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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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Preface

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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Executive Summary

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

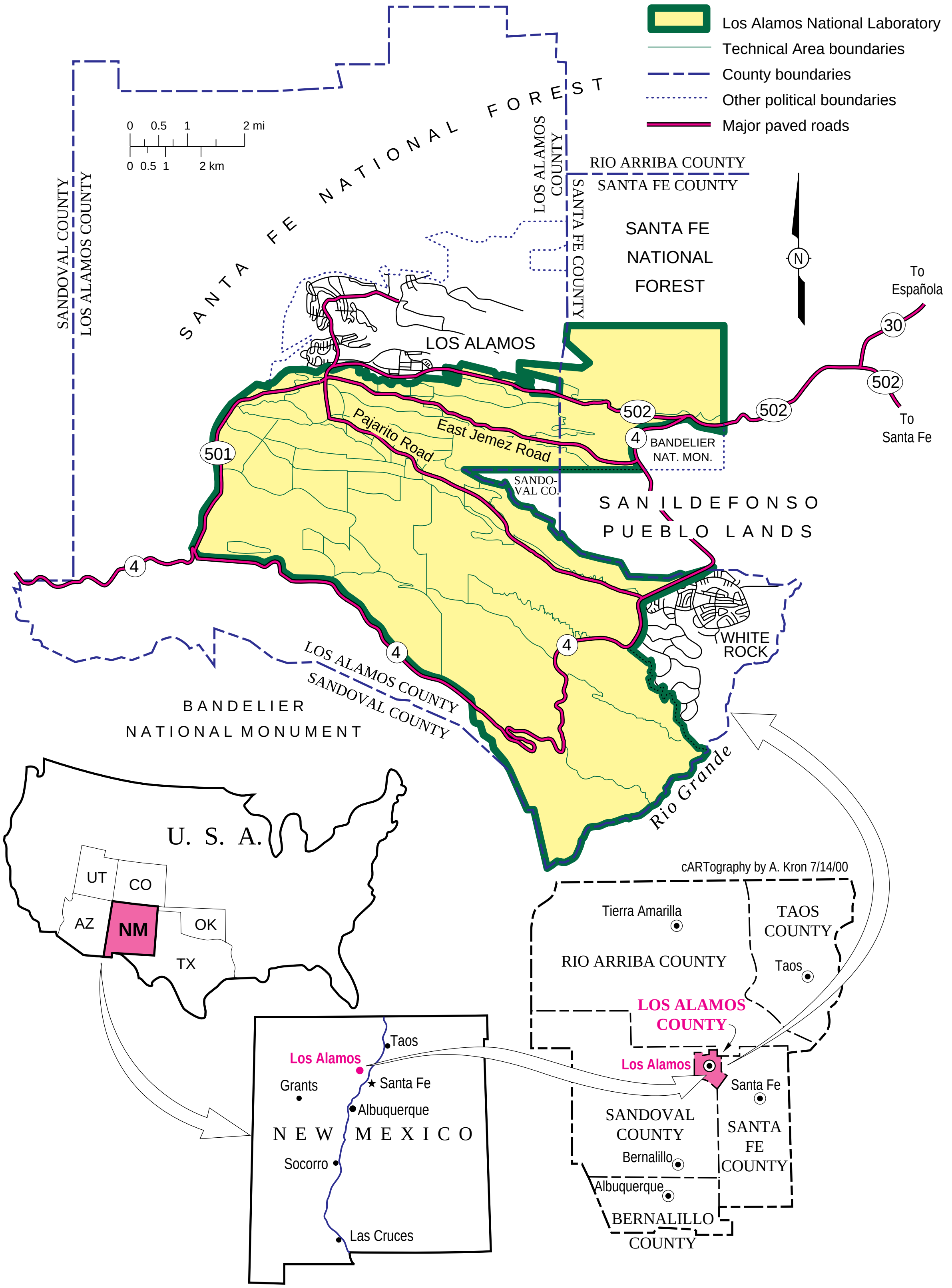

Figure 1-1. Regional location of Los Alamos National Laboratory.

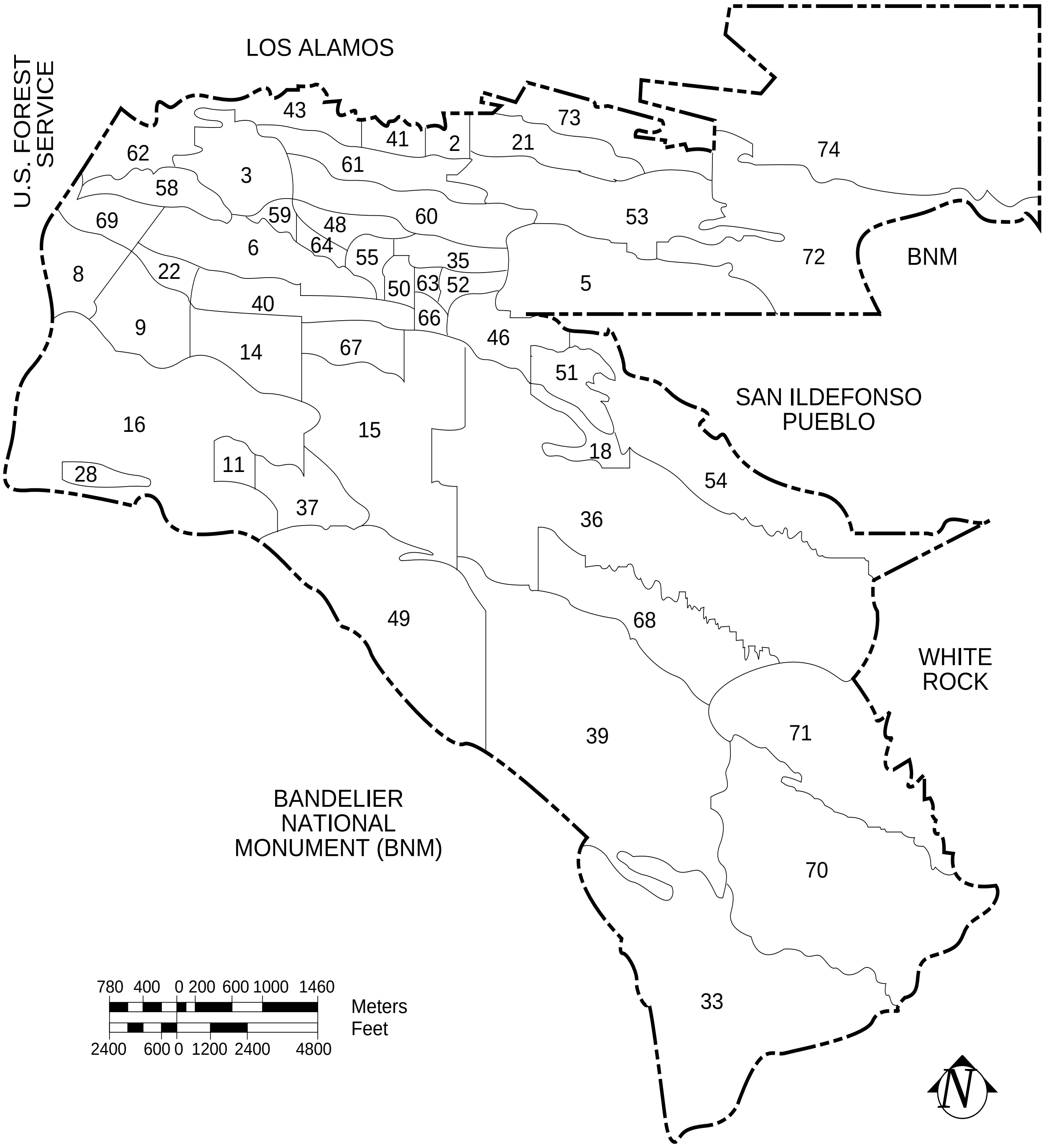

Figure 1-2. Technical Areas of Los Alamos National Laboratory in relation to surrounding landholdings.

