locations in the valley and in Santa Fe. Localized variations are to be expected as they are caused by natural differences in local geology and groundwater chemistry. Two locations in the valley and one in Santa Fe were above the new EPA drinking water standards, which are based on rabbit kidney toxicity, not radiologic effects.

b. Free Release of Personal and Real Property. The Laboratory frequently releases personal property to the general public as surplus items. The requirements for release of such property are found in Laboratory Implementation Requirements LIR—402-

700-01.0, "Occupational Radiation Protection. Chapter 14, Part 3. Releasing Items," and they follow the policies for free release of personal property described in DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). These requirements follow the authorized limits stated in Figure IV-1 of that order for residual surface contamination of released property. In keeping with the principle of maintaining radiation dose levels to "As Low As Reasonably Achievable," it is general Laboratory policy to not release any property showing residual radioactivity that is considered to Laboratory added. Therefore, there is no additional dose to the general public through the release of personal property for uncontrolled use by the general public.

Procedures for free release of real property also follow the policies outlined in DOE (1993, Chapter IV). In accordance with this order, DOE Albuquerque has adopted a procedure for the release of real property containing residual radioactivity (DOE 2000a). The DOE Albuquerque typically sets an Authorized Release Limit of 15 mrem/yr for real property. To date, no real property at Los Alamos has been released to the general public under these procedures. Future land ownership transfers will be evaluated under the requirements of this procedure and meet requirements before they can be implemented.

C. Dose Calculations and Results

Explanation of Reported Negative Doses. Because the concentrations of radionuclides are extremely low in most environmental samples, it is common that the analytical laboratory that performs the analyses will report some of these concentrations as negative values—which should be expected when very small concentrations are being analyzed. In fact, if all of our samples truly contained zero radioactivity, about half of our analyses would show positive numbers, about half would show negative results, and a few would actually show zero.

In Environmental Surveillance at Los Alamos reports before 1997, we carried these negative concentrations through all calculations, but then, if the calculated dose was less than zero, we reported it as zero. Starting in 1997, and continuing with this report, we report doses exactly as calculated based on analytical results. Therefore, you will see that some of the reported doses are less than zero. Obviously, a person could not receive a negative dose, and it may seem incorrect to report these numbers. However, many of the positive numbers we report are also not meaningfully positive. By reporting all of the calculated doses here, whether negative or positive, and using all these data over a period of years, it is possible to evaluate doses to individuals more accurately.

Many of the doses reported also include a number in parentheses. This number is one standard deviation of the dose. It means that approximately 67% of the dose values lie within the dose plus or minus one standard deviation. A large standard deviation means there is much uncertainty in the reported dose.

Explanation of Uncertainty in Calculated Doses. Where we report doses, we attempt to quantify the amount of uncertainty in the reported value. Some of the uncertainty is easily quantifiable. For example, the analytical laboratory that reports the activity for air and water samples (upon which some dose calculations are based) also reports the uncertainty in the result. The uncertainty reported by the lab is termed propagated error because it includes all identified uncertainties in the analytical process. Other uncertainties, such as those associated with the field sampling activities that gathered the air or water sample, are more difficult to quantify. In the case of air samples, there are several field measurements that are needed to calculate air concentrations. The measurement devices and manual reading of analog scales also have associated uncertainties. We believe that these are generally not quantifiable but that errors of this type tend to be random. In other words, one reading may be slightly high and the next one a little low such that over time the differences cancel each other out.

Other uncertainties are introduced with various models and computer programs we use to evaluate atmospheric dispersion and human dose. For example, we use GENII to evaluate atmospheric dispersion and, for the population dose, to calculate a dose based on all potential pathways of exposure. Every step of this process has large elements of uncertainty that are not quantified. For example, GENII uses certain consumption rates that are not verified for accuracy in this area. In fact, we can be sure that the consumption rates that are used are not representative of all those in the population for which the rates are assumed. For these types of parameters, we try to choose values that are reasonably realistic but that tend to be conservative so that we err on the side of overestimating doses. Thus, although we cannot quantify all the uncertainty associated with the doses we report, we believe we can conclude with a high degree of certainty that actual doses were lower than those reported here.

1. Dose to the Population within 80 km

We used the local population distribution to calculate the dose from Laboratory operations during 2000 to the population within 80 km (50 miles) of LANL (Figure 3-1). Approximately 264,000 persons live within an 80-km radius of the Laboratory. We used county population estimates for 1999 provided by the University of New Mexico Bureau of Business and Economic Research (BBER). These statistics are available at *http://www.unm.edu/~bber/*.

The collective EDE (or dose) from Laboratory operations is the sum of the estimated dose each member of the population within an 80-km radius of LANL received. The population dose from each facility is calculated using that facility as the center of a ring with an 80-km diameter. The dose calculation does not include those working on-site. It is intended to calculate doses to residents at their homes. Because this dose results from airborne radioactive emissions, we estimated the collective dose by modeling the transport of radioactive air emissions.

We calculated the collective dose with the GENII collection of computer programs (Napier et al., 1988). The analysis included airborne radioactive emissions from all types of releases. Stack emissions were modeled from all monitored stack sources. We also included diffuse emissions from LANSCE and Area G in the modeling. We used air concentration data from the nine AIRNET stations at Area G to calculate the diffuse emission source term from Area G. The exposure pathways included inhalation of radioactive materials; external radiation from materials present in the atmosphere and deposited on the ground; and ingestion of radionuclides in meat, produce, and dairy products.

We calculated the 2000 collective population dose attributable to Laboratory operations to persons living within 80 km of the Laboratory to be 1 person-rem (person-rem is the quantity used to describe population dose), which compares with the population dose of 0.3 person-rem reported for 1999 (ESP 2000) and 0.8 person-rem for 1998 (ESP 1999). Figure 3-2 shows the different contributors to the population dose. Short-lived air activation products such as carbon-11, nitrogen-13, and oxygen-15 that the accelerator at LANSCE creates contributed about 7% to the calculated population dose. This amount is more than last year, when LANSCE operated very little, but it is consistent with earlier years when LANSCE operated more. Diffuse emissions of uranium, plutonium, and tritium from Area G were about 2% of the dose, and tritium from stack sources was about 91% of the dose. Plutonium, uranium, and americium from stack sources contributed less than 1% of the dose.

2. Dose to Maximally Exposed Individual Not on Los Alamos National Laboratory Property (Off-Site MEI)

The location of the off-site MEI (a hypothetical member of the public who, while not on DOE/LANL property, received the greatest dose from LANL operations) has traditionally been at East Gate along State Road 502 entering the east side of Los Alamos County. East Gate is normally the location of greatest exposure because of its proximity to LANSCE. During experimentation at LANSCE, short-lived positron emitters are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential external radiation dose. During 1999, LANSCE operated much less than in previous years, the dose from LANSCE was very small, and East Gate was not the site of the off-site MEI. In 2000, LANSCE operations increased such that once again East Gate was the location of the off-site MEI.

Because many of the emissions from LANSCE are too short-lived for our AIRNET system to measure, we model the dose from LANSCE using GENII, an atmospheric dispersion and dose calculation computer code (Napier et al., 1988). To the dose modeled with GENII, we add the dose calculated from AIRNET results (to incorporate other LANL air emission sources) and modeled doses from TA-18 (if they are significant), whose emissions cannot be measured by AIRNET. We add the contribution from ingesting food grown or gathered locally, from drinking local tap water, and from living on contaminated soils in the vicinity (even though nobody actually lives at the location of these soils) if such doses were significant.

We also calculated the net dose received from direct exposure to, and ingestion of, contaminated soils in the Los Alamos/White Rock area. Analyses from all soil samples from the entire area in or near Los Alamos and White Rock were combined to estimate average soil concentrations in this area. We used these average soil concentrations (Table 6-1) as

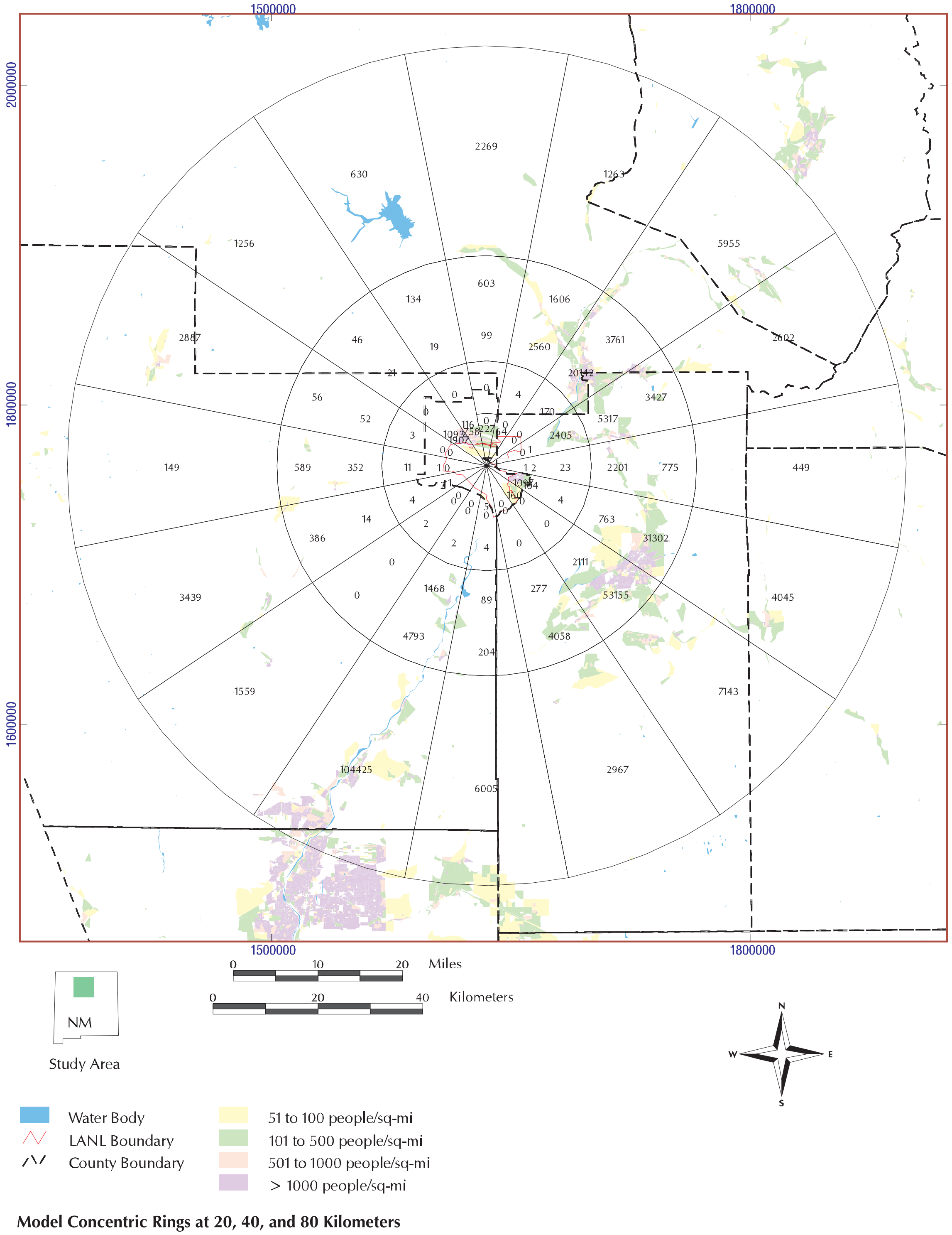

Figure 3-1. Estimated population around Los Alamos National Laboratory.

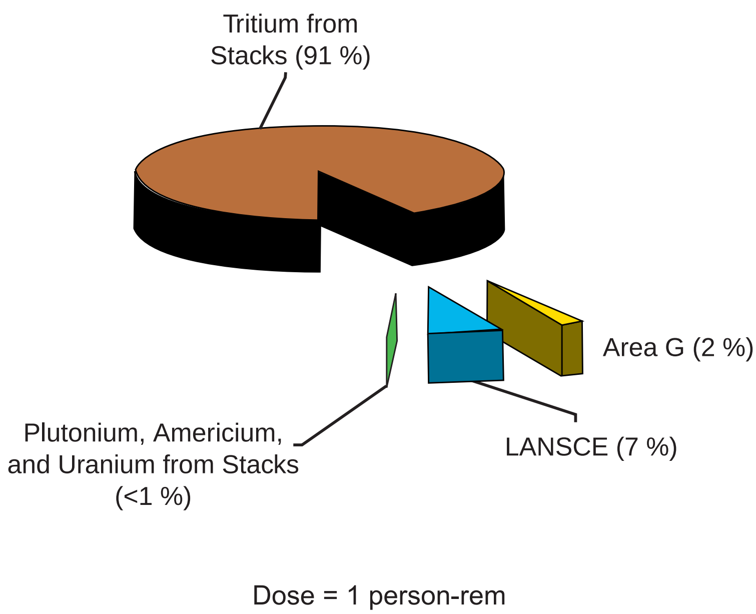

Figure 3-2. LANL contributions to population air pathway dose from Laboratory sources.

input to the RESRAD computer model Version 5.82 (Yu et al., 1993) to calculate the dose from gross (no background subtraction) soil concentrations. We calculated the net dose by subtracting the dose from background soil concentrations from the dose from gross concentrations and compared the doses calculated with those from exposure to background soils from the Embudo, Cochiti, and Jemez areas. We used a simplified version of the residential scenario, originally developed by Fresquez and others (1996) in RESRAD, to estimate the EDE from external radiation and the CEDE from internally deposited radiation. The primary simplification was that the modeling performed here did not consider horizons other than the surface zone from which the soil samples were taken (Table 3-1). The rationale behind the decision to not include the plant or drinking water ingestion or soil inhalation pathways here is that they are evaluated through direct measurement of these media.

Our intent with these calculations is to evaluate the potential exposure contribution from past or present LANL operations. Because uranium-238 is the source for atmospheric radon-222, uranium from LANL could be a source for atmospheric radon gas. However, uranium-238 has a half-life of several billion years and must decay through several long-lived radionuclides before radon is produced. Therefore, any Laboratory-produced uranium that was deposited in the soil will be producing negligible amounts of radon. For this reason, we do not include the radon pathway.

We found the net dose from soils and one standard deviation for Los Alamos/White Rock area to be 0.14 (0.4) mrem. The background dose was 0.26 (0.3) mrem. The dose summary (Table 3-2) includes the Los Alamos/White Rock doses. They are also added to the dose to an average member of Los Alamos or White Rock from other pathways or sources as described below. These doses are similar to the doses reported last year (within the range of uncertainty), as would be expected in the absence of any large-scale ground-contaminating event.

Figure 3-3 shows that the combination of the AIRNET calculated dose of 0.008 mrem, the GENII modeled doses of 0.4 and 0.00004 mrem (from LANSCE and TA-18, respectively), the food and water ingestion dose of 0 mrem, and the soils dose of 0.14 mrem give a total off-site MEI dose of 0.55 mrem (Table 3-2). This level is far below the applicable 100-mrem standard, and we conclude these doses would cause no human health effects.

This dose is not comparable directly with the doses reported in Chapter 2, which are calculated for compliance with 40 CFR 61. The Chapter 2 dose includes only the air pathway and is modeled using a different computer model, CAP88, as required by 40

Table 3-1. RESRAD Input Parameters for Soils Exposure Evaluation for 2000

Parameter	Value	Comments
Area of contaminated zone	10,000 m^2	RESRAD default value; a large area maximizes exposure via external gamma, inhalation, and ingestion pathways
Thickness of contaminated zone	3 m	Based on mesa top conditions (Fresquez et al., 1996)
Time since placement of material	0 yr	Assumes current year (i.e., no radioactive decay) and minimal weathering
Cover depth	0 m	Assumption of no cover maximizes dose
Density of contaminated zone	1.6 g/cm^3	Based on previous models (Buhl 1989) and mesa top conditions (Fresquez et al., 1996)
Contaminated zone erosion rate	0.001 m/yr	RESRAD default value
Contaminated zone total porosity	0.5	Average from several samples in Mortandad Canyon (Stoker et al., 1991)
Contaminated zone effective porosity	0.3	Table 3.2 in data handbook (Yu et al., 1993)
Contaminated zone hydraulic conductivity	440 m/yr	An average value for soil (not tuff) (Nyhan et al., 1978)
Contaminated zone b parameter	4.05	Mortandad Canyon consists of two units, the topmost unit being sand (Purtyman et al., 1983) and Table 13.1 in the data handbook (Yu et al., 1993)
Humidity in air	4.8 g/m^3	Average value from Los Alamos Climatology (Bowen 1990)
Evapotranspirations coefficient	0.85	Based on tritium oxide tracers in Mortandad Canyon (Penrose et al., 1990)
Wind Speed	2 m/s	RESRAD default value
Precipitation	0.48 m/yr	Average value from Los Alamos Climatology (Bowen 1990)
Irrigation rate	0 m/yr	Water in Mortandad Canyon is not used
Runoff coefficient	0.52	Based on mesa top conditions (Fresquez et al., 1996)
Inhalation rate	8,400 m^3/yr	RESRAD default value
Mass loading for inhalation	9 ¥ 10^{-5} g/m^3	Phermex (OU 1086) Risk Assessment for respirable particles
Exposure duration	1 year	Assumes current year exposure only
Dilution length for airborne dust	3 m	RESRAD default value
Shielding factor, inhalation	0.4	RESRAD default value
Shielding factor, external gamma	0.7	RESRAD default value
Fraction of time spent indoors in study area each year	0.5	RESRAD default value
Fraction of time spent outdoors in study area	0.25	RESRAD default value
Shape factor	1	Corresponds to a contaminated area larger than a circular area of 1,200 m^2
Depth of soil mixing layer	0.15 m	RESRAD default value
Soil ingestion rate	44 g/yr	Calculated based on 100 mg/d for 24 yr (adult) and 200 mg/d for 6 yr (child) (Fresquez et al., 1996)

Table 3-2. Summary of Doses to Various Receptors in the Los Alamos Area for 2000

	Receptors			
Sources	**Off-Site MEI East Gate (mrem)**	**On-Site MEI Diamond Drive & Pajarito Road (mrem)**	**LA Average Resident (mrem)**	**WR Average Resident (mrem)**
LANSCE[a]	0.4	0.002	0.002	0.003
TA-3-130	0	13	0	0
Ambient Air[b]	0.008	0.008	0.008	0.002
Food Stuffs Ingestion[c]	0	0	0	0
Well Water Ingestion[d]	0	0	0	0
Soils Exposure[e]	0.14	0.14	0.14	0.14
Total	0.55	13	0.15	0.15

[a] These doses are modeled using GENII.
[b] These doses are calculated based on data from AIRNET stations in these areas. The calculations include background subtraction. The dose at the intersection of Pajarito Road and Diamond Drive assumes that the receptor is an average Los Alamos resident.
[c] Calculated from ingestion of foods grown or gathered locally.
[d] Based on sampling and analyses of tap water samples from Los Alamos, White Rock, and regional locations.
[e] These doses are modeled with the RESDRAD Code 5.82 using radionuclide data from local soil concentrations.

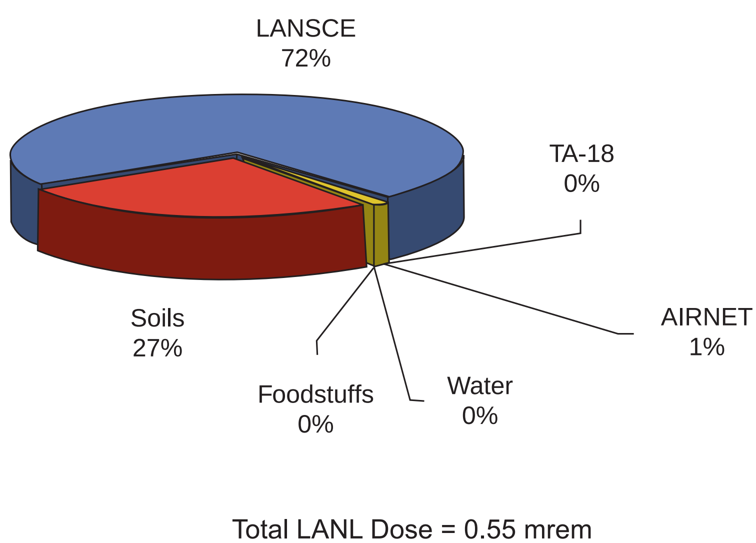

Figure 3-3. LANL contributions to maximally exposed off-site hypothetical individual during 2000.

CFR 61. The dose presented here is for all pathways and uses the DOE GENII computer code.

3. Dose to Maximally Exposed Individual on Los Alamos National Laboratory/Department of Energy Property (On-Site MEI)

Several years ago, in addition to calculating a dose for the maximally exposed off-site individual, we began including a calculation for the maximally exposed on-site individual. This receptor is described as a member of the public (who may also be a LANL employee but is not on official business at the time of exposure) who passes near enough to LANL facilities to be exposed. For the past few years, we calculated doses to individuals passing the Critical Assembly Facility at TA-18, believing this to be the site of maximum potential exposure. During 1999, we completed a review of all sources of direct penetrating radiation at LANL. As a result of that review, we identified sources that should be monitored. Monitoring began in January 2000 and indicated that, near an instrument calibration facility (TA-3-130) at the intersection of Diamond Drive and Pajarito Road, exposures to members of the public could be higher than those calculated near TA-18.

Dosimeters that were sensitive to the neutron and photon radiation from the calibration facility were located on the fence that surrounds the facility, along the sidewalk at the intersection of the two roads. We collected data continuously throughout 2000, and these data allowed us to calculate doses that might have been received by people walking by the calibration facility. The most likely recipients of dose from the calibration facility (other than those working in the facility) are LANL workers at TA-59 and other facilities nearby who walk or jog by TA-3-130 during nonwork (lunchtime) activities. After subtracting background exposure rates, we multiplied the total integrated photon and neutron dose by 1/16 to account for occupancy (NCRP 1976). This calculation indicates a dose of 13 mrem to a member of the public during 2000.

The calculation described above is quite conservative because assuming a 1/16 occupancy factor for a facility that can operate anytime day or night means that we are assuming a receptor is at that location 90 minutes per day every day of the year. Instead, people walk or run by the facility and normally spend no more than a minute or two nearby. People are rarely in this vicinity during nonwork hours. We report this dose as a conservative upper bound of the doses that might have been received by people passing near this facility frequently.

Assuming that the hypothetical member of the public exposed near the calibration facility was an average resident of Los Alamos during 2000, the dose from food and water ingestion, from LANSCE operation, and from exposure to contaminated soils and air would add to the dose from TA-3-130. These doses are shown in Table 3-2 and in Figure 3-4. The total calculated dose to this hypothetical resident of Los Alamos would be about 13 mrem (all other

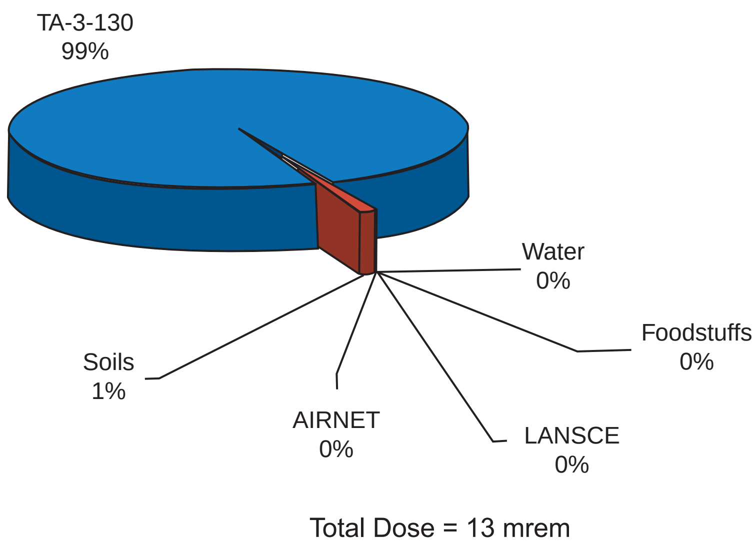

Figure 3-4. LANL contributions to maximally exposed on-site hypothetical individual during 2000.

pathways add less than 1 mrem to the calculated dose from TA-3-130). This dose is about 13% of the DOE public all-pathway dose limit of 100 mrem.

Because we had not previously evaluated TA-3-130 as a source for potential public exposure before the current surveillance report, we have not reported doses from this facility in previous reports. The sources used at TA-3-130 experience radioactive decay and become weaker over time. Therefore, even if we assume the same hours of operation and exposure times, the potential public doses are not constant from year to year. A new neutron source was installed in 1996, and because the source strength is greatest when the source is new, this was presumably the year of greatest exposure at the fence. We calculated doses back to 1996 based on the following assumptions:

- The gamma source was in use 300 hours each year.
- The neutron source was in use 500 hours each year.
- An occupancy factor of 1/16 (an individual was at the exposure location 1.5 hours per day, each day of the year).

The exposure rates at the fence were calculated based on current measurements and corrected for radioactive decay of the sources. To compare to the DOE 100-mrem dose limit, we calculate all-pathway doses. The sources or measurements and their doses for the past 5 years are provided in Table 3-3.

The greatest exposures from TA-3-130 occurred during 1997 because the new neutron source was only in use during the last few months of 1996. Direct comparison among years is hampered by changes in the way some of the doses were calculated, but general conclusions are possible. Our primary conclusion is that contributions from pathways other than direct radiation from TA-3-130 contributed little to past doses. These exposures are all below the DOE's 100-mrem per year limit to a member of the public for exposure from all exposure pathways (DOE 1990). Exposures from this facility decline as the neutron source strength decreases and are expected to continue to decline as long as the existing sources are in use. The calibration facility is being moved to a location more remote from public access. Irradiation activities at the current facility are expected to be discontinued there and transferred to the new facility by late 2001.

4. Doses to Average Residents of Los Alamos and White Rock

We calculated doses to average residents of Los Alamos and White Rock based on average air concentrations (as determined from AIRNET data) in these areas. To these calculated doses, we added the contributions from LANSCE (some radionuclides emitted from LANSCE are not measurable by AIRNET), from ingestion of local food products and water, and from exposure to radionuclides in soil. In years before 1997, the Laboratory's annual environmental surveillance report only included doses from LANSCE and those calculated from AIRNET data in estimating average doses to Los Alamos and White Rock residents. Therefore, the doses reported here are not directly comparable with those earlier estimates of

Table 3-3. Calculated Contributions to All-Pathway Dose for Past 5 Years Near TA-3-130

	Pathway or Source							
Year	**TA-3-130**	**LANSCE**	**^{41}Ar from TA-18**	**Air Pathway**	**Soil Exposure**	**Drinking Water**	**Food Ingestion**	**Total Dose**
1996[a]	14	0.2	not calculated	0.05	0.8	0	[b]	15
1997	23	0.011	7.60E-06	0.023	0.16	0.49	0.31	24
1998	19	0.006	2.30E-06	0.062	0.1	0	–0.097	19
1999	16	0.00045	5.30E-06	–0.039	0.33	0.25	0.037	17
2000	13	0.0018	not calculated	0.008	0.14	0	0	13

[a] With the exception of the TA-3-130 dose, the doses for 1996 were calculated with very different methods than those used for later years and are not comparable to those years.
[b] This dose is included in "Soils Exposure."

average doses in Los Alamos and White Rock. This year, we did not include dose from emission of argon-41 at TA-18 because earlier calculations have shown this source to be insignificant compared to the total dose.

a. Los Alamos Dose. The total LANL contribution to the dose to an average resident of Los Alamos during 2000 was 0.15 mrem from all pathways (Table 3-2). Figure 3-5 shows the various Laboratory contributions to this dose. The remainder of this section explains what contributed to this calculated dose.

We compiled air concentration data for uranium, plutonium, americium, and tritium from stations #4 (Barranca School), #5 (Urban Park), #6 (48th Street), #7 (Shell Station), #8 (McDonalds), #9 (Los Alamos Airport), #10 (East Gate), #12 (Royal Crest Trailer Court), #60 (Los Alamos Canyon), #61 (Los Alamos Hospital), and #62 (Trinity Bible Church). The inhalation dose we calculated from the Los Alamos AIRNET data is 0.008 mrem and includes a subtraction of background air concentrations. The dose does not include a contribution from uranium isotopes because, based on evaluation of the ratio of uranium isotopes 234 and 238, we measured only natural uranium in the ambient air. Because no significant LANL-derived uranium was measured, uranium was not included in the dose.

Because AIRNET does not measure most of the radioactive emissions from LANSCE, we modeled the dose from these emissions to a central point in Los Alamos using the GENII computer code. Exposure to the radioactive plume as it passed was the only significant pathway. We calculated the dose to a typical Los Alamos resident to be 0.002 mrem from LANSCE (Table 3-2).

As discussed earlier, the dose calculated from exposure to contaminated soil in Los Alamos is 0.14 mrem. Because the one-standard-deviation value associated with this dose is 0.4 mrem, the net dose most likely lies within a range that includes zero.

We evaluated ingestion of locally grown or gathered food and concluded that it would not provide a significant dose to an average member of Los Alamos or White Rock/Pajarito Acres. We therefore report the dose from ingestion of food gathered or grown in the Los Alamos area and consumed by locals to be 0 mrem (Table 3-2).

As described above, we found no evidence in local tap water that LANL operations had increased radionuclide concentrations in the local water supply in amounts that could result in a significant (greater than or equal to about 0.1 mrem) dose. We report the 2000 water ingestion dose as 0 mrem.

Summing all the possible contributors results in a total dose to an average Los Alamos resident of 0.15 mrem. This calculated dose derives almost entirely from soil exposure, which, as described above, has a large uncertainty of 0.4 mrem. This uncertainty indicates that the dose calculated is statistically indistinguishable from zero.

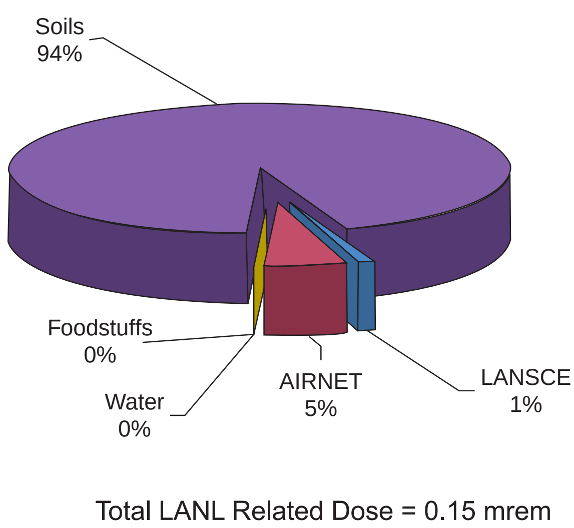

Figure 3-5. LANL contributions to an average Los Alamos resident's radiological dose in 2000.

b. White Rock Dose. The total dose from all pathways to an average resident of White Rock from Laboratory operations was 0.15 mrem in 2000. The methodology for calculating the White Rock dose was identical to that used for Los Alamos. We used the following AIRNET stations to calculate average White Rock air concentrations: #13 (Rocket Park Tennis Courts), #14 (Pajarito Acres), #15 (White Rock Fire Station), #16 (White Rock Church of the Nazarene), and #63 (Monte Rey South). The net air inhalation dose calculated from these data is 0.002 mrem. The dose contribution from LANSCE operations in 2000 was 0.003 mrem, and the contribution from living on local soils was 0.14 mrem (Table 3-2). Ingestion of locally grown or gathered foods and of local tap water was concluded to have zero measurable dose attributable to LANL operations. Summing all the possible contributors results in a total dose to an average White Rock resident of 0.15 mrem. As described for the average Los Alamos resident, this dose is statistically indistinguishable from zero.

5. Ingestion Doses for Various Locations in Northern New Mexico

We collected and analyzed many different types of food products for their radionuclide content. Doses from ingesting unit quantities of these foods are calculated (Table 3-4) for regional background concentrations (foods that were grown or gathered distant from LANL and are presumed to reflect concentrations not affected by LANL operations) and for net concentrations at all other locations. We calculated net concentrations by subtracting background concentrations from those at the location of interest. The general process for calculating ingestion doses is to multiply the amount of each radionuclide ingested in a food product by a dose conversion factor for that radionuclide (DOE 1988b). The uncertainty of one standard deviation, reported in the second column (Table 3-4), is the analytical uncertainty.

Statistically significant doses were seen for consumption of bone from an elk collected distant from LANL and from nongame fish upstream from drainages potentially affected by LANL. By significant, we mean that the uncertainty in the measurements (which is shown in parentheses) is smaller than the measured number and that the measured number is positive. When the uncertainty range includes zero (i.e., when the reported number minus the uncertainty is less than zero), then the number itself is not different from zero in a statistically significant sense.

Although some locally grown/gathered food types may not meet our criterion of providing a significant fraction of the local average diet, they may be consumed by certain individuals in significant amounts. For example, although fish from Cochiti make up an insignificant fraction of the fish consumed locally, they may be consumed in greater proportion by individuals in the Cochiti locale. To allow individuals to evaluate their potential doses from consuming local food products, we calculated the dose a person would receive from ingesting a unit (pound, gallon, or liter, as appropriate) amount of each food. Individuals can calculate their individual doses by multiplying the amount they consume (in appropriate units) by the unit dose amounts provided in Table 3-4.

6. Special Scenario

a. Inhalation Dose during the Cerro Grande Fire. During the Cerro Grande fire, people who remained in Los Alamos to protect homes or fight fires were exposed to the smoke that could potentially have carried contaminants from LANL sites. We calculated three doses for those potentially exposed during the fire: to the hypothetical maximally exposed firemen or volunteer who was working actively in the Los Alamos area throughout the worst of the burn duration, to the maximally exposed member of the public outside Los Alamos, and to a fireman or other worker in the vicinity of AIRNET station #23 in Mortandad Canyon where elevated levels of LANL-derived airborne uranium occurred during the peak of the fire. A more detailed analysis of potential inhalation doses is available (see Kraig et al., 2001).

The data for the inhalation calculation were those available as of December 2000, collected by ESH-17's AIRNET system. In addition to the analyses performed routinely for uranium isotopes, plutonium isotopes, americium-241, and tritium, we analyzed some of the samples taken during the fire for polonium-210 and lead-210. We evaluated lead and polonium because of the likelihood that increases in gross alpha and gross beta activity during the fire may have resulted from increased atmospheric suspension of these and other radionuclides in the natural radon-222 decay series. As radon gas decays in the atmosphere, its decay products attach to particles in the air, many of which deposit on plants and the soil. Because most of these particles are attached to vegetation or

Table 3-4. Ingestion Doses from Foods Gathered or Grown in the Area during 2000

	Dose per Unit (mrem)	1s[a] (mrem)
Deer		
Regional Background near LANL	**0.00036/lb muscle**	**0.00020**
	0.038/lb bone	**0.0044**
	0.00032/lb muscle	0.00033
	0.000023/lb bone	2.5
Elk		
Regional Background near LANL	0.00060/lb muscle	0.00065
	0.062/lb bone	**0.041**
	–0.00012/lb muscle	0.00071
	0.033/lb bone	0.042
Fish		
Game Fish Background	–0.000024/lb	0.00028
Game Fish Cochiti	0.00036/lb	0.00057
Nongame Fish Background	**0.0010/lb**	**0.00037**
Nongame Fish Cochiti	–0.00050/lb	0.00081
Goat's Milk		
Regional Background	0.00052/L	0.0021
White Rock	–0.00047/L	0.0027
Honey		
Regional Background	–0.000073/lb	0.0018
Los Alamos	–0.000088/lb	0.0018
White Rock	0.00018/lb	0.0018
Prickly Pear		
Regional Background	**0.0088/lb**	**0.0010**
Los Alamos	**0.0040/lb**	**0.0015**
White Rock	–0.0038/lb	0.0012
San Ildefonso	**0.0050/lb**	**0.0015**
Produce		
Regional Background	**0.00044/lb**	**0.00023**
On LANL	–0.00015/lb	0.00028
Los Alamos	0.000074/lb	0.00029
White Rock	0.00000044/lb	0.00033
Cochiti	0.000087/lb	0.00040
San Ildefonso	–0.00012/lb	0.00026

[a] This one standard deviation (1s) of the reported dose. Positive doses that have an associated 1s that is less than the dose are considered to be statistically significant (at the 1s level) and are indicated by bold text.

soil, most are not normally seen in our air sampling results. However, the heat and turbulence associated with the fire were very effective at stripping radioactive elements from the surfaces of vegetation and soil, as well as incinerating the vegetation and soil on which the radionuclides were located. These products of radon decay became airborne and probably caused most of the large increases in alpha and beta air concentrations during the Cerro Grande fire.

To calculate radiological dose from air contaminants, air concentrations at the location of the hypothetical receptor, the duration that these concentrations were inhaled, and the breathing rate during that time must be known or assumed. We assumed a breathing rate of 2.5 m^3 h^{-1} for all receptors (except for children), which is consistent with an adult male doing moderate work (EPA 1989). We used air concentrations derived from air sampling during the fire—primarily between May 9 and May 13. These samples provided concentrations of polonium-210, lead-210, plutonium-238, plutonium-239, -240, americium-241, uranium-234, uranium-235, uranium-238, and tritium at selected locations around LANL and Los Alamos County.

Maximally Exposed Person within the Los Alamos Area. These calculations (see Table 3-5) considered the dose contributions from naturally occurring radionuclides, such as uranium and those in the radon decay chain, and from potentially LANL-derived radionuclides including plutonium, uranium, and americium. Measured concentrations of radionuclides in the natural radon-222 decay series were approximately 1,000 times greater than those potentially of LANL origin.

The greatest measured radionuclide concentrations that occurred in public areas were in the western area of Los Alamos town site between May 9 and May 11. After that time, concentrations decreased as the fire center moved north. We calculated doses assuming that an individual worked in the western area for 60 hours because discussions with officials from the Los Alamos Fire Department indicated that no individual could have been in that area for more than 60 hours during that period.

Because of the short sampling times during the fire, the uncertainties associated with the plutonium and americium analyses were very large compared with the calculated concentrations. If the uncertainty of a number is larger than the number itself, the number is generally not considered quantitative. For the sake of conservatism regarding potential LANL contributions during the fire, we used the calculated concentrations for plutonium-238, plutonium-239, -240, and americium-241 in the Los Alamos area during the peak of the fire to calculate a dose. For each nonnatural radionuclide (plutonium-238, plutonium-239, -240, and americium-241), we averaged the values at each of 12 AIRNET stations in the Los Alamos area for the peak fire period. Because of the very large uncertainty of any single concentration value for these radionuclides, averages were used because they are better estimates with less uncertainty than individual values. Based on averages for these radionuclides for the three-year period 1997–1999 at these same stations, we subtracted background values for each radionuclide. Total (gross) doses for polonium, lead, and bismuth are reported because background values are not available for AIRNET stations.

Table 3-5. Dose to Maximally Exposed Individual in Los Alamos during the Cerro Grande Fire

LANL-Derived Radionuclides	Net Dose (mrem)		Natural Radionuclides	Gross Dose (mrem)	
^{241}Americium	–0.0028	(0.005)	^{210}Polonium	0.14	(0.005)
^{238}Plutonium	0.00053	(0.002)	^{210}Lead	0.057	(0.011)
^{239,240}Plutonium			^{210}Bismuth	0.00083	(0.00016)
			^{234}Uranium	0.0043	(0.0040)
			^{235}Uranium	–0.0001	(0.0011)
			^{238}Uranium	0.0043	(0.0038)
Total	0.0003	(0.007)		0.2	(0.01)

The doses from three uranium isotopes are shown with the natural radionuclides because the isotopic ratio of uranium-238 to uranium-234, which is nearly one, indicates that the airborne uranium was of natural, not LANL, origin. The calculated doses from americium and plutonium show the large uncertainty with extremely small numbers and are not statistically significant. The doses from polonium, lead, and bismuth are statistically significant (because the concentration is much larger than its uncertainty) and represent the increase in airborne concentrations of these natural radon products during the fire. However, these calculations did not include subtraction of background radon products because applicable data on pre-fire air concentrations for these radionuclides were not available. The fire-related doses from naturally occurring radionuclides tabulated above were less than those reported. But, these doses do not include other radionuclides in the radon-222 decay series, which are too short-lived to evaluate in this way and would have contributed additional dose. Tritium was not included in this analysis because none of the AIRNET stations showed tritium above background levels during the fire.

The calculations indicate that doses to any firefighter in the Los Alamos area were very small. No health effects would be expected to occur as a result of these radiological intakes during the Cerro Grande fire.

Maximally Exposed Person outside the Los Alamos Area. Outside of Los Alamos, Española had the highest measured concentrations of gross alpha and gross beta radiation, and these occurred between May 8 and May 11. The local gross alpha concentrations do not appear to have increased above normal levels other than during this period. We used the concentrations of the individual radionuclides from May 8 to May 11 to calculate the dose a person might have received had he or she been outside throughout that 72-hour period. We did not subtract background concentrations (what are normally seen) from the polonium, lead, bismuth, or uranium concentrations to make these calculations.

The doses from lead, polonium, and bismuth (Table 3-6) are quite small, barely above those that would have been experienced had the Cerro Grande fire never happened, and are due to the slight increases in airborne natural radioactive elements. The negative doses for plutonium and americium are obviously meaningless but result from the large uncertainties in these numbers.

These doses may be compared with the approximately 360-mrem dose received each year from natural background radiation in northern New Mexico, primarily from cosmic radiation and naturally occurring radioactive materials in soil and food. No health effects are expected to occur as a result of radiological intakes during the Cerro Grande fire.

Worker Exposed to Elevated Uranium near AIRNET Station #23, TA-5. The AIRNET station #5 showed elevated uranium concentrations during the sampling period ending May 13. Significantly, the uranium-238 air concentration was more than double the uranium-234 concentration, indicating a likely LANL source for some of the airborne uranium-234 and uranium-238. Based on the ambient air measurements and the assumption that depleted uranium from LANL is approximately 30% uranium-234, by activity, the calculated LANL contributions to the elevated uranium-234 and uranium-238 concentrations at station #5 were approximately 1,221 and 3,700 aCi m^{-3}, respectively. We used the gross (no background

Table 3-6. Maximally Exposed Individual Outside Los Alamos during the Cerro Grande Fire

LANL-Derived Radionuclides	Net Dose (mrem)		Natural Radionuclides	Gross Dose (mrem)	
^{241}Americium	–0.003	(0.01)	^{210}Polonium	0.022	(0.001)
^{238}Plutonium	–0.003	(0.004)	^{210}Lead	0.030	(0.011)
^{239,240}Plutonium	–0.001	(0.008)	^{210}Bismuth	0.00044	(0.00016)
			^{234}Uranium	0.0019	(0.0034)
			^{235}Uranium	0.0002	(0.003)
			^{238}Uranium	0.0027	(0.0029)
Total	–0.007	(0.2)		0.06	(0.01)

subtraction) concentrations to calculate the LANL contribution to worker doses in that location. A worker was assumed to be breathing these concentrations for 60 hours, even though it is very unlikely that this occurred. The radiological doses from uranium-234 and uranium-238 were determined to be 0.024 (0.001) and 0.067 (0.003) mrem, respectively, with the one standard deviation value in parentheses. The doses from uranium-235 would have been much smaller than those from the other two isotopes. These radiological doses are very small, and no health effects would be expected from them.

For uranium, toxicological effects should be considered as well as radiological effects. It is appropriate to compare the concentrations and total intakes of uranium during the fire with standards based on toxicological effects. We calculated the total intake of uranium during the assumed 60 hours of exposure to be 0.002 mg, and the average air concentration of total uranium in air was about 0.00001 mg m^{-3}. This average air concentration was many orders of magnitude below any published limits for workplace or other exposure. For example, the American Council of Industrial Hygienists has a time-weighted average limit of 0.2 mg m^{-3} for workday exposure to uranium compounds (compiled in the NIOSH Pocket Guide to Chemical Hazards, US Department of Health and Human Services 1985). The Agency for Toxic Substances and Disease Registry (ATSDR) developed Minimal Risk Levels (MRLs) to estimate exposure levels that represent minimal noncancer health risks. For insoluble uranium compounds inhaled for more than a day, their published MRL is 0.008 mg m^{-3} (see *http://www.atsdr.cdc.gov/mrls.html* for these limits). Sixty hours of exposure at the MRL air concentration would result in a total intake of 1.2 mg (assuming a breathing rate of 2.5 m^3 h^{-1}). Sixty hours of intake at the concentrations of uranium at AIRNET station #23 would have resulted in an intake of 0.002 mg, several orders of magnitude below the MRL. No radiological or toxicological health effects are expected from these potential exposures.

Notes on these dose calculations:

The analyses described above do *not* include other natural radionuclides that may have contributed to the dose. Radionuclides from the radon-220 decay series are not included because they are too short lived to be evaluated with the analytical methods we used even though they probably caused some of the increased gross alpha concentrations for air samples counted shortly after they were collected. Because of extremely large temporal and spatial variations in the amount of natural uranium present in the atmosphere, a value representative of the increase during the fire cannot be calculated. Because of temporal variations, using an historical average at several sites would tend to underestimate the airborne uranium that would be expected during the high winds that occurred with the fire. Additionally, no consistent appropriate background values are available because the areas surrounding but fairly distant from Los Alamos, such as Santa Fe, Pojoaque, and Española which are usually used as background stations for other radionuclides, have higher natural airborne uranium concentrations than does the Los Alamos area.

b. Potential Dose Implications in the Aftermath of the Cerro Grande Fire. Exposure pathways besides inhalation developed after the fire and needed to be evaluated for their potential human exposure. The burning of many acres of trees and ground cover during the fire created the possibility of enhanced flooding in the canyons draining the east-facing side of the Jemez Mountains. Several of these watersheds (Los Alamos, Mortandad, and to a lesser extent Pajarito) have residual contamination from LANL operations. If contaminated sediments in the canyons were mobilized during runoff and redeposited downstream in the lower parts of these canyons or transported into the Rio Grande, people could be exposed to these contaminated sediments or contaminated water.