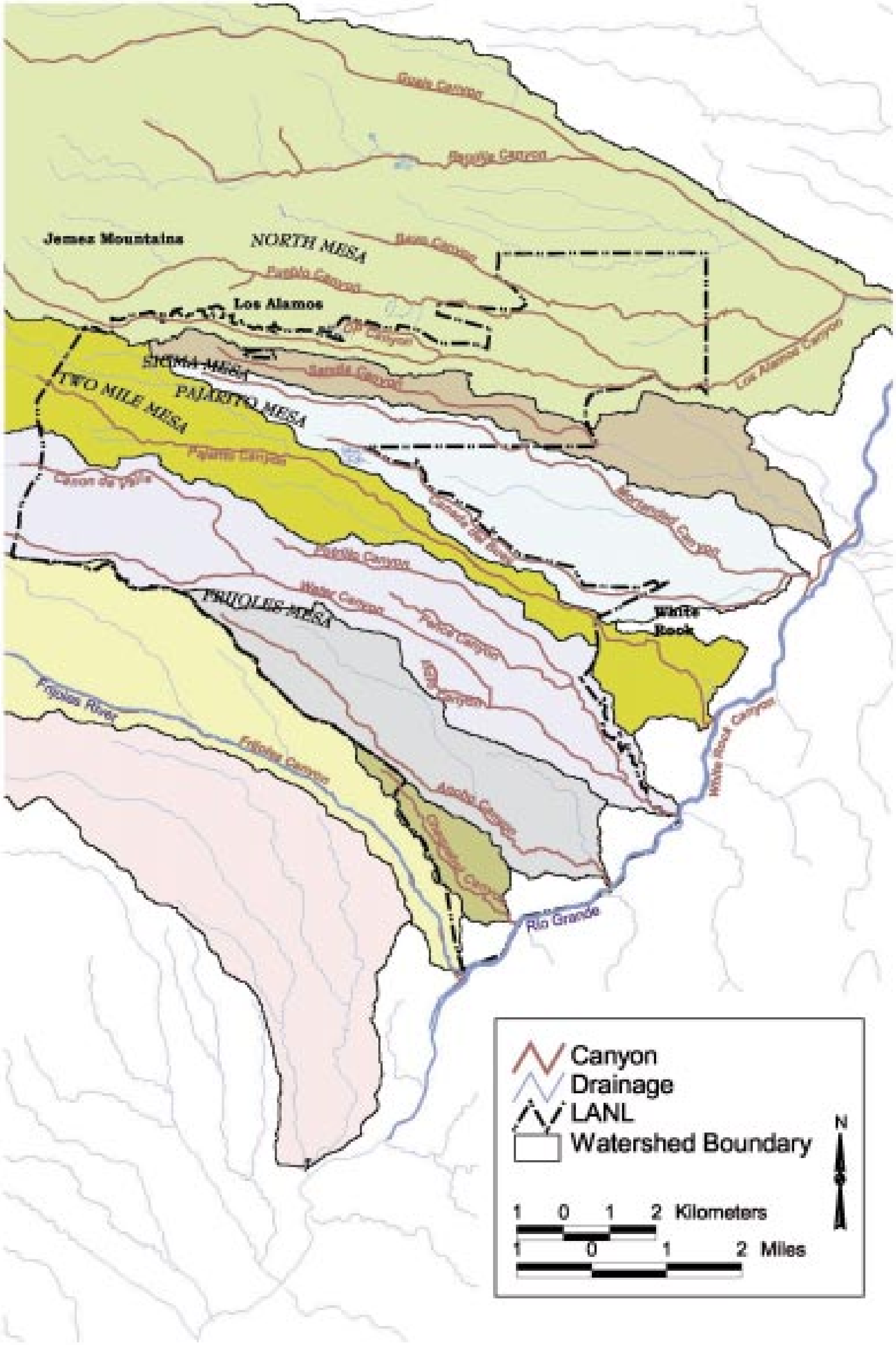

Figure 1-3. Major canyons and mesas.

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

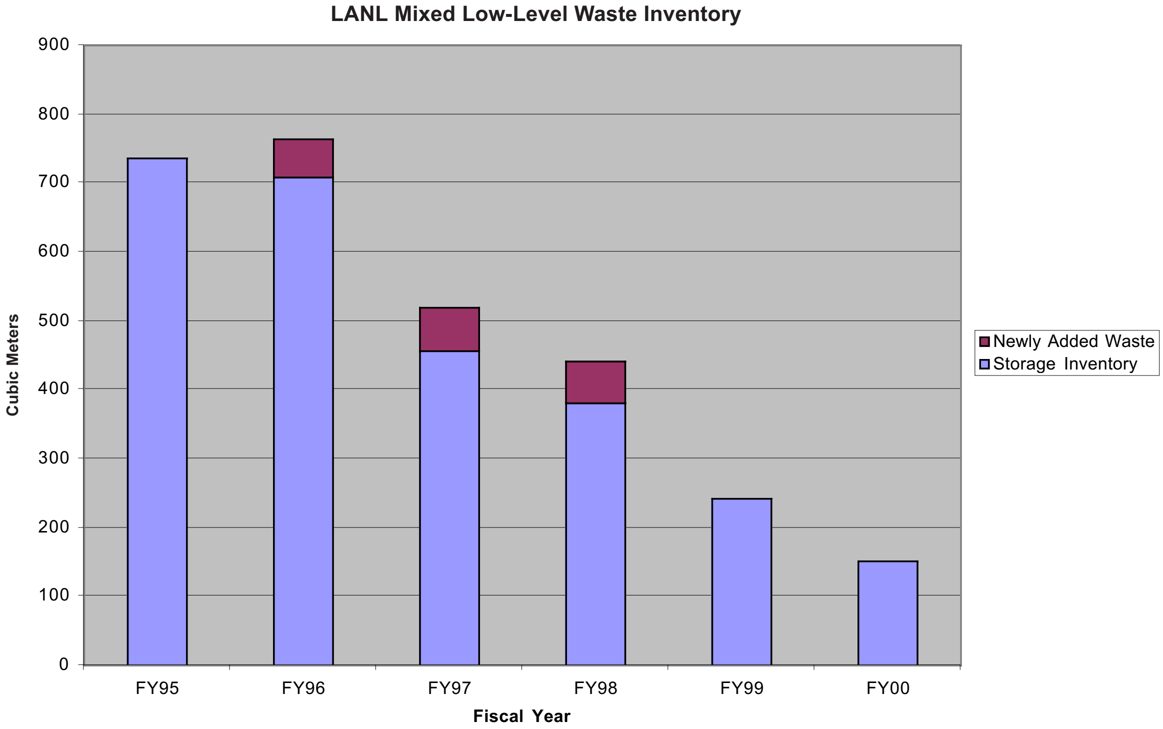

Figure 1-4. Treatment and disposal of mixed low-level waste.

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.

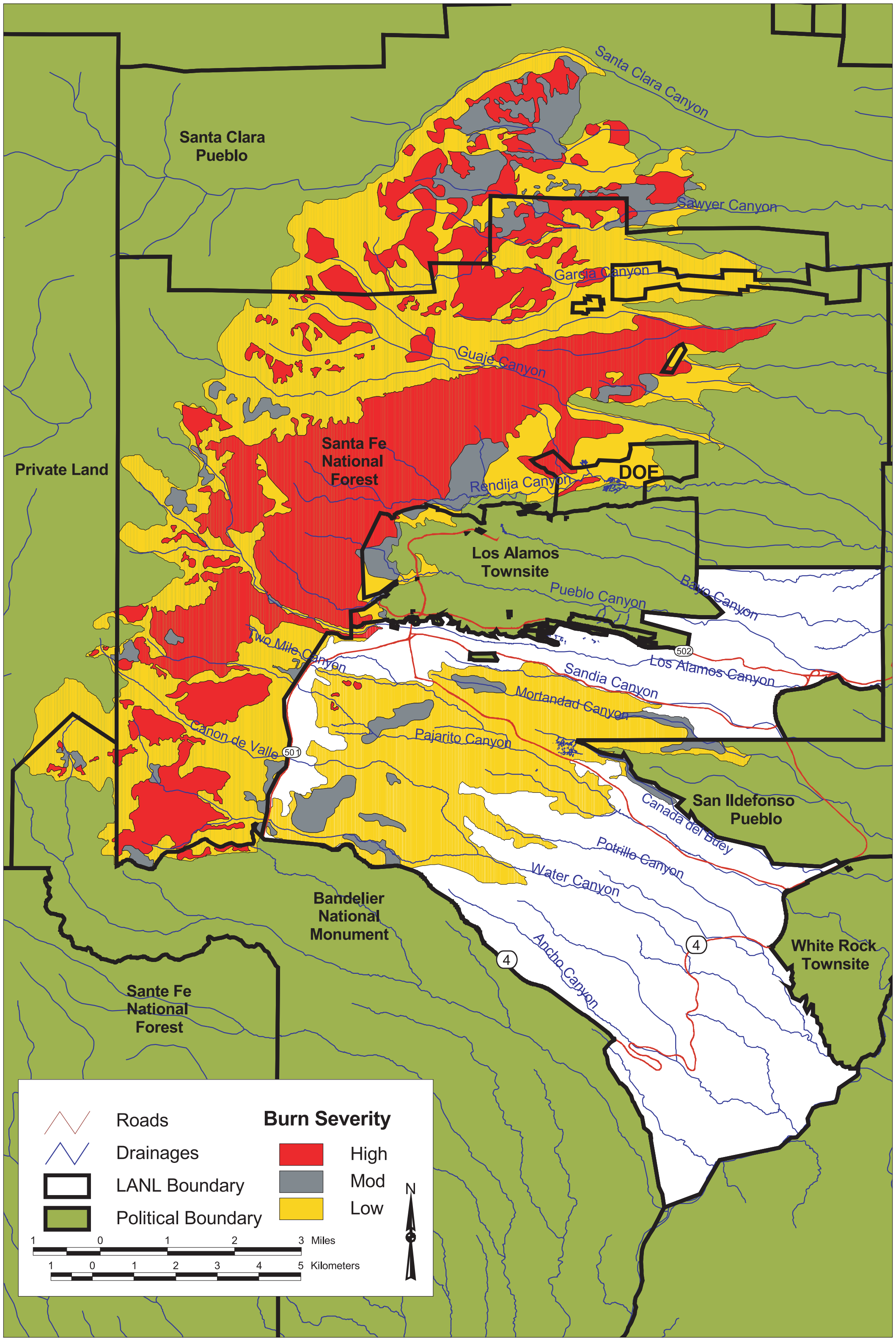

Figure 1-5. Cerro Grande fire burn area.

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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.

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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

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[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

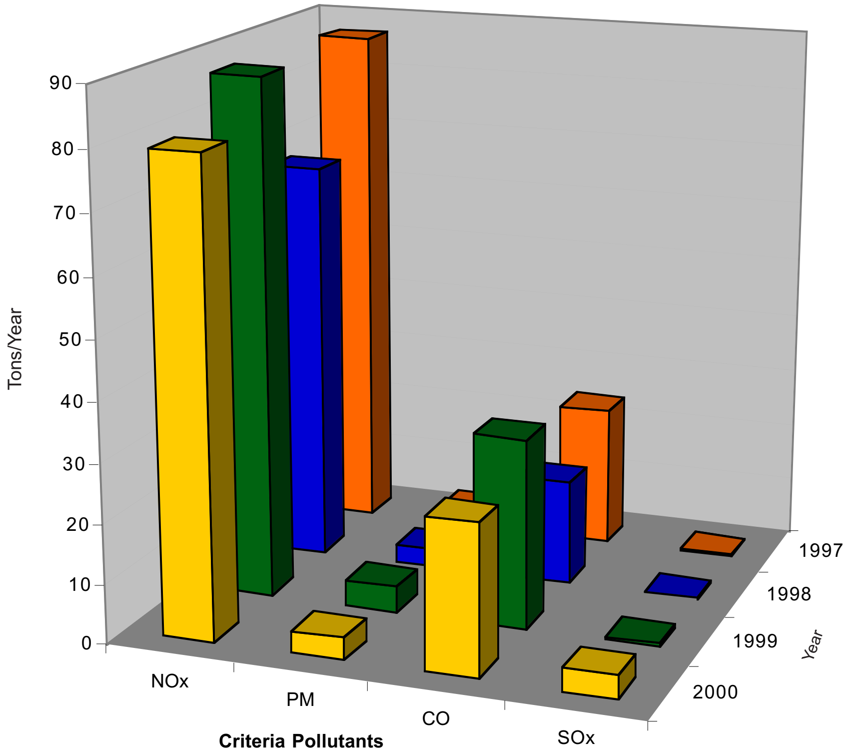

Figure 2-1. Criteria pollutant emissions from LANL.

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

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[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 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 2-9. 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.

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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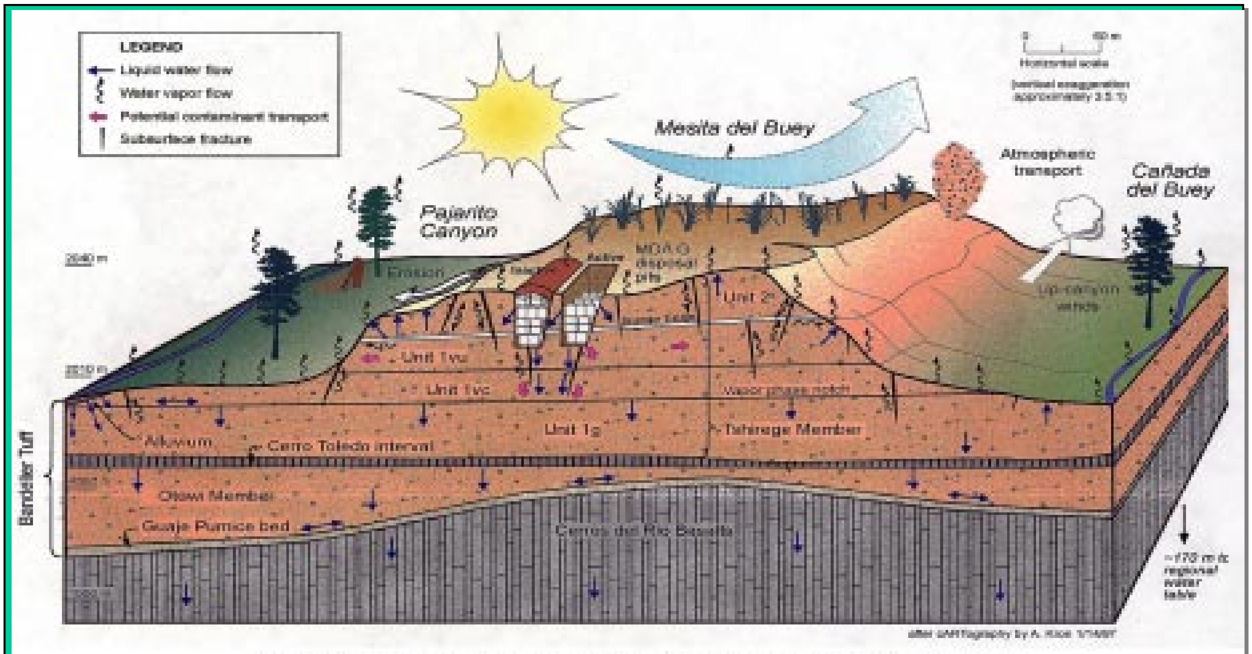
3. Environmental Radiological Dose Assessment



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.

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

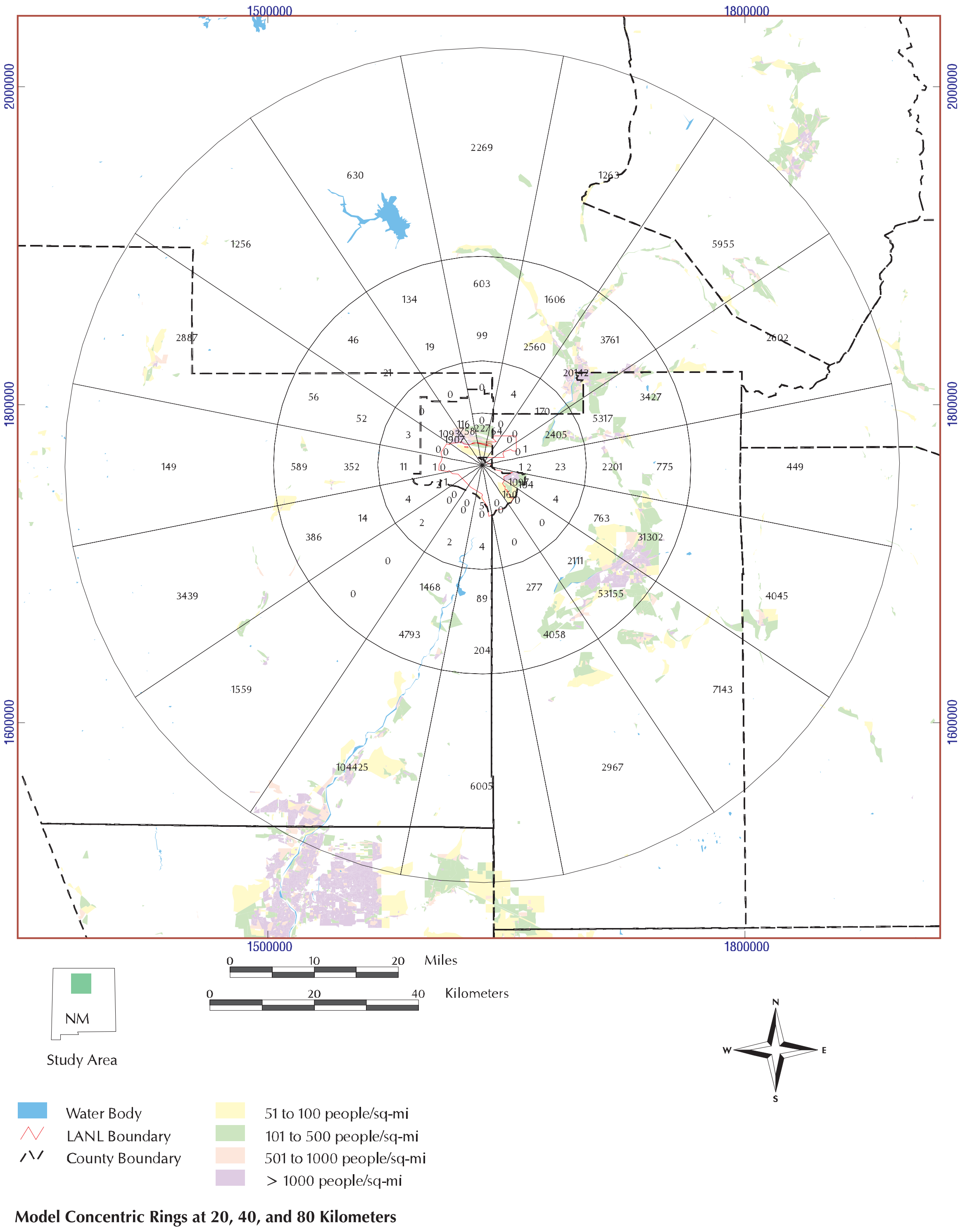

Figure 3-1. Estimated population around Los Alamos National Laboratory.

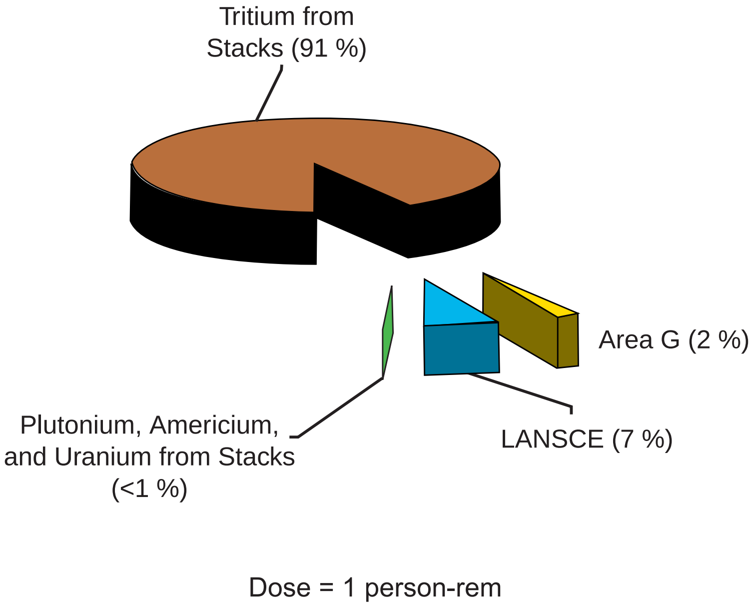

Figure 3-2. LANL contributions to population air pathway dose from Laboratory sources.

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.

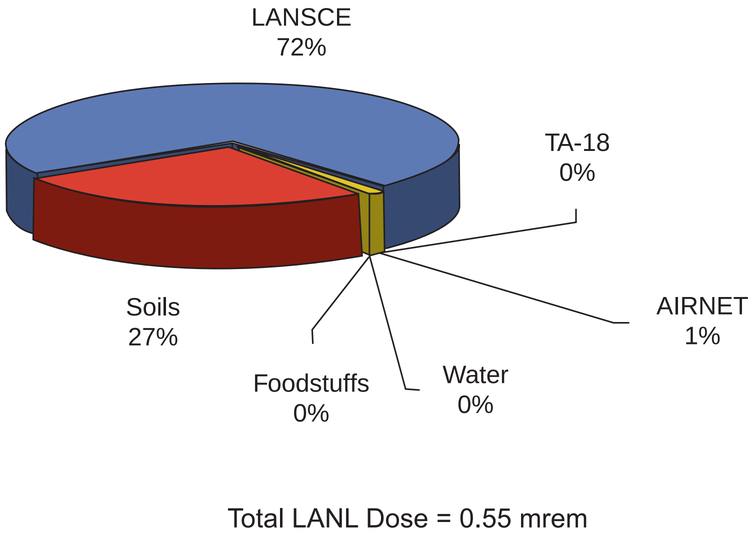

Figure 3-3. LANL contributions to maximally exposed off-site hypothetical individual during 2000.