The mobilization of LANL-related contamination is one source for exposure following the fire. However, during the past 50 years or so, radioactive fallout (from worldwide uses of radioactive materials) has accumulated in soils, vegetation, and duff and represents a much larger source term available for mobilization by rainfall and/or flooding. There is evidence that LANL has contributed somewhat to the existing levels of plutonium-239 and other radionuclides in areas within a few miles of LANL (Fresquez et al., 1998). These LANL-caused additions to fallout radionuclide components cannot be distinguished from fallout measured in sediments deposited downstream. Therefore, we include all radionuclides in our dose assessment that are seen at concentrations above those that existed before the Cerro Grande fire unless they are shown to be of non-LANL origin.

Our analysis considers two principal exposure scenarios: (1) to a resident who may have lived near contaminated sediments transported by post-Cerro

Grande runoff and (2) to individuals who may have been exposed to or used Rio Grande water contaminated by runoff events. The resident described in the preceding sentence is presumed to live in lower Los Alamos Canyon (Totavi), as those residences are closest to potential Cerro Grande impacts and to removable sources of LANL contamination. A more detailed analysis of post-fire radiological exposures is available (see Kraig et al., 2001b). The methodology we used and the parameter values we selected were intended to be as realistic as possible while incorporating enough conservatism that we could conclude that higher doses were unlikely to have occurred. To reduce uncertainty, wherever possible we based these calculations on actual measurements of the potentially affected media. Finally, as described above, we limited our evaluation to potential effects from the fire and its aftermath, and we tried to discern a LANL impact from the larger Cerro Grande impact where possible.

We did not calculate potential dose impacts associated with traditional or cultural uses of the land or water because we have insufficient knowledge of these uses to allow a defensible analysis. If information emerges to allow such an assessment, one may be completed in the future.

Exposure Assessment for Lower Los Alamos Canyon. During late 2000, rain storms caused runoff throughout the Los Alamos Canyon watershed, which includes Los Alamos, Pueblo, Rendija, and Guaje Canyons. In lower Los Alamos Canyon, which includes Totavi, an area with several residences, late-season floods deposited layers of ash and sediment. A March 2001 evaluation assessed the degree that these floods deposited sediment in the area behind the convenience store and residences at Totavi. We collected samples from locations in the reach near Totavi from layers representing a variety of sediment sizes within the deposits. All samples included one or more layers of ash-rich sediment typical of Cerro Grande storm water deposits. Samples from the Totavi area were analyzed for strontium-90, cesium-137, plutonium-238, plutonium-239, -240, and uranium isotopes 234, 235, and 238. We also collected samples just upstream of the low-head weir structure in Los Alamos Canyon at the Laboratory boundary in September 2000. These samples were analyzed for the same radionuclides as at Totavi.

We compared post-fire and flooding data from Totavi with those from LA-4 East reach and with background soils and sediment data from many areas presumed to be independent of LANL impacts. LA-4 East is a site immediately upstream of Totavi that the Environmental Restoration (ER) program investigated and for which a significant amount of sediment data are available (Reneau et al., 1998). Pre-fire contaminant concentrations from Totavi and LA-4 East reach should be comparable because no tributary drainages or contaminated sites affect Los Alamos Canyon between the two areas. We use the data from LA-4 East as indicators of presumed pre-Cerro Grande concentrations at Totavi. These concentrations may well include contributions from LANL sources up canyon. If concentrations at Totavi were higher than the corresponding LA-4 East values and were also above the background values (no LANL contributions), we would conclude that there has been an increase associated with the Cerro Grande fire.

Our analysis of these data indicated that cesium-137 was the only radionuclide seen in the Totavi area that was above background and pre-Cerro Grande concentrations. Therefore, it appears that in this area, cesium-137 was the only radionuclide that increased after the fire and was the only radionuclide considered in the radiological dose assessment (below) of potential Cerro Grande impacts at Totavi. The average cesium-137 concentration near Totavi of 1.2 pCi g^{-1} was about 0.7 pCi g^{-1} above the pre-Cerro Grande concentrations measured at LA-4 East (and presumed for Totavi). Therefore, the dose calculation for the Totavi area was based on the net 0.7 pCi g^{-1} of cesium-137 attributable to the Cerro Grande fire.

It is common to see increases in radionuclides such as cesium-137 in ash after fires (Paliouris et al., 1995; Amiro et al., 1996). Similar increases were seen in sediment from ash and sediment from the Viveash fire (Katzman et al., 2001). This increase occurs because burning the of biomass that has accumulated cesium-137 and other fallout radionuclides concentrates these radionuclides in the ash. Although we believe it is likely that most of the cesium-137 in new deposits at Totavi is related to Cerro Grande and not LANL sources, we have no way of discerning the source and have not attempted to do so here. Rather, we simply calculate the dose from the cesium-137 increment and do not conclude what portion of this increment was caused by LANL as opposed to by Cerro Grande.

The cesium-137-contaminated sediments were deposited on the low flood plain adjacent to the active channel behind (south) of the Totavi residences. No recent deposits occurred outside the existing low flood plain, which is about two meters below the level of the residences. Totavi residents had garden plots in their backyards, well removed and above the area of recent flood deposits. We assume that ash from the floodplains was not added to these garden plots. Because the local foods are apparently not being grown in Cerro Grande-derived ash, farming and production of fruits or vegetables for domestic use were not included in this exposure scenario. If contaminants from the sedimentary deposits became airborne and landed on the plants or in the garden beds, a small amount of contamination could have been consumed. It is unlikely that a significant exposure could occur through this specific pathway as we explain further in the assessment below. We believe that the exposure scenario presented below (which does not include ingestion of locally grown fruits or vegetables) is realistic. The scenario is conservative because the hypothetically exposed individuals who spent time in the streambed were much closer to the cesium than those who remained in the residences. In trying to keep this scenario realistic, we did not include evaluation of the hypothetical children swimming in or drinking the runoff in Los Alamos Canyon. An assessment of drinking runoff water in Los Alamos Canyon is available (see Johansen et al., 2001).

Our scenario involves children playing in the stream area among potentially contaminated sediments. The children are assumed to spend 4.4 hours each day (EPA 1997, Table 5-4) in an area 300 meters long and 10 meters wide encompassing 300 meters along the stream with the floodplains and banks 5 meters on each side. The scenario is presented according to the various exposure pathways that could have been significant.

Inhalation Pathway

While playing, the hypothetical children breathe at a rate of 1.9 m^3 per hour. This rate is an average respiration level for children doing heavy activities (EPA 1997, Table 5-23). The dust in the air they breathe is assumed to come from the local (10 m $\times$ 300 m) area. We assumed this dust-laden air does not mix with air outside the 3,000-m^2 area. We used dust-loading measurements from the Los Alamos area as a basis to estimate the amount of local sediments and soils that would become airborne and available for inhalation. These measurements indicated that the average amount of particles in the respirable size range (< 10 μm) in ambient air was 10 $\mu g\ m^{-3}$ and that maximum values were about 30 $\mu g\ m^{-3}$ (data published in annual environmental surveillance reports 1990–1999 and compiled by Steve Reneau, 3-10-00). For our calculations, we assumed 100 $\mu g\ m^{-3}$, a very conservative value that we consider represents an upper limit. By multiplying the concentration of a contaminant in soil by the dust-loading value, we calculated the concentration in air of that contaminant. The amount of dust that was assumed to become airborne from each sedimentary unit was calculated proportional to the exposed surface area of that unit. Then, we summed the contributions to the ambient air for all units to calculate the total air concentration of each radionuclide.

After we calculate the air concentration for each radionuclide, we can calculate the inhalation dose associated with that radionuclide. We multiply the air concentration by the amount of air breathed and then by a dose conversion factor (DOE 1988b) that tells how much dose is received for each intake of radioactive material. As described above, because cesium-137 was the only radionuclide that appears to have been elevated in this area from effects of the Cerro Grande fire, it is the only radionuclide that we included in the inhalation dose calculation.

Soil Ingestion Pathway

An ingestion rate of 200 mg/day, which is considered a conservative mean estimate (EPA 1997), is assumed. This rate is an upper estimate of the daily soil ingestion rate in that it assumes that all of the soil the children ingest hypothetically came from the stream area behind the Totavi homes. In reality, they would be expected to have ingested soil in other locations, thus decreasing the relative contribution from Totavi and reducing the dose. We weighted the soils similarly to the inhalation pathway; the amount of soil ingested from each sedimentary unit was proportional to the surface exposure of that unit. And, as described for inhalation, cesium-137 was the only radionuclide above background and above pre-Cerro Grande levels that we considered in this dose calculation.

Direct Exposure Pathway

Some radioactive materials, such as cesium-137, emit radiation that can cause exposures at some distance from the material. To calculate the exposure potential from these types of materials, a RESRAD (Yu et al., 1993) run was performed. For the run, only the direct exposure pathway was used. The contamination was assumed to be 9 cm deep spread uniformly over the surface of a 3,000-m^2 circular area. We assumed the area to be circular, even though it is actually rectangular, because that maximizes the calculated direct exposure. A person is assumed to be in the area for 4.4 hours per day (EPA 1997, Table 5-4), unshielded from the radiation. The assumption of a 9-cm deep continuous layer is also conservative because our field studies indicated that less than 25% of the area was actually covered by post-Cerro Grande flood deposits.

Dose Assessment for Lower Los Alamos Canyon

Table 3-7 presents the calculated radiological doses from the three exposure pathways. Because the increased local cesium-137 concentration that would cause these dose increments did not occur until October runoff events, a receptor would have been exposed to less than three months at these exposure rates during 2000. Assuming three months of exposure gives a total year 2000 dose from Cerro Grande effects of 0.015 mrem. It is important to note that the majority of this dose was from direct exposure to cesium-137 in the soil/sediment and that the inhalation dose experienced by children playing directly in the streambed was extremely small. Air concentrations from suspension of contaminated sediment were negligible, which means that indoor residents inhaled very little cesium-137 and very small amounts of the radionuclide deposited on garden produce in the area.

Table 3-7. Lower Los Alamos Canyon Dose per Month of Exposure after September 2000

Exposure Pathway	(mrem)
Inhalation	0.0000001
Ingestion	0.00004
Direct Penetrating Radiation	0.005
Total	0.005

As described above, these represent total effects from the Cerro Grande fire and may include an increment from LANL-related cesium-137 contamination.

Exposure Assessment for Rio Grande Water Users. As sediments wash out of the canyons draining the Jemez Mountains, they may be transported with the water or sediment in the Rio Grande. People downstream may be exposed by swimming in the river, drinking from it, by ingesting fish that have incorporated some of these materials, or by using affected water to irrigate their crops or to water livestock. Potential exposure scenarios are dependent on where along the Rio Grande the exposure assessment is considered. Upstream of Cochiti Reservoir, the exposure pathways we have identified include drinking from and/or swimming in the Rio Grande during a runoff event or someone consuming meat from cattle that have drunk from the Rio Grande during runoff. Below Cochiti Reservoir, the primary exposure scenario involves irrigation using Rio Grande water. Although the same potential exposure scenarios described for above Cochiti also exist below the reservoir, the dose below the dam (besides those involving irrigation) would presumably be less than above because of increased dilution and mixing as the flood waters get farther from their source. These various scenarios and the major exposure parameters are described individually below. In the Rio Grande exposure scenario, chemicals and radionuclides are carried into the river by floods from the Laboratory and the Cerro Grande burn area. The highest concentrations in the Rio Grande will likely occur during the pulse of floodwaters, which typically lasts only a few hours.

During the 2000 runoff season, the US Geological Survey (USGS) collected several post-fire samples of the river. Because of logistical constraints, however, not all runoff events could be sampled and usually only one location could be sampled per day. The specific analyses available to date are somewhat limited. For example, there are no cesium-137 data during the periods of runoff. The USGS data, though useful, are not sufficient to describe the peak concentrations for all the analytes of interest. We therefore calculated what the maximum concentrations might have been in the Rio Grande during 2000. The USGS results are compared against these calculated concentrations where possible.

There are two key components in determining the potential radionuclide concentrations in the Rio Grande: (1) concentrations in the runoff from source areas in the Jemez Mountains and Pajarito Plateau and (2) the volume of this runoff as a fraction of the total flow in the Rio Grande (dilution factor). To ensure that we calculated upper bounds for radionuclide concentrations in the Rio Grande (from LANL canyon input), we assumed that the maximum concentrations measured in runoff entered the Rio Grande during the time that the dilution factor was at its minimum. The peak concentration in the Rio Grande represents the maximum concentration change from baseline levels that is attributable to the added runoff.

To calculate the minimum dilution factor, we identified the date(s) with the smallest difference in flows between the Rio Grande and the LANL canyons (October 23, 24). We calculated the dilution factor by assuming that all of the runoff from LANL canyons for that day was delivered to the Rio Grande in about a 2-hour period. The 2-hour runoff period corresponds to runoff from an intense but short-lived thunderstorm. The peak concentrations in the Rio Grande from LANL inflows would occur during this pulse. During most of the summer months, flows in the Rio Grande were typically several hundred times greater than flows from the LANL canyons. The smallest difference in flows occurred on October 23 and 24, resulting in calculated dilution factors of 3.5 and 7, respectively. For simplicity, we chose a dilution factor of 4.

The dilution factor we use is highly conservative for irrigation and other scenario for several reasons:

- The minimum dilution factor is derived from flows in late October, a period of presumably reduced irrigation. Selection of a dilution factor from earlier summer months would yield factors about 5 times larger and result in calculated Rio Grande concentrations about 1/5 those used in our dose calculations.
- The scenario assumes that all flows in the LANL canyons arrive simultaneously at the Rio Grande, with no reduction in stream flow in transit from the LANL gages to the river. These factors yield a maximum theoretical concentration in the Rio Grande (from LANL canyon input). We also assume that all floodwaters reached the Rio Grande, which we know did not happen.

The dilution factor provides a margin of conservatism that accounts for runoff produced from large storms encompassing several large watercourses, including watercourses north of the Laboratory.

We sampled the storm water along the eastern segment of the Laboratory using automated sampling stations co-located with gaging stations. These sampling stations lie where the canyons discharge off Laboratory property. We collected post-fire runoff samples in Pueblo, Los Alamos, Cañada del Buey, Potrillo, and Water Canyons (see Figure 5-6). Additional samples were collected manually from the ungaged Rendija and Guaje Canyons north of LANL. We collected post-fire runoff samples June through October and analyzed them for strontium-90, cesium-137, plutonium-238, plutonium-239, -240, and americium-241.

Table 3-8 lists the maximum detected concentrations for these LANL canyon stations. Predicted maximums are reported for Guaje and LANL Can-

Table 3-8. Rio Grande Runoff Comparison of Predicted Peak Concentrations in Unfiltered Water in Rio Grande Runoff with Pre- and Post-Fire Measured Rio Grande Concentrations

Analyte	LANL Pre-Fire Measurements[a,b]		Post-Fire Predicted Maximums[b]		USGS Post-Fire Measurements Maximum
	Mean	Max	Guaje Canyon	LANL Canyons	
^{241}Am	0.014	0.05	1	1	NA[c]
^{137}Cs	1	1.1	90	27	NA
^{238}Pu	–0.0002	0.02	0.31	1	NA
$^{239,240}Pu$	0.02	0.15	4	6	NA
^{90}Sr	1	9	20	16	12.60[d]

[a] These are summaries of measurements of the Rio Grande at the Frijoles inlet for the years 1993–1999.
[b] All units are pCi/L.
[c] NA = not available.
[d] Sample collected from the Rio Grande near White Rock.

yons. Guaje Canyon is included here as a possible reference canyon to help interpret whether risks were strictly fire-related or had a possible LANL contribution. We believe that Guaje Canyon is far enough from LANL that sediment concentrations there do not show effects of LANL operations with the possible exception of plutonium-239 (Kraig et al., 2001b).

Pre-fire samples of runoff from the LANL canyons have been collected with automated samplers since 1995. The Laboratory's annual Environmental Surveillance Reports (ESP 1996, 1997, 1998, 1999, and 2000) present the concentrations of radionuclides, metals, and organic chemicals from these pre-fire samples. Average and peak concentrations in unfiltered runoff leaving LANL in 2000 were significantly greater than pre-fire levels for nearly every analyte during the months of June and July (Kraig et al., 2001b). The peak concentrations of these radionuclides increased by factors of about 2.

Comparison of upstream with downstream radionuclide concentrations indicates that there were Laboratory and fire-related impacts in year 2000 storm events. The presence of contributing sources on LANL was seen in the small magnitude runoff events of June 2 and 3 (Johansen et al., 2001). However, in many larger runoff events in other watercourses, the major changes in water quality were due primarily to physical and chemical factors caused by fire. Forest fires cause higher sediment loads, increased water yield, and higher concentrations of metals and radionuclides in ash (Bitner et al., 2001). Samples of runoff contain a mixture of Laboratory-associated and of fire-associated constituents, in unknown proportions. To be comprehensive, therefore, we have included all of the analytes in the dose assessments, unless evidence specifically eliminates the Laboratory as being a likely significant source. For example, we did not include the radionuclides uranium-234, uranium-235, and uranium-238 in the dose calculations because the Laboratory-derived proportion does not appear to be significant in year 2000 runoff samples (Kraig et al., 2001b).

Pre-Fire Concentrations in the Rio Grande

The Laboratory's Environmental Surveillance Program characterized pre-fire water quality in the Rio Grande at several locations. The most complete records are for the Rio Grande at Otowi and for the Rio Grande at Frijoles Canyon stations. Records from the Frijoles Canyon station are used to describe pre-fire levels downstream of LANL. Table 3-8 presents statistical summaries of Rio Grande at Frijoles water quality data from the years 1993 through 1999 as LANL pre-fire measurements.

Comparison of Measured versus Predicted Concentrations

Some data are available from the USGS post-fire sampling of the Rio Grande. Dates for which some Rio Grande data are available include June 28, July 5, July 7, July 11, October 24, and October 26. Table 3-8 shows the maximum concentrations from this sampling. The USGS results are compared against the peak concentrations predicted during the runoff pulse.

For most analytes, the predicted concentrations in the Rio Grande exceed the measured values by at least an order of magnitude. Of the primary radiological constituents, only the measured concentration for strontium-90 is of the same magnitude as during the peak runoff (13 pCi L^{-1} measured vs. 16 pCi L^{-1} predicted). This comparison indicates that the water concentrations in the risk and dose calculations appear to be reasonable and the calculated doses probably overestimate the typical doses resulting from use of the Rio Grande.

Irrigation Scenario

Downstream from Cochiti Reservoir, there is considerable use of irrigation water that could have been contaminated by runoff since the Cerro Grande fire. Irrigation water drawn from the river during runoff events and spread on crop fields, fruit trees, or pasture may represent an exposure pathway to animals and eventually to humans.

For our dose calculations, we assume the radionuclide concentrations provided in Table 3-8 under the column titled "Post-Fire Predicted Maximums, LANL Canyons." We assume that concentrations measured in Rio Grande water above Cochiti remain the same as the water travels through the reservoir. This assumption is very conservative because mixing with waters in and downstream of the reservoir is likely to provide significant dilution to the concentrations measured above the reservoir.

The irrigation scenario is based on the following assumptions:

- All irrigation is by flooding (not overhead spraying).
- The "event" covers the irrigated area one foot deep in water.

- All the “contamination” in the water is deposited in the top 30 cm (1 foot) of soil, and no soil covers the contamination.
- The roots of all plants growing in the contaminated soil are in the top 30 cm of soil.
- None of the contamination washes off or is leached out of the top 30 cm of soil. Therefore, all contamination remains in the rooting zone and the zone available for air dispersion and soil ingestion.
- The farmer lives on-site and consumes meat (cattle and poultry), cow milk, fruits, and vegetables grown there; the cattle and poultry are fed with locally grown grains. We used default consumption values provided in RESRAD 5.82.
- The farmer inadvertently consumes 100 mg of soil daily from her/his field.
- The cattle consume 0.5 kg of soil daily from the field.

Other applicable scenario parameters are shown in Table 3-9.

Assuming that the source of the flood runoff was LANL-affected canyons, we calculated the dose per irrigation event to be 0.09 mrem. The dose from non-LANL affected canyons was 0.2 mrem. It seems counterintuitive that the dose would be smaller from canyons that have LANL-contaminated sediments than from those that are presumably free of such contamination. We believe that the fundamental cause(s) of the higher cesium and strontium in the non-LANL canyons are related to aspects of the fire such as burn duration, burn intensity and heat, amount of biomass burned, length of transport to the Rio Grande, etc. Even though LANL may have added some increment of plutonium, americium, cesium, or strontium to the flow of the Rio Grande, that increment was so much smaller than the incremental cesium from fire effects that the LANL effect is dwarfed by the fire effect. Likewise, some non-LANL canyons were more affected by the fire than LANL canyons, so their contribution to the river is higher than that from LANL canyons.

Table 3-9. RESRAD Rio Grande

These are the values used for the applicable inputs to the RESRAD 5.82 run for calculating potential impacts from irrigating with runoff water.

Parameter (units)[a]	Value Used as Input
Area of contaminated zone (m^2)	10,000
Density of contaminated zone (g cm^{-3})	1.5
Thickness of cover (m)	0
Contaminated zone erosion rate (m y^{-1})	0.0000001
Evotranspiration Coefficient	0.99
Precipitation (m y^{-1})	0.2
Runoff Coefficient	0
Watershed area (m^2)	0.0001
Depth of soil mixing layer (m)	0.3
Depth of roots (m)	0.3

[a] Parameters not listed used the RESRAD default value.

Drinking Water from, Swimming in, or Fishing in the Rio Grande

Assuming someone drank unfiltered water from the Rio Grande during the runoff with the highest radionuclide concentrations (values from Table 3-8, above), his or her dose would be 0.04 mrem per liter consumed from potential LANL-affected canyons or 0.03 mrem from canyons presumed to be not affected by LANL operations. The largest dose contributor in either case would be pluutonium-239.

If someone swam in the Rio Grande during the time of highest radionuclide concentration, his or her dose (based on input from canyons potentially affected by LANL) would be about 0.00002 mrem per hour of swimming or about 0.00006 mrem based on floodwater concentrations from non-Laboratory affected canyons. Essentially all of this dose would result from direct exposure to cesium-137.

We collected fish from Cochiti reservoir in June, July, and August of 2000 (after the fire) and compared their radionuclide contents with fish collected from Abiquiu reservoir. Abiquiu is located on the Rio Chama, upstream from the confluence of the Rio Grande and intermittent streams that cross Laboratory lands (Fresquez and Gonzales 2000). Comparison of radionuclide concentrations in fish collected before (1999) and after (2000) the fire shows that mean radionuclide concentrations in fish collected after the fire were statistically indistinguishable ($p < 0.05$) or lower than radionuclide concentrations in fish collected before the fire in 1999. Therefore, we believe that fish collected and eaten from the Rio Grande or Cochiti Reservoir during year 2000 would not have caused a fire-related dose increment.

Cattle Watering Scenario

Livestock watered in the Rio Grande after it was affected by storm water runoff. If these cattle drank contaminated water from the Rio Grande, their consumption by humans could result in a radiation dose. We can calculate this dose by evaluating the amount of radionuclides that the cattle consumed, how much of the radionuclides that were consumed ended up in the cattle tissues, and how much of these radionuclides would be passed to humans if they consumed the cattle. The amounts of radionuclide passed along at each phase are called transfer factors.

We used the following factors and assumptions:

(1) Cattle drank 50 L per day of Rio Grande water (Kennedy 1992, p. 6.19) to give the daily radionuclide intake by the cattle in pCi d^{-1}.

(2) Values shown in Table 3-10 as the intake-to-meat transfer factor, which is the ratio of the radionuclide concentration in meat in pCi kg^{-1} to the daily radionuclide intake in pCi d^{-1} (Kennedy 1992, p. 6.29) to give the radionuclide concentration in meat, in pCi kg^{-1}.

(3) A rate of 59 kg per year (divided by 12 to make this a calculation of dose for monthly intake) as the annual meat consumption rate by humans (Kennedy 1992, 6.38) to give the intake of radionuclide by humans in pCi.

(4) Use of the standard dose conversion factors (DOE 1988) to convert the human radionuclide intake into estimated dose (in mrem).

(5) Exclusion of uranium from the calculated dose because there appears to have been no significant LANL contribution to the uranium in the runoff from potentially affected LANL canyons.

This dose estimate is conservative because it

- uses the highest predicted concentration for each radionuclide in water, including the suspended sediment as well as the dissolved fraction;
- assumes that the radioactive material in the suspended sediment is as biologically available for uptake by the cattle as the radioactive material dissolved in the water;
- assumes that the radionuclide concentration in the meat has reached equilibrium with the maximum daily intake, so it can be described by the transfer factor (this is unlikely to have taken place in the short time since the runoff occurred from potentially LANL-affected canyons);
- assumes that all the cattle's water comes from the Rio Grande and that the cattle drink only when the predicted concentrations are at their maximum. We know that the runoff periods when radionuclide concentrations were elevated represent a small fraction of the time the Rio Grande flowed and also a small fraction of the time the cattle watered there;
- assumes that all an individual's meat for a month comes from the affected animal.

Based on the concentrations assuming the source of the flood runoff was LANL-affected canyons, we calculated the dose to be 0.09 mrem per irrigation event. The dose from non-LANL affected canyons was 0.2 mrem. The majority of the dose in both cases is from cesium-137 exposure. The dose calculations, for which some of the parameters of are shown in Table 3-10, indicate that the potential LANL dose contribution from eating meat from cattle that have watered in the Rio Grande is less than 0.01 mrem. Perspective on this conservatively calculated dose is provided below.

Dose Summary and Perspective

The doses reported above for lower Los Alamos Canyon and for Rio Grande exposures were small for year 2000. It is possible that the hypothetical individuals exposed at Totavi may also have been exposed to some of the additional pathways described for the Rio Grande. If individuals were exposed to these various pathways, they can calculate their total dose from all pathways by adding the doses from the applicable exposure scenarios presented above. Future conditions and potential exposures after 2000 are under evaluation and will be described as they are calculated.

To put some perspective on these doses, a person travelling on a two-hour flight in a jet airliner would receive approximately 1 mrem, and people living in the Los Alamos area receive about 360 mrem from natural sources each year. No health effects are expected from the short-term increase in natural radioactivity associated with the Cerro

Table 3-10. Monthly Dose from Ingestion of Meat from Cattle that have Watered only in the Rio Grande and only while Runoff from LANL Canyons was Occurring

Radionuclide	Concentration in Rio Grande Water (pCi/L)	Transfer Factor (pCi/kg per pCi/day)[a]	Dose Conversion Factor (mrem/pCi)[b]	Effective Dose Equivalent (mrem)
^{90}Sr	16	3.0 E-04	0.00013	0.00015
^{137}Cs	27	2.0 E-02	0.00005	0.0066
^{238}Pu	1	5.0 E-07	0.0038	0.00000047
$^{239,240}Pu$	6	5.0 E-07	0.0043	0.0000032
^{241}Am	1	3.5 E-06	0.0045	0.0000039
Total				0.007

[a]Kennedy 1992, p. 6.29.
[b]DOE 1988.

Grande fire. LANL-derived airborne radionuclides did not increase measurably in the Los Alamos town site or residential areas during the fire. The effects on Rio Grande users were much greater from runoff from canyons not affected by LANL operations than from LANL-affected canyons.

D. Estimation of Radiation Dose Equivalents for Naturally Occurring Radiation

Operations at LANL contribute radiation and radioactive materials to the environment. To understand the Laboratory's impact, it is important to understand its contribution relative to existing natural and man-made radiation and radioactive materials in the environment.

External radiation, which affects the body by exposure to sources external to the body (not from inhalation or ingestion), comes from two sources that are approximately equal: cosmic radiation from space and terrestrial gamma radiation from radionuclides naturally in the environment. Estimates of dose rates from natural radiation come from a comprehensive report by the National Council on Radiation Protection and Measurements (NCRP 1987b) and assume the dose from cosmic radiation dose is reduced 20% because of time spent indoors and the dose from terrestrial radiation sources is reduced by 30% because our bodies provide some shielding for our internal organs from terrestrial photons. In general, doses from direct radiation from cosmic and terrestrial sources are higher in Los Alamos than White Rock because White Rock is at a lower elevation and less cosmic radiation reaches the earth's surface. Actual annual external background radiation exposures vary depending on factors such as snow cover and fluctuations of solar radiation (NCRP 1975).

The largest component of our annual dose is from the decay of natural uranium. Uranium products occur naturally in soil and are commonly incorporated into building construction materials. Radon-222 is produced by decay of radium-226, which is a member of the uranium decay series. Inhalation of radon-222 results in a dose to the lung, which is the largest component of natural background radiation dose. We assume the dose from radon-222 decay products to local residents to be equal to the national average of 200 mrem per year. This estimate may be revised if a nationwide study of background levels of radon-222 in homes is undertaken or if we obtain reliable data on average radon concentrations in homes in northern New Mexico. The NCRP (NCRP 1984, 1987a) has recommended a national survey.

Another naturally occurring source of radiological dose to the body is from naturally occurring radioactive materials incorporated into the body. Most importantly, a small percentage of all potassium is radioactive potassium-40. Because our bodies require potassium, we have a certain amount of radioactive potassium within us, and the decay of this potassium-40 gives us a dose of about 18 mrem per year. Natural uranium and carbon-11 contribute another 21 mrem or so to give a total dose from internal radionuclides of about 40 mrem each year. Doses from the global fallout associated with aboveground nuclear testing, the accident at Chernobyl, venting of belowground nuclear tests, and burn-up of satellites are a small fraction of total environmental doses (<0.3% [NCRP 1987a]).

Finally, members of the US population receive an average dose of 53 mrem per year from medical and dental uses of radiation (NCRP 1987a). The various contributors to radiation dose to the maximally exposed individual in the Los Alamos area appear graphically in Figure 3-6. In the Los Alamos area, we receive roughly 120 mrem from terrestrial and cosmic external sources, 200 mrem from radon, 40 mrem from internal sources, 53 mrem from medical and dental procedures, and perhaps 1 mrem from global fallout to give a total "background" dose of about 414 mrem.

E. Risk to an Individual from Laboratory Operations

Health effects from radiation exposure have been observed in humans only at doses in excess of 10 rem delivered at high dose rates (HPS 1996). Doses resulting from LANL operations are typically in the low mrem or fractional mrem range and are generally delivered at low dose rates—gradually, throughout the year. Our conclusion is that these doses would cause no adverse health effects, including cancer. Therefore, we have not calculated risks associated with the low doses presented in this report. A reader may calculate risk by multiplying the doses reported here by a cancer risk factor. The factor should be in units of excess cancer death risk per mrem or be converted to these units. For example, the EPA (EPA 1994) has published such a factor in units of risk per Sievert. A Sievert (Sv) is 100 rem or 100,000 mrem.

The doses calculated from natural background radiation and medical and dental radiation can be compared with the incremental dose caused by radiation from Laboratory operations. The average doses to residents of Los Alamos and White Rock from Laboratory activities were less than 0.2 mrem in each community. The exposure to average Los Alamos County residents from Laboratory operations is well within variations in exposure of these people to natural cosmic and terrestrial sources and global fallout. For example, variation in the amount of snow cover and in the solar sunspot cycle can cause a 10-mrem difference from year to year (NCRP 1975).

F. Estimating Radiological Dose to Nonhuman Biota

1. DOE Standard for Evaluating Dose to Aquatic and Terrestrial Biota

In June 2000, the Department of Energy, Air, Water, and Radiation Division (EH-412), issued interim DOE Technical Standard ENR-0011, entitled "A Graded Approach for Evaluating Radiation Dose to Aquatic and Terrestrial Biota" (DOE 2000b) [available at *http://homer.ornl.gov/oepal/public/bdac/*]. The interim standard provides guidance for the evaluation

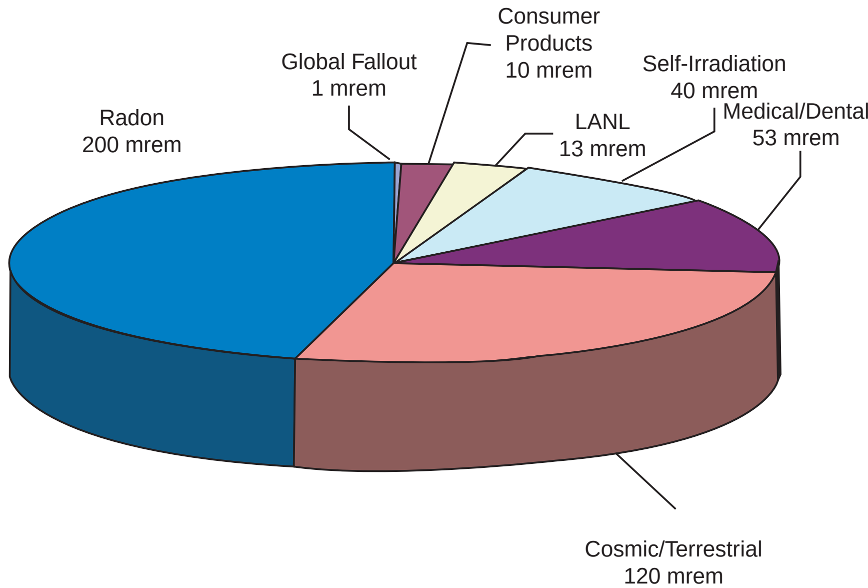

Figure 3-6. All contributions to the 2000 dose for the Laboratory's maximally exposed individual.

of ionizing radiation doses to aquatic animals and terrestrial animals and plants. DOE sites can use this guidance to establish that site conditions are in compliance with established radiation dose limits for protection of nonhuman biota. DOE Order 5400.5 (DOE 1993) establishes a dose limit of 1 rad day^{-1} (10 mGy day^{-1}) for protection of aquatic organisms. Based on this limit and a review of the radiation protection literature, the DOE technical standard adopts biota dose limits as follows:

- Aquatic animals: absorbed dose that does not exceed 1 rad day^{-1}
- Terrestrial plants: absorbed dose that does not exceed 1 rad day^{-1}
- Terrestrial animals: absorbed dose that does not exceed 0.1 rad day^{-1}

These limits are based on concerns for limiting reproductive impairment in free-living populations of organisms. Although the goal of the standard is to provide protection for population viability, population dose limits are inferred from observations of individual impairment among the most radiosensitive organisms. These dose limits for protection of populations ensure that there would be no observable adverse effects to members of populations for which protection of individual viability and productivity is of concern. Such considerations are of interest when evaluating impacts to threatened, endangered, or otherwise protected species of biota.

The assessment framework in DOE's technical standard proceeds from the screening phase through more detailed, site-specific dose assessment if the available data warrant such detail. The screening assessment uses parameters for radionuclide uptake that are deemed to ensure protection of the most sensitive and most exposed biota. For example, transfer factors for radionuclides from environmental media to organic tissue are selected from the high end of the range of the empirical data; higher rates of contaminated food uptake are included in the screening assessment; organisms are assumed to spend 100% of their life in contaminated areas; and decay of radionuclides taken up by an organism is assumed to deposit all its energy within the organism's body. More detailed focus on giving parameters more realistic values reflects site-specific conditions and the resource use styles of site-specific receptors.

2. Comparison of Media Concentrations to Biota Concentration Guides (BCG).

The DOE Biota Dose Assessment Team calculated Biota Concentration Guides (BCGs) for screening environmental media to determine the potential for doses to aquatic and terrestrial biota that exceed the prescribed limits. The BCGs are based on the dose limits given above and assume that the daily dose is averaged over a year. See DOE (2000b) Module 3 for the input parameters and equations used in derivation of the BCGs.

For aquatic and riparian (streamside) organisms, we used maximum media concentrations for persistent surface water and sediments (Tables 5-1 and 5-8) to compare to applicable BCGs (found in DOE 2000b, Module 1, Tables 7.1 and 7.2). The values for persistent surface waters were used because runoff (snowmelt and storm water) is generally not persistent enough to support aquatic or wetland/riparian communities. Thus, exposure to these organisms would be dominated by levels found in persistent surface water bodies.

We compared maximum media concentrations in 2000 to applicable BCGs and calculated the ratios (partial fractions) of measured concentrations to the guides (Table 3-11). The sum of these ratios is 1, indicating that total dose to aquatic organisms or riparian organisms is at the dose limit of 1 rad day^{-1}. The primary contributor to the dose here is cesium-137 in waters just downstream from the outfall at TA-50 that discharges effluent from the Laboratory's Radioactive Liquid Waste Treatment Facility. Concentrations of radionuclides in surface waters elsewhere are considerably lower by several orders of magnitude. Overall, releases of radionuclides to surface waters and sediments have not led to doses that exceed limits for the protection of aquatic and riparian animals.

Table 3-12 presents the results of comparing measured, maximum soil concentrations and wildlife drinking water concentrations to BCGs for protection of terrestrial biota. The limiting receptor in this case is the generic terrestrial animal for all radionuclides. The sum of the partial fractions in the terrestrial case is 0.05, well below the value of 1, indicating that terrestrial systems are very unlikely to receive exposures leading to exceedance of the dose limit.

Table 3-11. Comparison of Media Concentrations to Biota Concentration Guides (BCG) for Protection of Aquatic/Riparian Systems

	Water, Aquatic/Riparian Systems			Sediment, Aquatic/Riparian Systems			Water &	Organism Responsible for the Limiting Dose	
Nuclide	Water BCG pCi/L	Site Data[a]	Partial Fraction	Sediment BCG pCi/g	Site Data[b]	Partial Fraction	Sediment Sum of Fractions	Water	Sediment
^{241}Am	4.E+02	6.4.E+00	1.5E-02	5.E+03	4.4.E+01	8.8E-03	2.3E-02	Aquatic Animal	Riparian Animal
^{137}Cs	4.E+01	3.1.E+01	7.3E-01	3.E+03	1.9.E+01	6.3E-03	7.3E-01	Riparian Animal	Riparian Animal
^{3}H-3	3.E+08	5.3.E+04	2.0E-04	4.E+05	6.9.E+03	1.7E-02	1.7E-02	Riparian Animal	Riparian Animal
^{239}Pu	2.E+02	6.8.E+00	3.6E-02	6.E+03	1.7.E+01	2.8E-03	3.9E-02	Aquatic Animal	Riparian Animal
^{90}Sr	3.E+02	4.8.E+01	1.7E-01	6.E+02			1.7E-01	Riparian Animal	Riparian Animal
^{234}U	2.E+02	3.4.E+00	1.7E-02	5.E+03	3.5.E-01	7.0E-05	1.7E-02	Aquatic Animal	Riparian Animal
^{235}U	2.E+02	7.3.E-02	3.4E-04	4.E+03	1.4.E-02	3.5E-06	3.4E-04	Aquatic Animal	Riparian Animal
^{238}U	2.E+02	1.2.E+00	5.4E-03	2.E+03	3.6.E-01	1.8E-04	5.6E-03	Aquatic Animal	Riparian Animal
	Sum of fractions for radionuclides in water	➡	9.7E-01	Sum of fractions for radionuclides in sediment	➡	3.5E-02	1.0E+00		

[a]Maximum values from Table 5-4 surface water stations.

[b]Maximum values from Table 5-23 stations associated with surface water stations; uranium conversion to activity assuming natural isotopic mix.

Table 3-12. Comparison of Media Concentrations to Biota Concentration Guides (BCG) for Protection of Terrestrial Systems

	Water, Terrestrial Systems			Sediment, Terrestrial Systems			Water &	Organism Responsible for the Limiting Dose	
Nuclide	Water BCG pCi/L	Site Data[a]	Partial Fraction	Soil BCG pCi/g	Site Data[b]	Partial Fraction	Soil Sum of Fractions	Water	Sediment
^{241}Am	2.E+05	6.4E+00	3.2E-05	4.E+03	5.6E-02	1.4E-05	4.6E-05	Terrestrial Animal	Terrestrial Animal
^{137}Cs	6.E+05	3.1E+01	5.2E-05	2.E+01	5.8E-01	2.9E-02	2.9E-02	Terrestrial Animal	Terrestrial Animal
^{3}H	2.E+07	5.3E+04	2.7E-03	6.E+04	2.3E-01	3.8E-06	2.7E-03	Terrestrial Animal	Terrestrial Animal
^{239}Pu	2.E+05	6.8E+00	3.4E-05	6.E+03	1.3E-01	2.1E-05	5.5E-05	Terrestrial Animal	Terrestrial Animal
^{90}Sr	5.E+04	4.8E+01	9.6E-04	2.E+01	4.6E-01	2.3E-02	2.4E-02	Terrestrial Animal	Terrestrial Animal
^{234}U	4.E+05	3.4E+00	8.5E-06	5.E+03	1.6E+00	3.1E-04	3.2E-04	Terrestrial Animal	Terrestrial Animal
^{235}U	4.E+05	7.3E-02	1.8E-07	3.E+03	6.3E-02	2.1E-05	2.1E-05	Terrestrial Animal	Terrestrial Animal
^{238}U	4.E+05	1.0E+00	2.5E-06	2.E+03	1.7E+00	8.3E-04	8.3E-04	Terrestrial Animal	Terrestrial Animal
	Sum of fractions for radionuclides in water	➡	3.74E-03	Sum of fractions for radionuclides in soil	➡	5.3E-02	5.7E-02		

[a]Maximum values from Table 5-4.
[b]Maximum values from Table 6-1.

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4. Air Surveillance

4. Air Surveillance

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Abstract

Los Alamos National Laboratory (LANL or the Laboratory) operations emit radioactive and nonradioactive air pollutants and direct penetrating radiation into the atmosphere. Air surveillance at Los Alamos includes monitoring emissions, ambient air quality, direct penetrating radiation, and meteorological parameters to determine the air quality impacts of Laboratory operations.

The ambient air quality in and around the Laboratory meets all Environmental Protection Agency (EPA) and Department of Energy (DOE) standards for protecting the public and workers.

Radioactive air emissions, totaling 3050 Ci, were somewhat higher in 2000 than in 1999. The majority of the increase was from tritium emissions released during cleanup activities at Technical Area (TA) -21-209 and TA-33-86. There were no unplanned releases of radionuclides to the air that required reporting to the EPA or the New Mexico Environment Department (NMED). The Cerro Grande fire produced very high emissions of criteria pollutants, with ambient concentrations 2–20 times national ambient air quality standards.

Lower ambient air concentrations of plutonium and americium were recorded at TA-54, Area G, during 2000. Radioactive ambient air quality at other locations was similar to 1999. Highest air concentrations caused by Laboratory operations were measured at TA-54, Area G, and at two stations located near the original Laboratory TA-1. Tritium concentrations increased at several stations near TA-21 and TA-33 as a result of cleanup operations. Several instances of elevated air concentrations were investigated in 2000. These elevated air concentrations were the result of routine Laboratory operations. None of these elevated air concentrations exceeded DOE or EPA protection standards for workers or the public.

Ambient air samples were changed out and analyzed much more frequently than normal during the Cerro Grande fire. Elevated levels of gross alpha and gross beta were measured in locations impacted by the smoke. These increases were due to the resuspension of naturally occurring radionuclides produced by the decay of radon. High short-term uranium concentrations were measured, which appear to be attributable to the high winds that also spread the fire. The quarterly concentrations, which include these short-term measurements, were comparable to historical measurements with several on-site locations having low, but measurable concentrations of depleted uranium.

During 2000, measurements of direct penetrating radiation at most locations were similar to 1999 values. Highest doses were measured at locations on-site at TA-54, Area G; TA-3-130 (a new location in 2000); the Los Alamos Neutron Science Center (LANSCE) lagoons; and Area A at LANSCE. Measurements at several TA-54, Area G, locations were higher because of an increase in radioactive waste stored. We report one full year of albedo dosimeter (neutron) measurements, taken on-site in the vicinity of TA-18 and TA-3-130. The highest dose, 120.6 mrem, was measured adjacent to the LANL calibration facility, TA-3-130.

The dry winter and spring of 1999–2000, combined with exceptionally high winds, produced worst-case wildfire conditions during May 2000. A drier-than-normal summer rainfall season limited some of the potential for high runoff events following the Cerro Grande fire.

The Air Quality Group maintains a vigorous quality assurance program. Analytical laboratories met EPA requirements for quality control samples during 2000.

4. Air Surveillance

A. Ambient Air Sampling *(Craig Eberhart)*

1. Introduction

The radiological air-sampling network, referred to as AIRNET, at Los Alamos National Laboratory (LANL or the Laboratory) measures environmental levels of airborne radionuclides that may be released from Laboratory operations. Laboratory emissions include plutonium, americium, uranium, tritium, and activation products. Each AIRNET station collects two types of samples for analysis: a total particulate matter sample and a water vapor sample.