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

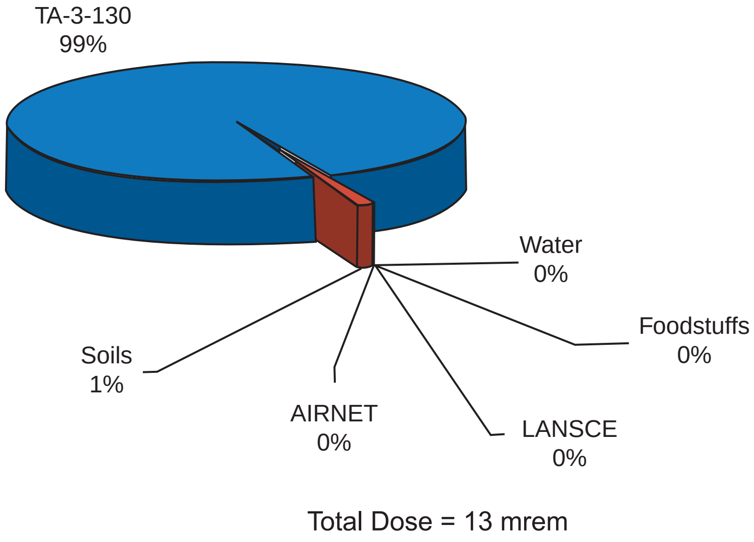

Figure 3-4. LANL contributions to maximally exposed on-site hypothetical individual during 2000.

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.

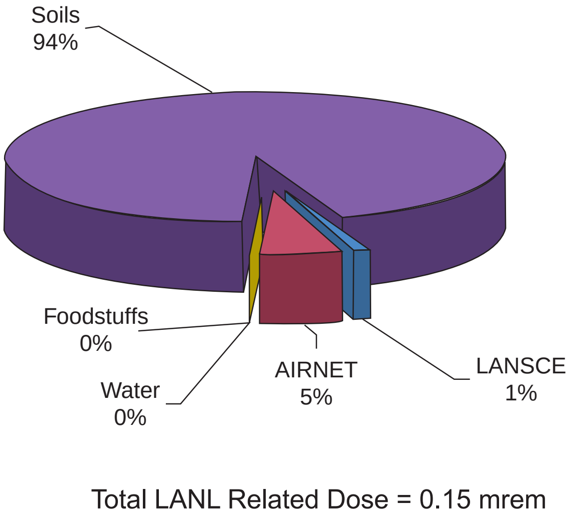

Figure 3-5. LANL contributions to an average Los Alamos resident's radiological dose in 2000.

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 × 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

	LANL Pre-Fire Measurements[a,b]		Post-Fire Predicted Maximums[b]		USGS Post-Fire Measurements
Analyte	Mean	Max	Guaje Canyon	LANL Canyons	Maximum
^{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

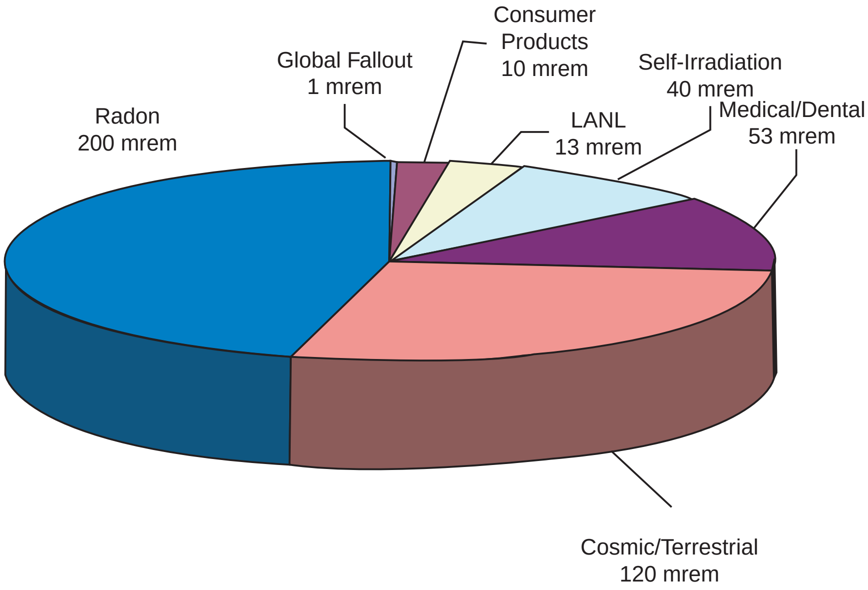

Figure 3-6. All contributions to the 2000 dose for the Laboratory's maximally exposed individual.

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	
	Water BCG	Site	Partial	Sediment BCG	Site	Partial	Sediment Sum		
Nuclide	pCi/L	Data[a]	Fraction	pCi/g	Data[b]	Fraction	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 &		
	Water BCG	Site	Partial	Soil BCG	Site	Partial	Soil Sum	Organism Responsible for the Limiting Dose	
Nuclide	pCi/L	Data[a]	Fraction	pCi/g	Data[b]	Fraction	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 biweekly 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.

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[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.

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[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.

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[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.

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[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.

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[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.

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[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.

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[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.

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[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.

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[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. (°F)	Daily Minimum Low Temp. (°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. (°F)	Daily Minimum Low Temp. (°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. (°F)	Daily Minimum Low Temp. (°F)	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.

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[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

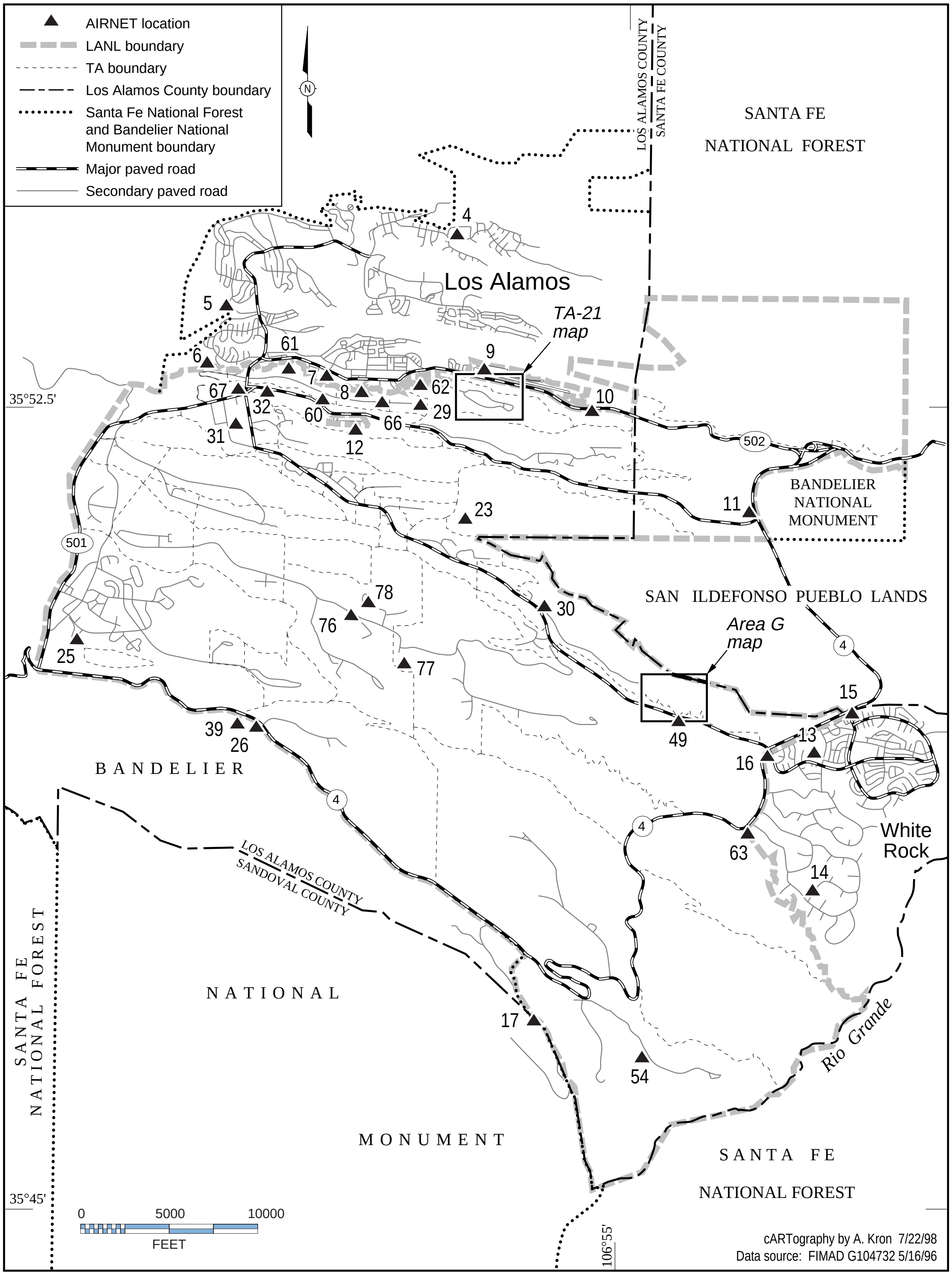


Figure 4-1. Off-site perimeter and on-site Laboratory AIRNET locations.