Natural atmospheric and fallout radioactivity levels fluctuate and affect measurements made by the Laboratory's air sampling program. Fallout from past atmospheric nuclear weapons tests by several countries, natural radioactive constituents in particulate matter such as uranium and thorium, terrestrial radon diffusing out of the earth and its subsequent decay products, and materials resulting from interactions with cosmic radiation (for example, natural tritiated water vapor produced by interactions of cosmic radiation and stable water) make up most of the regional airborne radioactivity. Table 4-1 summarizes regional levels of radioactivity in the atmosphere for the past five years, which can be useful in interpreting current air sampling data.

Particulate matter in the atmosphere is primarily caused by aerosolized soil, which is dependent on meteorological conditions. Windy, dry days can increase soil entrainment, but precipitation (rain or snow) can wash particulate matter out of the air. Consequently, changing meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity concentrations. During 2000, a major forest fire (the Cerro Grande fire) dramatically increased short-term ambient concentrations of particulate matter. See A.5 of this chapter for a separate discussion of ambient measurements associated with this fire.

The Air Quality Group (ESH-17) compares ambient air concentrations, as calculated from the AIRNET sample measurements, with environmental compliance standards or workplace exposure standards depending on the location of the sampler. Annual concentrations in areas accessible to the public are usually compared with the 10-mrem equivalent concentration established by the Environmental Protection Agency (EPA 1989) and published in 40 CFR Part 61 Appendix E Table 2—"Concentration Levels for Environmental Compliance." Concentrations in controlled access areas are usually compared with Department of Energy (DOE) Derived Air Concentrations (DAC) for workplace exposure (DOE 1988a) because access to these areas is generally limited to workers with a need to be in the controlled area.

2. Air Monitoring Network

During 2000, the Laboratory operated more than 50 environmental air samplers to sample radionuclides by collecting water vapor and particulate matter. AIRNET sampling locations (Figures 4-1 through 4-4) are categorized as regional, pueblo, perimeter, quality assurance (QA), Technical Area (TA) 21, TA-15 and TA-36, TA-54 (Area G), or other on-site locations. Four regional sampling stations determine regional background and fallout levels of atmospheric radioactivity. These regional stations are located in Española and El Rancho and at two locations in Santa Fe. The pueblo monitoring stations are located at San Ildefonso and Jemez Pueblos. In 2000, more than 20 perimeter stations were within 4 km of the Laboratory boundary.

Because maximum concentrations of airborne releases of radionuclides would most likely occur onsite, more than 20 stations are within the Laboratory boundary. For QA purposes, two samplers are co-located as duplicate samplers, one at TA-54 and one at TA-49. In addition, a backup station is located at East Gate. Stations can also be classified as being inside or outside a controlled area. A controlled area is a posted area that potentially has radioactive materials or elevated radiation fields (DOE 1988a). The active waste disposal site at TA-54, Area G, is an example of a controlled area.

We added two samplers to the sampling network in 2000: station 66 Los Alamos Inn-South and station 67 TA-3 Research Park. Station 66 replaced 07 Gulf/Exxon/Shell Station, which no longer met the AIRNET siting criteria because of a new apartment complex built nearby. However, station 07 operated through the end of the year. We installed station 67 to measure public exposure concentrations at the planned research park. Four samplers at TA-21 (72, 73, 74, and 75) were turned off in early 2000 because of the reduction in decontamination and decommissioning (D&D) activities at TA-21.

3. Sampling Procedures, Data Management, and Quality Assurance

a. Sampling Procedures. Generally, each AIRNET sampler continuously collects particulate matter and water vapor samples for approximately two weeks per sample. Particulate matter is collected on 47-mm polypropylene filters at airflow rates of about 0.11 m^3 per minute. The vertically mounted canisters each contain about 135 grams of silica gel with an airflow rate of about 0.0002 m^3 per minute; the gel collects the water vapor samples. This silica gel is dried in a drying oven before use in the field to remove most residual water. The gel is a desiccant that removes moisture from the sampled air; the moisture is then distilled, condensed, collected as a liquid, and shipped to the analytical laboratory. The AIRNET project plan (ESH-17 2000) and the numerous procedures through which the plan is implemented provide details about the sample collection, sample management, chemical analysis, and data management activities.

b. Data Management. Using a palm-top microcomputer, we recorded the 2000 sampling data, including timer readings, volumetric airflow rates at the start and stop of the sampling period, and comments pertaining to these data, electronically in the field. We later transferred these data to an electronic table format within the ESH-17 AIRNET Microsoft Access database. We also received the analytical data described in the next section in electronic form and loaded them into the database.

c. Analytical Chemistry. A commercial laboratory analyzed each 2000 particulate matter filter for gross alpha and gross beta activities. These filters were also grouped across sites, designated as “clumps,” and analyzed for gamma-emitting radionuclides. For 2000, clumps ranged from six to nine filters. Gamma-emitting radionuclides were also measured at each Federal Facilities Compliance Agreement station by grouping the filters collected each quarter. We combined half filters from the six or seven sampling periods at each site during the quarter to prepare a quarterly composite for isotopic analyses for each AIRNET station. These composites were dissolved, separated chemically, and then analyzed for isotopes of americium, plutonium, and uranium using alpha spectroscopy. Short-term particulate matter samples (two weeks and less) collected during the Cerro Grande fire were analyzed for the same isotopes. Some of these short-term samples were also analyzed for polonium-210 and lead-210, which used up the rest of the filter. Therefore, the net air concentration and uncertainty from these filters were combined with the quarterly composite concentrations and uncertainty on a time-weighted basis to provide a better estimate of quarterly concentrations (see Section A.5 later in this chapter for more details). Every two weeks, water was distilled from the silica gel that had been deployed to the field. A commercial laboratory analyzed this distillate for tritium using liquid scintillation spectrometry. All analytical procedures meet the requirements of 40 Code of Federal Regulations (CFR) 61, Appendix B, Method 114. The AIRNET project plan provides a summary of the target minimum detectable activity (MDA) for the biweekly and quarterly samples.

d. Laboratory Quality Control Samples. For 2000, ESH-17 and the contractor analytical laboratories maintained a program of blank, spike, duplicate, and replicate analyses. This program provided information on the quality of the data received from analytical chemistry laboratories. The chemistry met the QA requirements for the AIRNET program. Section F later in this chapter provides additional detail.

4. Ambient Air Concentrations

a. Explanation of Reported Concentrations. Tables 4-1 through 4-12 summarize the ambient air concentrations calculated from the field and analytical data. Table 4-1 summarizes the average background concentrations of airborne radioactivity for the last five years. Tables 4-2 through 4-12 summarize ambient air concentrations by the type of radioactivity or by specific radionuclides. The summaries include the number of measurements; the number of these measurements less than the 2s uncertainty; the maximum, minimum, and average concentrations; the sample standard deviation; and, for the group summaries, the 95% confidence intervals. The number of measurements is normally equal to the number of samples analyzed. The number of measurements less than the uncertainty is the number of calculated net air concentrations that are less than their individual propagated net 2s analytical uncertainties. These concentrations are defined as not having measurable amounts of the material of interest. The MDAs in Tables 4-11 and 4-12 are the levels that the instrumentation could detect under ideal conditions.

All AIRNET concentrations and doses are total measurements without any type of regional background subtractions. However, beginning this year, the concentrations and uncertainties reported in Tables 4-2 through 4-10 are net concentrations and net uncertainties. The net air concentrations, or blank-corrected data, include corrections for the radioactivity from the filter material and the analytical process. The net concentrations are usually somewhat lower than the gross concentrations because small amounts of radioactivity are present in the filter material, the acids used to dissolve the filter, and the tracers added to determine recovery efficiencies. The net uncertainties include the variation added by correcting for the blank measurements.

All data in this AIRNET section, whether in the tables or the text, that are expressed as a value plus or minus (±) another value represent a 95% confidence interval. Because these confidence intervals are calculated with data from multiple sites and throughout the year, they include not only random measurement and analytical errors but also seasonal and spatial variations as well. As such, the calculated 95% confidence intervals are overestimated (wider) for the average concentrations and probably represent confidence intervals that approach 100%. In addition, the air concentration standard deviations in the tables represent one standard deviation as calculated from the sample data. All ambient concentrations are activity concentrations per actual cubic meter of sampled air.

Some values in the tables indicate that we measured negative concentrations of radionuclides in the ambient air, which is physically impossible. However, it is possible for the measured concentration to be negative because the measured concentration is 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.

b. Gross Alpha and Beta Radioactivity. We use gross alpha and gross beta analyses primarily to evaluate general radiological air quality, to identify potential trends, and to detect sampling problems. If gross activity in a sample is consistent with past observations and background, immediate special analyses for specific radionuclides are not necessary. If the gross analytical results appear to be elevated, then immediate analyses for specific radionuclides may be performed to investigate a potential problem, such as an unplanned release. Gross alpha and beta activity in air exhibits considerable environmental variability and, for alpha measurements, analytical variability. These naturally occurring sources of variability generally overwhelm any Laboratory contributions.

The National Council on Radiation Protection and Measurements (NCRP) estimated the national average concentration of long-lived gross alpha activity in air to be 2 fCi per cubic meter. The primary alpha activity is due to polonium-210 (a decay product of radon) and other naturally occurring radionuclides (NCRP 1975, NCRP 1987). The NCRP also estimated national average concentration levels of long-lived gross beta activity in air to be 20 fCi per cubic meter. The presence of lead-210 and bismuth-210 (also decay products of radon) and other naturally occurring radionuclides is the primary cause of this activity.

In 2000, we collected and analyzed more than 1,000 air samples for gross alpha and gross beta activity. As shown in Table 4-2, the annual mean for all of the stations is less than the NCRP's estimated average (2 fCi per cubic meter) for gross alpha concentrations. At least two factors contribute to these seemingly lower concentrations: the use of actual sampled air volumes instead of converting to standard temperature and pressure volumes and the burial of alpha emitters in the filter that are not measured by front-face counting. Gross alpha activity is almost entirely from the decay of natural radionuclides, primarily radon, and is dependent on variations in natural conditions such as atmospheric pressure, atmospheric mixing, temperature, soil moisture, and the “age” of the radon. Differences among the sampler groups may be attributable to these factors (NCRP 1975, NCRP 1987).

Table 4-3 shows gross beta concentrations within and around the Laboratory. These data show variability similar to the gross alpha concentrations. All of the annual averages are below 20 fCi per cubic meter, the NCRP-estimated national average for beta concentrations, but the gross beta measurements include little if any lead-210 because of its low-energy beta emission. In addition, the gross beta measurements are also calculated on the actual sampled air volumes.

c. Tritium. Tritium is present in the environment primarily as the result of nuclear weapons tests and natural production by cosmogenic processes (Eisenbud and Gesell 1997). Tritium is released by the Laboratory in curie amounts; in 2000, Laboratory operations released approximately 2,400 curies of tritium. Tritium is released from Laboratory operations as hydrogen (HT or T_2) and as an oxide (HTO or T_2O) [water]. We measure the tritium as an oxide because the dose impact is about 14,000 times higher than if it were hydrogen (DOE 1988b).

Estimating ambient levels of tritium as an oxide (water) requires two factors: water vapor concentrations in the air and tritium concentrations in the water vapor. Both of these need to be representative of the true concentrations to obtain an accurate estimate of the ambient tritium concentrations. In early 1998, we found that the silica gel collection medium was not capable of removing all of the moisture from the atmosphere (Eberhart 1999). Collection efficiencies were as low as 10% to 20% in the middle of the summer when the ambient concentrations of water vapor were the highest. Because 100% of the water was not collected on the silica gel and we used this water to measure water vapor concentrations, the atmospheric water vapor, and therefore tritiated water, has been underestimated. However, data from the meteorological monitoring network provide accurate measurements of atmospheric water vapor concentrations and have been combined with the analytical results to calculate all ambient tritium concentrations in this report. The EPA approved use of this method for compliance calculations of atmospheric tritium concentrations in March 1999 (EPA 1999).

Table 4-4 presents the sampling results for tritiated water concentrations. The annual concentrations for 2000 at all of the regional and pueblo stations, with the exception of station 56 at El Rancho, were lower than all of the on-site and perimeter stations. The El Rancho site would have been lower also, but one biweekly measurement was unusually high with a concentration of 43 pCi per cubic meter. We were not able to identify any source for this higher number, but organic contamination of the sample, which had caused some analytical problems, may have been the cause. In addition, most of the on-site stations in technical areas with tritium sources (TA-16, TA-21, and TA- 54) had higher annual concentrations than the perimeter stations. These data indicate that the Laboratory is a measurable source of tritium based on ambient concentrations. All annual mean concentrations at all sampling sites were well below the applicable EPA and DOE guidelines.

Another way to view the data is by comparing the number of biweekly concentrations greater than their 2s uncertainty (that is, quantitatively measurable) with the total number of measurements. Less than 5% of the measurements at regional and pueblo locations are above their 2s uncertainties, whereas about half of the measurements at the perimeter locations are higher. Finally, more than 95% of the measurements in technical areas with tritium sources are higher than their uncertainties.

The highest off-site annual concentration, 5.5 pCi per cubic meter, was at station 09 (the Los Alamos Airport), which tends to be downwind of TA-21. This concentration is equivalent to about 0.4% of the EPA public dose limit. We calculated elevated concentrations at a number of on-site stations, with the highest maximum and annual mean concentrations at station 35 within TA-54, Area G. This sampler is located in a radiological control area, near shafts containing tritium-contaminated waste. The annual mean concentration, 837 pCi per cubic meter, is only 0.004% of the DOE DAC for worker exposure.

d. Plutonium. While plutonium occurs naturally at extremely low concentrations from cosmic radiation and spontaneous fission (Eisenbud and Gesell 1997), it is not naturally present in measurable quantities in the ambient air. All measurable sources are from plutonium research and development activities, nuclear weapons production and testing, the nuclear fuel cycle, and other related activities. With few exceptions, worldwide fallout from atmospheric testing of nuclear explosives is the primary source of plutonium in ambient air. Four isotopes of concern can be present in the atmosphere: plutonium-238, plutonium-239, plutonium-240, and plutonium-241. Plutonium-241 is not measured because it is a low-energy beta emitter that decays to americium-241, which we do measure. This beta decay is not only hard to measure, but the dose is small when compared to americium-241. Plutonium-239 and plutonium-240 are indistinguishable by alpha spectroscopy and are grouped together for analytical purposes. Therefore, any ambient air concentrations or analyses listed as plutonium-239 actually represent both plutonium-239 and plutonium-240.

Table 4-5 presents sampling results for plutonium-238. No off-site quarterly concentrations were above their uncertainty levels. Four on-site quarterly concentrations were above their uncertainties, with three at TA-54, Area G. Two of the three TA-54 measurements were at station 34, which indicates that the concentrations at this location are quantitative and above background levels. The annual mean activity at this location was 3.0 aCi/m^3, which corresponds to 0.0001% the DOE DAC for worker exposure. This same location also had the highest 1999 annual concentration.

Sampling results for plutonium-239, -240 appear in Table 4-6. As with the plutonium-238 analyses, most of the analytical results were below their estimated uncertainties. Three off-site locations (07, 32, and 66), all in Los Alamos, had two or more quarters with measurable concentrations of plutonium-239, -240. The highest off-site annual mean was at site 66 (Los Alamos Inn-South), with a concentration of 17 aCi/m^3 or about 0.8% of the EPA public dose limit. We installed this site to replace site 07 because a three-story apartment building was constructed close to site 07 and between it and the Laboratory. We had expected ambient concentrations at sites 07 and 66 to be comparable because both are located near or on the original LANL processing area (TA-1), but the annual concentration at site 66 was about three times greater. These higher ambient concentrations are apparently from historical TA-1 activities that deposited small amount of plutonium on the hillside below site 66.

We recorded the highest annual on-site concentration at station 34 in Area G. The concentration was 18 aCi/m^3, about 17% of the 1999 concentrations for this site. It is about 0.001% of the DOE DAC for workplace exposure.

e. Americium-241. Americium-241, a decay product of plutonium-241, is the primary source of radiation from this plutonium isotope. Nuclear explosions, the nuclear fuel cycle, and other processing of plutonium release plutonium-241 to the environment.

Table 4-7 presents the americium results. As with the plutonium isotopes, americium is present in very low concentrations in the environment. Two quarterly off-site measurements were above their uncertainty levels. One sample was collected at station 07, which may have been from historical TA-1 operations, and one was at station 32, the county landfill. The highest off-site annual concentration, at the county landfill, was 1.8 aCi/m^3, which is 0.1% of the EPA public dose limit. The high particulate matter concentrations at site 32, which contain proportionally more fallout radioactivity, may have caused the higher americium concentrations.

The only other location with measurements above the uncertainties was Area G where 12 of 32 quarterly samples were above their 2s uncertainties. The overall concentration at Area G was more than 10 times higher than for any group of samplers with an average of 14 aCi/m^3. The highest annual on-site concentration was 87 aCi/m^3 at station 34, which is similar to the 1999 average. This concentration is about 0.004% of the DOE DAC for worker exposure.

f. Uranium. Three isotopes of uranium are normally found in nature: uranium-234, uranium-235, and uranium-238. The natural sources of uranium are crustal rocks and soils. Therefore, the ambient concentrations depend upon the mass of suspended particulate matter, the uranium concentrations in the parent material, and any local sources. Typical uranium crustal concentrations range from 0.5 ppm to 5 ppm, but local concentrations can be well above this range (Eisenbud and Gesell 1997). Relative isotopic abundances are constant and well characterized. Uranium-238 and uranium-234 are essentially in radioactive equilibrium, with a measured uranium-238 to uranium-234 isotopic activity ratio of 0.993 (as calculated from Walker et al., 1989). Thus, activity concentrations of these two isotopes are effectively the same in particulate matter derived from natural sources. Because known LANL uranium emissions are enriched (excess uranium-234 and -235) or depleted (excess uranium-238), we can use comparisons of isotopic concentrations to estimate LANL contributions. Using excess uranium-234 to detect the presence of enriched uranium may not seem suitable because the enrichment process is usually designed to increase uranium-235 concentrations. However, the enrichment process normally increases uranium-234 at a faster rate than uranium-235, and the dose from natural uranium is about an order of magnitude higher for uranium-234 than for uranium-235. Tables 4-8 through 4-10 give uranium results by isotope. Figure 4-5 shows the plotted annual uranium-234 and -238 concentrations along with a line representing the natural abundance of the two isotopes. In addition, several samplers are identified by their site number and/or by their general location (firing sites or downwind from firing sites).

All annual mean concentrations of the three uranium isotopes were well below the applicable EPA and DOE guidelines. The maximum annual uranium concentrations were at locations with high dust levels from local soil disturbances such as dirt roads at the Los Alamos County Landfill and Area G. The maximum annual uranium-234 concentration was 62 aCi/m^3 at the landfill (station 32), which is about 0.1% of the EPA public exposure limit. The maximum annual uranium-235 concentration was 3.5 aCi/m^3 at station 27, which was slightly higher than the maximum off-site concentration of 3.1 aCi/m^3 at site 07 in Los Alamos. These uranium-235 concentrations are less than 0.01% of the EPA limit. Most of the uranium-235 measurements (89%), both on- and off-site, were below the uncertainties, whereas about 11% of the uranium-234 and uranium-238 concentrations were below their 2s uncertainties. Consequently, most uranium-235 data should not be considered quantitative measurements and will not be evaluated as such. The maximum annual uranium-238 concentration was 64 aCi/m^3, which was also at the landfill. As with the uranium-234 concentration, the uranium-238 concentration is about 0.1% of the EPA limit.

Both the regional and pueblo groupings had comparable or higher average concentrations of uranium-234 and uranium-238 than all of the other groupings except for the TA-54, Area G, stations. The higher concentrations for the regional and pueblo groups result from increased particulate matter concentrations associated with unpaved roads, unpaved parking lots, and other soil disturbances such as construction activities and even grazing but not any known “man-made” sources of uranium. Dry weather or a drier climate can also increase ambient concentrations of particulate matter and therefore uranium. Annual mean concentrations for both uranium-234 and uranium-238 were above 50 aCi/m^3 at five sites for 2000. Four of these stations are located at Area G (27, 38, 45, and 47), and one is located at the Los Alamos County Landfill (station 32).

Most of the quarterly uranium measurements above 50 aCi/m^3 were measured at Area G or at the county landfill. As noted earlier, some Area G sites have plutonium and americium concentrations that are above background levels. However, comparable concentrations of uranium-238 and uranium-234 indicate that the higher uranium concentrations at the Area G sites and at the county landfill (station 32) are attributable to natural uranium associated with higher levels of suspended particulate matter from unpaved roads and other surface soil disturbances.

Excess isotopic concentrations can also be identified using Figure 4-5. Two of the three firing site samplers (stations 77 and 78), the three samplers immediately downwind from the firing sites (stations 23, 30, and 49), and site 07 at the old TA-1 in the Los Alamos town site appear to have excess uranium-238. One of the new samplers, the TA-3 Research Park site (site 67), may have excess uranium-234 indicating enriched uranium. We collected only two quarterly composited samples during 2000 for site 67, but both showed excess uranium-234 indicating a possible source nearby. Sampler 07 may have measured excess depleted uranium from the recent construction entraining materials from historical TA-1 activities.

Station 77 at TA-36, which is located in an area where depleted uranium is still present as surface contamination from explosive tests, had uranium-238 concentrations that were more than double the uranium-234 concentrations. It has been previously identified as a location with excess ambient concentrations of uranium-238 (Eberhart et al., 1999; ESP 1999; and ESP 2000). The 2000 uranium-238 and uranium-234 concentrations at this site were 34 and 14 aCi/m^3 respectively. These concentrations are comparable to the 1999 concentrations of 30 and 13 aCi/m^3. If we assume that about 15% of the activity in depleted uranium is uranium-234, the calculated LANL contributions at this location were about 4 aCi/m^3 of uranium-234 and 24 aCi/m^3 of uranium-238. Therefore, the combined estimated LANL contribution at this on-site controlled access location is about 0.0001% of the DOE DAC for workplace exposure. Station 78 also has excess uranium-238, but the difference is smaller indicating a lower impact.

The three samplers immediately downwind from the firing sites (stations 23, 30, and 49) also appeared to have excess uranium-238. The excess uranium-238 is relatively small but may be due to resuspended material from the firing sites. Samplers further downwind from the firing sites do not exhibit excess uranium-238. Concentrations of both isotopes at these three samplers are lower than the natural uranium concentrations at the dusty sites.

g. Gamma Spectroscopy Measurements. In 2000, gamma spectroscopy measurements were made on groups of filters including analyses of “clumps” (biweekly filters grouped across sites for a single sampling period) and quarterly composites (biweekly filters grouped across time for a single site). Even though these gamma emitters have no action levels per se, we would investigate any measurement, other than beryllium-7, potassium-40, and lead-210, above the MDA because the existing data indicate that such a measurement is highly unlikely except after an accidental release. Instead of action levels, the AIRNET Sampling and Analysis Plan (ESH-17 2000) lists the minimum detection levels for 16 gamma emitters that could either be released from Laboratory operations or that occur naturally in measurable amounts (beryllium-7 and lead-210). The minimum levels are equivalent to a dose of 0.5 mrem. The beryllium-7 and lead-210 measurements were the only isotopes above their MDAs.

Table 4-11 summarizes the “less than” concentrations. The average annual MDA for every radionuclide in this table meets the required minimum detection levels. Because every value used to calculate the average annual MDA was a “less than” value for the 14 radionuclides listed in the table, it is likely that the actual concentrations are 3 or more standard deviations away from the average MDA. As such, the ambient concentrations, which were calculated from the MDA values, are expressed as “much less” (<<) values.

Table 4-12 summarizes the beryllium-7 and lead-210 data. Both beryllium-7 and lead-210 occur naturally in the atmosphere. Beryllium-7 is cosmogenically produced, whereas lead-210 is a decay product of radon-222. Some lead-210 is related to suspension of terrestrial particulate matter, but the primary source is atmospheric decay of radon-222 as shown in Figure 4-6. Even though the beryllium-7 and lead-210 are derived from gases, both become elements that are present as solids or particulate matter. These radionuclides will quickly coalesce into fine particles and also deposit on the surfaces of other suspended particles. The effective source is cosmic for beryllium-7 and terrestrial for lead-210, so the ratio of the two concentrations will vary, but they should be relatively constant for a given sampling period. Because all of the other radionuclides measured by gamma spectroscopy are “less than” values, measurements of these two radionuclides provide verification that the sample analysis process is working properly.

5. Ambient Air Quality Measurements during the Cerro Grande Fire

a. Introduction. The Cerro Grande fire dramatically influenced concentrations of particulate matter and radioactivity in the ambient air. This fire, or any vegetation fire, releases the radioactivity in and on the vegetation to the atmosphere. Conceptually, this material will be added to the concentrations already present in the air. The fire may also entrain additional particulate matter from the Earth’s surface by the physical turbulence associated with burning, or it could burn contaminated material and release radioactive particulate matter. The temperature of the fire and the volatility of the element or compound will greatly influence ambient concentrations. For example, volatile materials such as lead and polonium will be vaporized and then preferentially enriched on fine particles as a result of their high surface area. Conversely, most refractory, or nonvolatile, materials such as potassium and uranium that are not vaporized during a fire will be found in the large particles and the ash along with most of the remaining mass of burned materials and vegetation.

b. Sampling and Analysis. The first group of samples that may have been impacted by fire emissions were the biweekly particulate matter filters removed from our AIRNET samplers and replaced with new filters on May 9 or May 10. To expedite analysis, an employee hand-carried these samples to the Wastren-Grand Junction Analytical Laboratory for normal biweekly analyses and additional isotopic analyses. In an effort to assess the impact of the fire and to maintain continuous sampling, we replaced most filters at least one more time from May 10 through May 14. Even though filters are normally used in the field to collect continuous two-week samples, the smoke from the fire was clogging the filters after several days. Therefore, we replaced the filters more frequently to ensure that we would have as much sampling coverage as possible for the duration of the fire. All filters collected from May 9, 2000, through May 14, 2000, were individually counted for gross alpha and gross beta radiation. The filters were also clumped together and measured by gamma spectroscopy. Half of each filter was dissolved and analyzed for uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, -240, and americium-241. The remaining half of each filter was *either* used in the quarterly composite for isotopic analyses, or it was analyzed for polonium-210 and lead-210. Because these were destructive analyses, the filters that were analyzed for polonium and lead were not included in the quarterly composites. Therefore, we combined the net air concentration and uncertainty from these filters with the quarterly composite concentrations and uncertainty on a time-weighted basis to provide a better estimate of quarterly concentrations.

c. Gross Alpha and Beta Measurements. The first data the Laboratory received were screening counts for gross beta, gross alpha, and gamma spectroscopic measurements. These screening counts were later replaced by longer counts to provide more accurate measurements. Figure 4-7 graphs the gross alpha and the gross beta activity from the 1999 samples and the samples collected during the fire (approximately April 22–May 10, May 11–May 14, and May 14–May 22). Data from the Viveash fire in the Sangre de Cristo mountains east of Santa Fe, New Mexico, that the New Mexico Environment Department (NMED) collected in 2000 and from African fires (Lambert et al., 1991; Le Cloarec et al., 1995) also appear on this graph. The alpha and beta data did not dramatically increase until the May 11–14 samples. These data show that alpha concentrations increased by roughly a factor of 10 to 20 and beta concentrations by about a factor of two to four from before the fire. The net or incremental increase above background was similar for both types of radiation. The gross alpha and gross beta concentrations for the May 22 samples, which cover approximately May 13 and May 14 through May 23, are generally comparable to pre-fire concentrations and indicate a return to typical concentrations.

The increases in gross alpha and gross beta were expected because the decay of radon-222 as shown in Figure 4-6 produces lead-210, followed by bismuth-210, and then polonium-210. These radionuclides are constantly being deposited in forests and have been accumulating for many years because of the 22-year half-life of lead-210. As radon gas decays in the atmosphere, it creates charged radioactive particles, many of which deposit on suspended particulate matter or other surfaces such as leaves and needles. The amount of these radioactive particles suspended in the atmosphere is measurable, but relatively small, when compared with the amount present in the forests that the Cerro Grande fire burned. When these forests burned, the heat and turbulence from the fire were very effective at resuspending these radioactive elements from the surfaces of vegetation and the forest floor and from the soil surface. These resuspended radon decay products caused the large increases in alpha and beta air concentrations observed during the Cerro Grande fire. The comparable data from the Viveash and African fires in Figure 4-7 support this explanation.

d. Polonium-210 and Lead-210 Measurements. Figures 4-8 and 4-9 compare polonium-210 and lead-210 concentrations to gross alpha and gross beta concentrations. These graphs show a direct relationship between gross alpha and polonium-210 and between gross beta and lead-210. The polonium-210 concentrations are higher than the gross alpha concentrations, but the gross alpha concentrations are calculated from front-face counts, which can underestimate concentrations because of the burial of the alpha emitters in the filter. Burial will not affect gross beta activity, but gross beta activity will not include the lead-210 because of its low-energy beta particles. Therefore, most of the beta activity will be due to bismuth-210, which should be comparable to lead-210 concentrations because it is a short-lived decay product of lead-210. Differences in the lead-210 and gross beta concentrations may be due to differences in volatility during the fire, analytical uncertainty, an unidentified beta emitter, or other beta emitters suspended by the fire, such as potassium-40.

e. Uranium, Plutonium, and Americium Measurements. Because the air volumes being sampled and the mass of material being collected during these shorter periods were much lower than for a quarterly composite, we could not measure concentrations as sensitively or as precisely as we can with larger samples taken over longer periods of time. Therefore, our ability to detect low concentrations of uranium, plutonium, and americium has been reduced. Most of the estimated concentrations are below the analytical uncertainty indicating that the radionuclide was not detected. Figure 4-10 shows the effects of sampled air volume on the uncertainty of the measurements.

Calculated short-term concentrations of uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, -240, and americium-241 during the fire were more variable than historical quarterly concentrations with higher and lower concentrations. However, as Figures 4-11 and 4-12 show, all but two of the plutonium and americium concentrations were below their 3s measurement uncertainties. Those two samples were from sites with known sources of contamination: site 66 in the old TA-1 processing area and site 34 in Area G.

Many of the uranium measurements were above their uncertainties and much higher than the quarterly concentrations (see Figure 4-13), but isotopic comparisons generally indicate that the uranium is natural except at the firing site locations and immediately downwind as noted earlier. The high winds during the fire appear to be the primary causes of the high short-term concentrations. Winds about 7 m/sec or faster dramatically increase ambient concentrations of particulate matter (Whicker et al., 2001). During the second quarter of 2000, about 24% of these high winds occurred on May 10 and May 11 based on TA-54 meteorological tower data. The percent expected to occur on these days would have been only about 2.2%. Therefore, these windy days and the physical turbulence from the fire could cause much higher concentrations of natural uranium simply by resuspending more particulate matter. The fire may have also resuspended additional depleted uranium, but quarterly concentrations were not unusually high (Figure 4-5). Finally, recent wind tunnel studies of the AIRNET sampler indicate that it oversamples large particles during high winds (Rodgers et al., 2000), which may have also been a contributor to higher measurements during the high wind conditions.

f. Gamma Spectroscopy Measurements. The gamma spectroscopy data did not indicate any radionuclides other than from natural sources, which include beryllium-7, lead-210, and lead-212. Occasional samples also had detectable amounts of potassium-40. The beryllium-7 and the lead-210 measurements are the only isotopes normally above their minimum detectable activities. However, for the samples analyzed sooner than usual, lead-212, an additional radionuclide with a half-life of about 11 hours, was measured above its minimum detectable activity as a result of the short time between sample collection and analysis: normally, lead-212 has decayed away before gamma spectroscopy measurements commence. Beryllium-7, lead-210, and lead-212 occur naturally in the atmosphere. Beryllium-7 is cosmogenically produced, whereas lead-210 and lead-212 are radon decay products. Because gases produce all three radionuclides, they will quickly coalesce into fine particles and also deposit on other surfaces such as suspended particles and pine needles. Beryllium-7 has a relatively short half-life, 53 days, but it is still long enough to accumulate to some extent in the forests. These radionuclides did increase during the fire as Figure 4-14 shows. The proportionate increase for lead-210 was much greater than for beryllium-7 because of its much longer half-life. Concentrations of both radionuclides returned to pre-fire levels for the samples collected the week of May 22, 2000.

6. Investigation of Elevated Air Concentrations

Upon receiving the analytical chemistry data for biweekly and quarterly data, ESH-17 personnel calculated air concentrations and reviewed them to determine if any values indicated an unplanned release. Two action levels have been established: investigation and alert. Investigation levels are based on historical measurements and are designed to indicate that an air concentration is higher than expected. Alert levels are based on dose and require a more thorough, immediate follow-up.

In 2000, a number of air sampling values exceeded ESH-17 investigation levels. When a measured air concentration exceeds an investigation level, ESH-17 verifies that the calculations were done correctly and that the sampled air concentrations are likely to be representative, i.e., that no cross contamination has taken place. Next, we work with personnel from the appropriate operations to assess potential sources and possible mitigation for the elevated concentrations.

A number of uranium measurements exceeded action levels during 2000. In each case, the follow-up investigation demonstrated that natural uranium associated with higher levels of suspended particulate matter produced the elevated uranium concentrations except for the depleted on-site uranium concentrations discussed in Section A.4.f. We reached this conclusion by comparing the ratio of measured uranium-234 and uranium-238 air concentrations with the ratio in naturally occurring uranium. Therefore, no Laboratory source of uranium was identified as contributing to off-site concentrations. The following sections identify five investigations that are not covered elsewhere in this document and that warrant further discussion.

a. Post-Cerro Grande Fire Sampling. After the Cerro Grande fire was extinguished, we conducted some additional sampling for recovery operations. We took high-volume total suspended particulate (TSP) samples at TA-16, Material Disposal Area R, during June 2000 and at the sediment traps in Mortandad Canyon during August 2000. These samples were counted for gross alpha and gross beta and analyzed for uranium, plutonium, and americium isotopes. We identified no above-background levels of radionuclides at either location.

b. Elevated Tritium at TA-16 during March 2000. Tritium concentrations at station 25, at TA-16, exceeded the investigation level during the biweekly periods ending March 13 and March 27, 2000. The movement and/or handling of crates with tritium-contaminated equipment stored near the station probably caused the elevated air concentrations of 192 and 238 pCi/m^3. These crates will eventually be moved out of TA-16 for final disposal. If this bi-weekly concentration had occurred for an entire year, the annual concentration would be less than 0.001% of the DOE DAC for occupational workers.

c. Elevated Tritium near TA-21 in 2000. During the last week in March and the first week of April 2000, an equipment malfunction at the Tritium Science and Fabrication Facility (TSFF), TA-21-209, produced higher than average tritium emissions. Several nearby stations recorded ambient air concentrations above investigation levels. The highest off-site measurement, 29 pCi/m^3, was recorded at the Los Alamos Airport (station 9). This concentration is about 2% of the EPA public exposure limit. The highest on-site measurement occurred at TA-21 (station 71) with a concentration of 33 pCi/m^3, which is much less than 0.001% of the DOE DAC for workplace exposure.

A similar, but less distinctive pattern was observed in the first two weeks of August 2000 when emissions from TA-21 were somewhat higher, and ambient concentrations exceeded investigation levels. These concentrations were only about half of the levels listed above.

d. Elevated Tritium at TA-49. The investigation levels of tritium at the two TA-49 samplers were exceeded for the sampling period ending November 20, 2000, when concentrations reached about 17 pCi/m^3. The emissions at the Weapons Engineering Tritium Facility (WETF), TA-16-205, had increased somewhat during this two-week period and may have caused the increased concentrations given appropriate meteorological conditions.

e. Elevated Plutonium-239 and Americium-241 at Station 34 (TA-54, Area G-1 [behind trailer]). As described in Section A.4 of this chapter, this site had the highest concentrations of all three transuranic radionuclides. Americium-241 action levels were exceeded for the first three quarters of 2000, and plutonium-239 concentrations were exceeded for the first two quarters. One quarterly plutonium-238 measurement exceeded the action level for this location, but it was less than its associated uncertainty. Higher concentrations have been measured at this site since the first quarter of 1999. These higher concentrations are apparently associated with the operation of the Transuranic Waste Inspectable Storage Project (TWISP).

Based on the first quarter data from this sampler in 1999, the operations group instituted radiologically engineered controls to help minimize future releases to the air during these activities. These controls appeared to reduce ambient concentrations of plutonium and americium, but the concentrations are still above background levels. Because this sampler is very close to the TWISP operations and other Area G samplers do not appear to be impacted, the releases appear not to have been large or widespread. The action levels for site 34 were developed using pre-1999 data and need to be revised to reflect current operational activities.

7. Long-Term Trends

Previous Environmental Surveillance Reports covered long-term trends for tritium (ESP 1998 and ESP 1999) and gross alpha, gross beta, and gamma measurements (ESP 2000). This year, we evaluated trends for plutonium and americium.

Worldwide concentrations of plutonium and americium are primarily attributable to historical nuclear testing and, for plutonium-238, to the abortive reentry of a satellite in 1964 (Eisenbud and Gesell 1997). Background ambient concentrations are generally not measurable by using alpha spectroscopy on our quarterly composites: only one measurement out of 341 analyses during the last five years for the regional and pueblo samples was above its 2s analytical uncertainty. However, on-site measurements of plutonium-238, plutonium-239, and americium-241 are clearly higher for the TA-21 and the TA-54, Area G, samplers where about one-third of the measurements are detectable concentrations of these radionuclides. Perimeter samplers are somewhere in between, with about 4% of the samples having measurable concentrations.

Figures 4-15 (plutonium-238), 4-16 (plutonium-239, -240), and 4-17 (americium-241) graph the annual concentrations by isotope and general station location. Annual average concentrations for plutonium-238, plutonium-239, and americium-241 are above zero for the TA-21 and the TA-54, Area G, samplers. The decreasing concentrations at these two groups of samplers in the last five years are due to the reduced D&D activities at TA-21 and the increased engineering and fugitive dust controls at Area G. The average concentrations for the other sampler groupings vary around zero with occasional samples and/or locations having detectable concentrations.

B. Stack Sampling for Radionuclides *(Scott Miller)*

1. Introduction

Radioactive materials are an integral part of many activities at the Laboratory. Some operations involving these materials may vent them to the environment through a stack or other forced air release point. Air Quality personnel at the Laboratory evaluate these operations to determine impacts on the public and the environment. If this evaluation shows that emissions from a stack may potentially result in a member of the public receiving as much as 0.1 mrem in a year, the Laboratory must sample the stack in accordance with Title 40 Code of Federal Regulations (CFR) 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (EPA 1989). As of the end of 2000, 28 stacks were identified as meeting this criterion. An additional two sampling systems were in place to meet DOE requirements for nuclear facilities prescribed in their respective technical or operational safety requirements. Where sampling is not required, we estimate emissions using engineering calculations and radionuclide materials usage information.

2. Sampling Methodology

As of the end of 2000, LANL continuously sampled 30 stacks for the emission of radioactive material to the ambient air. LANL categorizes its radioactive stack emissions into one of four types: (1) particulate matter, (2) vaporous activation products (VAP), (3) tritium, and (4) gaseous/mixed air activation products (G/MAP). For each of these emission types, the Laboratory employs an appropriate sampling method, as described below.

The Laboratory samples emissions of radioactive particulate matter, generated by operations at facilities such as the Chemistry and Metallurgy Research Building (CMR) and TA-55, using a glass-fiber filter. A continuous sample of stack air is pulled through the filter, where small particles of radioactive material are captured. These samples are analyzed weekly using gross alpha/beta counting and gamma spectroscopy to identify any increase in emissions and to identify short-lived radioactive materials. Every six months, ESH-17 composites these samples for shipment to an off-site laboratory. The commercial laboratory analyzes these composited samples to determine the total activity of materials such as uranium-234, uranium-235, and uranium-238; plutonium-238 and plutonium-239, -240; and amercium-241. We then use these data to calculate emissions.

To sample VAP emissions such as selenium-75 and bromine-77 that the Los Alamos Neutron Science Center (LANSCE) operations and hot-cell activities at CMR and TA-48 generate, the Laboratory uses a charcoal cartridge. A continuous sample of stack air is pulled through a charcoal filter where vaporous emissions of radionuclides are adsorbed. The amount and identity of the radionuclide(s) present on the filter are determined through the use of gamma spectroscopy.

Tritium emissions from the Laboratory's tritium facilities are measured using a collection device known as a bubbler. This device enables the Laboratory to determine not only the total amount of tritium released but also whether it is in the elemental (HT) or oxide (HTO) form. The bubbler operates by pulling a continuous sample of air from the stack, which is then "bubbled" through three sequential vials containing ethylene glycol. The ethylene glycol collects the water vapor from the sample of air, including any tritium that may be part of a water molecule (HTO). After "bubbling" through these three vials, essentially all HTO is removed from the air, leaving only elemental tritium. The sample containing the elemental tritium is then passed through a palladium catalyst, which converts the elemental tritium to HTO. The sample is then pulled through three additional vials containing ethylene glycol, which collects the newly formed HTO. The amount of HTO and HT is determined by analyzing the ethylene glycol for the presence of tritium using liquid scintillation counting (LSC).

Although the tritium bubbler described above is the Laboratory's preferred method for measuring tritium emissions, we employ a silica gel sampler at the LANSCE facility. A sample of stack air is pulled through a cartridge containing silica gel. The silica gel collects the water vapor from the air, including any HTO. The water is distilled from the sample, and the amount of HTO is determined by analyzing the water using LSC. Using silica gel is necessary because some of the gaseous emissions from LANSCE other than tritium will also be collected by the ethylene glycol. These additional radionuclides will interfere with the determination of tritium, resulting in less than desirable results. Also, because the primary source for tritium is activated water, sampling for only HTO is appropriate.

G/MAP emissions resulting from activities at LANSCE are measured using real-time monitoring data. A sample of stack air is pulled through an ionization chamber that measures the total amount of radioactivity in the sample. Specific radioisotopes are identified through the use of gamma spectroscopy and decay curves.

3. Sampling Procedures and Data Management

Sampling and Analysis. Analytical methods were chosen for compliance with EPA requirements (40 CFR 61, Appendix B, Method 114). Results of analytical quality assurance measurements are discussed in detail in the section Quality Assurance Program in the Air Quality Group (see Section F). General discussions on the sampling and analysis methods for each of LANL's emissions follow.

Particulate Matter Emissions. Glass-fiber filters, used to sample facilities with significant potential for radioactive particulate emissions, were generally removed and replaced weekly and transported to the Health Physics Analysis Laboratory (HPAL). Before screening the samples for the presence of alpha and beta activity, the HPAL allowed approximately 72 hours for the short-lived progeny of radon to decay. These initial screening analyses established that potential emissions were within the normal range of values. Final analyses were performed after the sample had been allowed to decay for approximately one week. In addition to alpha and beta analyses, the HPAL used gamma spectroscopy to identify the energies of gamma ray emissions from the samples. Because the energy of decay is specific to a given radioactive isotope, the HPAL could determine the identity of any isotopes detected by the gamma spectroscopy. The amount, or activity, of an isotope could then be found by noting the number of photons detected during analysis. The HPAL analyzed glass-fiber filters from LANSCE using only gamma spectroscopy.

Because gross alpha/beta counting cannot identify specific radionuclides, the glass-fiber filters were composited every six months for radiochemical analysis at an off-site commercial laboratory. The data from these composite analyses were used to quantify emissions of radionuclides, such as the isotopes of uranium and plutonium. To ensure that the analyses requested (e.g., uranium-234, uranium-235, uranium-238 and plutonium-238, plutonium-239, etc.) identified all significant activity in the composites, ESH-17 compares the results of the isotopic analysis to gross activity measurements.

VAP Emissions. In general, ESH-17 removed and replaced the charcoal canisters used to sample facilities with the potential for significant VAP emissions weekly. These samples were transported to the HPAL where gamma spectroscopy, as described above, was used to identify and quantify the presence of vaporous radioactive isotopes.

Tritium Emissions. We generally collected the tritium bubbler samples, used to sample facilities with the potential for significant elemental and oxide tritium emissions, and transported them to the HPAL on a weekly basis. The HPAL added an aliquot of each sample to a liquid scintillation cocktail and determined the amount of tritium in each vial by LSC.

We used silica gel samples to sample facilities with the potential for significant tritium emissions in the oxide form only, where the bubbler system would not be appropriate. These samples were transported to the Analytical Chemistry Sciences Group (C-ACS), where the water was distilled from the silica gel and the amount of tritium in the sample was determined using LSC.

G/MAP Emissions. We used continuous monitoring to record and report G/MAP emissions for two reasons. First, the nature of the emissions is such that standard filter paper and charcoal filters will not collect the radionuclides of interest. Second, the half-lives of these radionuclides are so short that the activity would decay away before any sample could be analyzed offline. The G/MAP monitoring system includes a flow-through ionization chamber in series with a gamma spectroscopy system. Total G/MAP emissions were measured with the ionization chamber. The real-time current measured by this ionization chamber was recorded on a strip chart, and the total amount of charge collected in the chamber over the entire beam operating cycle was integrated on a daily basis. The gamma spectroscopy system analyzed the composition of these G/MAP emissions. Using decay curves and energy spectra to identify the various radionuclides, Air Quality personnel determined the relative composition of the emissions. Decay curves were typically taken one to three times per week based on accelerator operational parameters. When major ventilation configuration changes were made at LANSCE, new decay curves and energy spectra were recorded.