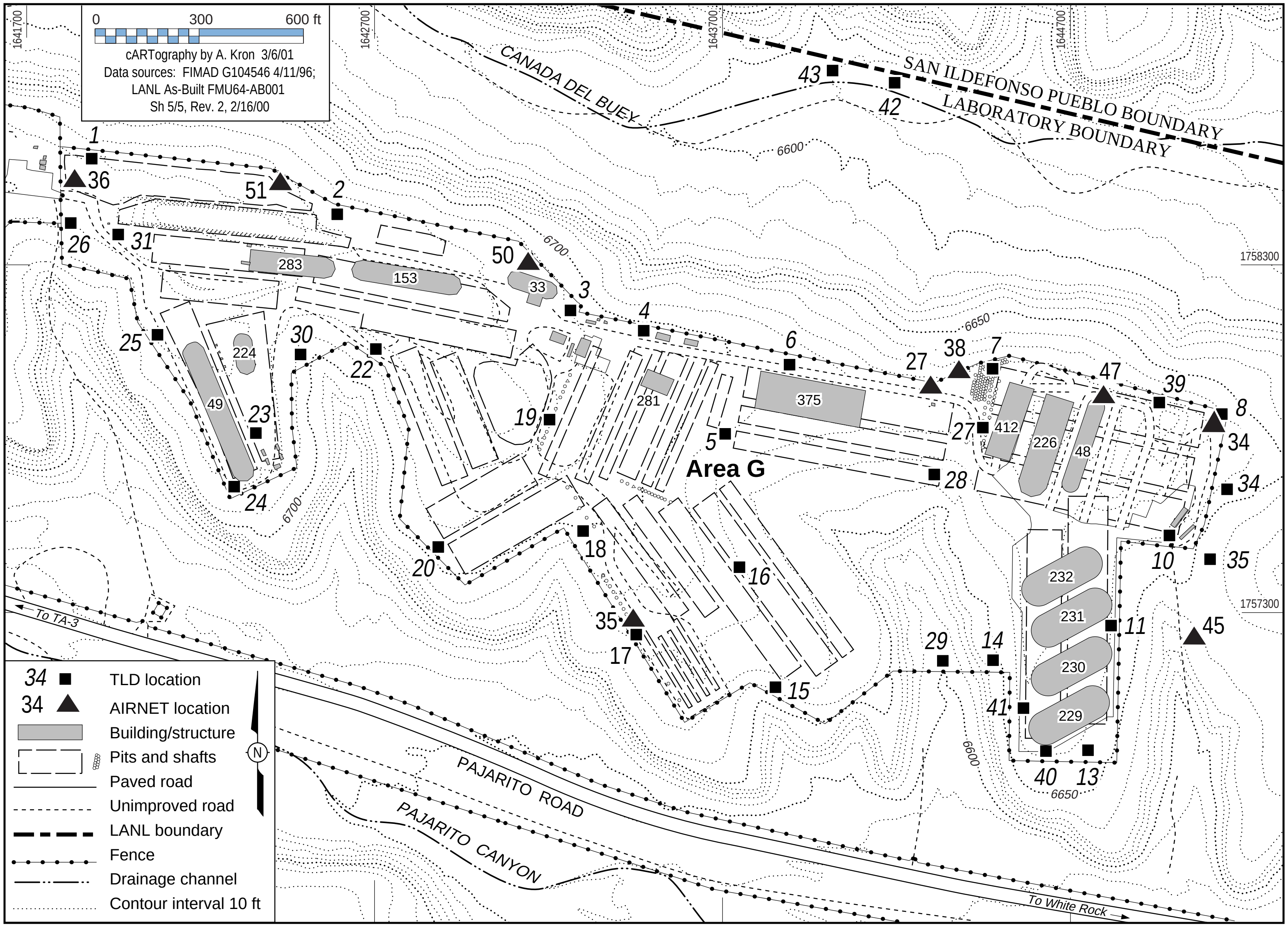


Figure 4-2. Technical Area 54, Area G, map of AIRNET and TLD locations.

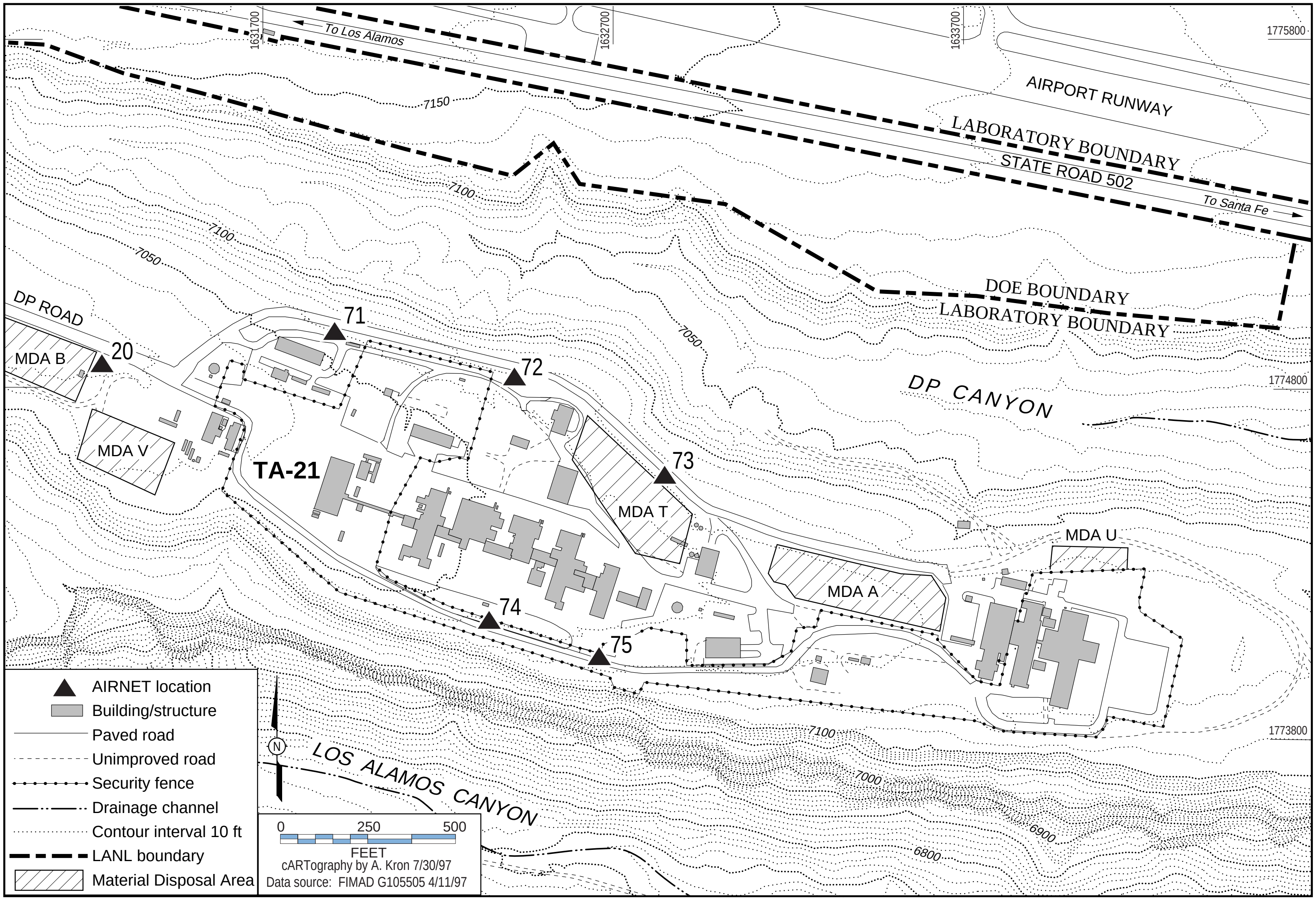


Figure 4-3. Technical Area 21 map of AIRNET locations.

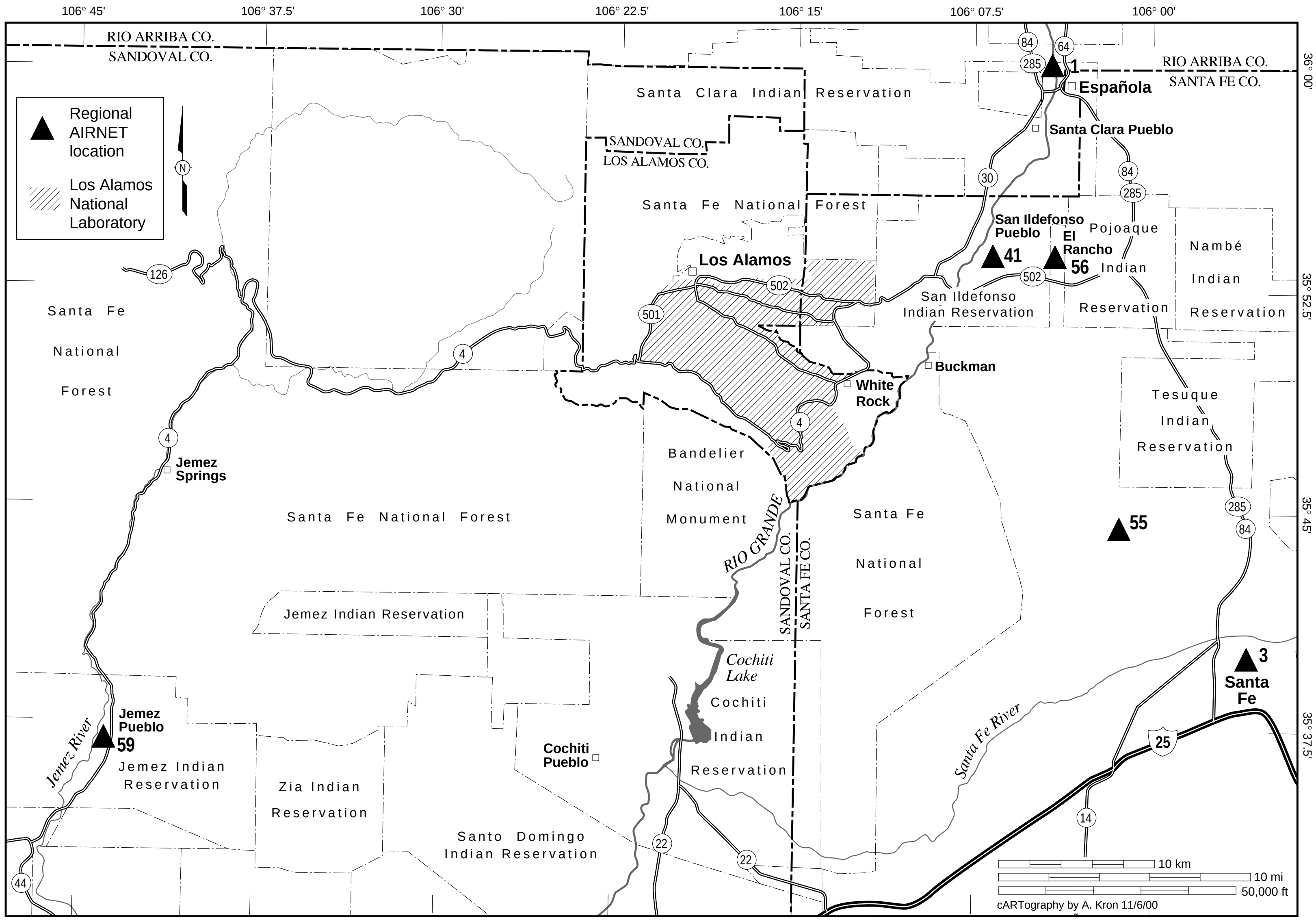


Figure 4-4. Regional and pueblo AIRNET locations.

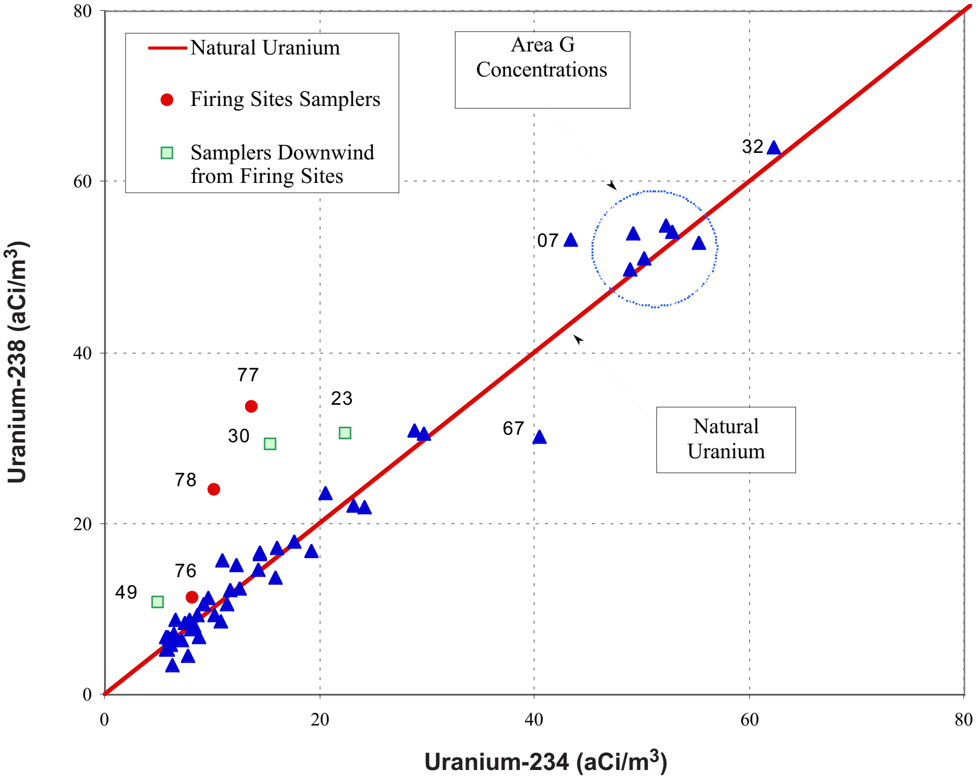


Figure 4-5. AIRNET uranium concentrations for 2000.

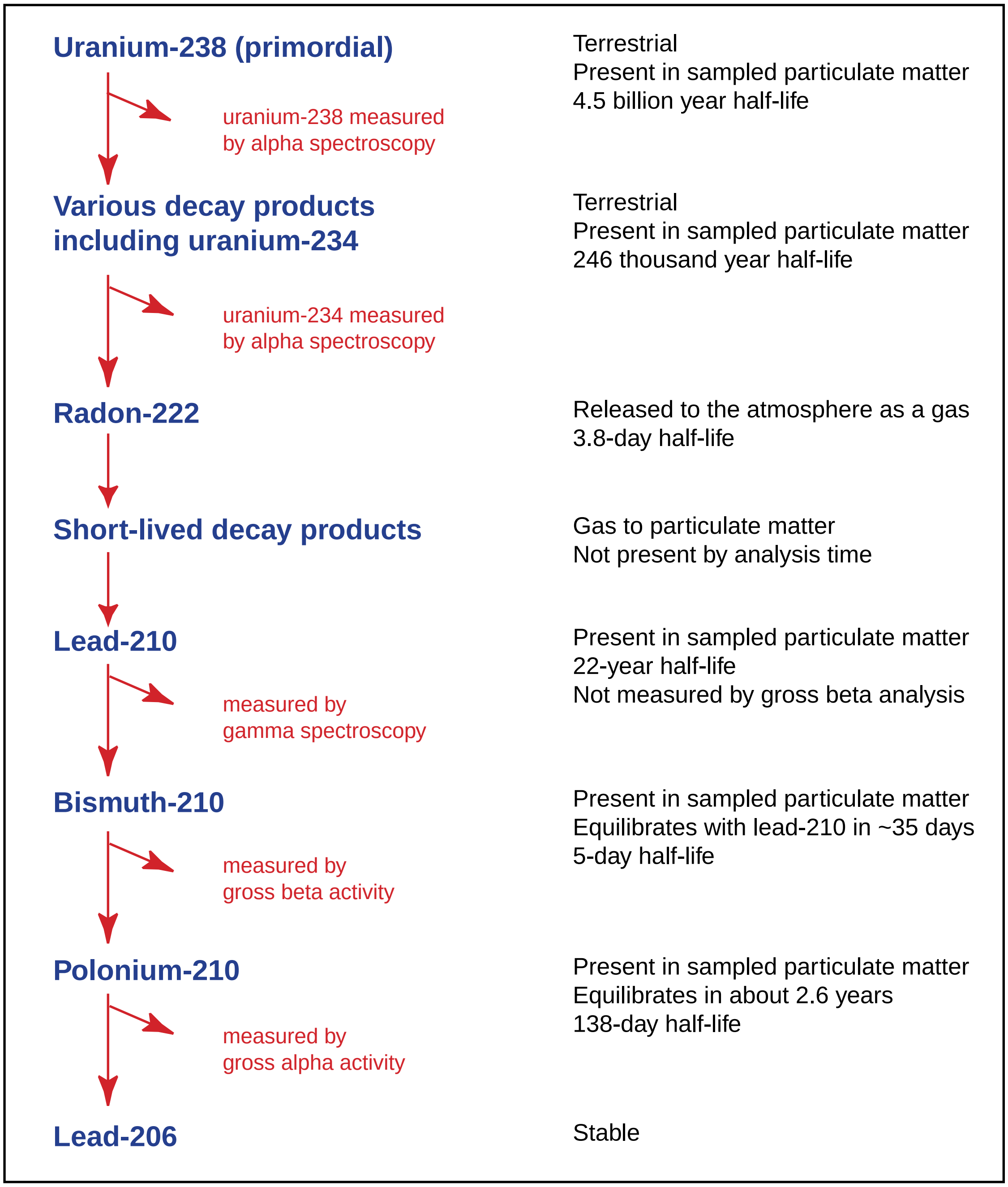


Figure 4-6. Uranium-238 decay series.

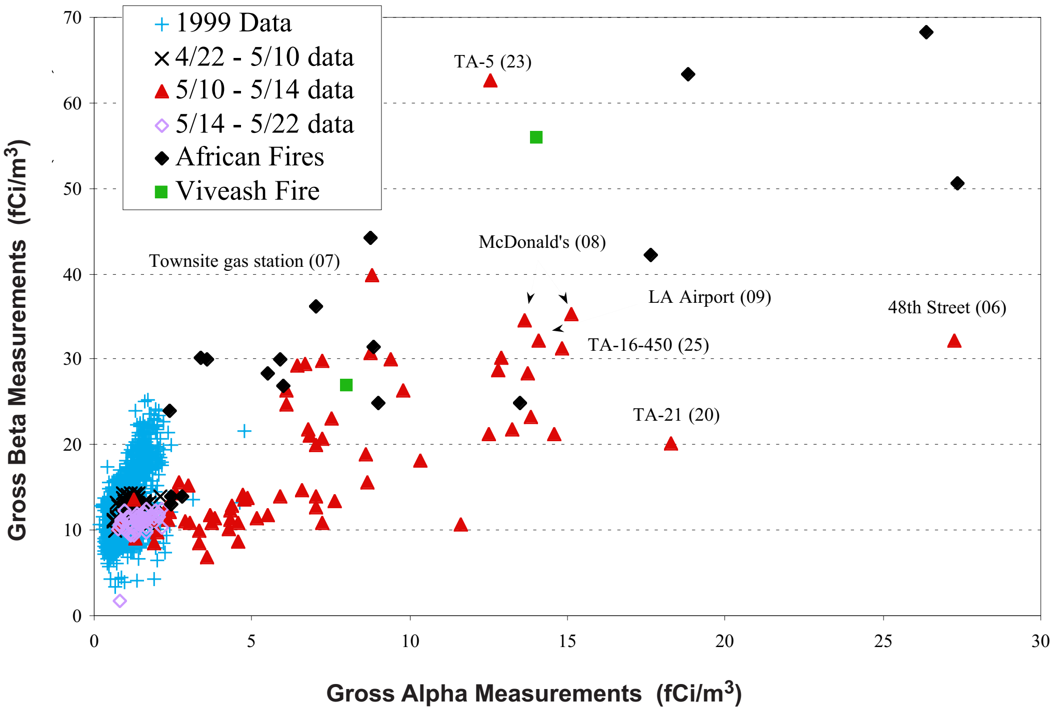


Figure 4-7. Gross alpha measurements versus gross beta measurements during the Cerro Grande fire.