4. Analytical Results

Measurements of Laboratory stack emissions during 2000 totaled approximately 3,050 Ci. Of this total, tritium emissions comprised approximately 2,350 Ci, and air activation products from LANSCE stacks contributed nearly 700 Ci. Combined airborne emissions of materials such as plutonium, uranium, americium, and particulate/vapor activation products were less than 1 Ci. Table 4-13 provides detailed emissions data for Laboratory buildings with sampled stacks. Table 4-14 provides a detailed listing of the constituent radionuclides in the groupings of G/MAP and particulate/vapor activation products (P/VAP). Table 4-15 presents the half-lives of the radionuclides emitted by the Laboratory. During 2000, nonpoint source emissions of activated air from the LANSCE facility (TA-53) comprised approximately 140 Ci carbon-11 and 6 Ci argon-41, whereas TA-18 contributed 0.8 Ci argon-41.

5. Long-Term Trends

Figures 4-18 through 4-21 show the radioactive emissions from sampled Laboratory stacks since 1986. These figures illustrate trends in measured emissions for plutonium, uranium, tritium, and G/MAP emissions, respectively. As the figures demonstrate, only tritium emissions showed a relatively significant increase for 2000. The increase in these emissions is attributable to cleanup activities at two of the Laboratory's tritium facilities: the High Pressure Tritium Laboratory (HPTL), TA-33-86, and the TSFF, TA-21-209. Combined, these two facilities accounted for over 1,900 Ci (or 80%) of the Laboratory's total tritium emissions.

Figure 4-22 presents the individual contribution of each of these emission types to the total Laboratory emissions. It clearly shows that G/MAP emissions and tritium emissions compose the vast majority of radioactive stack emissions. As in 1999, tritium emissions continue to make up the majority of Laboratory emissions. This result continues to be driven by a decrease in operations at the Area A beam stop at LANSCE and by an increase in cleanup activities at the Laboratory's tritium facilities.

The HPTL, which historically housed high-pressure tritium operations at TA-33, has been shut down for several years. As facility personnel prepare to transfer the facility for D&D, releases of tritium have increased. These increases result from activities such as opening pipes and containers to demonstrate that significant tritium has been removed.

In addition to the cleanup activities at the HPTL, tritium operations from TA-21 are being relocated to TA-16, where the WETF is located. As with the HPTL, increased emissions have been encountered as facility personnel remove facility components and prepare to transfer the facility for D&D. In both cases, emissions are well below any regulatory dose drivers.

6. Cerro Grande Fire

During the Cerro Grande fire, some problems with particulate stack sampling systems were encountered when facilities were forced to reduce or eliminate flow through their stacks to avoid clogging their filtration. As a result of decreased flow, dust and soot from the fire clogged several particulate-sampling systems. This problem was remedied when sample collection personnel changed out sample filters beginning May 15, 2000.

Although sampling was lost on several of these samplers, the amount of time was well within quality assurance requirements for completeness established in the Quality Assurance Project Plan for the Radioactive National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance Project (ESH-17-RN). Additionally, all activities involving radionuclides were suspended during this period, eliminating the concern that operational releases may have been missed during the downtime.

All other sample systems continued to operate normally during the fire.

C. Gamma and Neutron Radiation Monitoring Program *(Mike McNaughton)*

1. Introduction

ESH-17 monitors gamma and neutron radiation in the environment—that is, outside of the workplace—

according to the criteria specified in McNaughton et al. (2000).

This radiation consists of both naturally occurring and man-made radiation. Naturally occurring radiation originates from terrestrial and cosmic sources. Because the natural radiation doses are generally much larger than those from man-made sources, it is extremely difficult to distinguish man-made sources from the natural background.

Naturally occurring terrestrial radiation varies seasonally and geographically. Seasonally, radiation levels can vary up to 25% at a given location because of changes in soil moisture and snow cover that reduce or block the radiation from terrestrial sources (NCRP 1975). Spatial variation results from both the soil type and the geometry; for example, dosimeters that are placed in a canyon will receive radiation from the side walls of the canyon as well as from the canyon bottom and will record higher radiation exposures than those dosimeters on a mesa top that do not receive exposure from the walls. The aerial surveys of Los Alamos (EG&G 1989, EG&G 1990, DOE/NV 1998, and DOE/NV 1999) show variations of a factor of three in terrestrial radiation. Measurements of soil concentrations support these surveys: according to Longmire 1996, thorium and uranium concentrations on the Pajarito Plateau range from 0.7 to 3 pCi/g, and potassium-40 ranges from 12 to 30 pCi/g, which result in terrestrial radiation from 50 to 150 mrem/yr, with the higher values generally being in the canyons.

Naturally occurring ionizing radiation from cosmic sources increases with elevation because of reduced atmospheric shielding (NCRP 1975). At sea level, the dose rate from cosmic sources is 27 mrem/yr. Los Alamos, with a mean elevation of about 2.2 km, receives 70 mrem/yr from cosmic sources, whereas White Rock, at an elevation of 1.9 km, receives 60 mrem/yr. Other locations in the region range in elevation from 1.7 km at Española to 2.7 km at the Pajarito Ski Hill, resulting in a corresponding range of 50 to 90 mrem/yr from cosmic sources. These variations along with those from terrestrial sources make it difficult to detect an increase in radiation levels from man-made sources, especially because the increases are generally small relative to the magnitude of natural variations.

In summary, the dose rate from natural terrestrial and cosmic sources varies from about 100 to 200 mrem/yr. In publicly accessible locations, the dose rate from man-made radiation is much smaller than, and difficult to distinguish from, natural radiation.

2. Monitoring Network

a. Dosimeter Locations. In an attempt to distinguish any impact from Laboratory operations, ESH-17 has located 134 thermoluminescent dosimeter (TLD) stations around the Laboratory and in the surrounding communities. Beginning in January 2000, the monitoring locations were selected according to the criteria in McNaughton et al., 2000. As discussed in the 1999 Environmental Surveillance Report, some locations were retired and some were added. The historical TLD-Station-ID numbers have been kept for locations that were retained to assist in comparison with data from previous years. See Figure 4-23 for the present locations of TLDs.

b. Albedo Dosimeters. We monitor potential neutron doses with ten albedo TLD stations. We maintain these stations around TA-18 and Building 130 of TA-3. Albedo dosimeters are sensitive to neutrons and use a hydrogenous material to simulate the human body, which causes neutron backscatter.

At TA-18, each monitoring station has two albedo TLDs. If Pajarito Road closes during TA-18 experiments, we remove one of the dosimeters and store it at a control location until the road reopens. This procedure allows for a comparison of the total annual dose measured at these stations with the total annual dose that a member of the public could receive at these stations. Background stations are located at Santa Fe and TA-49, and a control dosimeter is kept in a shielded vault.

3. Quality Assurance

ESH-17's operating procedures (ESH-17 1997) contain procedures that outline the QA/QC (quality assurance/quality control) protocols; placement and retrieval of the dosimeters; reading of the dosimeters; and data handling, validation, and tabulation. The Health Physics Measurements Group (ESH-4) calibration lab calibrates the dosimeters every calendar quarter.

We estimated the uncertainty in the TLD data by combining the uncertainties from three sources. The standard deviation of the individual TLD chips was calculated from the spread in sets of 5 chips exposed to the same dose and was 3%. We calculated the uncertainty in the light-output-to-dose calibration from the variation of the individual calibrations; it was 5%. The uncertainty in the fade correction was calculated from 20 sets of fade dosimeters with each set each exposed to the same conditions and was 4%. Combining these in the standard way, the overall one-standard-deviation uncertainty is 7%.

As an independent check of the accuracy of our dosimeters, we submitted 14 dosimeters to the 12th International Intercomparison of Environmental Dosimeters organized by the DOE's Environmental Measurements Lab (EML) (*http://www.eml.doe.gov/iied/*). According to the preliminary results, the average dose our field dosimeters measured was 168 mrem, which is 4% higher than the EML measurement of 161 mrem. This result is within the expected margin of uncertainty and is therefore satisfactory.

The DOE Laboratory Accreditation Program has accredited the albedo dosimeters that ESH-4 provides. ESH-4 provides quality assurance for the albedo dosimeters.

4. Analytical Results

a. Gamma TLD Dosimeters. Table 4-16 presents the results for the gamma TLD dosimeters. For some stations, one or more quarters of data are not available as a result of dosimeter loss. The missing data have been replaced by the average of the other quarters.

The annual dose equivalents at almost all stations ranged from 100 to 200 mrem. These dose rates are consistent with natural background radiation and with previous measurements. The largest natural-background dose rates are in low-lying areas and canyons (e.g., at stations 20, 37, 59, and 70) where terrestrial background is high (DOE/NV/11718-107) and canyon walls contribute additional dose. None of these measurements indicates a contribution from Laboratory operations.

The stations with a measurable contribution from Laboratory operations are at TA-18 (station 28), TA-53 (stations 64, 104, and 114-116), TA-3-130 (station 117), and TA-21 (station 323).

At TA-18, most of the external radiation dose is from neutrons, which are measured by the albedo dosimeters discussed in section 4.c, below. The gamma dose at station 28 is smaller than the uncertainty in the measurement. Though the gamma dose at station 18 is larger than average, this is mostly a result of terrestrial radiation in the canyon.

Stations 104 and 114-6 are close to the TA-53 lagoons where activated material such as cobalt-60 has accumulated. Station 64 is close to the TA-53 "boneyard" where radioactive materials are stored. Access to TA-53 is restricted.

Station 117 is 27 m north of the sources in the TA-3-130 calibration laboratory; the dosimeter is on the fence along the south side of Pajarito Road. The potential dose to an individual on Pajarito Road is the sum of the gamma dose discussed in this section and the neutron dose discussed in section 4.c, below. The doses reported in the tables include natural background and would only apply if an individual remained close to the dosimeter 24 hours a day and 365 days per year.

Station 323 at TA-21, Material Disposal Area T, is contaminated with 50 pCi/g of cesium-137 (LANL 1991, pp. 16-124). The calculated dose rate from this contamination is 200 mrem/yr. Considering that the dosimeter is on the boundary fence of Area T, the calculation is in reasonable agreement with the measurement, which is about 100 mrem/yr above background. Area T is not accessible to the public.

b. TA-54, Area G. Table 4-17 presents the results from monitoring the TA-54, Area G, waste site. We have two types of dosimeter deployed at Area G: TLDs and electret ion chambers (EIC). However, we are still evaluating the EIC data, which are sensitive both to changes in pressure and to the presence of radon. The results presented in the table are from the TLDs only.

Figure 4-2 shows the locations of stations 601 through 641 within the waste site and along the security fence. The doses measured at this site are representative of storage and disposal operations that occur at the facility. Evaluation of these data is useful in minimizing occupational doses. However, Area G is a controlled-access area, and these measurements are not representative of a potential public dose.

The readings from dosimeter stations 605-6 and 623-4 are higher than in previous years. These dosimeters are near building 375 (to the north) and building 49 (to the southwest). The dose rates are the result of radioactive waste stored in these buildings. The increased dose rate from building 375 led us to locate new dosimeter stations 642 and 643 on the fence at the boundary between DOE and San Ildefonso Pueblo land. Although the dose rates at these stations are at the upper end of the range of natural background radiation, we believe this is a result of high levels of terrestrial radiation in the canyon and from the canyon walls. Two items of evidence support this conclusion: calculations show the dose from building 375 at the DOE boundary is too small to measure, and the NEWNET station “LANL Buey East,” which is close to stations 642 and 643, does not show an increased dose rate. NEWNET is discussed in Section H.

c. TA-18 Albedo Dosimeters. Table 4-18 presents the monitoring results from the TA-18 albedo dosimeters. Two dosimeters were placed at each of the seven locations around TA-18, and as in previous years, we removed dosimeter #2 whenever Pajarito Road was closed. At station 4, dosimeter #2 read more than #1, which is a result of the random nature of the uncertainty. At the other stations, the difference is the extra dose received while the road was closed. The values in Table 4-18 would apply to a hypothetical individual who remains continuously at the specified location.

An additional uncertainty of 50% comes from the neutron correction factor, NCF. The neutron dose a dosimeter measures depends on the neutron-energy spectrum. The actual neutron dose is obtained by multiplying the dosimeter reading by the NCF. We calculated the dose from TA-18 using the NCF = 0.145, which corresponds to the neutron energy spectrum from the DOE-standard D_2O-moderated neutron spectrum from californium-252. The reference McNaughton (2000) discusses the reasons for this choice.

Albedo-dosimeter location #10 is co-located with gamma-dosimeter station #117, on the fence south of Pajarito Road and 27 m north of the TA-3-130 calibration sources. The total dose at this location is the sum of the gamma and the neutron dose equivalents.

D. Nonradioactive Emissions Monitoring *(Jean Dewart)*

1. Introduction

The Laboratory, in comparison with industrial sources such as power plants, semiconductor manufacturing plants, and refineries, is a relatively small source of nonradioactive air pollutants. Thus, opacity monitoring was the only nonradioactive air emissions monitoring we performed as required by state or federal air quality regulations during 2000.

We calculate emissions from industrial-type sources annually as NMED requires. These sources are responsible for the majority of all the nonradiological air pollutant emissions at the Laboratory. See Chapter 2 for these data. Research sources vary continuously and have very low emissions. Chemical procurement data are used to estimate emissions from R&D operations. These R&D emissions are also reported in Chapter 2.

We have estimated emissions of criteria pollutants from the Cerro Grande fire to compare them with LANL emissions. We conducted some limited monitoring for metals and volatile organic compounds (VOCs) following the fire. As part of a study to characterize the particulate matter collection of the AIRNET system, we began real-time monitoring of particulate matter less than 10 um in diameter (PM-10) during CY2000. This sampler operated almost continuously through the year, including during the Cerro Grande fire. We also performed ambient sampling for beryllium to determine the impact of Laboratory beryllium emissions.

2. Cerro Grande Fire Emissions

The Cerro Grande fire produced large quantities of criteria pollutant emissions. We calculated emissions (Table 4-19) based on EPA emission factors for wildfires and prescribed burning (EPA 1996) using the acreage burned during the fire and estimated fuel loading. For perspective, criteria pollutant emissions from the fire are much larger than LANL emissions of criteria pollutants (see Table 2-5 in Chapter 2).

Because the criteria pollutant emissions from the fire are so large, we have performed atmospheric dispersion calculations to estimate the air concentrations. The EPA Industrial Source Complex model was used, with site specific meteorology during the fire, to estimate downwind air concentrations on the days May 10–15, 2000. As expected, modeled air concentrations of particulate matter, nitrogen oxides, and carbon monoxides exceeded national ambient air quality standards by factors of 2 to 20 in areas close to the fire. The modeled concentrations of particulate matter compare well with measurements taken during the fire (see below).

During the Cerro Grande fire, Material Disposal Area R, located at TA-16, began smoldering when the fire ran over the site on May 10–11. Area R is a World War II-vintage high-explosives burning area; characterization of the area indicated the presence of metals and high explosives at levels greater than background. We conducted air sampling for metals and VOCs from June 2–16. No above-background levels of VOCs were detected. Background data are not available for metals in air at LANL. However, concentrations of metals were orders of magnitude below Occupational Safety and Health Act (OSHA) 8-hour standards for workers.

3. Particulate Matter Sampling

The Laboratory began operating a particulate matter monitor at TA-54-1001 (TA-54 West, located about 2 km west of waste disposal Area G) in April 2000. This monitor, known as a Tapered Element Oscillating Microbalance (TEOM), continuously monitors concentrations for PM-10. The TEOM monitor provides an average air concentration every 30 minutes. Typical values range from 5 ug/m^3 to 20 ug/m^3.

The monitor operated almost continuously through the Cerro Grande fire (Figure 4-24). The EPA has established a 24-hour standard of 150 ug/m^3. The 30-minute TEOM data have been averaged over a running 24-hour period, so that comparisons can be made with the EPA standard. During the early days of the fire, air concentrations at TA-54 were only slightly elevated. A small portion of the fire moved through TA-54 West on May 12 and 13. During this period, short-term air concentrations were as high as 1000 ug/m^3. These air concentrations were the closest PM-10 measurements made to the actual fire. We can extrapolate to other locations during the fire and estimate that firefighters were exposed to these very high particulate matter concentrations while fighting the fire. The nearby community of White Rock had been evacuated, and residents were not exposed to these very high levels of particulate matter on May 12 and 13.

4. Detonation and Burning of Explosives

The Laboratory tests explosives by detonating them at firing sites that the Dynamic Testing Division operates. Data for 2000 are not available at the publication date of this report. The 2000 data will be published in the 2001 Environmental Surveillance Report. The Laboratory also burns scrap and waste explosives because of treatment requirements and safety concerns. In 2000, the Laboratory burned 3.8 tons of high explosives.

5. Beryllium Sampling

a. Routine Sampling. In the early 1990s, we analyzed a limited number of AIRNET samples for beryllium in an attempt to detect potential impact from regulated sources and releases from explosive testing. All values were well below the New Mexico 30-day ambient air quality standard of 10 ng/m^3. With the recent heightened interest in the health effects of beryllium, we are again analyzing AIRNET samples for this contaminant.

However, New Mexico no longer has an ambient air quality standard for beryllium for comparison with AIRNET measurements. Therefore, we selected another air quality standard to use for comparison purposes: the NESHAP standard of 10 ng/m^3 (40 CFR Part 61 Subpart C National Emission Standard for Beryllium) can be, with EPA approval, an alternative to meeting the emission standard for beryllium. LANL is not required to use this alternative standard because the permitted sources meet the emission standards, but it is used in this case for comparative purposes.

We analyzed quarterly composited samples from 27 sites for beryllium in 2000. These sites are located near potential beryllium sources or in nearby communities. Our previous results indicated that the source of beryllium in our AIRNET samples was naturally occurring beryllium in resuspended dust. Dust may be resuspended mechanically, by vehicle traffic on dirt roads or construction activities, or by the wind in dry periods.

For 2000, air concentrations have been calculated including a blank subtraction, thus comparisons with the 1999 published data are not exact. Air concentrations for 2000, shown in Table 4-20 are, on average, similar to the 1999 values. Concentrations at two Area G stations were much lower during 2000. All values are 2% or less than the NESHAP standard.

The highest measured beryllium concentrations occur at TA-54, Area G, the county landfill, and at site 7. Because TA-54 and the county landfill have no beryllium handling operations, the source of the beryllium is most likely from naturally occurring beryllium in the soils, resuspended by the wind or by vehicles on dirt roads and earthmoving/construction operations. TA-54, Area G, is located in the drier portion of the Laboratory, making wind resuspension a more important contributor than at other Laboratory locations. A construction project began immediately adjacent to site 7 during 1999, causing a large increase in the amount of resuspended dust and, therefore, beryllium. Because of the proximity of buildings now located adjacent to site 7, we closed this station at the end of 2000.

Earlier in this chapter, we used the ratio of uranium-238 to uranium-234 to detect impacts from LANL because these isotopes are naturally present at a constant ratio. No comparable situation exists for beryllium isotopes, but the ratio of beryllium to other elements present in the soil will be relatively constant if the local sources of particulate matter are similar. We analyzed AIRNET filters for cerium, a rare earth element occurring in our soils and not emitted by Laboratory activities. Because most of our sites are located on the Pajarito Plateau, a direct relationship between the ambient concentrations of cerium and beryllium is likely unless there are naturally occurring local variations or releases to the environment. The direct correlation of beryllium to cerium for all 2000 samples, as shown in Figure 4-25, indicates no unexpectedly high beryllium concentrations at any of the sampling locations, including the TA-15-36 sites where beryllium has been used in explosives testing.

b. Special Sampling. We performed short-term ambient air sampling for a high-explosives test shot at the Dual-Axis Radiographic Hydrotest Facility (DARHT) in November 2000. TSP matter samples were taken at 12 locations before and during the test. We analyzed samples for beryllium and uranium isotopes. Although there were samplers in the downwind direction at the time of the test shot, no measured air concentrations definitively indicated the impact of the plume (Dewart 2001).

E. Meteorological Monitoring *(George Fenton)*

1. Introduction

Data obtained from the meteorological monitoring network support many Laboratory activities, including emergency management and response, regulatory compliance, safety analysis, engineering studies, and environmental surveillance programs. To accommodate the broad demands for weather data at the Laboratory, we measure a wide variety of meteorological variables across the network, including wind, temperature, pressure, relative humidity and dewpoint, precipitation, and solar and terrestrial radiation. Details of the meteorological monitoring program are provided in the Meteorological Monitoring Plan (Baars et al., 1998). An electronic copy of the Meteorological Monitoring Plan is available on the World Wide Web at *www.weather.lanl.gov/monplan/mmp1998.pdf*.

2. Climatology

Los Alamos has a temperate, semiarid mountain climate. However, large differences in locally observed temperature and precipitation exist because of the 1,000-ft elevation change across the Laboratory site.

Four distinct seasons occur in Los Alamos. Winters are generally mild, with occasional winter storms. Spring is the windiest season. Summer is the rainy season, with frequent afternoon thunderstorms. Fall is typically dry, cool, and calm. The climate statistics summarized below are from analyses provided in Bowen (1990 and 1992).

Temperatures at Los Alamos are characterized by wide daily variations (a 23°F range on average) as a result of diurnal heating and cooling. Because of the elevations of the Laboratory (6,500 to 7,400 feet), atmospheric density is low, and in our semiarid climate zone, atmospheric moisture levels are low, and clear skies are prevalent (clear about 75% of the time). These factors minimize absorption of incoming solar radiation by the atmosphere and clouds (hence very high local UV indices) and lower the capacity of the atmosphere to store heat, promoting significant daytime solar heating and nighttime radiative cooling. The sloped terrain of the Pajarito Plateau allows the cooled nighttime air to drain off the plateau, with nighttime temperatures at lower elevations often cooler than higher up the plateau. The Sangre de Cristo Mountains to the east also act as a barrier to wintertime arctic air masses that descend into the central United States, making the occurrence of local subzero temperatures rare.

Winter temperatures range from 30°F to 50°F during the daytime and from 15°F to 25°F during the nighttime, with a record low temperature of –18°F. Winds during the winter are relatively light, so extreme windchills are uncommon. Summer temperatures range from 70°F to 88°F during the daytime and from 50°F to 59°F during the nighttime, with a record high temperature of 95°F.

The average annual precipitation (which includes both rain and the water equivalent for frozen precipitation) is 18.95 in. The average annual snowfall is 58.7 in., with freezing rain and sleet occurring rarely.

Winter precipitation in Los Alamos is often due to storms approaching from the Pacific Ocean or to cyclones forming and/or intensifying leeward of the Rocky Mountains. Large snowfalls may occur locally as a result of orographic lifting of the storms by the

Jemez Mountains. The record single day snowfall is 22 in., and the record single season snowfall is 153 in. The snow is usually a dry fluffy powder, with an equivalent water-to-snowfall ratio of 1:20.

The summer rainy season, from June until September, accounts for 55% of the annual precipitation. Afternoon thunderstorms form as a result of moist air advected from the Pacific Ocean and the Gulf of Mexico that convects and/or is orographically lifted by the Jemez Mountains. These thunderstorms can yield hail, heavy downpours, strong winds, and lightning. Local lightning density, among the highest in the US, is estimated at 7 to 22 strikes per square mile per year (from an internal communication by Stone in 1998). Almost all (95%) of the detected local lightning activity (within a 30-mile radius) occurs during the summer rainy season.

The complex topography of Los Alamos influences local-scale wind patterns, notable in the absence of large-scale disturbances. Often a distinct diurnal cycle of winds is observed. Daytime upslope flow of heated air on the Pajarito Plateau adds a southeasterly component to the winds on the plateau. Nighttime downslope flow of cooled air from the mountain and plateau adds a light westerly to northwesterly component to local winds. Flow in the canyons of the Pajarito Plateau is very complex and different from flow over the plateau. Canyon flows are often aligned with the canyon axes, usually from the west as drainage flow. The interaction of drainage flow down the canyon and mesa-top flows across the tops of the canyons occasionally causes the winds to exhibit a vortex pattern on the canyon axis.

3. Monitoring Network

A network of six towers gathers meteorological data (winds, atmospheric state, precipitation and fluxes) at the Laboratory (see Meteorological Network [Figure 4-26] and the Meteorological Monitoring Plan [Baars et al., 1998]). Four of the towers are located on mesa tops (TA-6, -49, -53, -54), one is in a canyon (TA-41), and one is on top of Pajarito Mountain (PJMT). The TA-6 tower is the official meteorological measurement site for the Laboratory. A sonic detection and ranging (SODAR) instrument is also located adjacent to the TA-6 meteorological tower. Precipitation is measured at TA-16, TA-74, Pajarito and Water Canyons, and in the North Community of the Los Alamos town site, in addition to each of the tower sites.

4. Sampling Procedures, Data Management, and Quality Assurance

We site instruments in the meteorological network in areas with good exposure to the elements being measured, usually in open fields, to avoid wake effects (from trees and structures) on wind and precipitation measurements. Open fields also prevent the obstruction of radiometers, measuring solar and terrestrial radiation (ultraviolet to infrared spectra).

Temperature and wind are measured at multiple levels on open lattice towers. Instruments are positioned on west-pointing booms (toward the prevailing wind), at a distance of at least two times the tower width (to reduce tower wake effects). The multiple levels provide a vertical profile of conditions important in assessing boundary layer flow and stability conditions. The multiple levels also provide redundant measurements, which support data quality checks. The boom-mounted temperature sensors are shielded and aspirated to minimize solar heating effects.

Data loggers at the tower sites sample most of the meteorological variables at 0.33 Hz, store the data, then average the samples over a 15-minute period, and transmit the data to a Hewlett Packard workstation by telephone or cell phone. The workstation automatically edits measurements that fall outside of allowable ranges and also generates time-series plots of the data for data quality review by a meteorologist. Daily statistics of certain meteorological variables (i.e., daily minimum and maximum temperatures, daily total precipitation, maximum wind gust, etc.) are also generated and checked for quality.

All meteorological instruments are annually refurbished and calibrated during an internal audit/inspection. Field instruments are replaced with backup instruments, with the replaced instruments checked to verify that they remained in calibration while in service. All instrument calibrations are traceable to the National Institute of Standards and Technology. An external audit is typically performed once every 2 or 3 years, with the most recent performed during the summer of 1999. Results indicated no significant anomalies with the instruments in the network.

5. Analytical Results

Figure 4-27 presents a graphical summary of Los Alamos weather for 2000. The figure depicts the year's monthly average temperature ranges and monthly precipitation and snowfall totals, comparing them with monthly normals (averaged from 1971–2000).

Climatologically, Los Alamos weather for 2000 continued a trend that has been warmer and dryer than normal, with the highest average annual temperature since 1956 and the lowest annual precipitation since 1980. The year's average maximum, mean, and minimum temperatures were all 2°F above normal. Maximum and minimum temperatures for January through September were 2° to 8°F above normal, and conversely temperatures for October through December were 2° to 9°F below normal. The annual total precipitation was 73% of normal at 13.80 inches. Monthly precipitation totals were 5% to 40% of normal for January, February, April, May, July, August, September, and December, whereas March and June were normal, and October and November were 270% and 170% of normal, respectively. Figure 4-28 tabulates monthly totals for the LANL precipitation gages. The annual snowfall total was 48% of normal at 27.9 inches with monthly snowfall totals 0% to 50% of normal, except for November, which was 260% of normal.

Figure 4-29 shows wind statistics, based upon 15-minute averaged wind observations at the four Pajarito Plateau towers and the Pajarito Mountain tower for 2000, as wind roses. The wind roses depict the percentage of time that the wind blows from each of 16 compass rose points, as well as the distribution of wind speed for each of the 16 directions, represented by shaded wind rose barbs.

Daytime winds (sunrise to sunset) measured by the four Pajarito Plateau towers were predominately from the south, consistent with the typical upslope flow of heated daytime air (see Daytime Wind Roses, Figure 4-30). Nighttime winds (sunset to sunrise) on the Pajarito Plateau were lighter and more variable than daytime winds and typically from the west because of a combination of prevailing winds from the west and downslope drainage flow of cooled mountain air (see Figure 4-31). Winds atop Pajarito Mountain are more representative of upper-level flows and primarily ranged from the northwest to the southwest, largely as a result of the prevailing westerly winds.

6. Cerro Grande Fire Meteorological Conditions

The winter and spring preceding the Cerro Grande fire were extremely dry, with 6-month precipitation totals through May only 40% of normal. The Standardized Precipitation Index (SPI), a normalized probability distribution of local precipitation, for Los Alamos during this period was –1.90, which corresponded to "very dry" conditions. In May, a persistent high-pressure ridge settled over New Mexico. This ridge deflected the jet stream north of New Mexico, preventing organized weather systems (bearing moisture and cloud cover) from entering the area. The ridge also induced southwesterly surface flows, adding to the local warm, dry, and windy surface conditions.

Table 4-21 gives a summary of LANL meteorological conditions from May 4, when the prescribed burn was set at Bandelier, until May 21, when the Cerro Grande fire was contained. Included in the table are daily wind, temperature, relative humidity, and precipitation statistics for the TA-6, TA-49, TA-53, TA-54, and Pajarito Mountain meteorological towers. Relative humidity on the Plateau was below 20% on May 4 through 7, 10 through 12, and on the 15 and 16. Winds on the Plateau were predominately from the southwest (see Figure 4-32), averaging 9 mph from May 4 through the 21 and averaging 12–17 mph on the 10 and 11 (8 mph is typical for May). The fuel moisture (10-hr moisture, measured at TA-6, used in rating local fire danger), ranged from 2% to 5% on May 4, when the prescribed burn was set (see Figure 4-33).

Before the Cerro Grande fire, ESH-17 had evaluated the joint probability of the occurrence of high winds and high fire danger; this evaluation indicated that the probability of a major fire moving to the boundary of LANL was once every ten years. This probability is based upon an existing fire danger rating of "high" or "very high" and average afternoon winds from the south to west at greater than 10 mph. These conditions existed during the Cerro Grande fire.

The Cerro Grande fire burned most of the watersheds above LANL on the eastern slopes of the Jemez Caldera. These watersheds feed the streams within the canyons in and around LANL. The burned watersheds became hydrophobic, losing much of their water retention capacity, which increased the risk of flash flooding in local canyons during significant rain events (>1 in./hr—which historically occurs once every 2 years) over the burned area. To provide early warning of flash flood danger, the Bureau of Land Management (BLM) placed 9 Remote Automated Weather System (RAWS) stations in threatened watersheds. The RAWS stations are sited in the Quemazon, Water, Pajarito, Upper Los Alamos, Pueblo, Guaje, Garcia, Santa Clara, and Upper Santa

Clara watersheds (see Figure 4-34). The stations are equipped to send a radio warning to local authorities if they measure a rain total of 0.16 inches in a given ten-minute period. The LANL RAWS station data are available on the World Wide Web at *http://www.wrcc.dri.edu/losalamos/*.

F. Quality Assurance Program in the Air Quality Group *(Ernest Gladney, Terry Morgan, Angelique Leudeker)*

1. Quality Assurance Program Development

During 2000, ESH-17 revised five quality plans that affect collection and use of air quality compliance data. We also revised approximately 39 implementing procedures to reflect the constant improvements in the processes. Together, these plans and procedures describe or prescribe all the planned and systematic activities believed necessary to provide adequate confidence that ESH-17 processes perform satisfactorily. All current quality related documents are available on the ESH-17 public Web site (*www.Air-Quality.lanl.gov*).

2. Field Sampling Quality Assurance

Overall QA of this portion of the program is maintained through the rigorous use of carefully documented procedures governing all aspects of the sample collection program. Particulate and water vapor samples are taken on commercially available media of known performance, collected under common EPA chain-of-custody procedures using field-portable electronic data systems to minimize the chances of data transcription errors, and prepared in a secure and radiologically clean laboratory for shipment. They are then delivered to internal and external analytical laboratories under full chain-of-custody utilizing secure FedEx shipment for all external vendors and tracked at all stages of their collection and analysis through the AIRNET and RADAIR relational databases. A complete suite of blanks is also taken with each set of samples, to include matrix blanks, trip blanks, and process blanks (where applicable). All blanks are submitted to analytical suppliers for chemical measurements.

Field sampling completeness is assessed every time the analytical laboratory returns the AIRNET bi-weekly gross alpha/beta data. RADAIR field sampling completeness is done each week upon receipt of the gross alpha/beta and tritium bubbler data. All these calculations are performed for each ambient air and stack sampling site and are included in the quality assessment memo that the Chemistry Coordination and Information Management staff prepare to evaluate every data group received from a supplier.

3. Analytical Laboratory Quality Assessment

Specific Statements of Work (SOWs) are written to govern the acquisition and delivery of analytical chemistry services after the application of EPA's data quality objectives process has identified and quantified our program objectives. These SOWs are sent to potentially qualified suppliers who then undergo pre-award on-site assessment by experienced and trained ESH-17 quality systems and chemistry laboratory assessors. SOW specifications, professional judgment, and quality system performance at each lab (including recent past performance on nationally conducted performance evaluation programs) are primarily used to award contracts for specific types of radiochemical analyses. Each laboratory conducts its chain-of-custody and analytical processes under its own quality plans and analytical procedures. The laboratories return preliminary data to ESH-17 by e-mail in an Electronic Data Deliverable (EDD) of specified format and content. Each set of samples contains all the internal QA/QC data generated by the analytical laboratory during each phase of chemical analysis (including laboratory control standards, process blanks, matrix spikes, duplicates, and replicates, where applicable). All data are electronically uploaded into either the AIRNET or RADAIR databases and immediately subjected to a variety of quality and consistency checks. Analytical completeness is calculated, tracking and trending of all blank and control sample data is performed, and all are included in the quality assessment memo mentioned in the field sampling section. All parts of the data management process are tracked electronically in each database, and periodic reports to management are prepared.

4. Analytical Quality Assessment Results

The Clean Air Act requires an EPA-compliant program of QC samples be included as an integral part of the sampling and analysis process. Tables 4-22 and 4-23 document the types and numbers of QC samples run vs. the overall sampling program.

Our sample and data management procedures document the specific evaluations of each type of QC sample for each analytical measurement. The evaluation criteria and overall outcome of these QC tests appear in Tables 4-24 through 4-28.

All QC data are tracked and trended and reported in specific QC evaluation memos that are submitted to project staff along with each set of analytical data received from our chemistry laboratories. Figure 4-35 shows an examples of AIRNET tritium tracking and trending of matrix blank data. Similar plots are available for each analyte in each QC type for both AIRNET and RADAIR programs.

5. Analytical Laboratory Assessments

During 2000, one internal and two external laboratories performed all chemical analyses reported for AIRNET and RADAIR samples. The Wastren-Grand Junction Analytical Laboratory (associated with the DOE's Grand Junction Project Office) provided biweekly gross alpha, gross beta, and isotopic gamma analytical services for AIRNET. Paragon Analytics, Inc., Fort Collins, CO, provided biweekly AIRNET tritium analytical services. Wastren-Grand Junction Analytical Laboratory also provided chemistry services for alpha-emitting isotopes (americium, plutonium, polonium, thorium, and uranium), beta-emitting isotopes (lead-210), and stable beryllium on AIRNET quarterly composite samples. Our on-site Health Physics Analytical Laboratory (ESH-4) performed all instrumental analyses (gross alpha, gross beta, isotopic gamma, and tritium) reported for stack emissions and in-stack samples. Semester composites of in-stack filters were analyzed for alpha- and beta-emitting isotopes (lead-210 and strontium-90) at the Wastren-Grand Junction site.

ESH-17 also performed formal on-site assessments at all three laboratories during 2000. All three analytical laboratories participated in national performance evaluation studies during 2000. The DOE Environmental Measurements Laboratory in New York, NY, sponsors a DOE-wide environmental intercomparison study, sending spiked air filters (among other matrices) twice a year to the participating laboratories. Other commercial and state agencies also produce materials and sponsor a wide variety of intercomparison programs. The results of these performance evaluations are included in each assessment report (Lochamy 2000 and Gladney 2000a,b).

G. Unplanned Releases

During 2000, the Laboratory had no instances of increased airborne emissions of radioactive or nonradioactive materials that required reporting to either NMED or the EPA.

H. Special Studies-Neighborhood Environmental Watch Network Community Monitoring Stations

Neighborhood Environmental Watch Network (NEWNET) is a LANL program for radiological monitoring in local communities. It establishes gamma-radiation monitoring stations in local communities and near radiological sources. These stations are the responsibility of a station manager from the local community. The stations have a local readout, and the data can be downloaded onto a personal computer at the station if this process is coordinated with the station manager.

The station measures gross gamma radiation using a pressurized ion chamber. The radiation sensors are sampled at 1-minute intervals and averaged every 15 minutes. The data are converted to engineering units, checked and annotated for transmission errors or station problems, stored in a public access database, and presented on the World Wide Web. The data from all the stations are available to the public with, at most, a 24-hour delay. The NEWNET web page also includes a Spanish language version.

More information about NEWNET and the data are available at *http://newnet.LANL.gov/* on the World Wide Web.

I. Tables.

Table 4-1. Average Background Concentrations of Radioactivity in the Regional[a] Atmosphere

	Units	EPA Concentration Limit[c]	Annual Averages[b] 1996	1997	1998	1999	2000
Gross Alpha	fCi/m^3	NA[d]	1.0	0.7	0.8	1.0	1.0
Gross Beta	fCi/m^3	NA	10.9	14.1	12.4	13.4	13.0
Tritium	pCi/m^3	1,500	1.0	0.4	0.3	0.3	0.5
^{238}Pu	aCi/m^3	2,100	–0.5[e]	0.0	0.1	–0.2	0.0
$^{239,240}Pu$	aCi/m^3	2,000	–0.2	–0.2	0.4	0.1	0.0
^{241}Am	aCi/m^3	1,900	–0.1	0.2	0.3	–0.2	0.3
^{234}U	aCi/m^3	7,700	33.6	14.1	12.9	16.1	17.1
^{235}U	aCi/m^3	7,100	2.2	0.6	0.9	1.2	0.9
^{238}U	aCi/m^3	8,300	23.1	12.2	12.8	15.2	15.9

[a] Data from regional air sampling stations operated by LANL during the last five years. Locations can vary by year.
[b] Gross Alpha and Beta annual averages are calculated from gross air concentrations. All other annual averages are calculated from net air concentrations.
[c] Each EPA limit equals 10 mrem/yr.
[d] NA = not available.
[e] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 2000

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	26	0	2.27	0.57	1.16	0.45
03	Santa Fe	26	0	1.54	0.52	0.95	0.31
55	Santa Fe West (Buckman Booster #4)	26	0	1.69	0.31	0.93	0.40
56	El Rancho	26	0	1.94	0.37	1.05	0.40
Pueblo Stations							
41	San Ildefonso Pueblo	26	0	1.94	0.55	1.01	0.36
59	Jemez Pueblo-Visitor’s Center	24	0	2.23	0.56	1.07	0.36
Perimeter Stations							
04	Barranca School	26	0	3.03	0.47	0.93	0.50
05	Urban Park	25	0	1.23	0.32	0.86	0.24
06	48th Street	26	0	6.21	0.27	1.05	1.11
07	Gulf/Exxon/Shell Station	26	0	4.14	0.56	1.15	0.68
08	McDonald’s Restaurant	26	0	5.12	0.38	1.03	0.88
09	Los Alamos Airport	26	0	5.09	0.32	1.02	0.88
10	East Gate	25	0	4.47	0.42	1.04	0.77
11	Well PM-1 (E. Jemez Road)	26	1	2.57	0.00	0.95	0.46
12	Royal Crest Trailer Court	26	0	3.95	0.35	1.03	0.65
13	Rocket Park	26	0	1.84	0.53	1.07	0.35
14	Pajarito Acres	26	0	1.41	0.43	0.88	0.28
15	White Rock Fire Station	26	0	1.72	0.53	1.06	0.31
16	White Rock Nazarene Church	26	0	1.55	0.45	0.91	0.27
17	Bandelier Fire Lookout	26	0	1.42	0.44	0.90	0.31
26	TA-49	26	0	1.68	0.36	0.78	0.33
32	County Landfill (TA-48)	25	0	3.03	0.59	0.95	0.48
54	TA-33 East	26	0	1.50	0.55	0.91	0.27
60	LA Canyon	26	0	2.55	0.28	1.01	0.50
61	LA Hospital	26	0	3.67	0.52	1.09	0.58
62	Crossroads Bible Church	26	0	3.56	0.49	1.13	0.62
63	Monte Rey South	26	0	1.36	0.30	0.88	0.29
66	Los Alamos Inn-South	17	0	3.36	0.53	1.20	0.70
67	TA-3 Research Park	8	0	1.27	0.79	1.03	0.15
90	East Gate-Backup	1	0	1.56	1.56	1.56	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	0	1.56	0.28	0.84	0.36
77	TA-36 IJ Site	26	0	2.65	0.38	0.89	0.49
78	TA-15-N	26	0	1.62	0.28	0.93	0.37
TA-21 Stations							
20	TA-21 Area B	26	0	5.73	0.36	1.06	1.00
71	TA-21.01 (NW Bldg 344)	25	0	4.48	0.48	1.10	0.76
72	TA-21.02 (N Bldg 344)	7	0	1.19	0.57	0.79	0.19
73	TA-21.03 (NE Bldg 344)	7	0	1.16	0.45	0.88	0.31
74	TA-21.04 (SE Bldg 344)	7	0	1.17	0.77	0.99	0.15
75	TA-21.05 (S Bldg 344)	7	0	1.07	0.61	0.80	0.17

Table 4-2. Airborne Long-Lived Gross Alpha Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	2.31	0.53	1.14	0.36
34	Area G-1 (behind trailer)	26	0	3.14	0.36	1.14	0.51
35	Area G-2 (back fence)	26	0	2.13	0.56	1.07	0.38
36	Area G-3 (by office)	26	0	2.11	0.34	1.05	0.44
45	Area G/South East Perimeter	25	0	1.80	0.58	1.22	0.33
47	Area G/North Perimeter	26	0	2.71	0.70	1.20	0.44
50	Area G-expansion	25	0	1.59	0.44	1.11	0.26
51	Area G-expansion pit	26	0	2.88	0.48	1.05	0.48
Other On-Site Stations							
23	TA-5	26	0	3.43	0.49	1.09	0.58
25	TA-16-450	26	0	2.69	0.47	0.94	0.46
29	TA-2 Omega Site	9	0	1.32	0.34	0.90	0.30
30	Pajarito Booster 2 (P-2)	26	0	3.04	0.53	1.16	0.51
31	TA-3	26	0	2.93	0.62	1.09	0.45
49	Pajarito Road (TA-36)	24	0	2.33	0.42	0.93	0.38
QA Stations							
38	TA-54 Area G-QA (next to #27)	24	0	2.70	0.51	1.13	0.44
39	TA-49-QA (next to #26)	25	1	2.05	0.42	0.88	0.37

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	104	0	2.27	0.31	1.02	±0.08	0.40
Pueblo	50	0	2.23	0.55	1.04	±0.10	0.36
Perimeter	569	1	6.21	0.00	0.99	±0.05	0.56
TA-15 and TA-36	78	0	2.65	0.28	0.89	±0.09	0.41
TA-21	79	0	5.73	0.36	1.00	±0.16	0.73
TA-54 Area G	206	0	3.14	0.34	1.12	±0.06	0.41
Other On-Site	137	0	3.43	0.34	1.03	±0.08	0.47

Concentration Guidelines
Concentration Guidelines are not available for gross alpha concentrations.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 2000

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	26	0	26.4	9.1	14.2	3.8
03	Santa Fe	26	0	20.4	6.7	11.8	3.0
55	Santa Fe West (Buckman Booster #4)	26	0	21.3	7.9	12.6	2.8
56	El Rancho	26	0	23.8	8.3	13.3	3.5
Pueblo Stations							
41	San Ildefonso Pueblo	26	0	21.4	9.1	13.5	3.0
59	Jemez Pueblo-Visitor's Center	24	0	20.4	8.5	13.0	3.2
Perimeter Stations							
04	Barranca School	26	0	18.9	7.6	11.8	2.6
05	Urban Park	25	0	16.2	6.7	11.4	2.2
06	48th Street	26	0	17.1	6.3	11.4	2.5
07	Gulf/Exxon/Shell Station	26	0	21.0	5.3	12.3	3.5
08	McDonald's Restaurant	26	0	18.7	7.1	12.2	2.6
09	Los Alamos Airport	26	0	17.1	7.4	12.6	2.6
10	East Gate	25	0	20.0	8.0	12.2	2.8
11	Well PM-1 (E. Jemez Road)	26	0	17.9	6.3	11.5	2.5
12	Royal Crest Trailer Court	26	0	19.5	7.9	11.9	2.6
13	Rocket Park	26	0	19.9	8.9	12.8	2.7
14	Pajarito Acres	26	0	18.4	7.9	11.9	2.3
15	White Rock Fire Station	26	0	20.0	8.1	12.5	3.2
16	White Rock Nazarene Church	26	0	17.5	7.9	12.5	2.5
17	Bandelier Fire Lookout	26	0	18.9	8.1	12.7	2.6
26	TA-49	26	0	16.4	6.7	11.4	2.2
32	County Landfill (TA-48)	25	0	18.0	5.7	11.2	3.1
54	TA-33 East	26	0	21.8	8.6	12.9	2.8
60	LA Canyon	26	0	17.2	7.3	11.8	2.2
61	LA Hospital	26	0	19.8	7.8	12.6	2.7
62	Crossroads Bible Church	26	0	19.8	7.7	12.7	2.7
63	Monte Rey South	26	0	17.9	7.8	12.2	2.4
66	Los Alamos Inn-South	17	0	20.2	7.6	13.2	3.3
67	TA-3 Research Park	8	0	19.2	8.2	13.3	3.2
90	East Gate-Backup	1	0	13.3	13.3	13.3	
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	26	0	17.0	7.9	11.8	2.3
77	TA-36 IJ Site	26	0	20.0	7.4	12.3	2.6
78	TA-15-N	26	0	17.5	7.4	11.6	2.2
TA-21 Stations							
20	TA-21 Area B	26	0	16.1	6.0	11.9	2.3
71	TA-21.01 (NW Bldg 344)	25	0	19.7	8.3	12.4	2.7
72	TA-21.02 (N Bldg 344)	7	0	15.4	9.1	11.8	2.1
73	TA-21.03 (NE Bldg 344)	7	0	12.2	7.8	10.3	1.7
74	TA-21.04 (SE Bldg 344)	7	0	13.6	8.7	11.6	2.0
75	TA-21.05 (S Bldg 344)	7	0	13.8	8.6	11.3	2.3

Table 4-3. Airborne Long-Lived Gross Beta Concentrations for 1999 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	0	19.1	3.6	11.8	3.2
34	Area G-1 (behind trailer)	26	0	22.1	3.3	12.2	3.8
35	Area G-2 (back fence)	26	0	18.8	7.5	12.1	2.8
36	Area G-3 (by office)	26	0	19.1	6.8	12.0	2.7
45	Area G/South East Perimeter	25	0	20.6	2.5	12.1	3.6
47	Area G/North Perimeter	26	0	20.1	3.0	12.0	3.5
50	Area G-expansion	25	0	19.2	7.3	12.8	2.9
51	Area G-expansion pit	26	0	20.0	6.8	12.0	3.4
Other On-Site Stations							
23	TA-5	26	0	21.8	8.2	13.3	3.5
25	TA-16-450	26	0	18.6	7.3	11.6	2.5
29	TA-2 Omega Site	9	0	16.5	7.1	12.4	2.8
30	Pajarito Booster 2 (P-2)	26	0	18.7	7.3	12.3	2.7
31	TA-3	26	0	18.1	7.1	11.7	2.2
49	Pajarito Road (TA-36)	24	0	20.7	7.2	12.1	3.2
QA Stations							
38	TA-54 Area G-QA (next to #27)	24	0	21.3	4.0	11.9	3.6
39	TA-49-QA (next to #26)	25	0	16.1	8.2	11.2	2.0

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional	104	0	26.4	6.7	13.0	±0.7	3.4
Pueblo	50	0	21.4	8.5	13.3	±0.9	3.1
Perimeter	569	0	21.8	5.3	12.2	±0.2	2.7
TA-15 and TA-36	78	0	20.0	7.4	11.9	±0.5	2.4
TA-21	79	0	19.7	6.0	11.8	±0.5	2.4
TA-54 Area G	206	0	22.1	2.5	12.1	±0.4	3.2
Other On-Site	137	0	21.8	7.1	12.2	±0.5	2.8

Concentration Guidelines

Concentration guidelines are not available for gross beta concentrations.

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 2000

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	26	26	1.3	–1.4[a]	–0.1	0.7
03 Santa Fe	26	26	1.2	–1.7	0.0	0.7
55 Santa Fe West (Buckman Booster #4)	26	25	6.6	–1.6	0.5	1.5
56 El Rancho	26	25	42.6	–2.0	1.6	8.4
Pueblo Stations						
41 San Ildefonso Pueblo	26	23	13.9	–1.4	0.8	2.8
59 Jemez Pueblo-Visitor's Center	26	26	0.8	–1.2	0.0	0.4
Perimeter Stations						
04 Barranca School	26	16	7.6	–1.2	1.3	1.6
05 Urban Park	26	23	3.5	–1.1	0.9	1.0
06 48th Street	26	23	2.9	0.2	1.0	0.6
07 Gulf/Exxon/Shell Station	26	17	9.9	–0.4	1.6	1.9
08 McDonald's Restaurant	26	5	5.6	0.4	2.4	1.3
09 Los Alamos Airport	26	1	29.2	0.4	5.5	5.5
10 East Gate	26	2	11.2	1.3	4.3	2.5
11 Well PM-1 (E. Jemez Road)	26	13	6.1	0.1	2.0	1.3
12 Royal Crest Trailer Court	26	11	4.8	0.3	2.1	1.3
13 Rocket Park	26	4	8.2	0.6	3.0	1.9
14 Pajarito Acres	26	15	13.0	–0.3	2.3	3.0
15 White Rock Fire Station	26	16	7.1	0.2	2.1	1.5
16 White Rock Nazarene Church	26	3	9.2	0.4	4.2	2.6
17 Bandelier Fire Lookout	26	10	40.9	1.0	5.2	9.8
26 TA-49	26	6	16.6	1.2	3.5	3.2
32 County Landfill (TA-48)	26	13	5.1	–0.2	2.0	1.2
54 TA-33 East	26	12	21.3	0.1	3.4	5.0
60 LA Canyon	26	18	4.8	–0.7	1.6	1.2
61 LA Hospital	26	20	5.0	–0.2	1.3	1.0
62 Crossroads Bible Church	26	10	16.4	0.1	2.8	3.0
63 Monte Rey South	26	16	12.7	–0.5	2.3	2.9
66 Los Alamos Inn-South	17	8	6.3	0.7	2.3	1.4
67 TA-3 Research Park	8	5	2.5	0.1	1.2	0.9
90 East Gate-Backup	1	0	4.5	4.5	4.5	
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	26	14	5.9	–0.6	1.7	1.5
77 TA-36 IJ Site	26	17	4.9	0.5	1.7	1.1
78 TA-15-N	26	15	6.0	0.4	1.9	1.4
TA-21 Stations						
20 TA-21 Area B	26	1	13.2	1.3	4.8	3.0
71 TA-21.01 (NW Bldg 344)	26	1	33.3	1.4	5.4	6.2
72 TA-21.02 (N Bldg 344)	7	0	9.1	2.9	5.2	2.1
73 TA-21.03 (NE Bldg 344)	7	0	27.5	5.8	11.8	7.9
74 TA-21.04 (SE Bldg 344)	7	0	20.0	4.1	8.1	5.5
75 TA-21.05 (S Bldg 344)	7	0	23.0	2.5	8.5	6.9

Table 4-4. Airborne Tritium as Tritiated Water Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (pCi/m^3)	Minimum (pCi/m^3)	Mean (pCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	26	1	62.6	0.7	21.5	19.5
34	Area G-1 (behind trailer)	26	0	33.5	3.1	14.2	8.8
35	Area G-2 (back fence)	26	0	2937.0	18.1	805.2	837.0
36	Area G-3 (by office)	26	0	43.4	4.6	19.9	13.5
45	Area G/South East Perimeter	25	1	31.6	0.6	13.6	9.0
47	Area G/North Perimeter	26	0	61.6	2.7	22.3	20.4
50	Area G-expansion	25	0	30.0	3.1	13.5	8.8
51	Area G-expansion pit	26	0	339.0	3.1	22.8	64.7
Other On-Site Stations							
23	TA-5	26	10	12.0	0.0	2.7	2.6
25	TA-16-450	26	1	238.7	0.4	60.7	55.1
29	TA-2 Omega Site	9	4	3.5	1.1	1.8	0.8
30	Pajarito Booster 2 (P-2)	26	12	4.7	–1.1	1.8	1.2
31	TA-3	26	8	5.3	0.5	2.4	1.4
49	Pajarito Road (TA-36)	25	18	3.3	–0.4	1.4	0.9
QA Stations							
38	TA-54 Area G-QA (next to #27)	26	0	87.5	3.0	25.1	24.2
39	TA-49-QA (next to #26)	26	6	17.3	–0.3	3.6	3.5

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (fCi/m^3)	Minimum (fCi/m^3)	Mean (fCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	104	102	42.6	–2.0	0.5	±0.8	4.3
Pueblo	52	49	13.9	–1.4	0.4	±0.6	2.0
Perimeter	572	267	40.9	–1.2	2.6	±0.3	3.4
TA-15 and TA-36	78	46	6.0	–0.6	1.8	±0.3	1.3
TA-21	80	2	33.3	1.3	6.3	±1.2	5.5
TA-54 Area G	206	2	2,937.0	0.6	117.6	±53.7	393.4
Other On-Site	138	53	238.7	–1.1	13.1	±5.5	32.9

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 pCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,500 pCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-5. Airborne Plutonium-238 Concentrations for 2000

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	4	0.4	–1.1[a]	–0.2	0.7
03 Santa Fe	4	4	0.4	–0.3	0.0	0.4
55 Santa Fe West (Buckman Booster #4)	4	4	1.0	–1.0	0.0	0.9
56 El Rancho	4	4	0.4	–0.2	0.1	0.3
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	0.3	–0.2	0.1	0.2
59 Jemez Pueblo-Visitor's Center	4	4	0.1	–0.6	–0.3	0.3
Perimeter Stations						
04 Barranca School	4	4	0.6	–0.4	0.0	0.5
05 Urban Park	4	4	0.3	–0.4	–0.2	0.3
06 48th Street	4	4	0.4	–0.3	0.1	0.3
07 Gulf/Exxon/Shell Station	4	4	0.5	–0.7	–0.2	0.5
08 McDonald's Restaurant	4	4	0.3	–0.5	–0.3	0.4
09 Los Alamos Airport	4	4	0.9	–0.3	0.2	0.5
10 East Gate	4	4	1.1	–0.5	0.2	0.8
11 Well PM-1 (E. Jemez Road)	4	4	0.1	–1.2	–0.4	0.6
12 Royal Crest Trailer Court	4	4	1.0	–0.2	0.3	0.5
13 Rocket Park	4	4	0.7	–0.3	0.2	0.5
14 Pajarito Acres	4	4	0.3	–0.2	0.1	0.2
15 White Rock Fire Station	4	4	0.6	–0.6	0.2	0.6
16 White Rock Nazarene Church	4	4	0.6	–0.3	0.2	0.4
17 Bandelier Fire Lookout	4	4	0.1	–0.7	–0.1	0.4
26 TA-49	4	4	0.4	–0.3	0.1	0.3
32 County Landfill (TA-48)	4	4	0.5	0.2	0.3	0.1
54 TA-33 East	4	4	0.3	–0.9	–0.1	0.5
60 LA Canyon	4	4	0.4	–0.3	0.0	0.3
61 LA Hospital	4	4	0.7	–0.3	0.0	0.5
62 Crossroads Bible Church	4	4	0.5	0.0	0.2	0.2
63 Monte Rey South	4	4	0.5	0.1	0.2	0.2
66 Los Alamos Inn-South	3	3	1.6	–0.1	0.5	0.9
67 TA-3 Research Park	2	2	0.3	–0.2	0.0	0.4
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	0.8	–0.3	0.3	0.5
77 TA-36 IJ Site	4	4	1.4	–1.3	0.3	1.2
78 TA-15-N	4	4	0.1	–0.6	–0.2	0.3
TA-21 Stations						
20 TA-21 Area B	4	4	0.2	–0.3	0.0	0.2
71 TA-21.01 (NW Bldg 344)	4	4	0.4	–0.6	0.0	0.4
72 TA-21.02 (N Bldg 344)	1	1	0.9	0.9	0.9	
73 TA-21.03 (NE Bldg 344)	1	1	0.3	0.3	0.3	
74 TA-21.04 (SE Bldg 344)	1	1	0.0	0.0	0.0	
75 TA-21.05 (S Bldg 344)	1	1	0.5	0.5	0.5	

Table 4-5. Airborne Plutonium-238 Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	4	1.3	–0.8	0.2	0.9
34	Area G-1 (behind trailer)	4	2	7.5	0.0	3.0	3.2
35	Area G-2 (back fence)	4	4	0.7	–0.4	0.0	0.5
36	Area G-3 (by office)	4	4	0.6	–0.2	0.4	0.4
45	Area G/South East Perimeter	4	4	0.9	–0.7	–0.1	0.7
47	Area G/North Perimeter	4	3	3.6	0.3	1.5	1.5
50	Area G-expansion	4	4	0.5	–0.5	0.0	0.5
51	Area G-expansion pit	4	4	0.4	–0.3	–0.1	0.3
Other On-Site Stations							
23	TA-5	4	4	0.5	–0.8	–0.3	0.6
25	TA-16-450	4	4	0.4	–0.6	–0.3	0.5
29	TA-2 Omega Site	2	2	0.9	–0.2	0.3	0.7
30	Pajarito Booster 2 (P-2)	4	4	0.6	–0.3	0.1	0.4
31	TA-3	4	3	1.9	0.1	1.1	0.8
49	Pajarito Road (TA-36)	4	4	0.1	–0.3	–0.1	0.2
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	4	1.7	0.3	1.0	0.6
39	TA-49-QA (next to #26)	4	4	0.5	–0.5	–0.2	0.5

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	1.0	–1.1	0.0	±0.3	0.5
Pueblo	8	8	0.3	–0.6	–0.1	±0.3	0.3
Perimeter	89	89	1.6	–1.2	0.1	±0.1	0.4
TA-15 and TA-36	12	12	1.4	–1.3	0.1	±0.5	0.7
TA-21	12	12	0.9	–0.6	0.1	±0.2	0.4
TA-54 Area G	32	29	7.5	–0.8	0.6	±0.6	1.6
Other On-Site	22	21	1.9	–0.8	0.1	±0.3	0.7

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 3,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 2,100 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-6. Airborne Plutonium-239 Concentrations for 2000

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	4	0.5	–0.7[a]	–0.3	0.5
03 Santa Fe	4	4	2.2	–1.2	0.4	1.4
55 Santa Fe West (Buckman Booster #4)	4	4	0.5	–1.5	–0.4	0.9
56 El Rancho	4	4	0.7	0.0	0.4	0.3
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	0.9	–1.4	–0.1	1.0
59 Jemez Pueblo-Visitor's Center	4	4	1.5	–0.7	0.6	0.9
Perimeter Stations						
04 Barranca School	4	4	2.3	–0.8	0.9	1.3
05 Urban Park	4	4	1.3	–0.5	0.6	0.8
06 48th Street	4	4	0.2	0.0	0.1	0.1
07 Gulf/Exxon/Shell Station	4	1	11.3	1.1	5.4	4.4
08 McDonald's Restaurant	4	3	4.8	–0.5	1.1	2.5
09 Los Alamos Airport	4	3	3.6	0.5	1.8	1.4
10 East Gate	4	4	3.0	–0.2	0.7	1.5
11 Well PM-1 (E. Jemez Road)	4	4	1.0	–0.2	0.3	0.5
12 Royal Crest Trailer Court	4	4	2.3	–0.2	0.8	1.1
13 Rocket Park	4	4	0.3	–0.5	0.0	0.4
14 Pajarito Acres	4	4	0.4	–0.7	–0.1	0.5
15 White Rock Fire Station	4	4	2.4	0.0	1.3	1.2
16 White Rock Nazarene Church	4	4	0.5	–0.5	–0.1	0.4
17 Bandelier Fire Lookout	4	4	1.0	–0.3	0.3	0.5
26 TA-49	4	4	1.2	–0.4	0.2	0.8
32 County Landfill (TA-48)	4	1	7.2	0.0	4.6	3.2
54 TA-33 East	4	4	1.0	–0.5	0.2	0.6
60 LA Canyon	4	4	1.0	–0.5	0.2	0.7
61 LA Hospital	4	4	2.2	–0.3	0.5	1.2
62 Crossroads Bible Church	4	4	2.8	–0.8	0.7	1.5
63 Monte Rey South	4	4	0.4	–0.5	–0.1	0.4
66 Los Alamos Inn-South	3	1	35.3	1.9	16.8	17.0
67 TA-3 Research Park	2	2	1.0	–2.0	–0.5	2.2
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	0.8	–0.6	0.3	0.7
77 TA-36 IJ Site	4	4	1.3	–0.1	0.5	0.5
78 TA-15-N	4	4	0.3	–1.3	–0.4	0.6
TA-21 Stations						
20 TA-21 Area B	4	1	11.6	1.2	5.5	4.4
71 TA-21.01 (NW Bldg 344)	4	3	3.5	–0.5	1.3	1.7
72 TA-21.02 (N Bldg 344)	1	1	1.3	1.3	1.3	
73 TA-21.03 (NE Bldg 344)	1	0	3.1	3.1	3.1	
74 TA-21.04 (SE Bldg 344)	1	0	7.4	7.4	7.4	
75 TA-21.05 (S Bldg 344)	1	1	2.1	2.1	2.1	

Table 4-6. Airborne Plutonium-239 Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	1	16.2	2.2	8.4	5.9
34	Area G-1 (behind trailer)	4	1	49.6	0.6	17.5	22.0
35	Area G-2 (back fence)	4	4	1.7	0.1	0.9	0.7
36	Area G-3 (by office)	4	4	1.1	–0.2	0.3	0.5
45	Area G/South East Perimeter	4	1	11.2	2.7	5.1	4.1
47	Area G/North Perimeter	4	2	7.6	–0.2	3.3	3.3
50	Area G-expansion	4	3	3.2	0.6	2.2	1.1
51	Area G-expansion pit	4	4	1.7	–0.2	1.2	0.9
Other On-Site Stations							
23	TA-5	4	3	7.1	–0.6	2.0	3.5
25	TA-16-450	4	4	0.0	0.0	0.0	0.0
29	TA-2 Omega Site	2	2	2.4	0.0	1.2	1.7
30	Pajarito Booster 2 (P-2)	4	4	0.0	–0.5	–0.2	0.2
31	TA-3	4	4	2.7	0.0	1.5	1.2
49	Pajarito Road (TA-36)	4	4	0.6	–1.1	–0.4	0.7
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	1	14.7	1.9	9.6	5.7
39	TA-49-QA (next to #26)	4	4	1.5	–1.2	0.2	1.2

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	2.2	–1.5	0.0	±0.5	0.9
Pueblo	8	8	1.5	–1.4	0.2	±0.8	0.9
Perimeter	89	79	35.3	–2.0	1.4	±0.9	4.3
TA-15 and TA-36	12	12	1.3	–1.3	0.2	±0.4	0.7
TA-21	12	6	11.6	–0.5	3.4	±2.1	3.4
TA-54 Area G	32	20	49.6	–0.2	4.9	±3.3	9.1
Other On-Site	22	21	7.1	–1.1	0.6	±0.8	1.8

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 2,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 2,000 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-7. Airborne Americium-241 Concentrations for 2000

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	4	0.2	–0.5[a]	–0.2	0.3
03 Santa Fe	4	4	1.1	–0.8	–0.1	0.8
55 Santa Fe West (Buckman Booster #4)	4	4	3.2	–0.1	0.9	1.5
56 El Rancho	4	4	1.8	–0.5	0.7	0.9
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	1.9	–1.6	–0.4	1.6
59 Jemez Pueblo-Visitor’s Center	4	4	0.8	–1.1	0.2	0.8
Perimeter Stations						
04 Barranca School	4	4	0.6	0.1	0.4	0.2
05 Urban Park	4	4	2.7	–0.8	0.6	1.5
06 48th Street	4	4	0.8	–1.6	–0.2	1.0
07 Gulf/Exxon/Shell Station	4	3	3.5	–1.5	1.2	2.2
08 McDonald’s Restaurant	4	4	1.6	–0.9	0.4	1.0
09 Los Alamos Airport	4	4	2.1	–0.3	0.7	1.1
10 East Gate	4	4	1.5	–0.8	0.7	1.0
11 Well PM-1 (E. Jemez Road)	4	4	0.8	–0.5	0.2	0.6
12 Royal Crest Trailer Court	4	4	2.0	–0.8	0.4	1.2
13 Rocket Park	4	4	0.6	–0.4	0.0	0.4
14 Pajarito Acres	4	4	1.1	–0.9	0.0	0.8
15 White Rock Fire Station	4	4	1.2	–1.2	0.1	1.0
16 White Rock Nazarene Church	4	4	2.2	–0.5	0.8	1.1
17 Bandelier Fire Lookout	4	4	1.3	–1.4	–0.2	1.2
26 TA-49	4	4	1.5	–0.9	0.4	1.2
32 County Landfill (TA-48)	4	3	4.7	0.7	1.8	1.9
54 TA-33 East	4	4	2.0	–0.9	–0.1	1.3
60 LA Canyon	4	4	1.2	–0.3	0.5	0.6
61 LA Hospital	4	4	1.7	0.3	1.1	0.6
62 Crossroads Bible Church	4	4	3.1	–0.1	1.3	1.4
63 Monte Rey South	4	4	0.9	–1.3	–0.2	0.9
66 Los Alamos Inn-South	3	3	1.0	–0.5	0.3	0.8
67 TA-3 Research Park	2	2	0.4	–0.6	–-0.1	0.7
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	0.8	–0.6	0.1	0.6
77 TA-36 IJ Site	4	4	3.1	–0.7	1.0	1.6
78 TA-15-N	4	4	2.1	–0.9	0.7	1.3
TA-21 Stations						
20 TA-21 Area B	4	4	1.3	0.4	0.8	0.4
71 TA-21.01 (NW Bldg 344)	4	4	2.6	–0.1	0.9	1.2
72 TA-21.02 (N Bldg 344)	1	1	0.8	0.8	0.8	
73 TA-21.03 (NE Bldg 344)	1	1	2.7	2.7	2.7	
74 TA-21.04 (SE Bldg 344)	1	1	1.6	1.6	1.6	
75 TA-21.05 (S Bldg 344)	1	1	–1.2	–1.2	–1.2	

Table 4-7. Airborne Americium-241 Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	1	12.3	2.9	6.6	4.2
34	Area G-1 (behind trailer)	4	0	258.4	9.2	87.4	116.6
35	Area G-2 (back fence)	4	4	0.1	–0.8	–0.3	0.4
36	Area G-3 (by office)	4	4	1.3	–2.3	0.0	1.7
45	Area G/South East Perimeter	4	2	9.7	–0.5	4.5	4.3
47	Area G/North Perimeter	4	2	24.6	–0.9	7.3	11.7
50	Area G-expansion	4	3	5.0	–1.2	1.4	2.8
51	Area G-expansion pit	4	4	2.5	–0.2	0.7	1.2
Other On-Site Stations							
23	TA-5	4	4	1.1	–0.7	0.3	0.9
25	TA-16-450	4	4	0.8	–1.7	–0.1	1.1
29	TA-2 Omega Site	2	2	0.1	–0.8	–0.3	0.6
30	Pajarito Booster 2 (P-2)	4	4	2.0	–0.2	1.1	1.0
31	TA-3	4	4	0.6	–0.6	0.0	0.5
49	Pajarito Road (TA-36)	4	4	0.6	–0.7	0.0	0.5
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	1	11.6	3.0	6.3	3.7
39	TA-49-QA (next to #26)	4	4	1.0	–1.0	–0.2	0.9

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	16	3.2	–0.8	0.3	±0.5	1.0
Pueblo	8	8	1.9	–1.6	–0.1	±1.0	1.2
Perimeter	89	87	4.7	–1.6	0.5	±0.2	1.1
TA-15 and TA-36	12	12	3.1	–0.9	0.6	±0.8	1.2
TA-21	12	12	2.7	–1.2	0.9	±0.7	1.1
TA-54 Area G	32	20	258.4	–2.3	13.5	±16.7	46.3
Other On-Site	22	22	2.0	–1.7	0.2	±0.4	0.9

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 2,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 1,900 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-8. Airborne Uranium-234 Concentrations for 2000

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	0	25.1	7.0	17.6	7.9
03 Santa Fe	4	0	47.3	9.8	23.1	16.7
55 Santa Fe West (Buckman Booster #4)	4	0	14.6	6.1	8.7	3.9
56 El Rancho	4	1	30.2	2.8	19.2	11.7
Pueblo Stations						
41 San Ildefonso Pueblo	4	0	27.7	10.6	17.8	8.0
59 Jemez Pueblo-Visitor’s Center	4	0	42.2	18.9	29.7	9.6
Perimeter Stations						
04 Barranca School	4	1	23.8	5.0	14.4	7.7
05 Urban Park	4	0	17.1	5.5	11.4	5.9
06 48th Street	4	1	11.2	0.9	5.6	4.3
07 Gulf/Exxon/Shell Station	4	0	94.5	9.6	43.4	38.9
08 McDonald’s Restaurant	4	1	25.1	3.6	11.6	9.3
09 Los Alamos Airport	4	1	16.8	3.8	9.1	5.5
10 East Gate	4	1	28.7	2.7	12.2	11.4
11 Well PM-1 (E. Jemez Road)	4	1	16.4	1.7	6.6	6.7
12 Royal Crest Trailer Court	4	0	28.7	5.7	12.6	10.9
13 Rocket Park	4	1	15.9	2.5	7.7	5.7
14 Pajarito Acres	4	1	9.1	1.5	5.8	3.3
15 White Rock Fire Station	4	1	17.0	0.2	7.8	7.0
16 White Rock Nazarene Church	4	1	15.4	0.8	8.0	6.7
17 Bandelier Fire Lookout	4	1	13.3	1.4	7.2	5.3
26 TA-49	4	2	15.0	1.4	5.9	6.2
32 County Landfill (TA-48)	4	0	86.6	39.5	62.3	23.4
54 TA-33 East	4	2	14.3	1.6	5.8	5.8
60 LA Canyon	4	0	16.3	5.3	9.7	4.7
61 LA Hospital	4	0	22.1	7.7	14.4	6.4
62 Crossroads Bible Church	4	1	17.7	3.0	8.5	6.4
63 Monte Rey South	4	1	15.9	3.4	7.4	5.7
66 Los Alamos Inn-South	3	1	24.5	0.2	11.0	12.4
67 TA-3 Research Park	2	0	40.6	40.3	40.5	0.2
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	1	12.2	4.0	8.2	3.5
77 TA-36 IJ Site	4	1	26.1	4.1	13.7	9.5
78 TA-15-N	4	2	28.6	1.8	10.1	12.6
TA-21 Stations						
20 TA-21 Area B	4	1	44.2	3.1	20.5	17.2
71 TA-21.01 (NW Bldg 344)	4	0	19.7	5.6	10.2	6.6
72 TA-21.02 (N Bldg 344)	1	0	6.2	6.2	6.2	
73 TA-21.03 (NE Bldg 344)	1	0	8.3	8.3	8.3	
74 TA-21.04 (SE Bldg 344)	1	0	6.3	6.3	6.3	
75 TA-21.05 (S Bldg 344)	1	0	5.7	5.7	5.7	

Table 4-8. Airborne Uranium-234 Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	0	105.7	18.0	55.2	37.0
34	Area G-1 (behind trailer)	4	0	114.7	13.9	48.9	45.1
35	Area G-2 (back fence)	4	0	21.7	9.7	15.9	5.1
36	Area G-3 (by office)	4	0	20.9	6.3	14.3	6.2
45	Area G/South East Perimeter	4	0	81.2	38.0	52.9	19.4
47	Area G/North Perimeter	4	0	97.9	10.0	50.2	36.8
50	Area G-expansion	4	0	74.1	11.9	49.2	27.0
51	Area G-expansion pit	4	0	44.0	7.2	28.8	17.9
Other On-Site Stations							
23	TA-5	4	1	59.2	5.6	22.4	25.3
25	TA-16-450	4	1	14.7	–0.6[a]	6.4	6.3
29	TA-2 Omega Site	2	1	21.6	0.0	10.8	15.2
30	Pajarito Booster 2 (P-2)	4	1	32.6	3.0	15.4	12.7
31	TA-3	4	1	26.1	5.9	15.9	10.0
49	Pajarito Road (TA-36)	4	2	9.9	0.0	5.0	4.2
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	0	92.2	15.9	52.2	31.7
39	TA-49-QA (next to #26)	4	2	13.6	2.5	6.4	5.0

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	1	47.3	2.8	17.1	±6.0	11.3
Pueblo	8	0	42.2	10.6	23.8	±8.6	10.3
Perimeter	89	18	94.5	0.2	13.7	±3.6	17.1
TA-15 and TA-36	12	4	28.6	1.8	10.7	±5.6	8.8
TA-21	12	1	44.2	3.1	12.5	±7.3	11.4
TA-54 Area G	32	0	114.7	6.3	39.4	±10.6	29.4
Other On-Site	22	7	59.2	–0.6	12.8	±6.1	13.7

Concentration Guidelines

DOE Derived Air Concentation (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,700 a Ci/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-9. Airborne Uranium-235 Concentrations for 2000

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations						
01 Española	4	2	3.3	0.2	1.9	1.6
03 Santa Fe	4	3	3.5	–0.1[a]	1.1	1.6
55 Santa Fe West (Buckman Booster #4)	4	4	0.8	–0.4	0.2	0.6
56 El Rancho	4	4	1.8	–1.9	0.2	1.7
Pueblo Stations						
41 San Ildefonso Pueblo	4	4	0.7	–0.6	0.1	0.6
59 Jemez Pueblo-Visitor’s Center	4	4	2.4	0.0	1.7	1.1
Perimeter Stations						
04 Barranca School	4	4	2.2	–0.6	0.8	1.1
05 Urban Park	4	4	0.9	–0.6	0.4	0.7
06 48th Street	4	4	0.9	–1.0	–0.1	0.9
07 Gulf/Exxon/Shell Station	4	2	6.6	–0.4	3.1	3.3
08 McDonald’s Restaurant	4	4	0.5	0.1	0.3	0.2
09 Los Alamos Airport	4	4	2.7	0.5	1.4	1.0
10 East Gate	4	4	0.9	–0.5	0.1	0.6
11 Well PM-1 (E. Jemez Road)	4	4	1.5	–1.2	–0.1	1.2
12 Royal Crest Trailer Court	4	4	2.6	0.7	1.3	0.9
13 Rocket Park	4	4	0.9	–0.3	0.3	0.5
14 Pajarito Acres	4	4	0.8	–0.7	–0.1	0.7
15 White Rock Fire Station	4	4	1.3	–2.1	–0.1	1.5
16 White Rock Nazarene Church	4	4	0.8	–1.7	–0.2	1.2
17 Bandelier Fire Lookout	4	4	1.5	–0.6	0.2	0.9
26 TA-49	4	4	3.0	–1.0	0.4	1.8
32 County Landfill (TA-48)	4	3	3.5	1.2	2.3	1.0
54 TA-33 East	4	4	1.0	–0.9	–0.1	0.8
60 LA Canyon	4	4	1.6	–2.2	0.2	1.7
61 LA Hospital	4	4	0.9	–0.9	0.1	0.8
62 Crossroads Bible Church	4	4	1.4	–0.5	0.2	0.9
63 Monte Rey South	4	4	2.1	–0.5	0.4	1.2
66 Los Alamos Inn-South	3	3	2.6	–1.0	0.9	1.8
67 TA-3 Research Park	2	2	2.5	0.9	1.7	1.1
TA-15 and TA-36 Stations						
76 TA-15-41 (formerly 15-61)	4	4	1.5	–1.6	–0.4	1.5
77 TA-36 IJ Site	4	3	4.6	–1.0	1.1	2.5
78 TA-15-N	4	3	2.6	–0.4	0.8	1.3
TA-21 Stations						
20 TA-21 Area B	4	3	2.3	0.1	1.3	1.0
71 TA-21.01 (NW Bldg 344)	4	4	1.6	–0.1	0.5	0.8
72 TA-21.02 (N Bldg 344)	1	1	0.4	0.4	0.4	
73 TA-21.03 (NE Bldg 344)	1	1	0.5	0.5	0.5	
74 TA-21.04 (SE Bldg 344)	1	1	1.1	1.1	1.1	
75 TA-21.05 (S Bldg 344)	1	0	1.9	1.9	1.9	

Table 4-9. Airborne Uranium-235 Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	1	5.6	0.5	3.5	2.3
34	Area G-1 (behind trailer)	4	3	3.7	0.3	1.8	1.5
35	Area G-2 (back fence)	4	4	0.8	0.4	0.6	0.2
36	Area G-3 (by office)	4	4	0.8	–0.7	0.3	0.7
45	Area G/South East Perimeter	4	3	2.7	0.2	1.4	1.1
47	Area G/North Perimeter	4	2	6.6	–1.3	2.1	3.3
50	Area G-expansion	4	3	2.6	1.4	1.9	0.5
51	Area G-expansion pit	4	3	2.5	–1.0	1.0	1.7
Other On-Site Stations							
23	TA-5	4	4	1.4	–0.3	0.6	0.7
25	TA-16-450	4	3	3.2	–1.1	0.6	1.8
29	TA-2 Omega Site	2	2	–0.9	–2.8	–1.8	1.4
30	Pajarito Booster 2 (P-2)	4	4	1.7	0.5	1.1	0.6
31	TA-3	4	4	0.9	–0.3	0.2	0.5
49	Pajarito Road (TA-36)	4	3	3.5	–0.9	0.8	1.8
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	3	4.4	0.3	1.7	1.8
39	TA-49-QA (next to #26)	4	4	3.3	–2.3	0.3	2.3

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	13	3.5	–1.9	0.9	±0.8	1.5
Pueblo	8	8	2.4	–0.6	0.9	±1.0	1.2
Perimeter	89	86	6.6	–2.2	0.6	±0.3	1.4
TA-15 and TA-36	12	10	4.6	–1.6	0.5	±1.1	1.8
TA-21	12	10	2.3	–0.1	0.9	±0.5	0.8
TA-54 Area G	32	23	6.6	–1.3	1.6	±0.6	1.8
Other On-Site	22	20	3.5	–2.8	0.4	±0.6	1.4

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 7,100 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-10. Airborne Uranium-238 Concentrations for 2000

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
Regional Stations							
01	Española	4	0	26.6	9.0	17.9	9.1
03	Santa Fe	4	0	40.3	12.4	22.2	12.4
55	Santa Fe West (Buckman Booster #4)	4	0	8.9	4.5	6.7	1.8
56	El Rancho	4	0	27.4	6.0	16.8	9.0
Pueblo Stations							
41	San Ildefonso Pueblo	4	0	26.1	11.1	17.5	6.4
59	Jemez Pueblo-Visitor's Center	4	0	46.6	16.2	30.6	12.5
Perimeter Stations							
04	Barranca School	4	0	29.6	7.8	16.6	9.3
05	Urban Park	4	1	17.0	3.3	10.6	6.4
06	48th Street	4	1	16.1	2.5	6.8	6.4
07	Gulf/Exxon/Shell Station	4	0	111.0	16.9	53.2	43.3
08	McDonald's Restaurant	4	0	27.6	7.0	12.2	10.3
09	Los Alamos Airport	4	0	23.3	5.4	10.7	8.5
10	East Gate	4	0	35.8	6.4	15.2	13.8
11	Well PM-1 (E. Jemez Road)	4	1	21.2	2.1	8.7	8.5
12	Royal Crest Trailer Court	4	0	25.1	5.3	12.4	8.7
13	Rocket Park	4	2	9.4	–0.5[a]	4.5	4.1
14	Pajarito Acres	4	0	8.8	4.5	6.8	2.1
15	White Rock Fire Station	4	1	20.5	2.1	8.8	8.1
16	White Rock Nazarene Church	4	1	13.6	3.8	7.8	4.3
17	Bandelier Fire Lookout	4	0	12.5	3.3	6.5	4.1
26	TA-49	4	1	15.6	1.8	6.6	6.2
32	County Landfill (TA-48)	4	0	84.5	41.6	64.1	20.5
54	TA-33 East	4	1	9.9	2.2	5.4	3.5
60	LA Canyon	4	0	20.9	5.4	11.3	6.8
61	LA Hospital	4	0	27.1	8.1	16.5	8.1
62	Crossroads Bible Church	4	0	17.7	5.1	9.3	5.8
63	Monte Rey South	4	0	12.3	6.4	8.4	2.7
66	Los Alamos Inn-South	3	0	33.1	4.7	15.8	15.2
67	TA-3 Research Park	2	0	34.3	26.3	30.3	5.6
TA-15 and TA-36 Stations							
76	TA-15-41 (formerly 15-61)	4	0	23.7	5.6	11.4	8.3
77	TA-36 IJ Site	4	0	50.9	17.9	33.6	16.5
78	TA-15-N	4	0	53.1	2.8	24.0	21.2
TA-21 Stations							
20	TA-21 Area B	4	0	45.4	7.5	23.5	15.8
71	TA-21.01 (NW Bldg 344)	4	0	15.9	4.3	9.3	4.9
72	TA-21.02 (N Bldg 344)	1	0	5.9	5.9	5.9	
73	TA-21.03 (NE Bldg 344)	1	0	8.0	8.0	8.0	
74	TA-21.04 (SE Bldg 344)	1	0	3.5	3.5	3.5	
75	TA-21.05 (S Bldg 344)	1	0	5.3	5.3	5.3	

Table 4-10. Airborne Uranium-238 Concentrations for 2000 (Cont.)

Station Location		Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	Sample Standard Deviation
TA-54 Area G Stations							
27	Area G (by QA)	4	0	104.2	16.0	52.9	37.4
34	Area G-1 (behind trailer)	4	0	104.6	20.9	49.8	37.7
35	Area G-2 (back fence)	4	0	19.8	13.0	17.3	3.0
36	Area G-3 (by office)	4	0	17.9	8.4	14.7	4.4
45	Area G/South East Perimeter	4	0	84.8	42.2	54.2	20.4
47	Area G/North Perimeter	4	0	92.0	12.7	51.0	33.4
50	Area G-expansion	4	0	77.8	15.0	54.0	27.9
51	Area G-expansion pit	4	0	45.9	8.2	31.0	18.2
Other On-Site Stations							
23	TA-5	4	0	85.1	7.1	30.5	37.1
25	TA-16-450	4	1	13.4	0.8	7.2	5.3
29	TA-2 Omega Site	2	1	15.3	1.8	8.6	9.6
30	Pajarito Booster 2 (P-2)	4	0	56.0	6.2	29.3	25.0
31	TA-3	4	0	23.5	4.3	13.8	9.3
49	Pajarito Road (TA-36)	4	0	17.8	6.4	10.9	4.9
QA Stations							
38	TA-54 Area G-QA (next to #27)	4	0	86.9	19.4	55.0	29.3
39	TA-49-QA (next to #26)	4	1	17.9	1.0	6.8	7.5

Group Summaries

Station Location	Number of Measurements	Number of Measurements <Uncertainty	Maximum (aCi/m^3)	Minimum (aCi/m^3)	Mean (aCi/m^3)	95% Confidence Interval[b]	Sample Standard Deviation
Regional	16	0	40.3	4.5	15.9	±5.3	9.9
Pueblo	8	0	46.6	11.1	24.1	±9.7	11.6
Perimeter	89	9	111.0	–0.5	14.8	±3.8	18.3
TA-15 and TA-36	12	0	53.1	2.8	23.0	±11.1	17.5
TA-21	12	0	45.4	3.5	12.8	±7.5	11.8
TA-54 Area G	32	0	104.6	8.2	40.6	±10.1	28.1
Other On-Site	22	2	85.1	0.8	17.4	±9.0	20.2

Concentration Guidelines

DOE Derived Air Concentration (DAC) Guide for workplace exposure is 20,000,000 aCi/m^3. See Appendix A.
EPA 40 CFR 61 Concentration Guide 8,300 aCi/m^3.

[a] See Section A.4.a of this chapter and Appendix B for an explanation of negative values.
[b] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-11. Airborne Gamma-Emitting Radionuclides That Are Potentially Released by LANL Operations

Gamma-Emitting Radionuclide	Number of Results	Number of Results ≤MDA[a]	Mean (fCi/m^3)	Measured Average MDA as a Percent of the Required MDA
^{73}As	331	331	<<1.77	0.3
^{74}As	331	331	<<0.92	0.8
^{109}Cd	331	331	<<0.91	3.1
^{57}Co	331	331	<<0.25	0.4
^{60}Co	331	331	<<0.48	56.1
^{134}Cs	331	331	<<0.44	32.2
^{137}Cs	331	331	<<0.40	42.6
^{54}Mn	331	331	<<0.47	3.4
^{22}Na	331	331	<<0.49	37.6
^{83}Rb	331	331	<<0.95	5.6
^{86}Rb	331	331	<<6.96	24.8
^{103}Ru	331	331	<<0.44	0.3
^{75}Se	331	331	<<0.40	4.8
^{65}Zn	331	331	<<0.97	21.3

[a] Minimum detectable amounts.

Table 4-12. Airborne Concentrations of Gamma-Emitting Radionuclides That Naturally Occur in Measurable Quantities

Gamma Emitting Radionuclide	Number of Measurements	Number of Measurements <MDA[a]	Mean[b] (fCi/m^3)
^{7}Be	330	1	69
^{210}Pb	293	38	11

[a] Minimum detectable activities.
[b] Measurements that are less than the MDA are not included in the Mean.

Table 4-13. Airborne Radioactive Emissions from Laboratory Buildings with Sampled Stacks in 2000 (Ci)

TA-Building	^{3}H[a]	^{241}Am	Pu[b]	U[c]	Th	P/VAP[d]	G/MAP[e]
TA-03-029		1.8×10^{-7}	3.2×10^{-6}	6.7×10^{-6}	1.3×10^{-7}		
TA-03-102				5.7×10^{-8}	1.2×10^{-9}		
TA-16-205	2.6×10^{2}						
TA-21-155	1.8×10^{2}						
TA-21-209	7.6×10^{2}						
TA-33-086	1.2×10^{3}						
TA-41-004	6.3×10^{0}						
TA-48-001						1.7×10^{-2}	
TA-50-001			9.8×10^{-9}		5.3×10^{-8}		
TA-50-037							
TA-50-069							
TA-53-003	6.0×10^{-1}						8.4×10^{0}
TA-53-007	2.3×10^{0}					9.3×10^{-1}	6.8×10^{2}
TA-55-004	6.4×10^{0}	3.3×10^{-7}	2.5×10^{-6}				
Total[f]	2.4×10^{3}	5.1×10^{-7}	5.8×10^{-6}	6.8×10^{-6}	1.8×10^{-7}	9.5×10^{-1}	6.9×10^{2}

[a] Includes both gaseous and oxide forms of tritium.
[b] Includes ^{238}Pu, ^{239}Pu, and ^{240}Pu.
[c] Includes ^{234}U, ^{235}U, and ^{238}U.
[d] P/VAP—Particulate/vapor activation products.
[e] G/MAP—Gaseous/mixed activation products.
[f] Some differences may occur because of rounding.