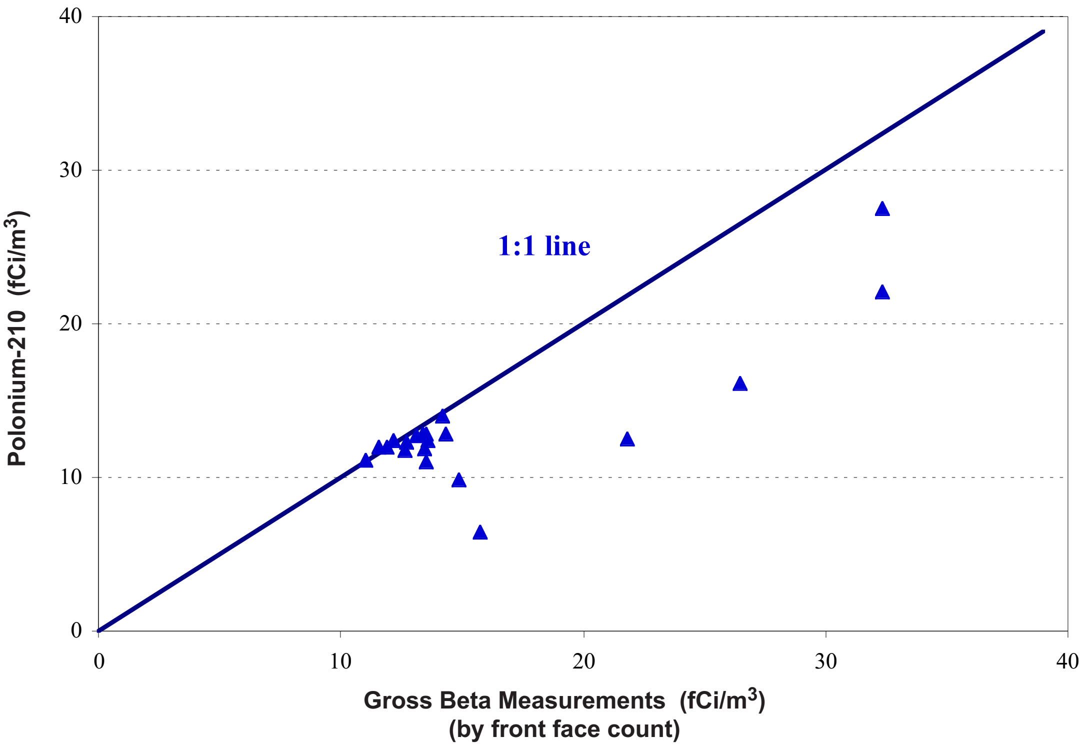


Figure 4-8. Gross beta measurements versus lead-210 measurements during the Cerro Grande fire.

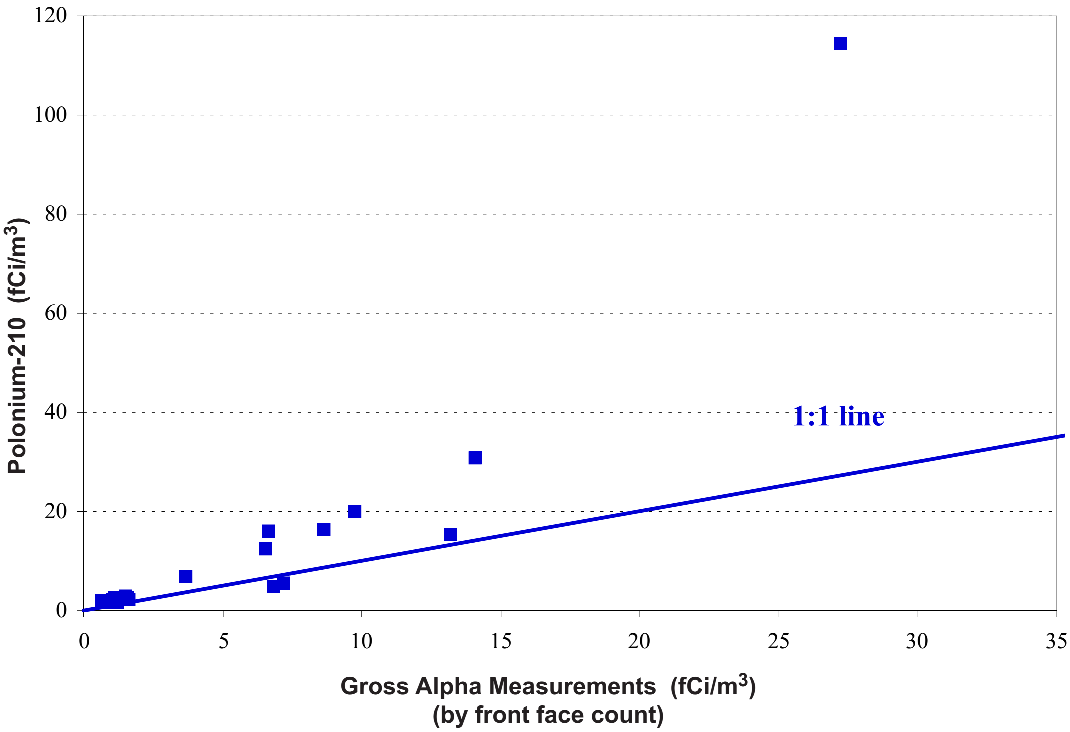


Figure 4-9. Gross alpha measurements versus polonium-210 measurements during the Cerro Grande fire.

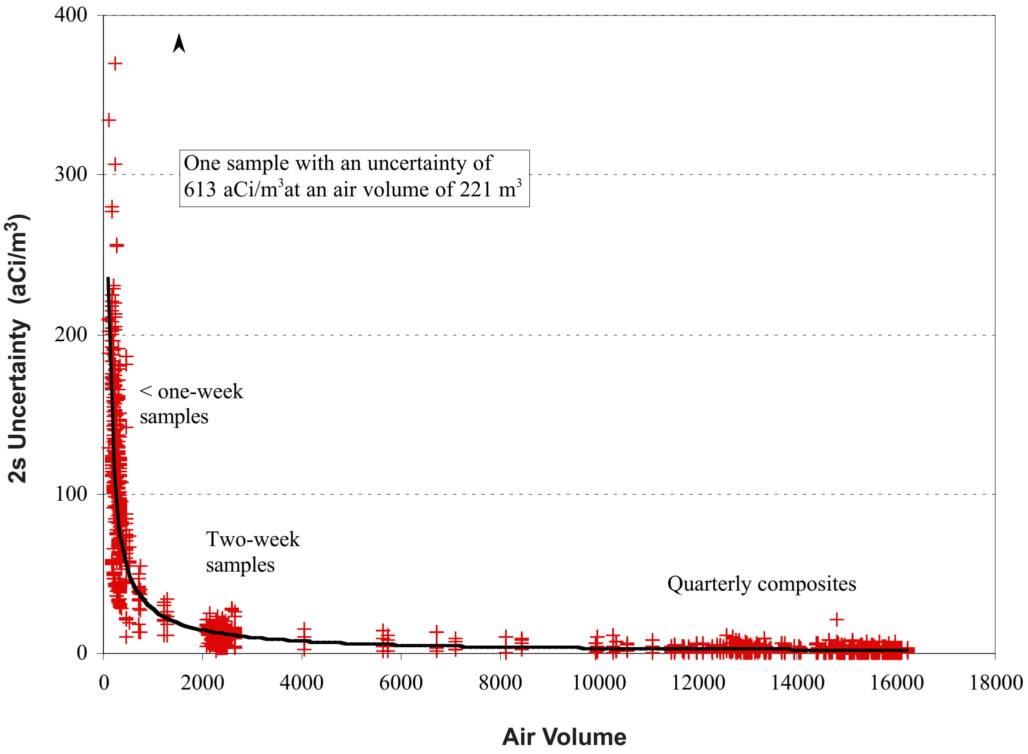


Figure 4-10. The effects of sampled air volume on uranium, plutonium, and americium uncertainties.

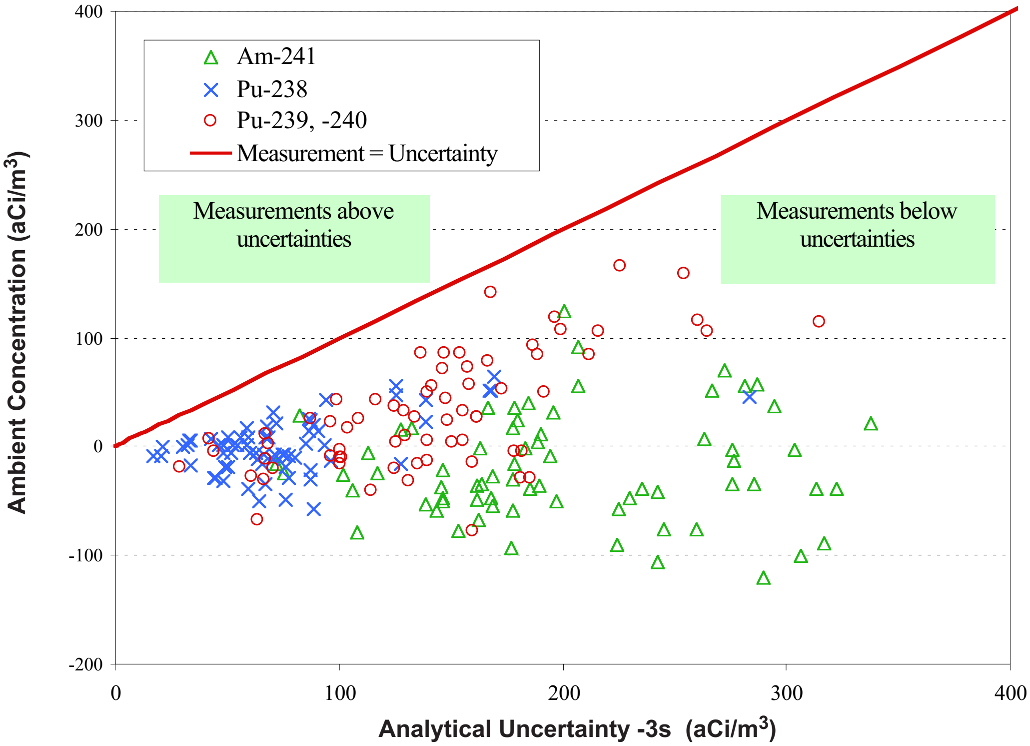


Figure 4-11. Short-term americium and plutonium concentrations during the Cerro Grande fire (May 9–14, 2000)