Table 4-14. Detailed Listing of Activation Products Released from Sampled Laboratory Stacks in 2000 (Ci)

TA-Building	Radionuclide	Emission
TA-48-001	^{73}As	4.4×10^{-5}
TA-48-001	^{74}As	2.8×10^{-5}
TA-48-001	^{77}Br	2.8×10^{-5}
TA-48-001	^{68}Ga	8.1×10^{-3}
TA-48-001	^{68}Ge	8.1×10^{-3}
TA-48-001	^{75}Se	1.4×10^{-4}
TA-53-003	^{41}Ar	1.0×10^{-1}
TA-53-003	^{11}C	8.3×10^{0}
TA-53-007	^{41}Ar	2.3×10^{1}
TA-53-007	^{73}As	2.2×10^{-5}
TA-53-007	^{76}Br	2.6×10^{-4}
TA-53-007	^{82}Br	4.2×10^{-3}
TA-53-007	^{10}C	1.4×10^{-1}
TA-53-007	^{11}C	5.4×10^{2}
TA-53-007	^{193}Hg	8.0×10^{-1}
TA-53-007	^{195m}Hg	2.0×10^{-2}
TA-53-007	^{197}Hg	1.0×10^{-1}
TA-53-007	^{13}N	2.8×10^{1}
TA-53-007	^{16}N	1.7×10^{-2}
TA-53-007	^{14}O	4.1×10^{-1}
TA-53-007	^{15}O	9.1×10^{1}

Table 4-15. Radionuclide: Half-Life Information

Nuclide	Half-Life
^{3}H	12.3 yr
^{7}Be	53.4 d
^{10}C	19.3 s
^{11}C	20.5 min
^{13}N	10.0 min
^{16}N	7.13 s
^{14}O	70.6 s
^{15}O	122.2 s
^{22}Na	2.6 yr
^{24}Na	14.96 h
^{32}P	14.3 d
^{40}K	1,277,000,000 yr
^{41}Ar	1.83 h
^{54}Mn	312.7 d
^{56}Co	78.8 d
^{57}Co	270.9 d
^{58}Co	70.8 d
^{60}Co	5.3 yr
^{72}As	26 h
^{73}As	80.3 d
^{74}As	17.78 d
^{76}Br	16 h
^{77}Br	2.4 d
^{82}Br	1.47 d
^{75}Se	119.8 d
^{85}Sr	64.8 d
^{89}Sr	50.6 d
^{90}Sr	28.6 yr
^{131}I	8 d
^{134}Cs	2.06 yr
^{137}Cs	30.2 yr
^{183}Os	13 h
^{185}Os	93.6 d
^{191}Os	15.4 d
^{193}Hg	3.8 hr
^{195}Hg	9.5 hr
^{195m}Hg	1.67 d
^{197}Hg	2.67 d
^{197m}Hg	23.8 hr
^{234}U	244,500 yr
^{235}U	703,800,000 yr
^{238}U	4,468,000,000 yr
^{238}Pu	87.7 yr
^{239}Pu	24,131 yr
^{240}Pu	6,569 yr
^{241}Pu	14.4 yr
^{241}Am	432 yr

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1999–2000

TLD Station ID #	Location	2000 Annual Dose (mrem)	2000 Quarters Monitored	1999 Annual Dose (mrem)
01	NNMCC, Española	108 ± 8	1–4	110 ± 14
05	Barranca School, Los Alamos	141 ± 10	1–4	134 ± 17
08	48th Street, Los Alamos	152 ± 11	1–4	156 ± 20
09	Los Alamos Airport	124 ± 9	1–4	154 ± 20
11	Shell Station, Los Alamos	152 ± 11	1–4	158 ± 21
12	Royal Crest Trailer Court, Los Alamos	138 ± 10	1–4	139 ± 18
13	White Rock Fire Station	135 ± 9	1–4	140 ± 18
15	Bandelier National Monument	144 ± 10	1–4	157 ± 20
17	TA-21 (DP West)	150 ± 11	1–4	154 ± 20
18	TA-6 Entrance Station	134 ± 9	1–4	145 ± 19
19	TA-53 (LANSCE)West	155 ± 11	1–4	158 ± 21
20	TA-72 Well PM-1, SR 4 and Truck Rt.	165 ± 12	1–4	169 ± 22
21	TA-16 (S-Site) Rt. 501	143 ± 10	1–4	154 ± 20
22	TA-54 West, Booster P-2	145 ± 10	1–4	154 ± 20
23	TA-3 East Gate of SM 43	123 ± 9	1–4	122 ± 16
25	TA-49 (Frijoles Mesa)	131 ± 9	1–4	140 ± 18
28	TA-18 (Pajarito Site)	180 ± 13	2–4	189 ± 25
29	TA-35 (Ten Site A)	126 ± 9	1–4	131 ± 17
30	TA-35 (Ten Site B)	114 ± 8	1–4	130 ± 17
37	TA-72 (Pistol Range)	160 ± 11	1–4	177 ± 23
38	TA-55 (Plutonium Facility South)	150 ± 11	1–4	162 ± 21
39	TA-55 (Plutonium Facility West)	155 ± 11	1–4	165 ± 21
41	McDonald’s Restaurant, Los Alamos	138 ± 10	1–4	147 ± 19
47	Urban Park, Los Alamos	141 ± 10	1–4	143 ± 19
48	TA-61 Los Alamos County Landfill	132 ± 9	1–4	140 ± 18
49	Piñon School (Rocket Park) White Rock	127 ± 9	1–4	130 ± 17
50	White Rock Church of the Nazarene	124 ± 9	1–4	130 ± 17
53	San Ildefonso Pueblo	125 ± 9	1–4	116 ± 15
55	Monte Rey South, White Rock	122 ± 9	1–4	132 ± 17
58	TA-36 Pajarito Road (South of TA-54)	154 ± 11	1–4	167 ± 22
59	TA-43 Los Alamos Canyon	162 ± 11	1–4	167 ± 22
60	Piedra Drive, White Rock	122 ± 9	1–4	133 ± 17
64	TA-53 NE LANSCE Area A Stack	201 ± 8	1–4	240 ± 31
65	TA-53 NW LANSCE Area A Stack	160 ± 11	2–4	219 ± 28
66	TA-73 East Gate	150 ± 11	1–4	150 ± 19
67	Los Alamos Medical Center	134 ± 9	1–4	134 ± 17
68	Trinity (Crossroads) Bible Church	140 ± 10	1,2,4	156 ± 20
69	TA-50 Old Outfall	166 ± 12	1,3,4	185 ± 24
70	TA-50 Dirt Road to Outfall	170 ± 12	1–4	175 ± 23
71	TA-50 Dirt Road Turnoff	150 ± 11	1–4	157 ± 20
72	TA-50 East Fence, S. Corner	148 ± 10	1–4	166 ± 22
73	TA-50 East Fence, N. Corner	125 ± 9	1–4	148 ± 19
74	TA-50 Pecos Drive	126 ± 9	1–4	141 ± 18
75	TA-50-37 West	140 ± 10	1–4	158 ± 21
76	TA-16-450 WETF	136 ± 10	1–4	141 ± 18
77	TA-16-210 Guard Station	144 ± 10	1–4	147 ± 19
78	TA-8-24 Fitness Trail SW	140 ± 10	1–4	158 ± 21
79	TA-8-24 Fitness Trail SE	144 ± 10	1–4	157 ± 20
80	TA-16 SR 4 Back Gate	133 ± 9	1,3,4	148 ± 19

Table 4-16. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation 1999–2000 (Cont.)

TLD Station ID #	Location	2000 Annual Dose (mrem)	2000 Quarters Monitored	1999 Annual Dose (mrem)
81	TA-16 SR 4 Ponderosa Camp	134 ± 9	1–4	147 ± 19
82	TA-15 Phermex N TA-15-185	163 ± 11	1–4	163 ± 21
83	TA-15 Phermex Entrance	130 ± 9	1–4	120 ± 16
84	TA-15 Phermex NNE Entrance	134 ± 9	1–4	132 ± 17
85	TA-15 Phermex N DAHRT	135 ± 9	1–4	146 ± 19
86	TA-15-312 DAHRT Entrance	144 ± 10	1–4	146 ± 19
87	TA-15-183 Access Control	143 ± 10	1–4	157 ± 20
88	TA-15 R-Site Road	143 ± 10	1–4	150 ± 20
89	TA-15-45 SW	157 ± 11	1–3	153 ± 20
90	TA-15-306 North	151 ± 11	1–4	152 ± 20
91	TA-15, IJ Firing Point	142 ± 10	1–4	151 ± 20
92	TA-36 Kappa Site	153 ± 11	1–4	160 ± 21
93	TA-15 Ridge Road Gate	134 ± 9	1–4	138 ± 18
94	TA-33 East (VLBA Dish)	120 ± 8	1–4	124 ± 16
95	El Rancho	126 ± 9	1–4	133 ± 17
100	TA-5 Mortandad Canyon, MCO-13	143 ± 10	1,3,4	155 ± 20
101	Santa Fe West	117 ± 8	1–4	127 ± 17
103	Santa Clara Pueblo	162 ± 11	1–4	145 ± 19
104	TA-53 NE LANSCE Lagoons	198 ± 14	1–4	242 ± 31
105	TA-3 Wellness Center	122 ± 9	1,4	NA[a]
106	TA-3 University House	127 ± 9	1–4	NA[a]
107	TA-5 AIRNET	120 ± 8	1–4	NA[a]
108	TA-43 HRL	130 ± 9	1–4	NA[a]
109	TA-48 South	130 ± 9	1–4	NA[a]
110	TA-21 AIRNET	131 ± 9	1–4	NA[a]
114	TA-53 E of LANSCE Lagoons	163 ± 11	1–4	NA[a]
115	TA-53 N of LANSCE Lagoons	181 ± 13	1–4	NA[a]
116	TA-53 Old LANSCE Lagoons	355 ± 25	1–4	NA[a]
117	TA-3-130 Calibration Lab	224 ± 16	1–4	NA[a]
228	TA-49 AB-8	136 ± 10	1–4	142 ± 19
229	TA-49 AB-9	137 ± 10	1–4	149 ± 19
230	TA-49 AB-10	140 ± 10	1–4	164 ± 21
254	TA-21 Area B-14	142 ± 10	2–4	153 ± 20
261	TA-50 NW Area C	125 ± 9	1–4	138 ± 18
262	TA-50 N Area C	144 ± 10	1–4	166 ± 22
265	TA-50 SE Area C	141 ± 10	1–4	159 ± 21
267	TA-50 S Area C	144 ± 10	1–4	154 ± 20
268	TA-50 SW Area C	137 ± 10	1–4	139 ± 18
269	TA-50 SW Area C	142 ± 10	1–4	152 ± 20
270	TA-50 W Area C	140 ± 10	1–4	161 ± 21
323	TA-21 Area T	278 ± 19	1–4	297 ± 39
361	TA-21 Area V	140 ± 10	1–4	133 ± 17
401	TA-73 NE of LANSCE	148 ± 10	1–4	164 ± 21
403	TA-73 NNE of LANSCE	152 ± 11	1–4	209 ± 27
405	TA-73 N of LANSCE	151 ± 11	1–4	176 ± 23
408	TA-73 NNW of LANSCE	160 ± 11	1–4	170 ± 22
412	TA-73 NW of LANSCE	148 ± 10	2–4	174 ± 23

[a] NA = Not applicable–there were no 1999 data at this location.

Table 4-17. Thermoluminescent Dosimeter (TLD) Measurements of External Radiation at the Waste Disposal Area G during 1999–2000

TLD Station ID #	Location	2000 Annual Dose (mrem)	2000 Quarters Monitored	1999 Annual Dose (mrem)
601	TA-54 Area G, 1	170 ± 12	1–4	192 ± 25
602	TA-54 Area G, 2	269 ± 19	1–4	291 ± 38
603	TA-54 Area G, 3	165 ± 12	1–4	184 ± 24
604	TA-54 Area G, 4	169 ± 12	1–4	180 ± 23
605	TA-54 Area G, 5	253 ± 18	1–4	198 ± 26
606	TA-54 Area G, 6	835 ± 60	1–4	295 ± 38
607	TA-54 Area G, 7	212 ± 15	1–4	245 ± 32
608	TA-54 Area G, 8	180 ± 13	1–4	254 ± 33
610	TA-54 Area G, 10	202 ± 14	1–4	236 ± 31
611	TA-54 Area G, 11	489 ± 34	1–4	473 ± 61
613	TA-54 Area G, 13	352 ± 25	1–4	357 ± 46
614	TA-54 Area G, 14	273 ± 19	1–4	291 ± 38
615	TA-54 Area G, 15	174 ± 12	1–4	192 ± 25
616	TA-54 Area G, 16	193 ± 14	1–4	184 ± 24
617	TA-54 Area G, 17	170 ± 12	1–4	185 ± 24
618	TA-54 Area G, 18	170 ± 12	1–4	179 ± 23
619	TA-54 Area G, 19	225 ± 16	1–4	219 ± 28
620	TA-54 Area G, 20	167 ± 12	1–4	200 ± 26
622	TA-54 Area G, 22	227 ± 16	1–4	242 ± 31
623	TA-54 Area G, 23	254 ± 18	1–4	215 ± 28
624	TA-54 Area G, 24	457 ± 32	1–4	170 ± 22
625	TA-54 Area G, 25	196 ± 14	1–4	199 ± 26
626	TA-54 Area G, 26	164 ± 11	1–4	173 ± 22
627	TA-54 Area G, 27	237 ± 17	1–4	323 ± 42
628	TA-54 Area G, 28	232 ± 16	1–3	235 ± 31
629	TA-54 Area G, 29	195 ± 14	1–4	215 ± 29
630	TA-54 Area G, 30	248 ± 17	1–4	257 ± 33
631	TA-54 Area G, 31	180 ± 13	1–4	190 ± 25
634	TA-54 Area G, 34	212 ± 15	1–4	269 ± 35
635	TA-54 Area G, 35	238 ± 17	1–4	260 ± 34
636	TA-54 Area G, 36	162 ± 11	1–4	186 ± 24
637	TA-54 Area G, 37	164 ± 11	1–4	183 ± 24
638	TA-54 Area G, 38	154 ± 11	1–4	166 ± 22
639	TA-54 Area G, 39	225 ± 16	1–4	300 ± 39
640	TA-54 Area G, 40	268 ± 19	1–4	271 ± 35
641	TA-54 Area G, 41	276 ± 19	1–4	278 ± 36
642	TA-54 Area G, 42	190 ± 13	2–4	
643	TA-54 Area G, 43	205 ± 14	2–4	

Table 4-18. TA-18 Albedo Dosimeter Network

Location ID#	Location	Dosimeter #1 (mrem)	Dosimeter #2 (mrem)
1	NEWNET Kappa Site	7.9	3.9
2	TA-36 Entrance	6.9	4.3
3	TA-18 Personnel Gate at Parking Lot	27.2	19.4
4	P2 Booster Station at TA-54 Entrance	4.8	5.2
5	TA-51 Entrance	1.4	1.3
6	Pajarito Hill West of TA-18 Entrance	6.7	5.8
7	TA-18 Entrance at Pajarito Road	12.4	8.4
8	TA-49 Background	1.1	NA[a]
9	Santa Fe Background	1.9	NA[a]
10	TA-3-130 Calibration Lab	120.6	NA[a]

[a] NA = not applicable—background or control location with one dosimeter.

Table 4-19. Estimated Criteria Pollutants from the Cerro Grande Fire

			Pollutants (tons)		
Property	**Area Acres**	**Fuel Loading[a] (ton/acre)**	**Particulate**	**Carbon Monoxide**	**Nitrogen Oxides**
EF (lb/ton)[b]			17	140	4
LANL	1,300	20	221	1,820	52
	6,200	10	527	4,340	124
Total LANL	7,500		748	6,160	176
Non-DOE	39,500	20	6,715	55,300	1,580
Total Acreage	47,000		7,463	61,460	1,756

[a] LA-13572-MS Fuels Inventories in the Los Alamos National Laboratory Region: 1997 (Balice 1999).
[b] AP-42, Section 13.1 Wildfires and Prescribed Burning 10/96.

Table 4-20. Airborne Beryllium Concentrations

Station Location		Number of Measurements	Maximum (ng/m^3)	Minimum (ng/m^3)	Mean (ng/m^3)	Sample Standard Deviation
Regional/Pueblo Stations						
01	Española	4	0.043	0.013	0.027	0.013
03	Santa Fe	4	0.066	0.019	0.035	0.021
41	San Ildefonso Pueblo	4	0.041	0.017	0.025	0.011
55	Santa Fe West (Buckman Booster #4)	4	0.011	0.003	0.008	0.004
56	El Rancho	4	0.031	0.006	0.018	0.011
59	Jemez Pueblo-Visitor's Center	4	0.104	0.041	0.067	0.029
Perimeter Stations						
04	Barranca School	4	0.024	0.011	0.019	0.006
07	Gulf/Exxon/Shell Station	4	0.183	0.020	0.092	0.074
09	Los Alamos Airport	4	0.018	0.004	0.010	0.006
10	East Gate	4	0.040	0.005	0.020	0.015
12	Royal Crest Trailer Court	4	0.031	0.007	0.016	0.011
16	White Rock Nazarene Church	4	0.023	0.005	0.012	0.008
26	TA-49	4	0.026	0.001	0.010	0.011
32	County Landfill (TA-48)	4	0.164	0.080	0.123	0.038
39	TA-49-QA (next to #26)	4	0.019	0.003	0.008	0.008
61	LA Hospital	4	0.030	0.013	0.021	0.008
66	Los Alamos Inn-South	1	0.010	0.010	0.010	
67	TA-3 Research Park	1	0.063	0.063	0.063	
On-Site Stations						
23	TA-5	4	0.047	0.009	0.023	0.018
31	TA-3	4	0.030	0.009	0.021	0.009
76	TA-15-41 (formerly 15-61)	4	0.013	0.002	0.006	0.005
77	TA-36 IJ Site	4	0.016	0.002	0.008	0.006
78	TA-15-N	4	0.014	0.001	0.006	0.006
TA-54 Area G Stations						
27	Area G (by QA)	4	0.203	0.027	0.108	0.073
35	Area G-2 (back fence)	4	0.042	0.022	0.034	0.009
36	Area G-3 (by office)	4	0.041	0.009	0.028	0.014
38	Area G-QA (next to #27)	4	0.181	0.035	0.110	0.060

Group Summaries

Station Location	Number of Measurements	Maximum (ng/m^3)	Minimum (ng/m^3)	Mean (ng/m^3)	95% Confidence Interval[a]	Sample Standard Deviation
Regional/Pueblo Stations	24	0.104	0.003	0.030	±0.010	0.024
Perimeter Stations	42	0.183	0.001	0.033	±0.014	0.045
On-Site Stations	20	0.047	0.001	0.013	±0.005	0.012
TA-54 Area G Stations	16	0.203	0.009	0.070	±0.031	0.059

[a] 95% confidence intervals are calculated using all calculated sample concentrations from every site within the group.

Table 4-21. LANL Meteorological Conditions During the Cerro Grande Fire

	Average Daily Wind Speed (mph)	Maximum Daily Wind Gust (mph)	Average Daily Wind Direction	Daily Maximum High Temp. (^{o}F)	Daily Minimum Low Temp. (^{o}F)	Average Daily Relative Humidity (%)	Total Daily Rainfall (inches)
TA-6							
May 4	6	30	SW	83	47	15	0
May 5	8	37	SW	80	52	9	0
May 6	7	30	WSW	77	50	11	0
May 7	11	35	WSW	76	57	18	0
May 8	9	40	SW	71	44	34	0
May 9	5	27	SSW	74	39	31	0
May 10	12	46	WSW	79	49	[a]	0
May 11	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 12	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 13	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 14	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 15	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 16	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 17	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 18	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 19	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 20	[a]	[a]	[a]	[a]	[a]	[a]	[a]
May 21	[a]	[a]	[a]	[a]	[a]	[a]	[a]
TA-49							
May 4	6	24	SW	85	53	14	0
May 5	8	34	SW	82	55	8	0
May 6	7	33	WSW	80	53	10	0
May 7	11	38	SW	80	56	17	0
May 8	11	41	WSW	74	49	30	0
May 9	8	34	SW	77	44	28	0
May 10	15	46	WSW	85	54	17	0
May 11	17	54	SW	78	51	13	0
May 12	8	28	SW	65	38	11	0
May 13	12	34	SSW	66	35	22	0
May 14	9	29	WSW	79	44	22	0
May 15	7	43	SSW	86	51	11	0
May 16	12	39	SSW	74	55	10	0
May 17	14	47	W	60	42	24	0
May 18	9	33	SSW	70	41	31	0
May 19	7	32	SW	64	35	51	0.02
May 20	7	43	SSW	74	43	37	0
May 21	8	29	WSW	82	48	22	0

Table 4-21. LANL Meteorological Conditions During the Cerro Grande Fire (Cont.)

	Average Daily Wind Speed (mph)	Maximum Daily Wind Gust (mph)	Average Daily Wind Direction	Daily Maximum High Temp. (^{o}F)	Daily Minimum Low Temp. (^{o}F)	Average Daily Relative Humidity (%)	Total Daily Rainfall (inches)
TA-53							
May 4	5	23	S	85	55	15	0
May 5	6	29	SSW	83	53	9	0
May 6	7	28	WSW	80	58	9	0
May 7	9	44	WSW	80	57	17	0
May 8	10	46	SW	74	52	30	0
May 9	6	31	S	78	44	28	0
May 10	13	56	WSW	83	54	18	0
May 11	14	54	SW	76	55	17	0
May 12	7	27	SSW	65	41	11	0
May 13	11	36	S	66	38	22	0
May 14	9	47	SW	78	47	21	0
May 15	7	38	S	85	49	12	0
May 16	10	35	SSW	75	58	10	0
May 17	14	46	WSW	62	44	23	0
May 18	7	45	S	70	43	31	0
May 19	7	27	SW	63	40	47	0.02
May 20	6	48	SE	75	47	38	0
May 21	6	27	SW	82	49	22	0
TA-54							
May 4	5	22	SW	86	41	19	0
May 5	6	29	WSW	85	39	13	0
May 6	6	32	WSW	82	43	11	0
May 7	9	36	SW	82	50	18	0
May 8	9	46	SW	77	45	30	0
May 9	7	32	SW	80	38	33	0
May 10	12	47	SW	87	44	21	0
May 11	13	48	SW	81	54	17	0
May 12	6	27	SSE	66	32	14	0
May 13	11	39	SSW	68	27	24	0
May 14	9	32	SW	81	38	25	0
May 15	7	39	SW	87	39	17	0
May 16	10	33	SW	76	51	14	0
May 17	13	43	WSW	64	40	24	0
May 18	7	35	SSW	71	33	34	0
May 19	7	27	SW	65	39	49	0
May 20	6	36	S	75	35	45	0
May 21	6	32	WSW	84	39	28	0

Table 4-21. LANL Meteorological Conditions During the Cerro Grande Fire (Cont.)

	Average Daily Wind Speed (mph)	Maximum Daily Wind Gust (mph)	Average Daily Wind Direction	Daily Maximum High Temp. (ºF)	Daily Minimum Low Temp. (ºF)	Average Daily Relative Humidity (%)	Total Daily Rainfall (inches)
Pajarito Mountain							
May 4	14	28	WNW	69	50	16	0
May 5	17	45	WNW	65	49	14	0
May 6	19	45	WNW	60	44	20	0
May 7	25	49	W	61	44	31	0
May 8	22	64	WNW	55	39	54	0
May 9	19	43	WNW	61	36	37	0
May 10	30	63	W	65	43	33	0
May 11	37	70	W	58	38	32	0
May 12	16	40	WNW	51	26	21	0
May 13	18	35	S	51	28	37	0
May 14	19	44	WSW	60	39	28	0
May 15	21	49	W	66	47	14	0
May 16	25	57	SW	58	46	16	0
May 17	25	53	W	46	26	44	0
May 18	15	43	SW	53	33	50	0
May 19	10	27	SSW	47	31	70	0.08
May 20	13	38	W	60	40	43	0
May 21	12	31	WNW	65	44	27	0

[a] Data lost (fire burned over TA-6 on May 10).

Table 4-22. AIRNET QC Sample Types

Analyte	Number of Samples	Number of Lab Control Standards	Number of Matrix Spikes	Number of Matrix Blanks	Number of Matrix Duplicates	Number of Process Blanks	Number of Trip Blanks
Alpha/Beta	1,303	77	2	154	75		52
^{241}Am	202	13	11	26		13	8
Beryllium	128	18	17	24		17	8
Cerium	104	3	11	16		10	8
Gamma Nuclides	377	37		38	37	37	33
Tritium	1,334	159	104	129	8	185	52
Plutonium Isotopes	202	13	11	25		13	8
Uranium Isotopes	226	19	17	32		19	8

Table 4-23. Stack QC Sample Types

Analyte	Number of Samples	Number of Lab Control Standards	Number of Matrix Blanks	Number of Trip Blanks	Number of Matrix Duplicates	Number of Matrix Replicates	Number of Matrix Spikes	Number of Process Blanks
Alpha/Beta	1,563	4	112	76	2	104	108	4
^{241}Am	54	4	8	4	2		4	4
Beryllium	51	102	51	51				51
Gamma Nuclides	2,010	211	418	76		260	104	211
Tritium	1,836	306	612		306		100	612
^{210}Pb	25	2	4	2	2		2	2
^{210}Po	45	4	8	4	2		4	4
Plutonium Isotopes	54	4	8	4	2		4	4
^{90}Sr	45	4	8	4	2		4	4
Thorium Isotopes	72	6	10	6	2		4	6
Uranium Isotopes	54	5	9	4	2		5	5

Table 4-24. QC Performance Evaluation for AIRNET for CY 2000

Evaluation Performed	AIRNET Acceptance Criteria	Gross Alpha	Gross Beta	Tritium	Gamma
Laboratory Control Standard (LCS) Recovery Check	100 ± 10%	10% UC 90% W	96% UC 4% W	100% UC	85% UC 11% W 4% OC
Process Blank (PB)	See control criteria below.	NA[a]	NA	99.5% UC 0.5% OC	100% UC
Matrix Blank (MB)	See control criteria below.	100% UC	100% UC	92% UC 5% W 3% OC	100% UC
Trip Blank (TB)	See control criteria below.	96% UC 4% W	96% UC 4% W	98% UC 2% W	100% UC
Matrix Duplicate Evaluation	For analytically significant, positive results, similar to control criteria below.	100% agreement within ± 30%	100% agreement within ± 6%	NA	NA
Matrix Replicate Evaluation	Qualitative agreement (within a factor of 5) for analytically insignificant results (i.e. "less-than" values).	NA	NA	NA	99% UC 1% OC
Matrix Spike	100 ± 10% of added spike.	NA	NA	100% UC	NA
MDA[b] Target Achieved	All samples below SOW[c] specification.	100%	100%	100%	83%
Collection Efficiency	Between 70 and 130% of theoretical.	NA	NA	76% UC 10% low 14% high	NA
Naturally Occurring Radionuclides	All should have positive results.	NA	NA	NA	100% Yes
Analytical Completeness	80% successful analysis of valid samples.	100%	100%	100%	100%

General Control Criteria
Under Control (UC) is ≤2s of annual mean for that QC type.
Warning (W) is between 2s and 3s of annual mean for that QC type.
Out of Control (OC) is ≥3s of annual mean for that QC type.

[a]NA = not applicable.
[b]Minimum detectable activity.
[c]Statement of work.

Table 4-25. QC Performance Evaluation for AIRNET for CY 2000

Evaluation Performed	AIRNET Acceptance Criteria	Be	^{241}Am	Plutonium Isotopes	Uranium Isotopes
Laboratory Control Standard (LCS) Recovery Check	100 ± 10%	50% UC 50% in 85–90% range	100% UC	100% UC	83% UC 17% in 85–90% range
Process Blank (PB)	See control criteria below.	75% UC 25% W	100% UC	100% UC	100% UC
Matrix Blank (MB)	See control criteria below.	87% UC 13% W	100% UC	97% UC 3% OC	98% UC 2% W
Trip Blank (TB)	See control criteria below.	100% UC	100% UC	100% UC	100% UC
Matrix Spike	100 ± 10% of added spike.	50% UC 50% in 80–90% range	100% UC	100% UC	67% UC 33% in 110–120% range
MDA[a] Target Achieved	All samples below SOW[b] specification.	100%	100%	100%	100%
Analytical Completeness	80% successful analysis of valid samples.	100%	100%	100%	100%
Tracer Recovery	Mean ± Std Dev % recovery.	NA[c]	78 ± 15%	80 ± 8%	68 ± 8%
Tracer Recovery Control	50–110% is UC	NA	97% UC	100% UC	98% UC

General Control Criteria
Under Control (UC) is ≤2s of annual mean for that QC type.
Warning (W) is between 2s and 3s of annual mean for that QC type.
Out of Control (OC) is ≥3s of annual mean for that QC type.

[a] Minimum detectable activity.
[b] Statement of work.
[c] NA = not applicable.

Table 4-26. QC Performance Evaluation for Stack Sampling for CY 2000

Evaluation Performed	RADAIR Acceptance Criteria	Alpha/Beta	Gamma	Tritium	Beryllium
Laboratory Control Standard (LCS) Recovery Check	100 ± 10%	NA[a]	83% UC 13% W 4% OC	99% UC 1% W	94% UC 6% W
Process Blank (PB)	See control criteria below.	NA	98% UC 2% W	96% UC 3% W 1% OC	100% UC
Matrix Blank (MB)	See control criteria below.	95% UC 3%W 2% OC	99% UC 1% W	98% UC 1% W <1% OC	100% UC
Trip Blank (TB)	See control criteria below.	97% UC 3% OC	99% UC 1% W	NA	100% UC
Matrix Duplicate Evaluation	For analytically significant, positive results, similar to control criteria below.	80% UC 20% W	NA	NA	none done
	1–10 uCi/L under control at RPD <10%.	NA	NA	100% UC	NA
Matrix Replicate Evaluation	Qualitative Agreement (within a factor of 5) for analytically insignificant results (i.e. "less-than" values).	NA	99% UC 1% W	NA	NA
Matrix Spike	100 ± 10% of added spike.	46% UC 32% W 22% OC	98% UC 2% W	98% UC 2% W	NA
MDA[b] Target Achieved	All samples below SOW[c] specification.	100% UC	99% UC	100% UC	100%UC
Analytical Completeness	80% successful analysis of valid samples.	100%	100%	100%	100%

General Control Criteria
Under Control (UC) is ≤2s of annual mean for that QC type.
Warning (W) is between 2s and 3s of annual mean for that QC type.
Out of Control (OC) is ≥3s of annual mean for that QC type.

[a] NA = not applicable.
[b] Minimum detectable activity.
[c] Statement of work.

Table 4-27. QC Performance Evaluation for Stack Sampling for CY 2000

Evaluation Performed	RADAIR Acceptance Criteria	^{241}Am	Thorium Isotopes	Plutonium Isotopes	Uranium Isotopes
Laboratory Control Standard (LCS) Recovery Check	100 ± 10%	100% UC	75% UC 25% W	100% UC	80% UC 7% W 13% OC
Process Blank (PB)	See control criteria below.	100% UC	100% UC	100% UC	100% UC
Matrix Blank (MB)	See control criteria below.	100% UC	100% UC	100% UC	86% UC 14% W
Trip Blank (TB)	See control criteria below.	100% UC	100% UC	100%UC	100% UC
Matrix Spike	100 ± 10% of added spike.	100% UC	100% UC	100% UC	80% UC 20% W
MDA[a] Target Achieved	All samples below SOW[b] specification.	100% UC	100% UC	100% UC	100% UC
Analytical Completeness	80% successful analysis of valid samples.	100%	100%	100%	100%

General Control Criteria

Under Control (UC) is ≤2s of annual mean for that QC type.

Warning (W) is between 2s and 3s of annual mean for that QC type.

Out of Control (OC) is ≥3s of annual mean for that QC type.

[a] Minimum detectable activity.

[b] Statement of work.

Table 4-28. QC Performance Evaluation for Stack Sampling for CY 2000

Evaluation Performed	RADAIR Acceptance Criteria	^{210}Po	^{210}Pb	^{90}Sr
Laboratory Control Standard (LCS) Recovery Check	100 ± 10%	50% UC 50% W	50% UC 50% W	100% UC
Process Blank (PB)	See control criteria below.	100% UC	100% UC	100% UC
Matrix Blank (MB)	See control criteria below.	100% UC	100% UC	100% UC
Trip Blank (TB)	See control criteria below.	100% UC	100% UC	100%UC
Matrix Spike	100 ± 10% of added spike.	100% UC	NA[a]	100% UC
MDA[b] Target Achieved	All samples below SOW[c] specification.	98% UC 2% W	0% UC 100% OC	0% UC 100% OC
Analytical Completeness	80% successful analysis of valid samples.	100%	100%	100%

General Control Criteria
Under Control (UC) is ≤2s of annual mean for that QC type.
Warning (W) is between 2s and 3s of annual mean for that QC type.
Out of Control (OC) is ≥3s of annual mean for that QC type.

[a] NA = not applicable.
[b] Minimum detectable amounts.
[c] Statement of work.

J. Figures

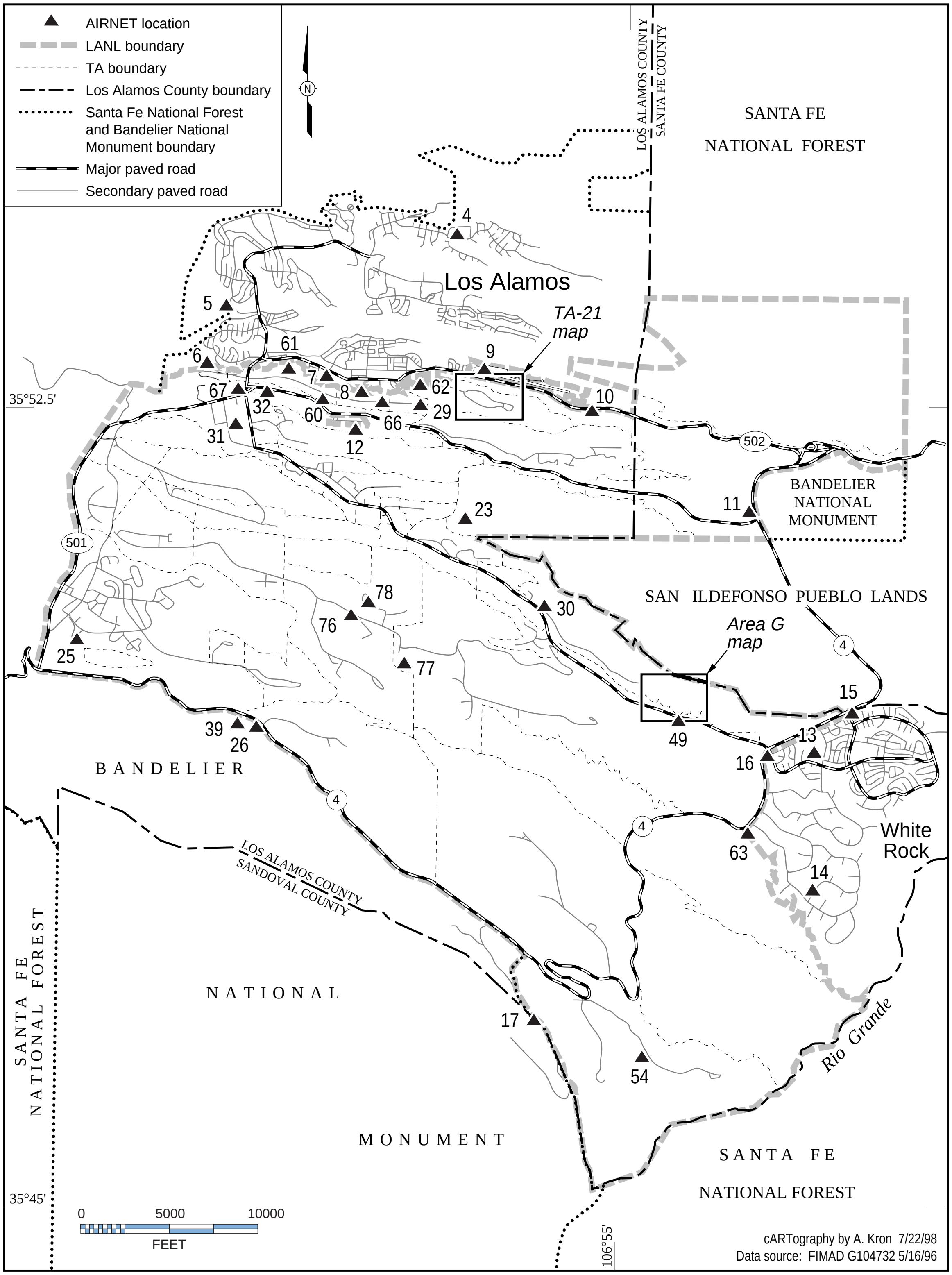


Figure 4-1. Off-site perimeter and on-site Laboratory AIRNET locations.

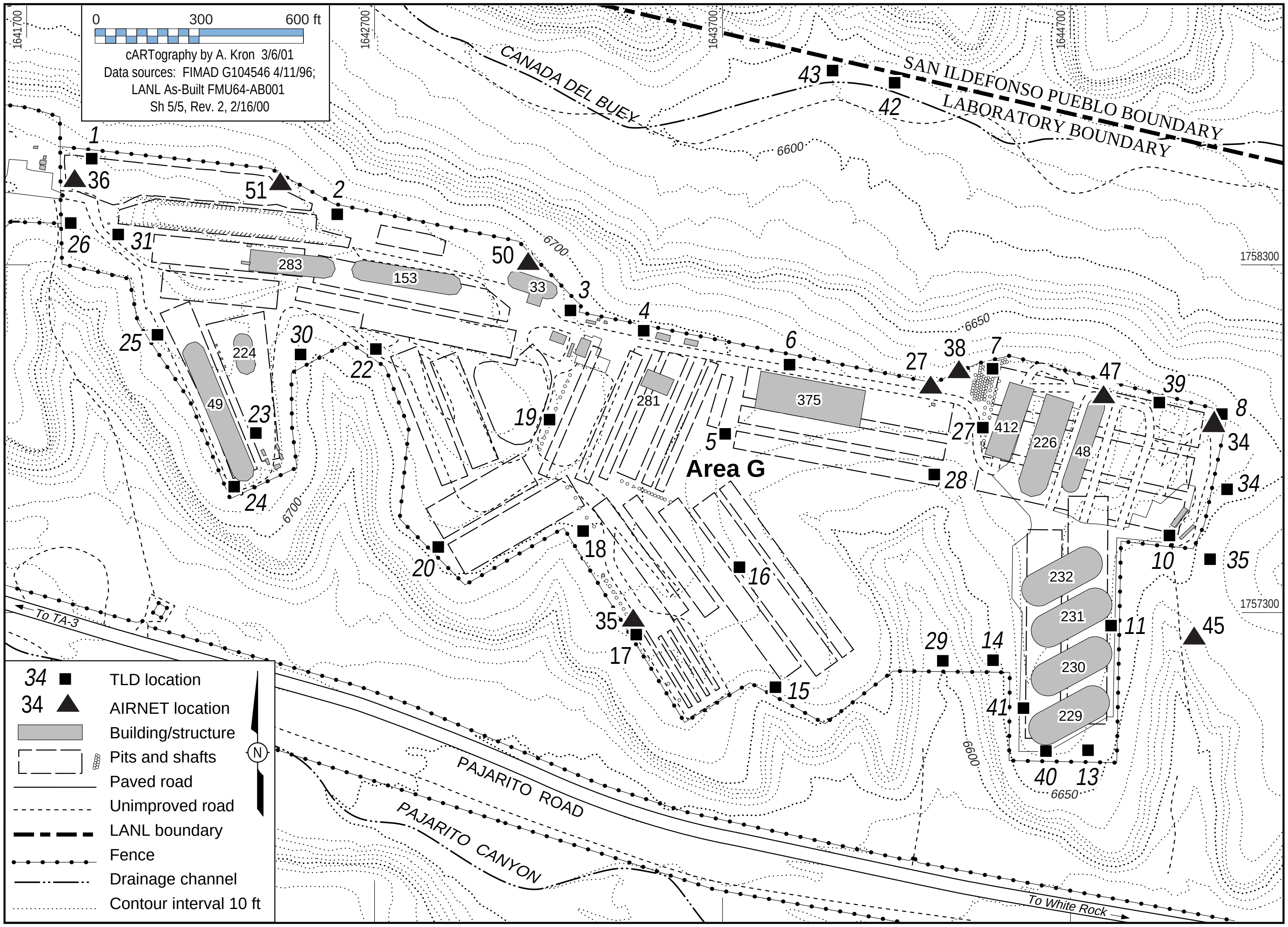


Figure 4-2. Technical Area 54, Area G, map of AIRNET and TLD locations.

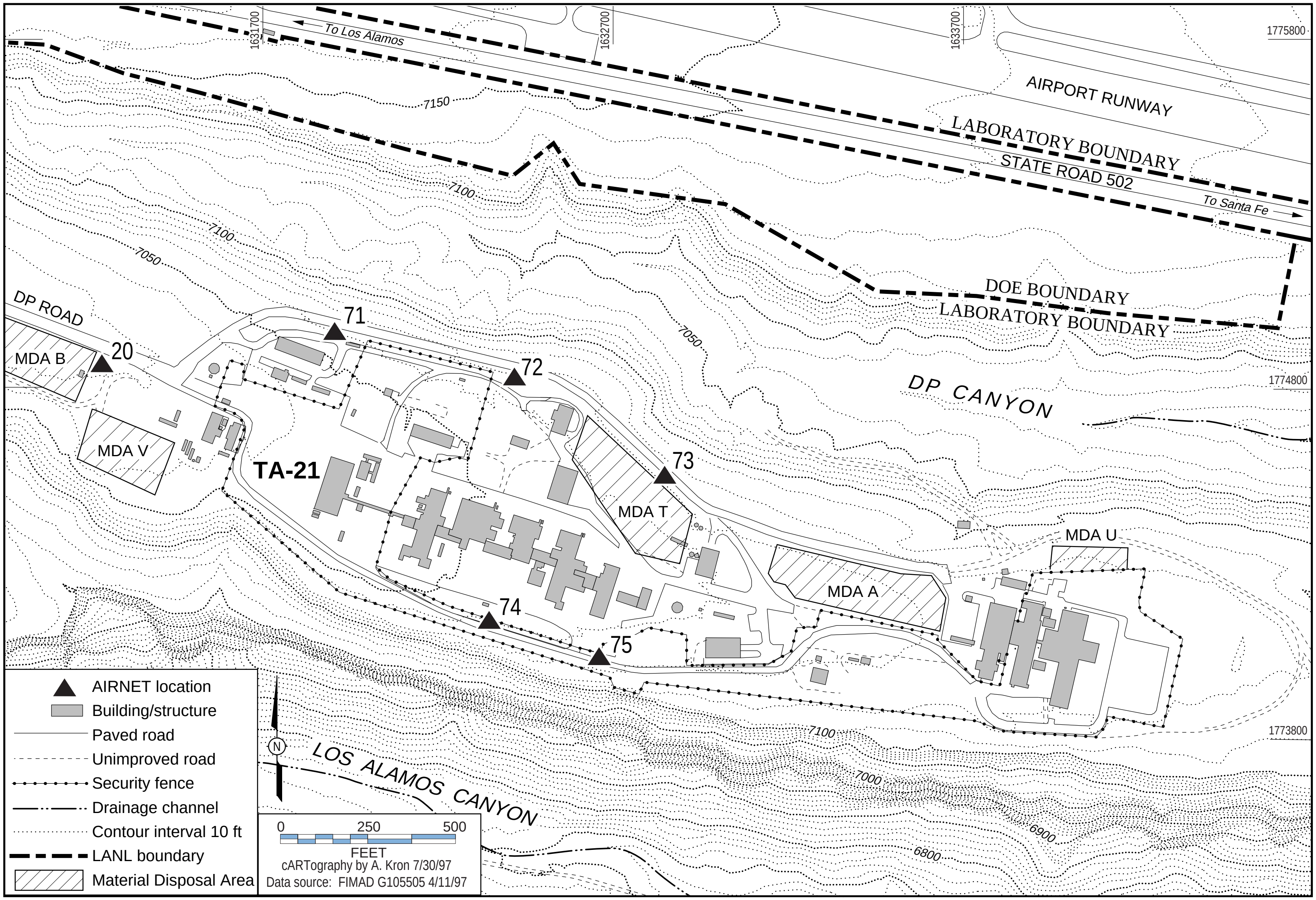


Figure 4-3. Technical Area 21 map of AIRNET locations.

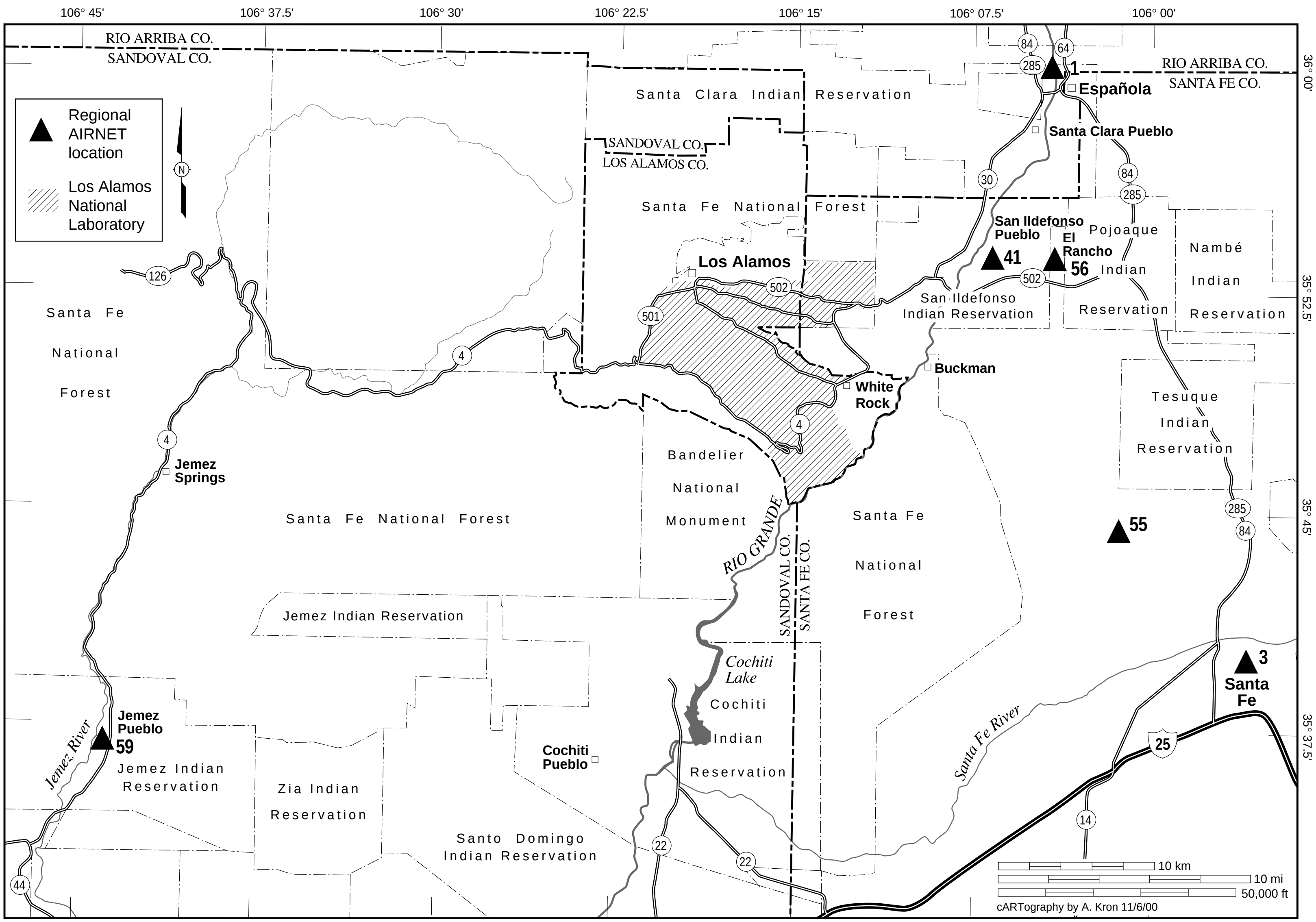


Figure 4-4. Regional and pueblo AIRNET locations.

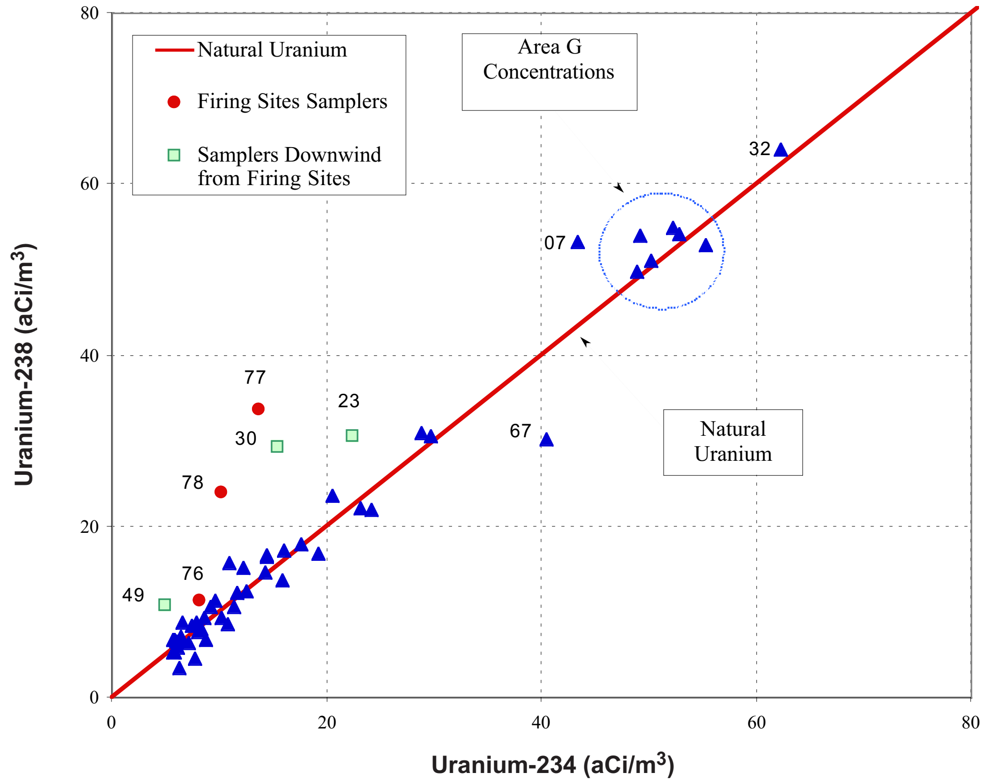


Figure 4-5. AIRNET uranium concentrations for 2000.

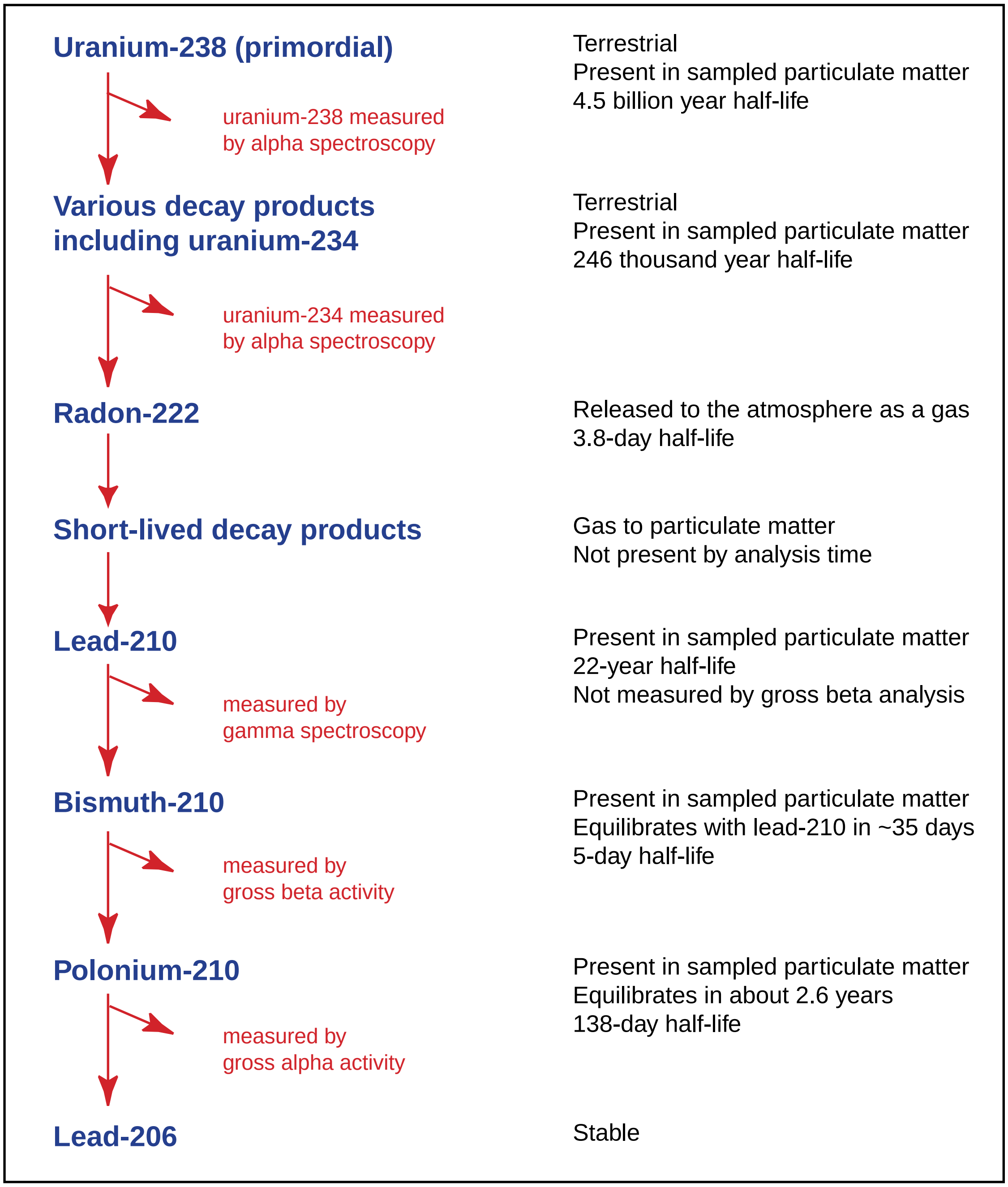


Figure 4-6. Uranium-238 decay series.

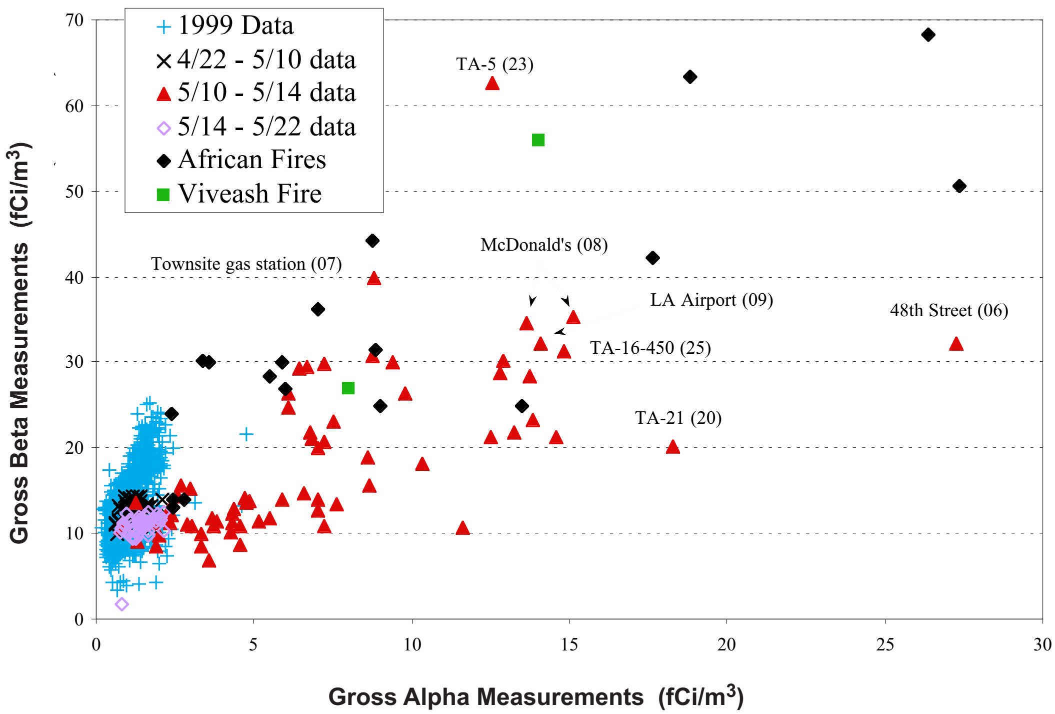


Figure 4-7. Gross alpha measurements versus gross beta measurements during the Cerro Grande fire.

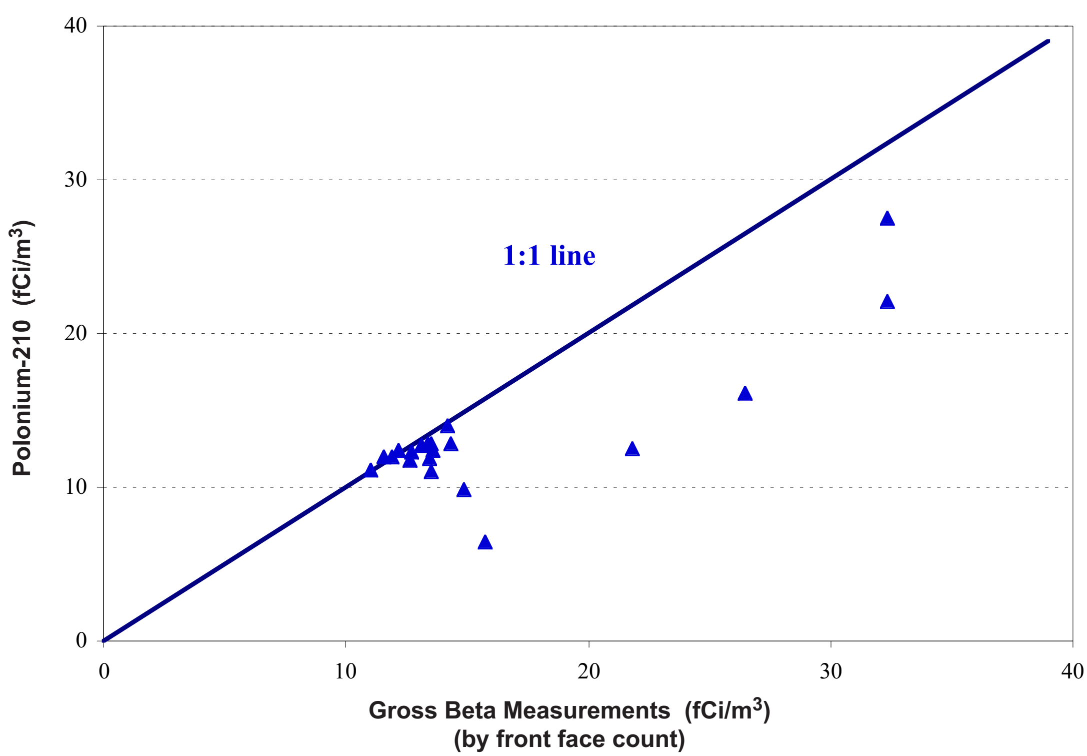


Figure 4-8. Gross beta measurements versus lead-210 measurements during the Cerro Grande fire.

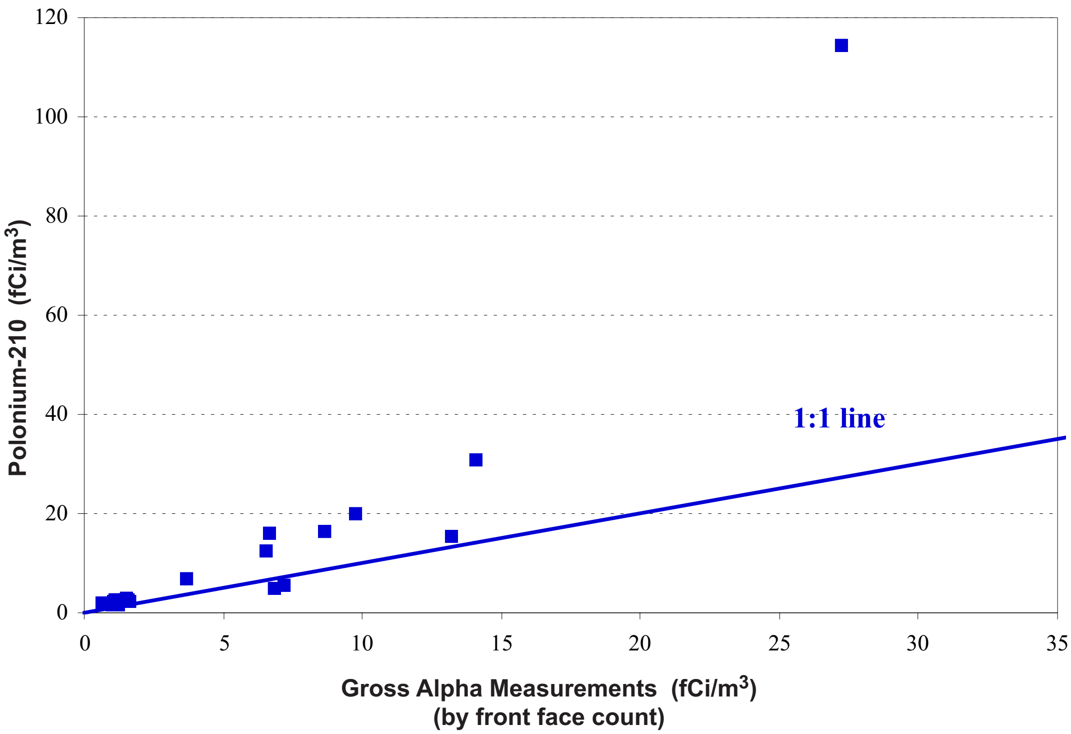


Figure 4-9. Gross alpha measurements versus polonium-210 measurements during the Cerro Grande fire.

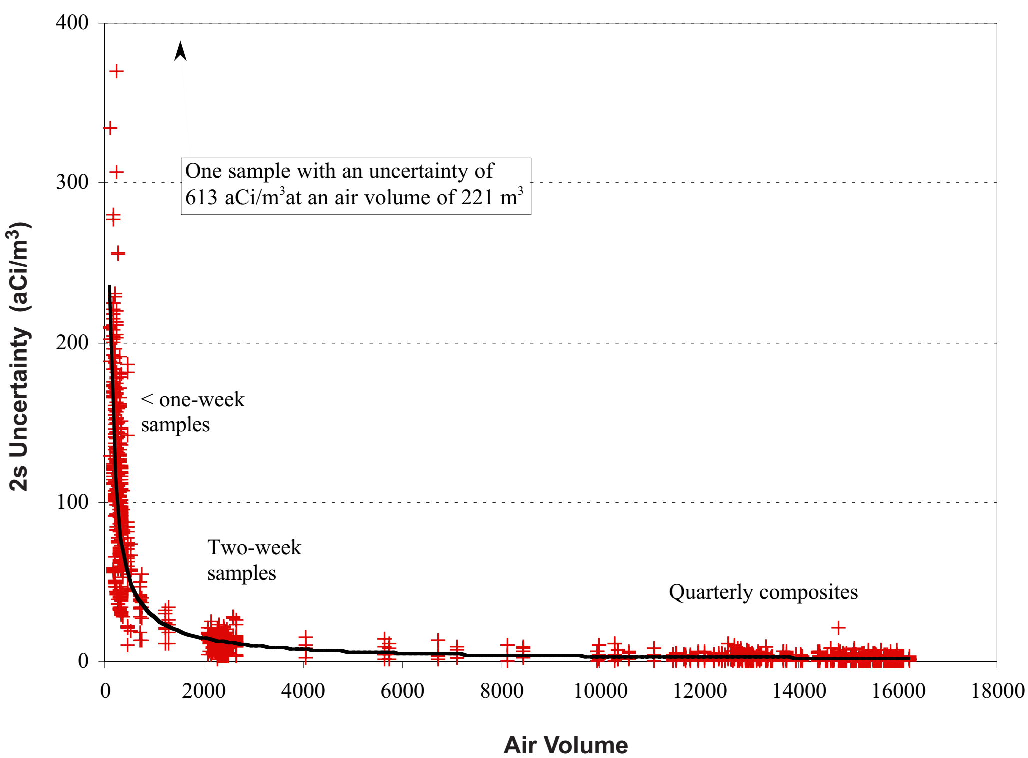


Figure 4-10. The effects of sampled air volume on uranium, plutonium, and americium uncertainties.

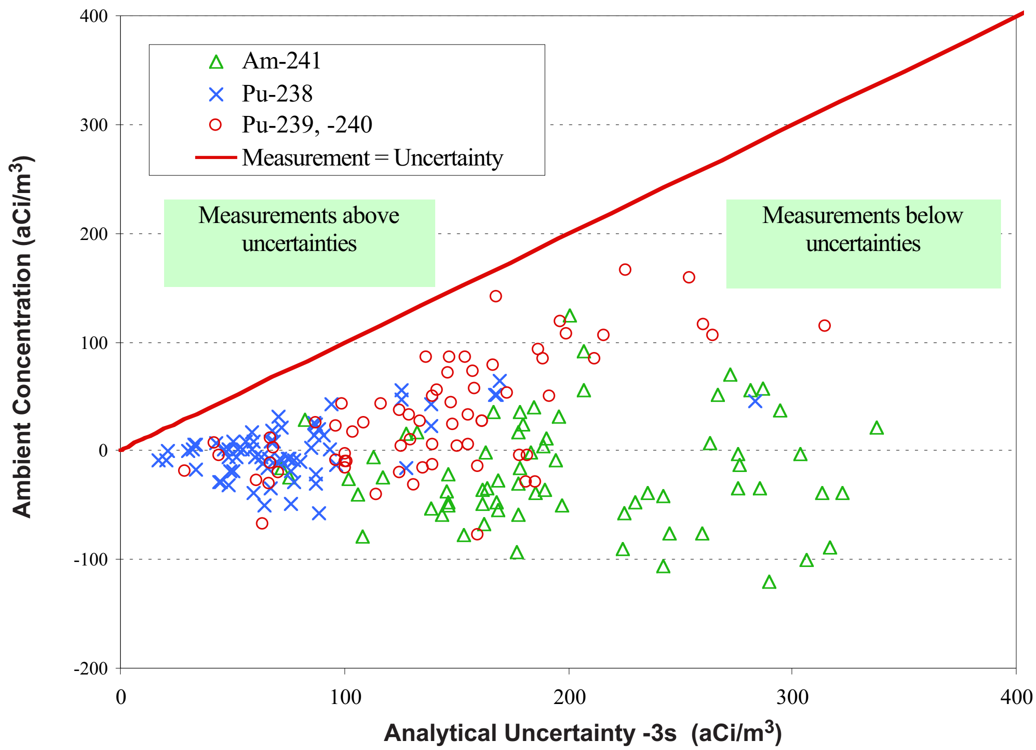


Figure 4-11. Short-term americium and plutonium concentrations during the Cerro Grande fire (May 9–14, 2000)

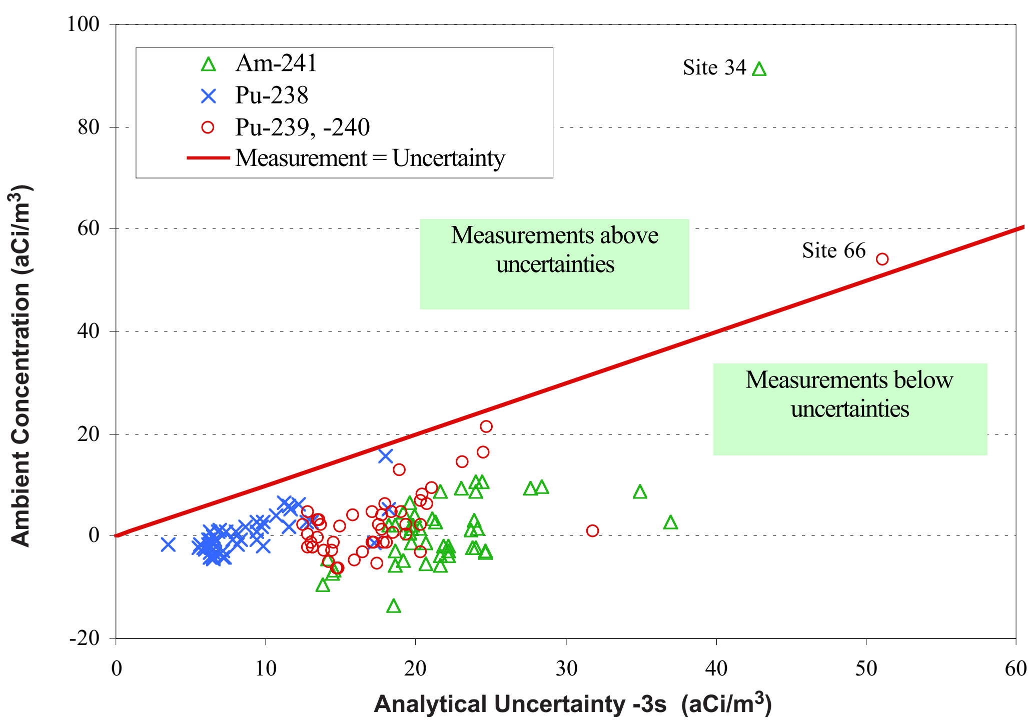


Figure 4-12. Two-week americium and plutonium concentrations at the beginning of the Cerro Grande fire (April 24–May 10, 2000.

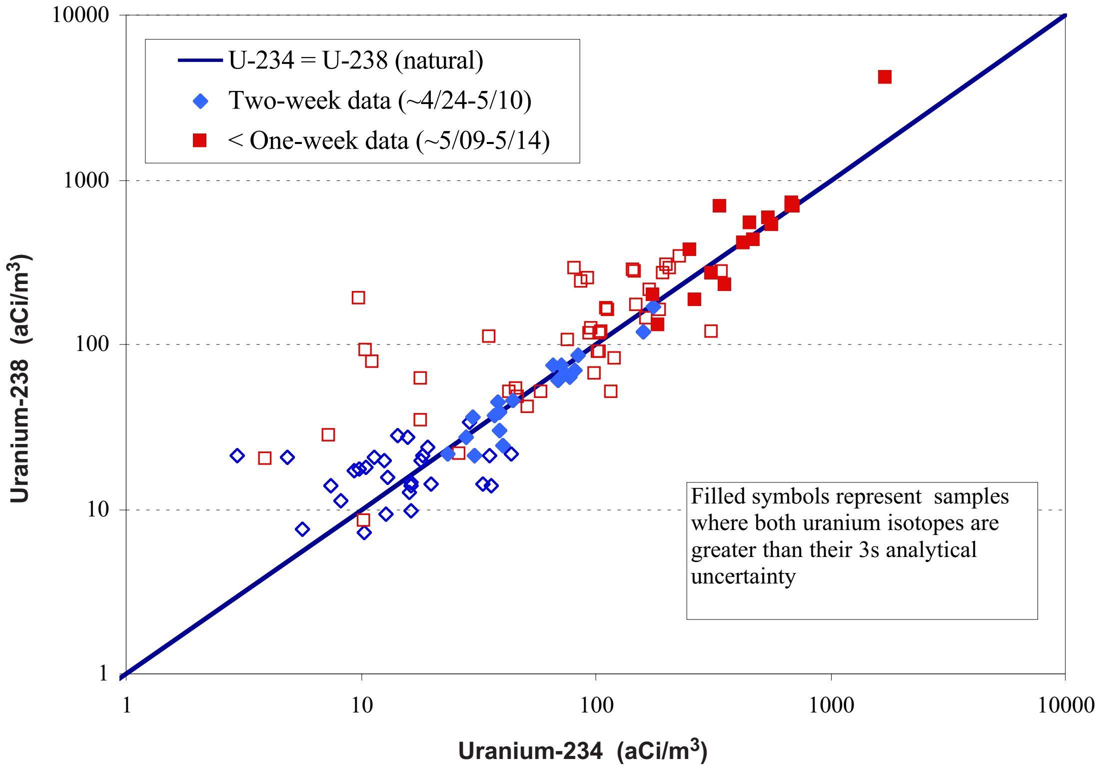


Figure 4-13. Short-term uranium isotopic concentrations during the Cerro Grande fire.

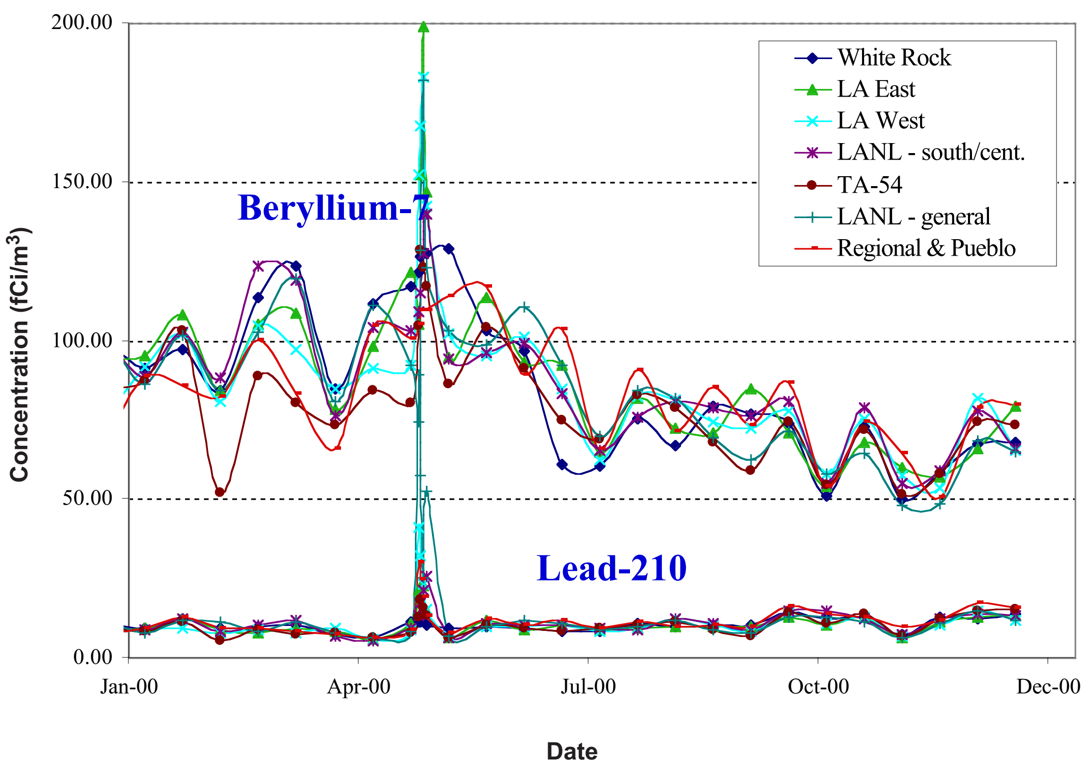


Figure 4-14. Gamma spectroscopy measurements grouped by general location.

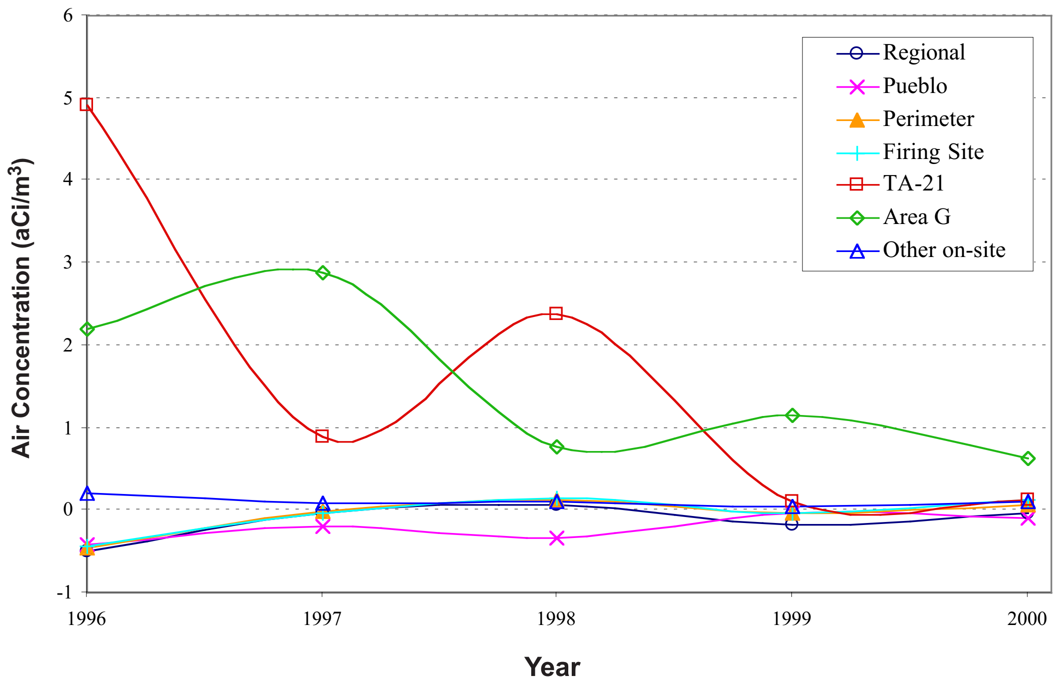


Figure 4-15. Plutonium-238 annual concentrations grouped by general location.

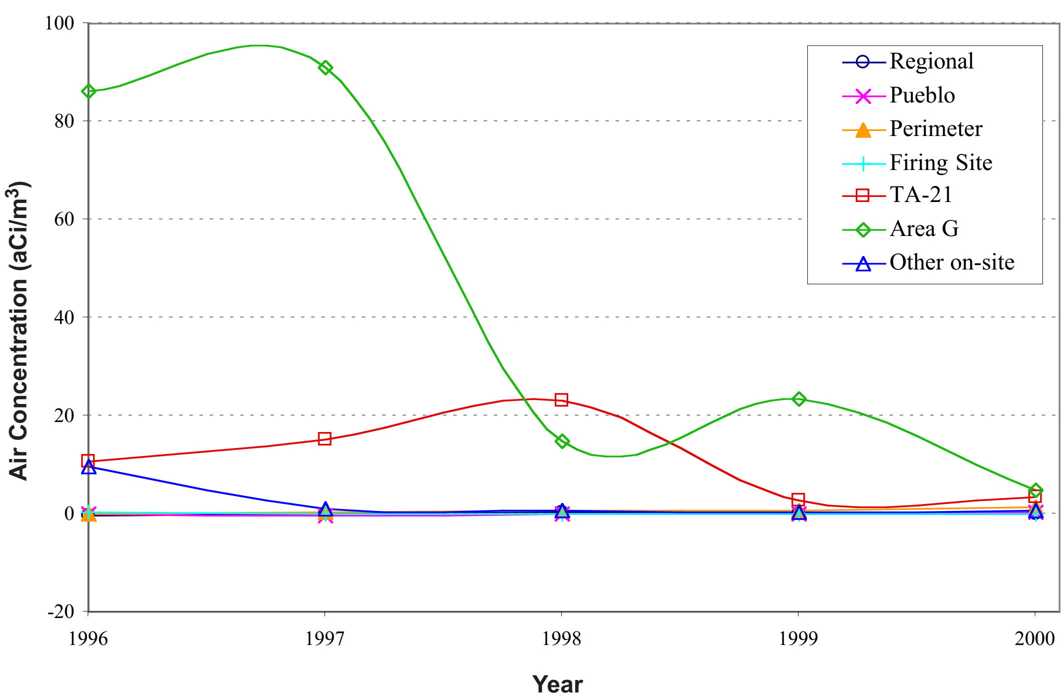


Figure 4-16. Plutonium-239, -240 annual concentrations grouped by general location.

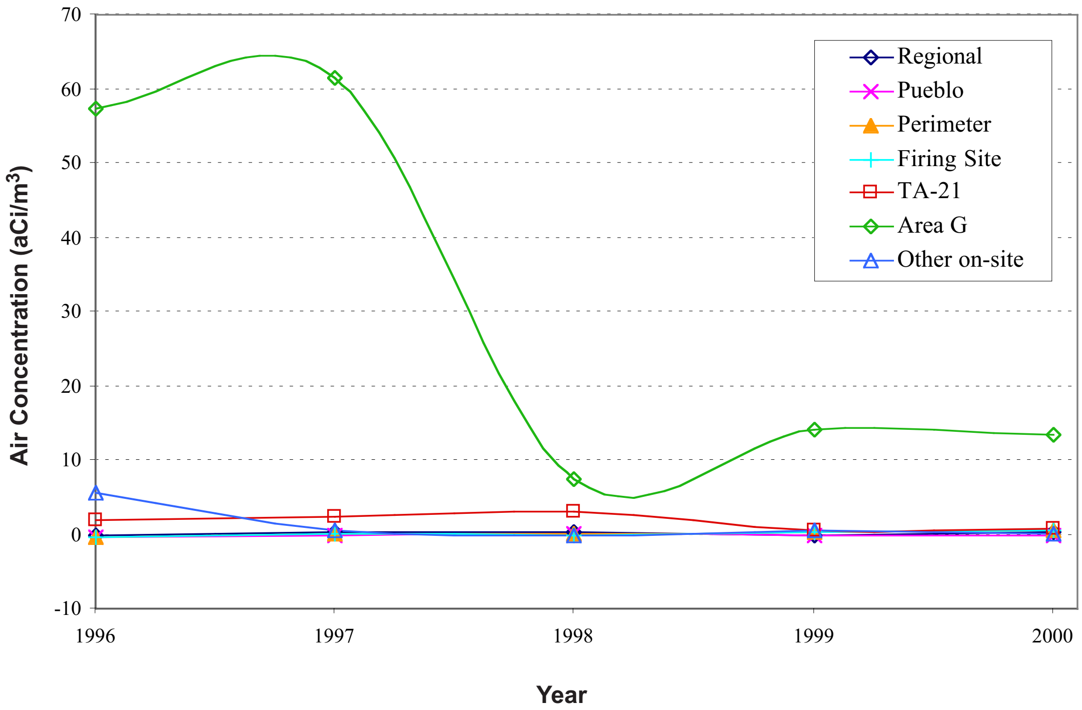


Figure 4-17. Americium-241 annual concentrations grouped by general location.

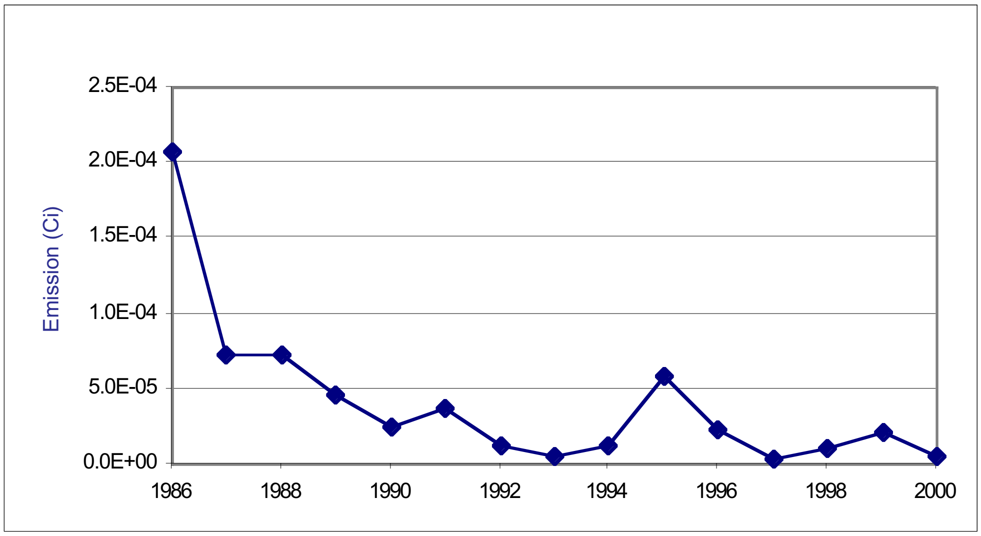


Figure 4-18. Plutonium emissions from sampled Laboratory stacks since 1986.

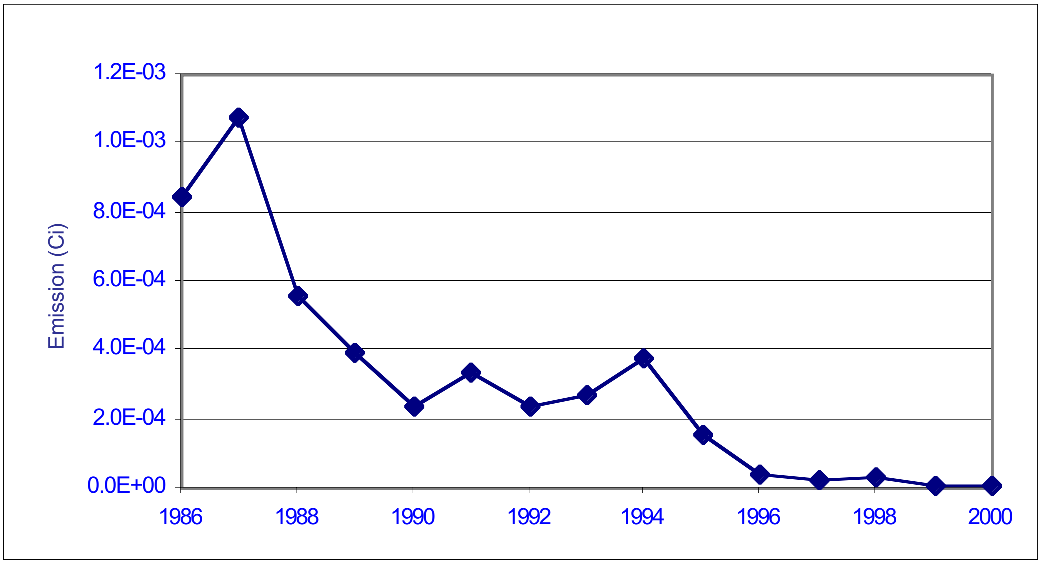


Figure 4-19. Uranium emissions from sampled Laboratory stacks since 1986.

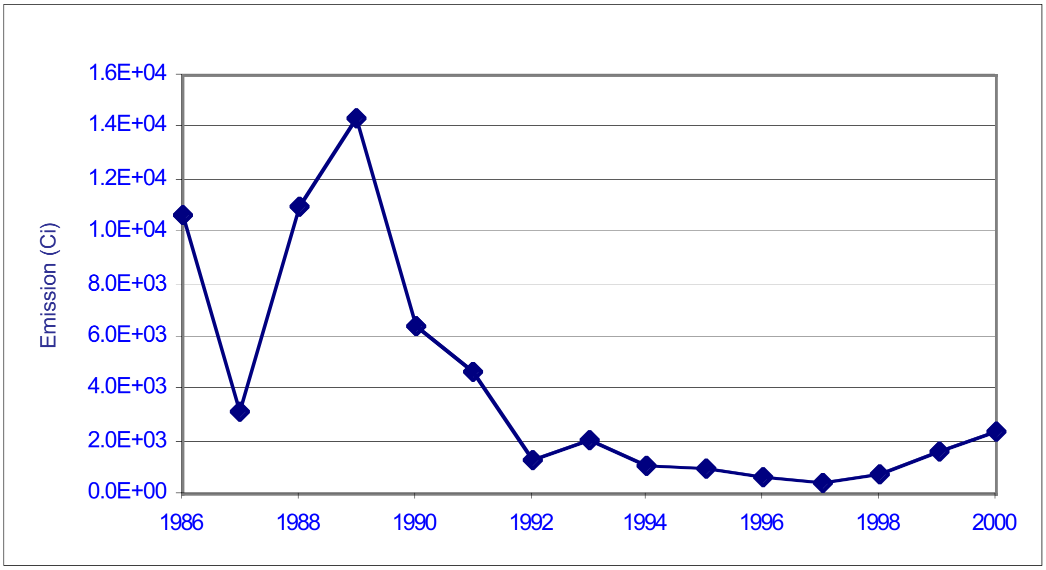


Figure 4-20. Tritium emissions from sampled Laboratory stacks since 1986.

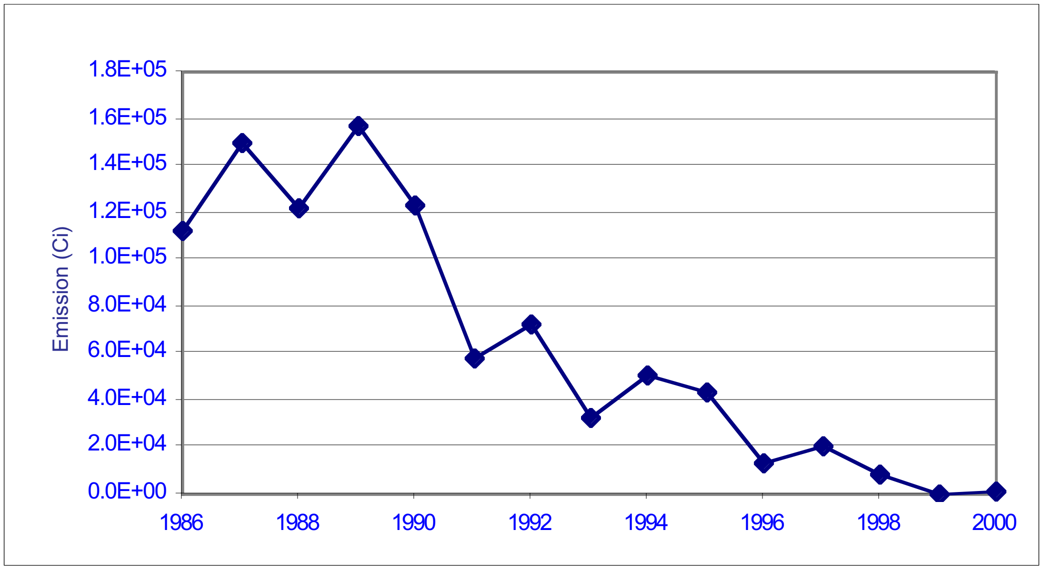


Figure 4-21. G/MAP emissions from sampled Laboratory stacks since 1986.

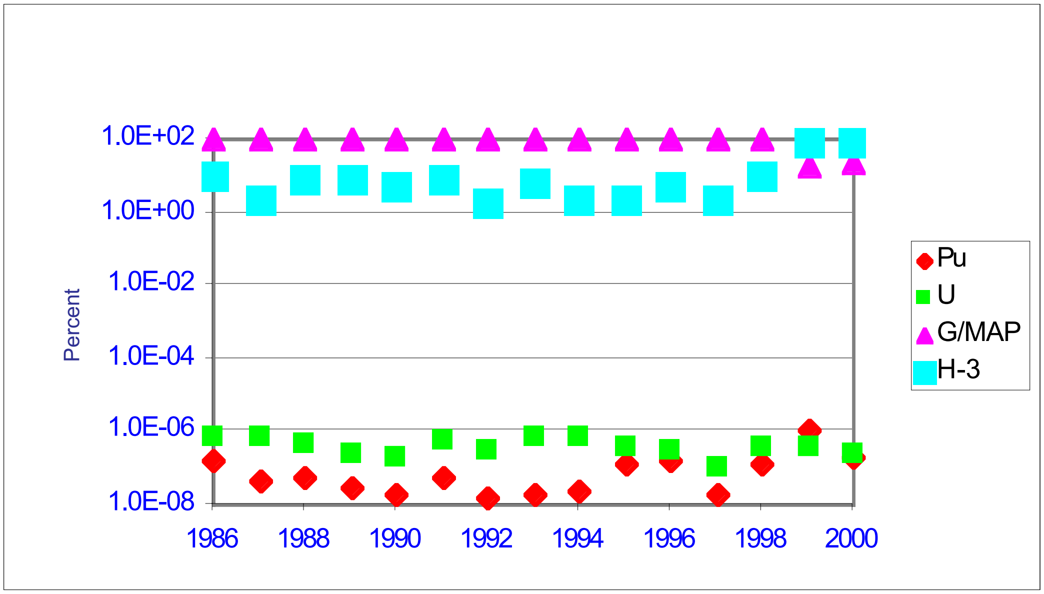


Figure 4-22. Percent of total stack emissions resulting from plutonium, uranium, tritium, and G/MAP.

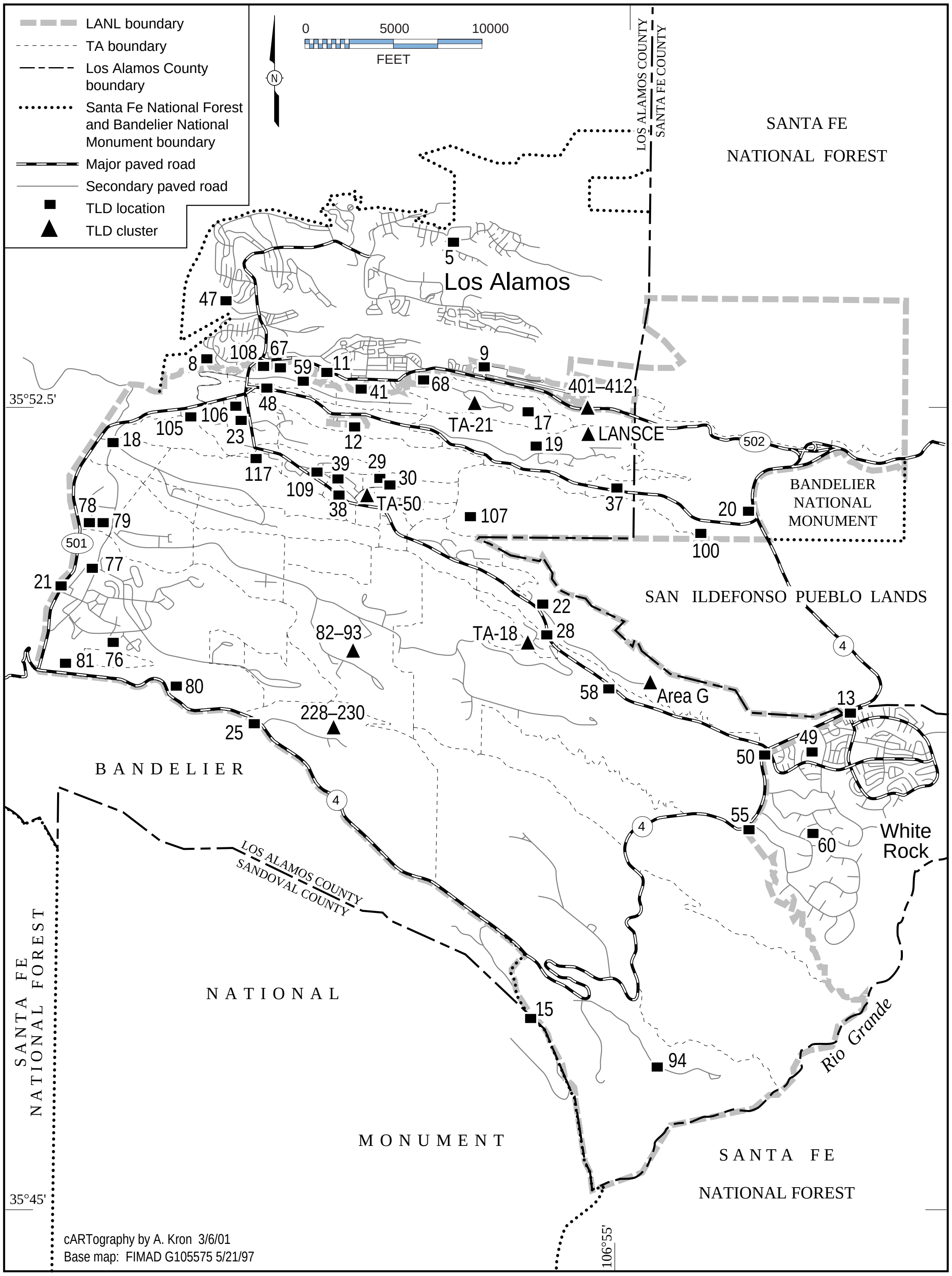


Figure 4-23. Off-site perimeter and on-site Laboratory TLD locations.

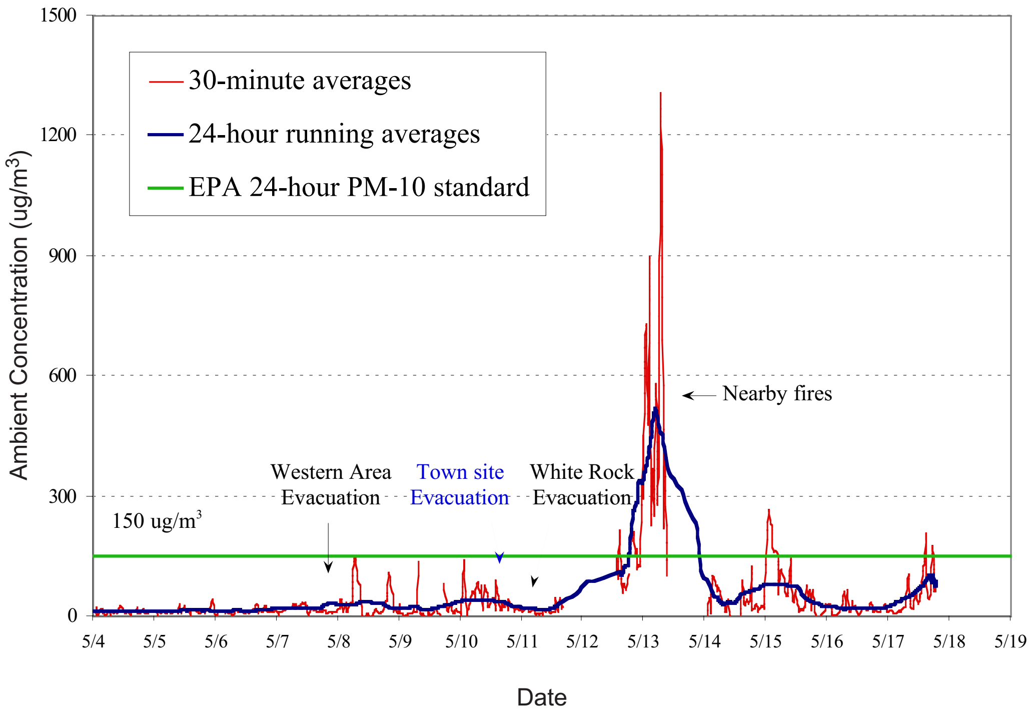


Figure 4-24. Particulate matter concentrations (TEOM measurements at TA-54-1001).

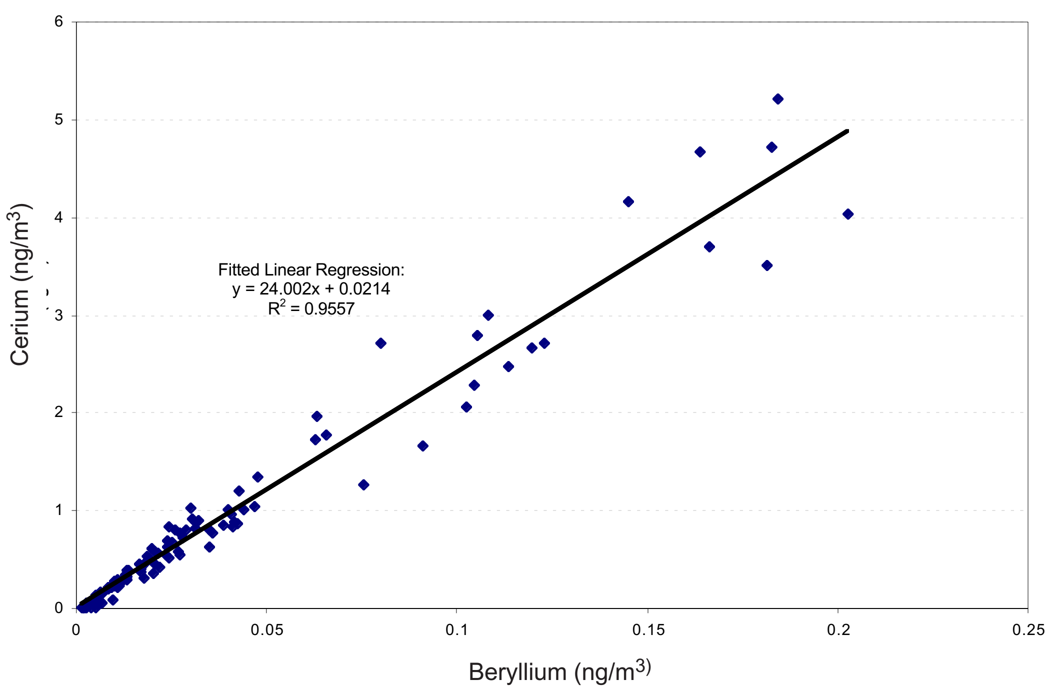


Figure 4-25. Quarterly beryllium and cerium concentrations for 2000.

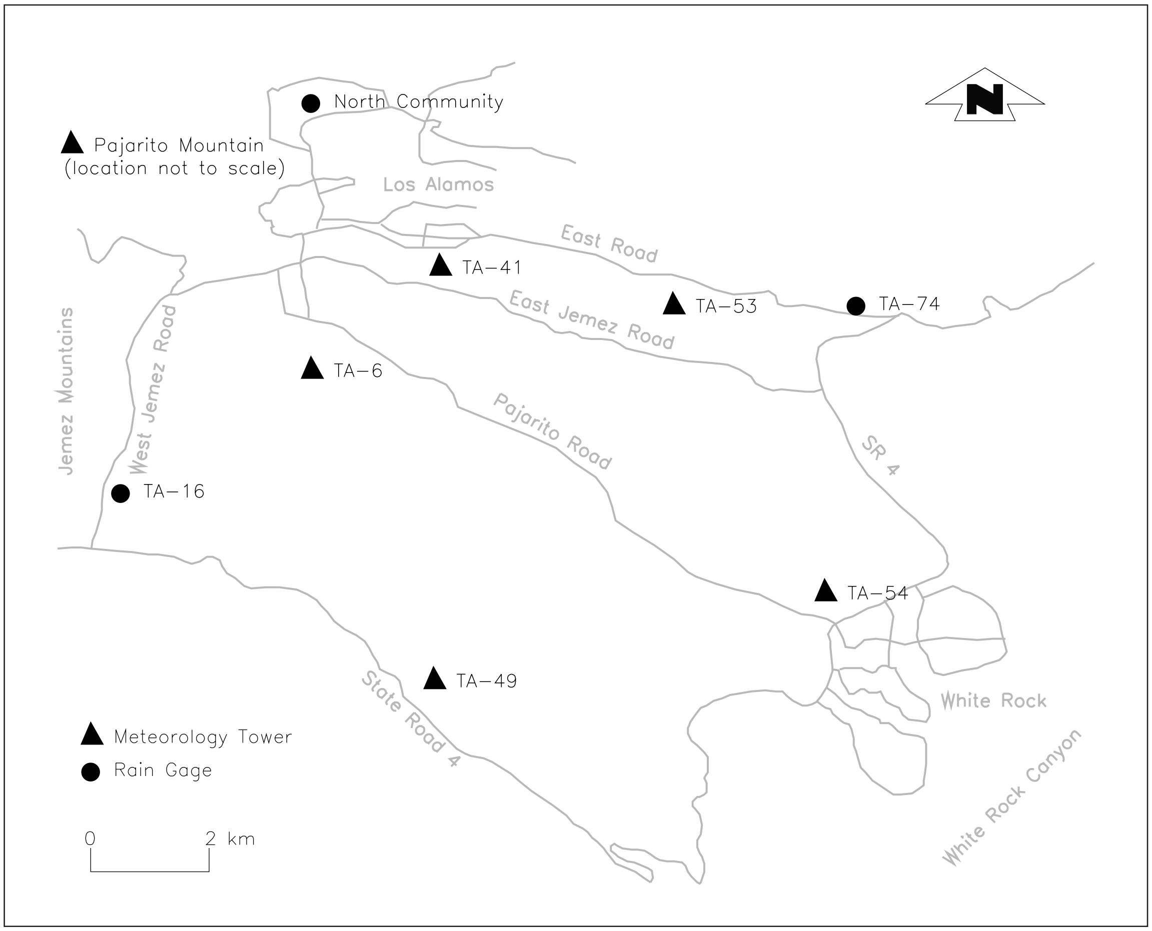


Figure 4-26. Meteorological network.

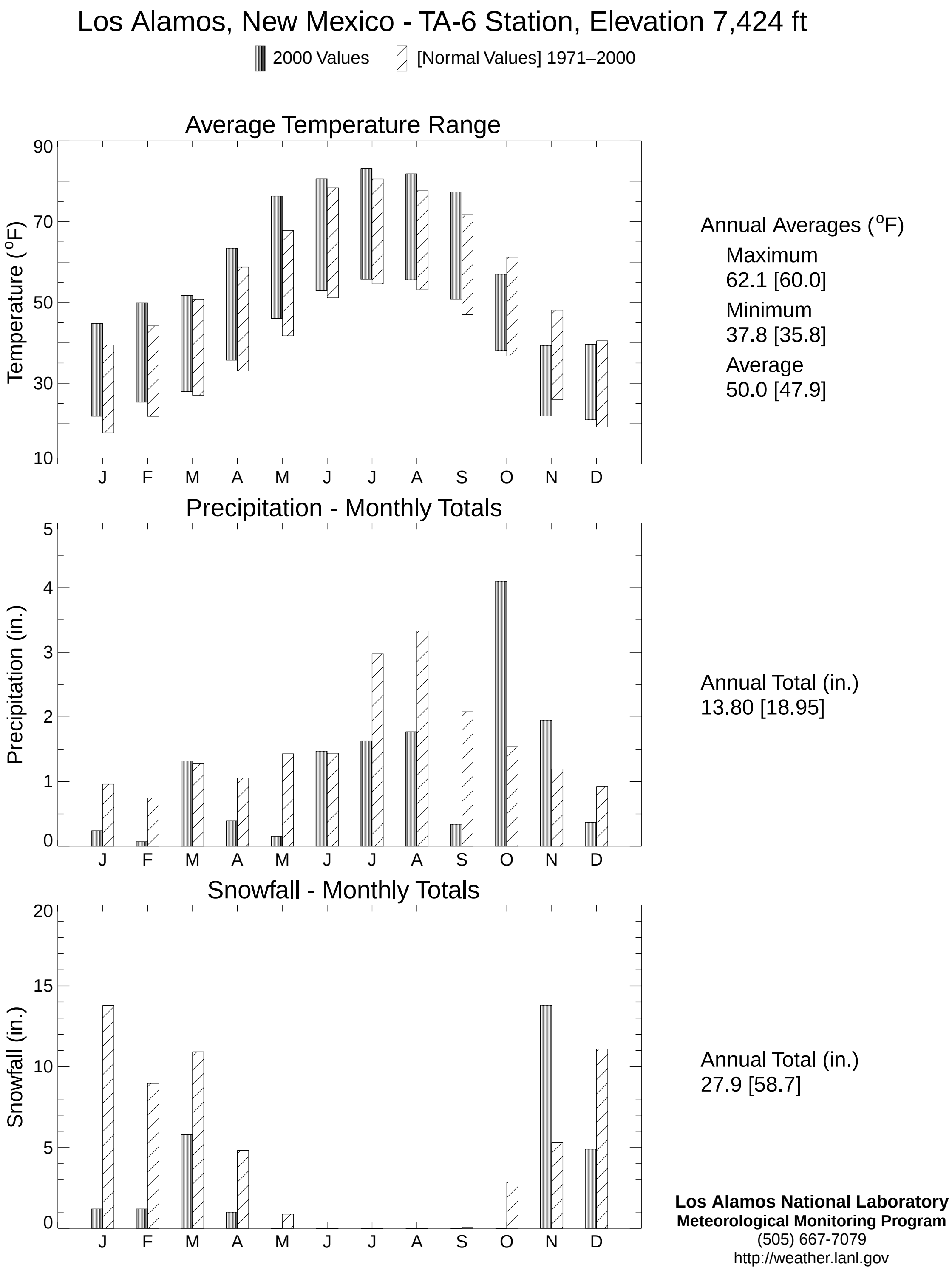
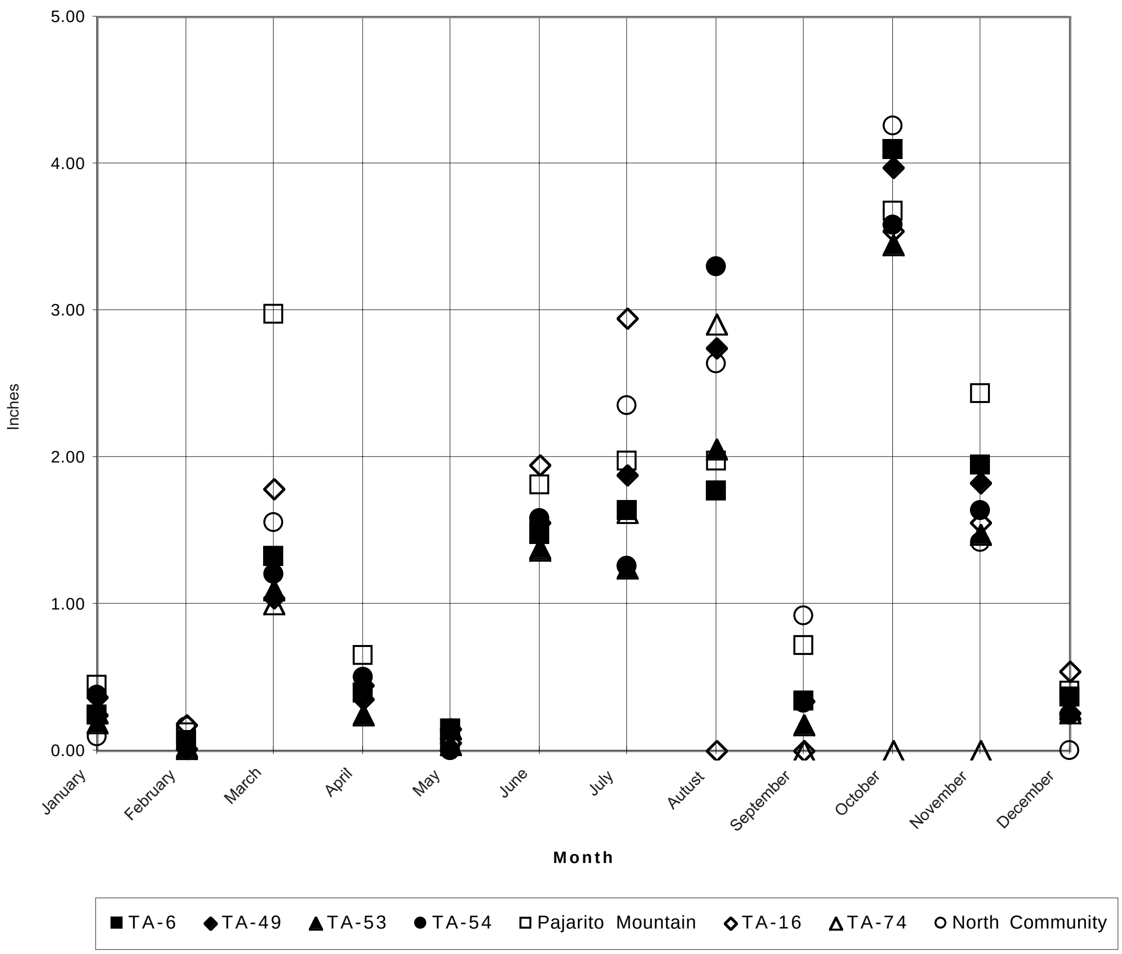


Figure 4-27. 2000 weather summary for Los Alamos.



2000 Precipitation (in.)

	TA-6	TA-16	TA-49	TA-53	TA-54	TA-74	North Community	Pajarito Mountain
January	0.24	0.37	0.24	0.19	0.38	0.26	0.09	0.45
February	0.07	0.17	0.02	0.03	0.03	0.01	0.16	0.12
March	1.32	1.78	1.04	1.09	1.20	1.00	1.55	2.97
April	0.39	0.44	0.35	0.25	0.50	0.24	0.38	0.65
May	0.15	0.05	0.15	0.15	0.00	0.04	0.00	0.08
June	1.47	1.94	1.56	1.38	1.58	1.36	1.57	1.81
July	1.63	2.94	1.88	1.24	1.26	1.62	2.35	1.97
August	1.77	*	2.74	2.06	3.30	2.90	2.63	1.97
September	0.34	*	0.34	0.17	0.32	*	0.92	0.72
October	4.10	3.54	3.97	3.45	3.58	*	4.26	3.68
November	1.95	1.55	1.83	1.47	1.63	*	1.42	2.43
December	0.37	0.54	0.26	0.29	0.25	0.26	*	0.4
Total	13.80	*	14.38	11.77	14.03	*	*	17.25

* - data lost due to gage malfunction

Figure 4-28. 2000 precipitation.

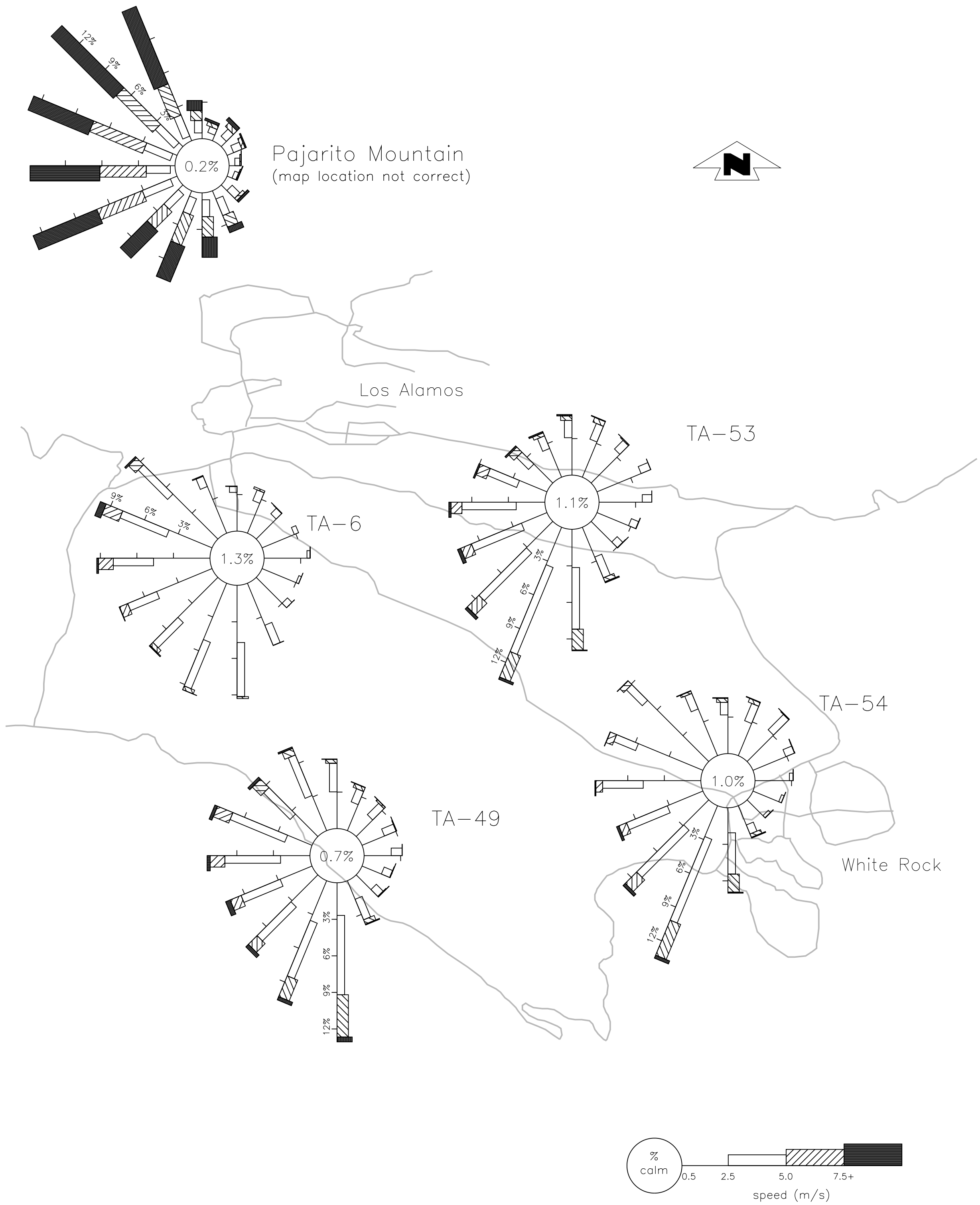


Figure 4-29. 2000 total wind roses.

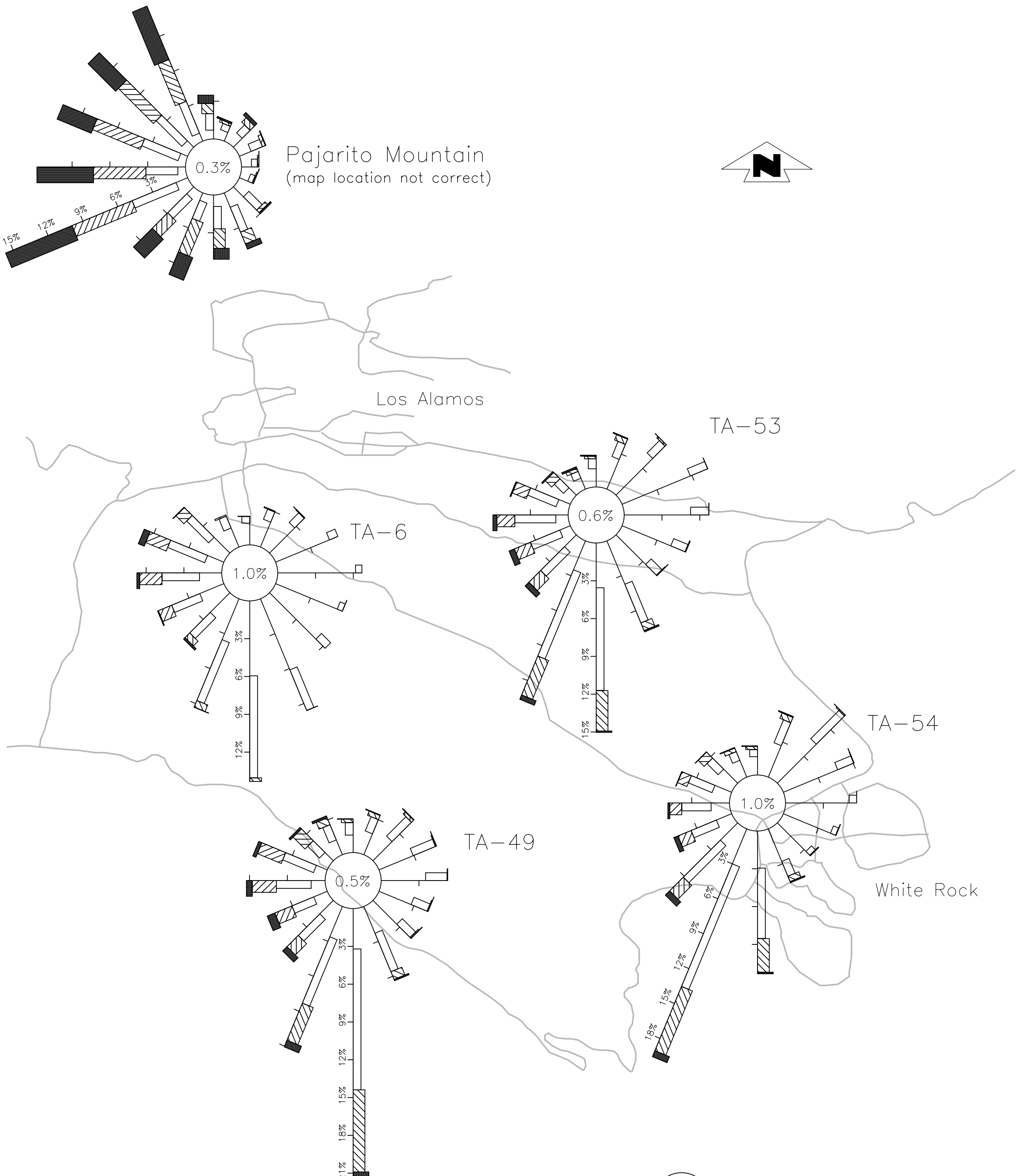


Figure 4-30. Daytime wind roses.

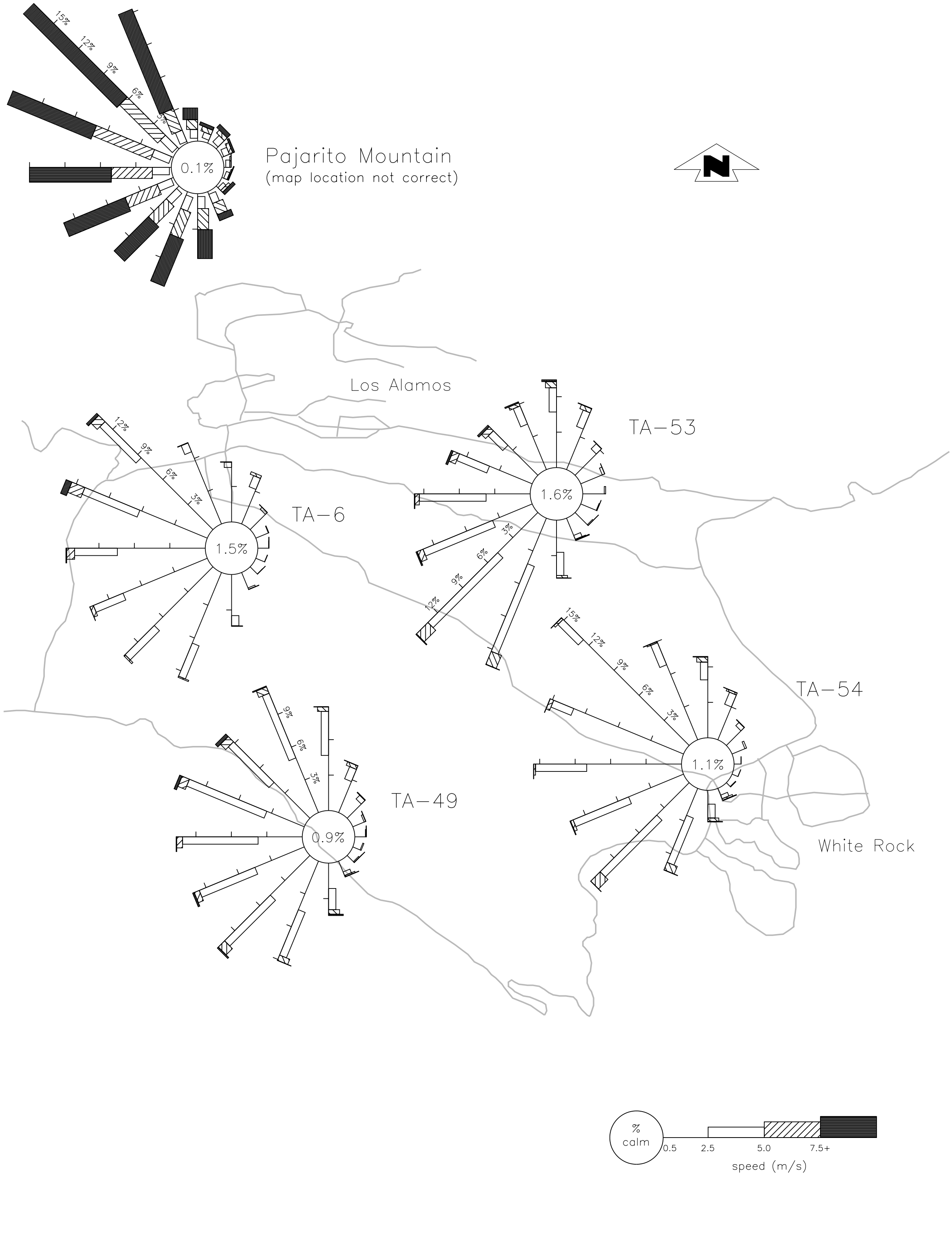


Figure 4-31. Nighttime wind roses.

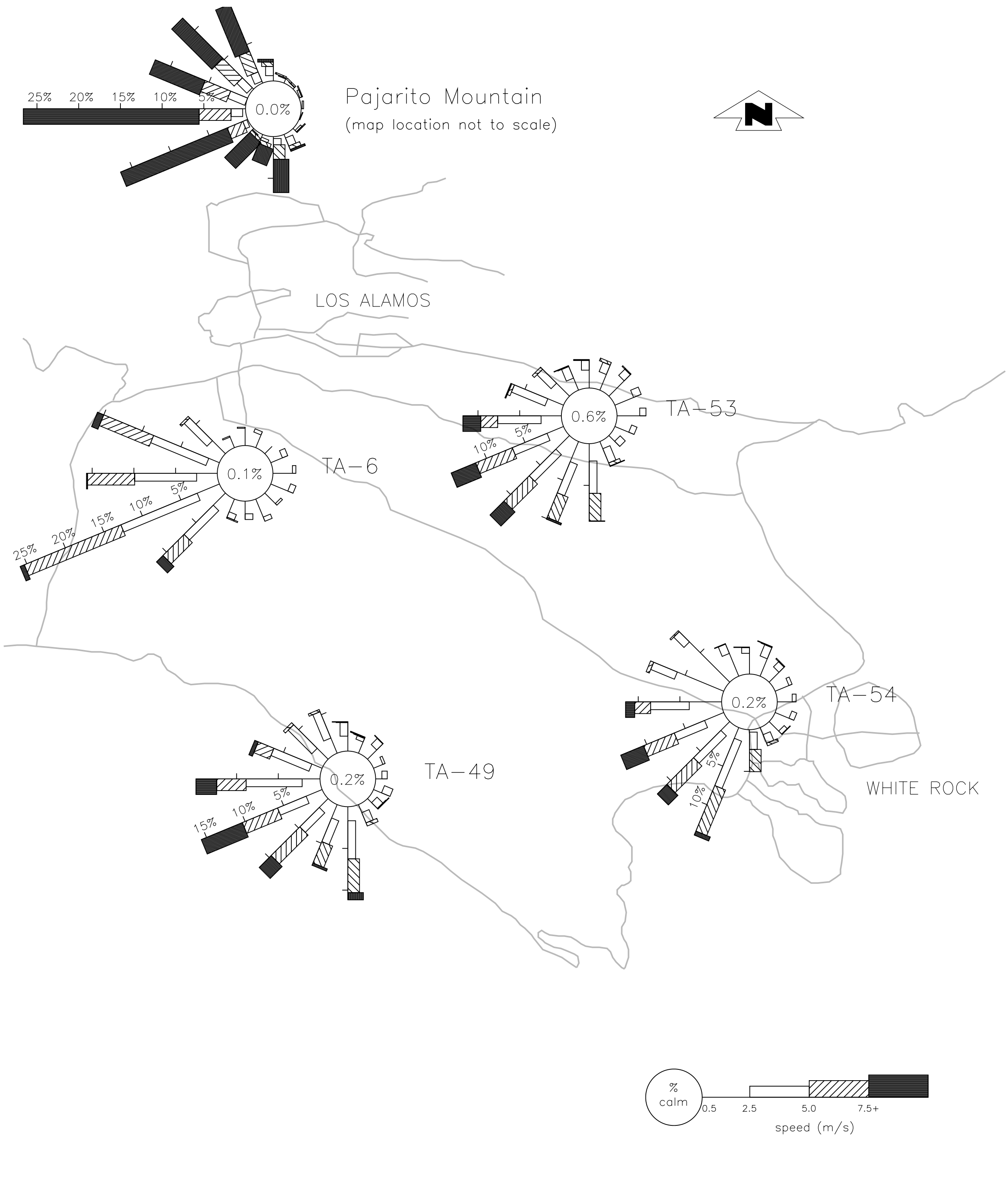


Figure 4-32. Cerro Grande fire wind roses, May 4–21, 24-hour.

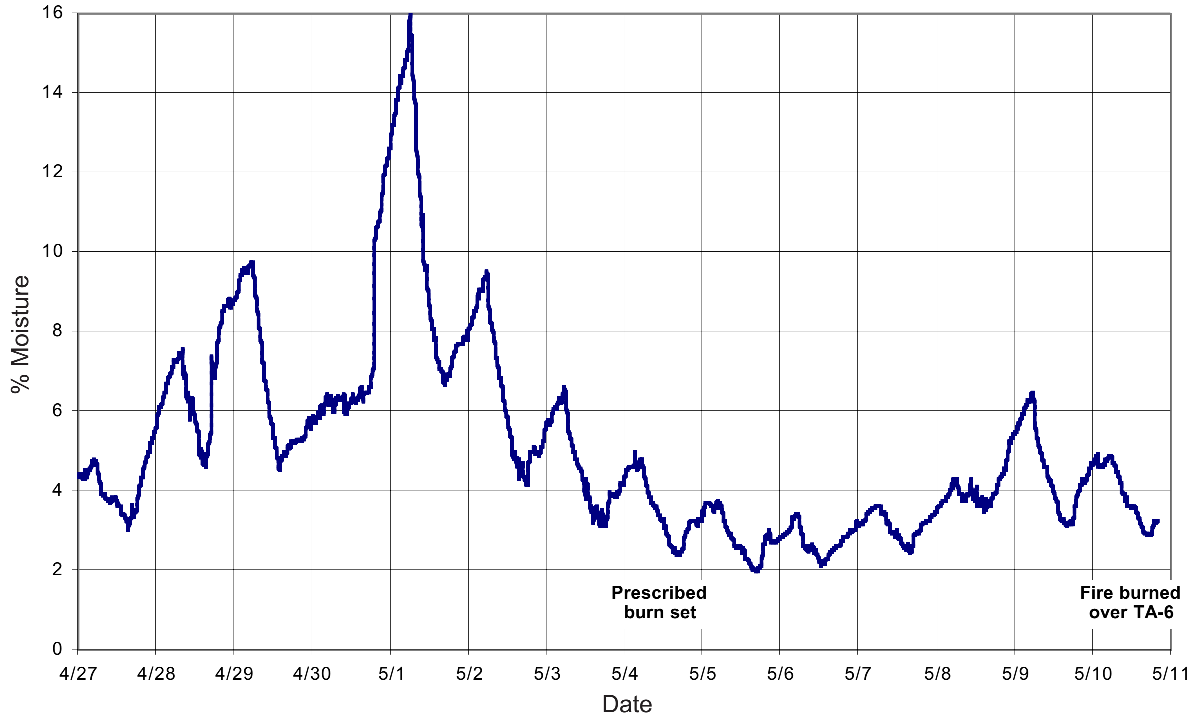


Figure 4-33. 10-hour fuel moisture.

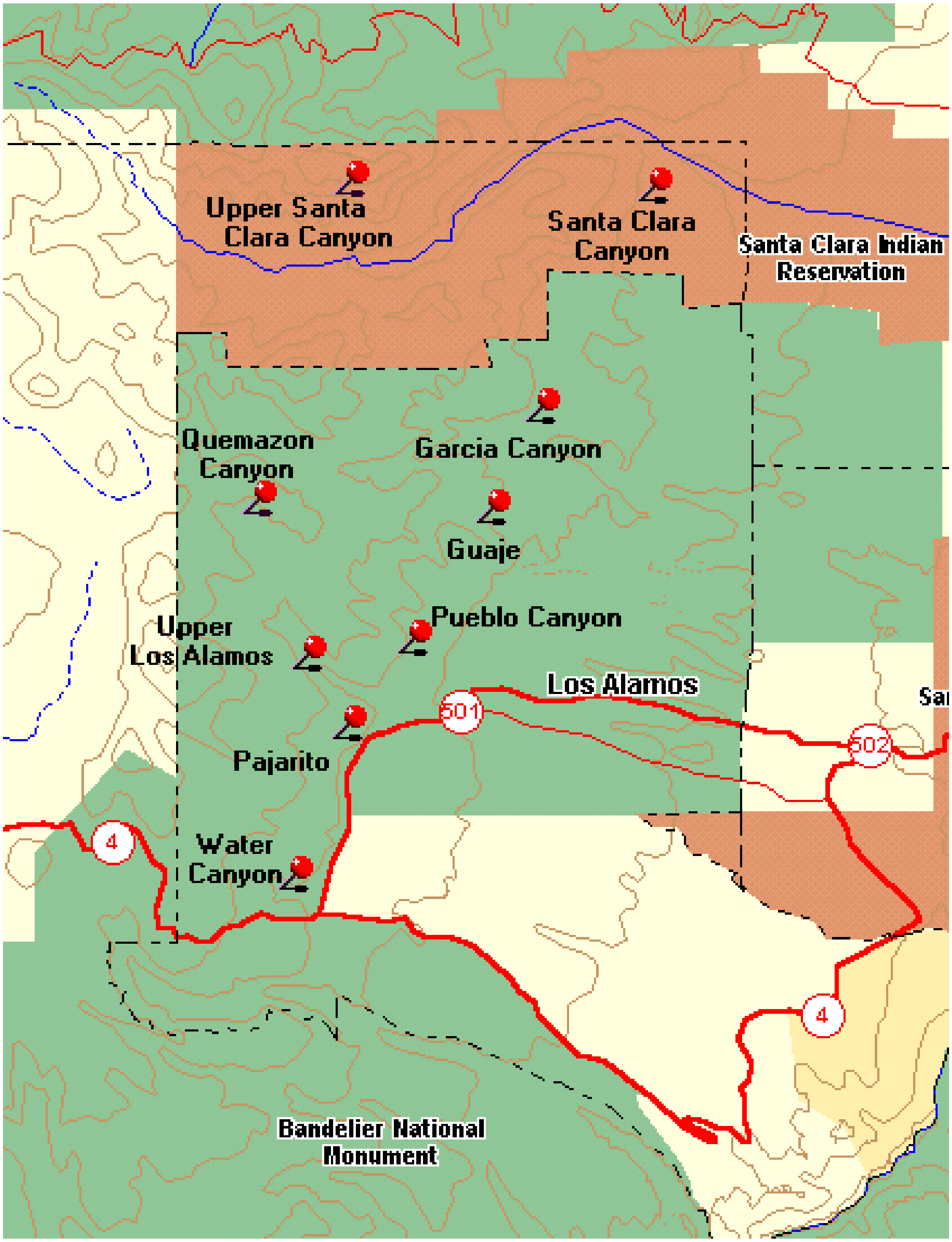


Figure 4-34. LANL Remote Automated Weather Station (RAWS) locations.

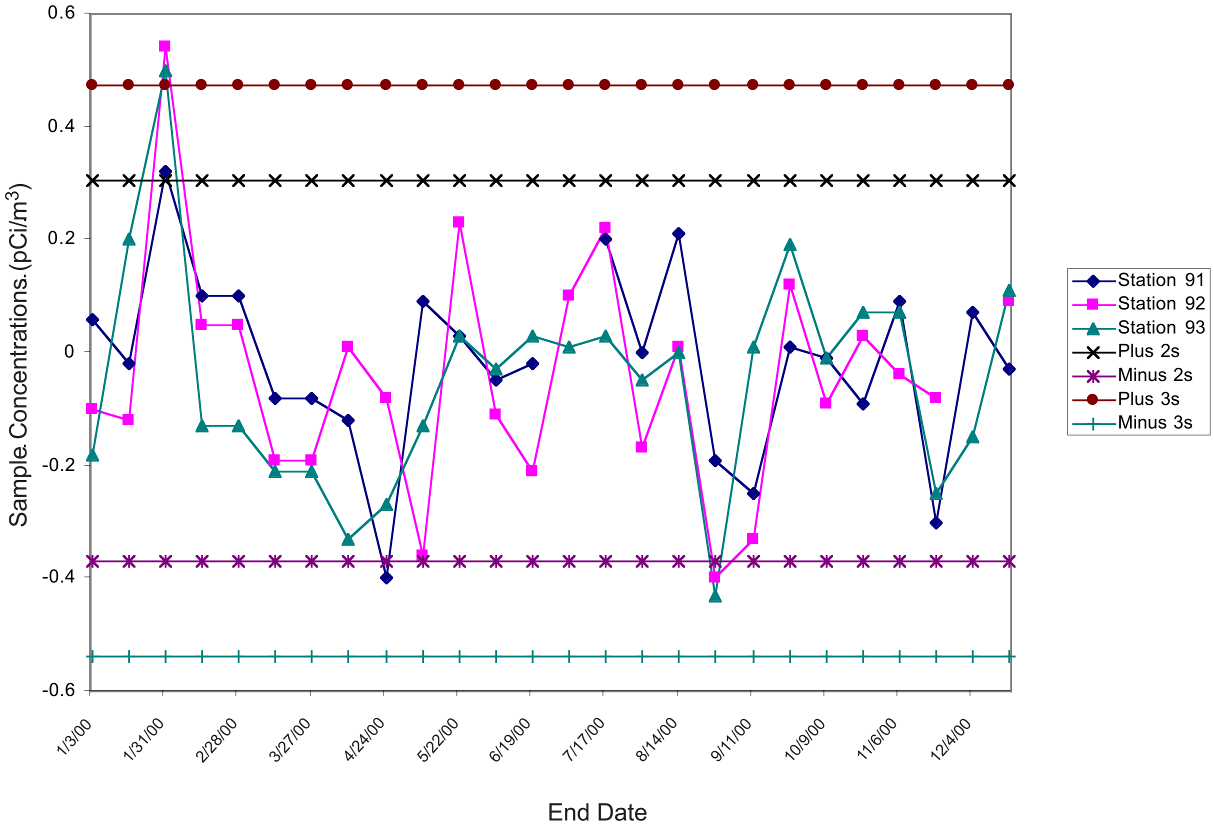


Figure 4-35. Tritium matrix blanks.

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