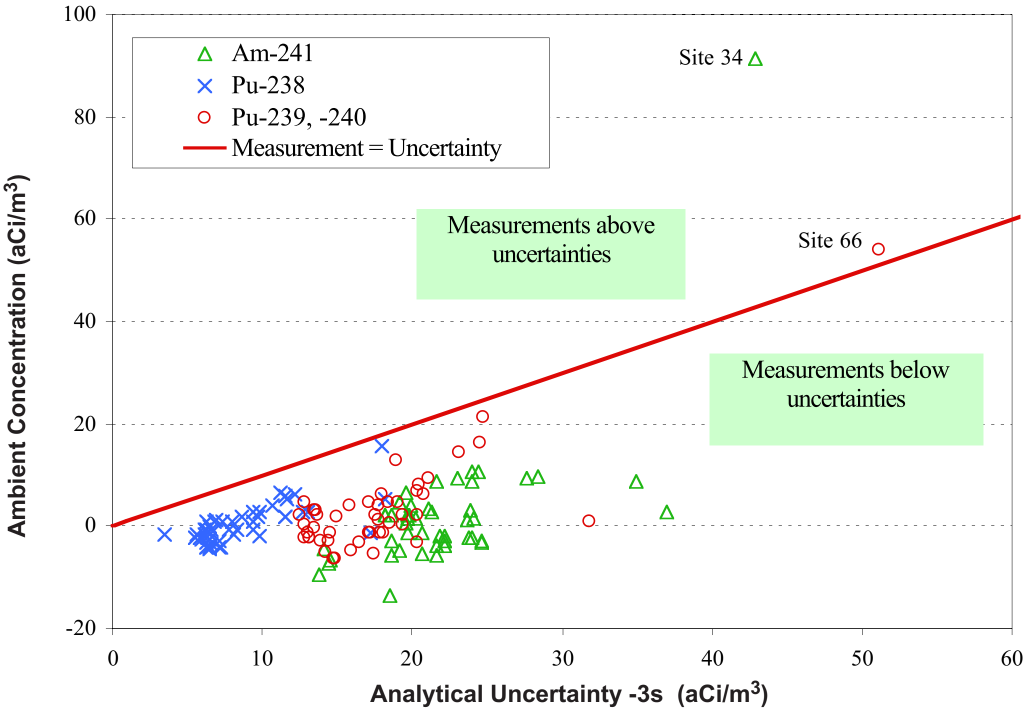


Figure 4-12. Two-week americium and plutonium concentrations at the beginning of the Cerro Grande fire (April 24–May 10, 2000.

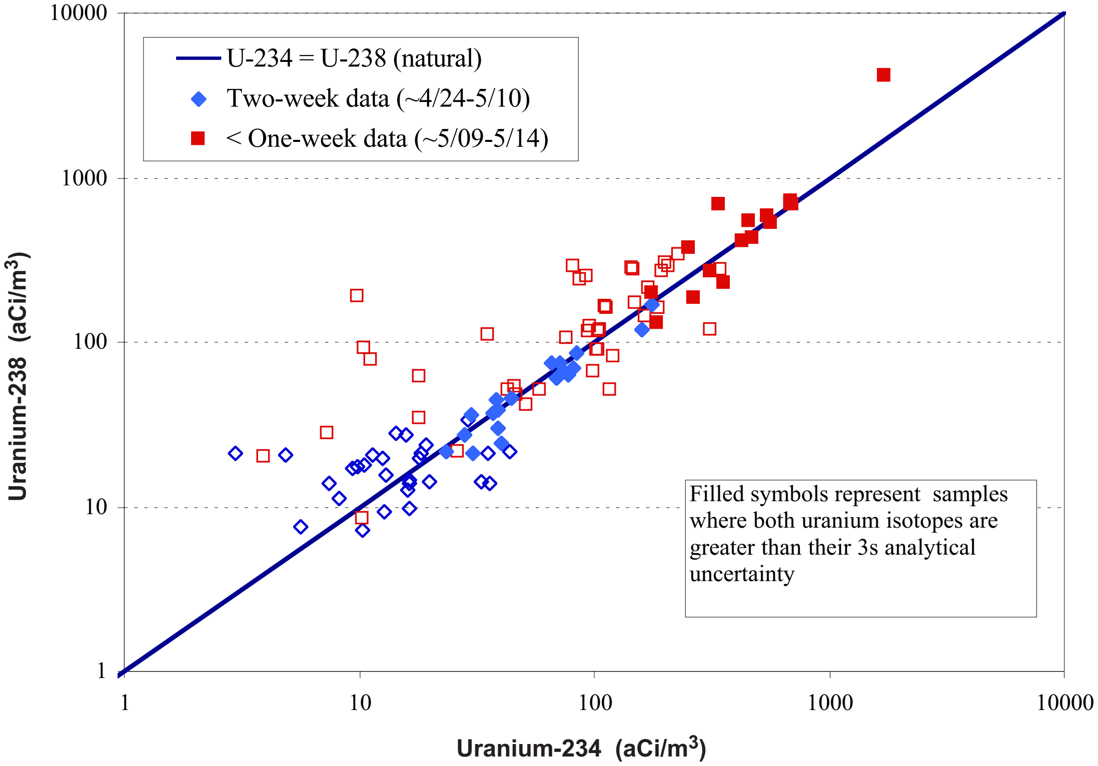


Figure 4-13. Short-term uranium isotopic concentrations during the Cerro Grande fire.

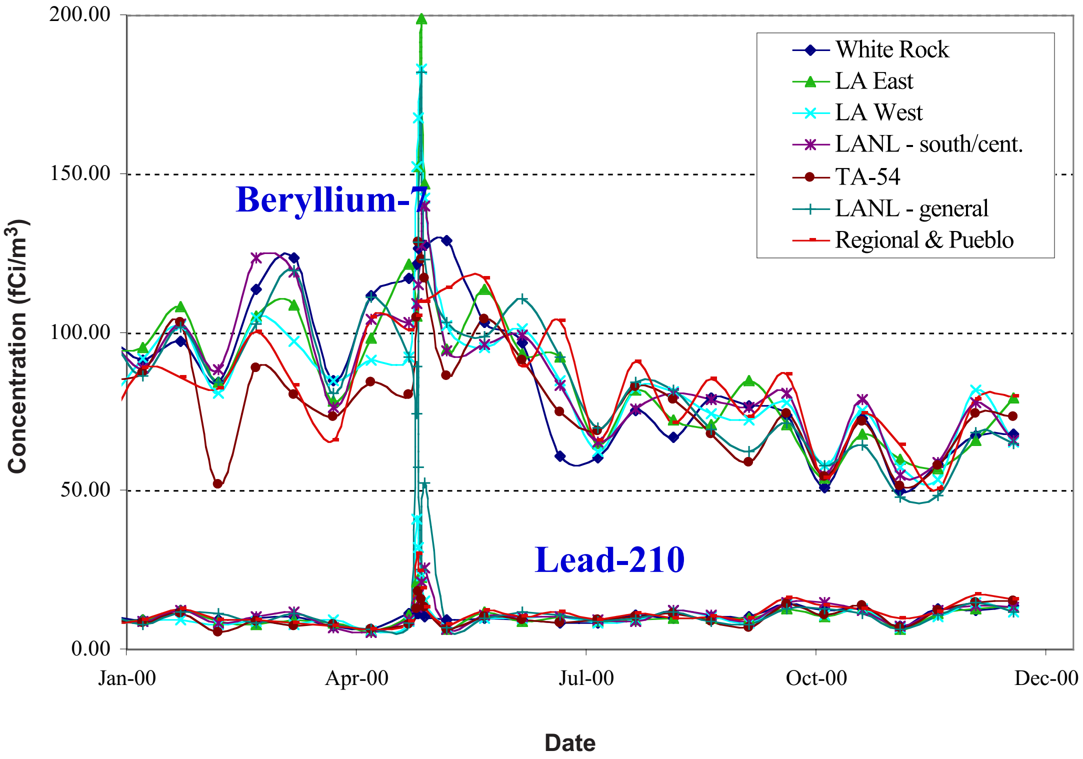


Figure 4-14. Gamma spectroscopy measurements grouped by general location.

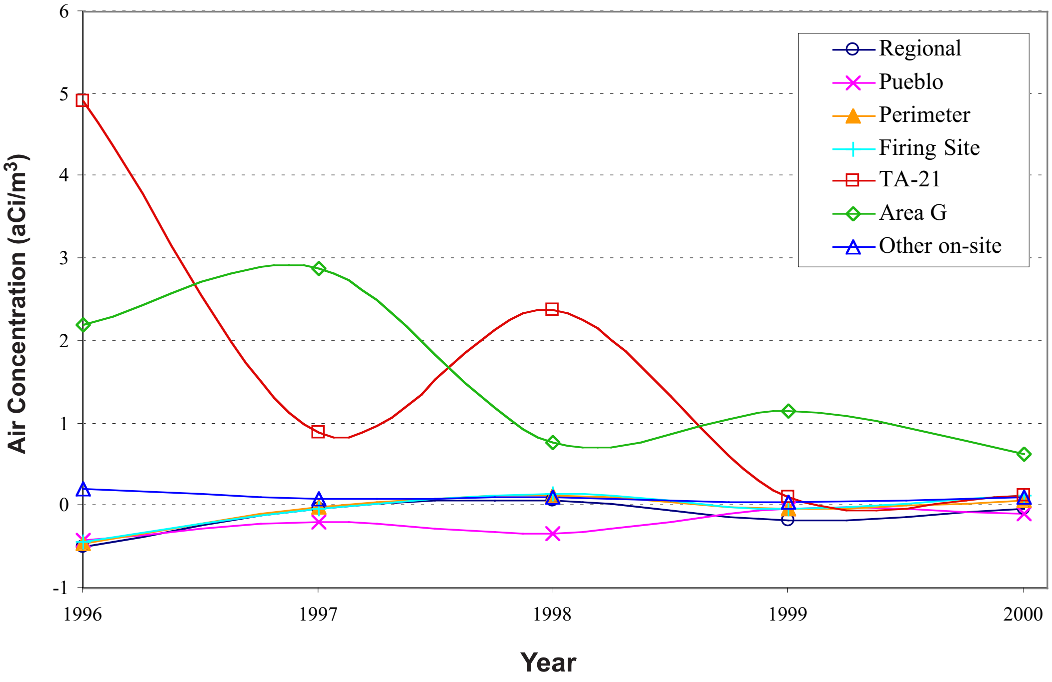


Figure 4-15. Plutonium-238 annual concentrations grouped by general location.

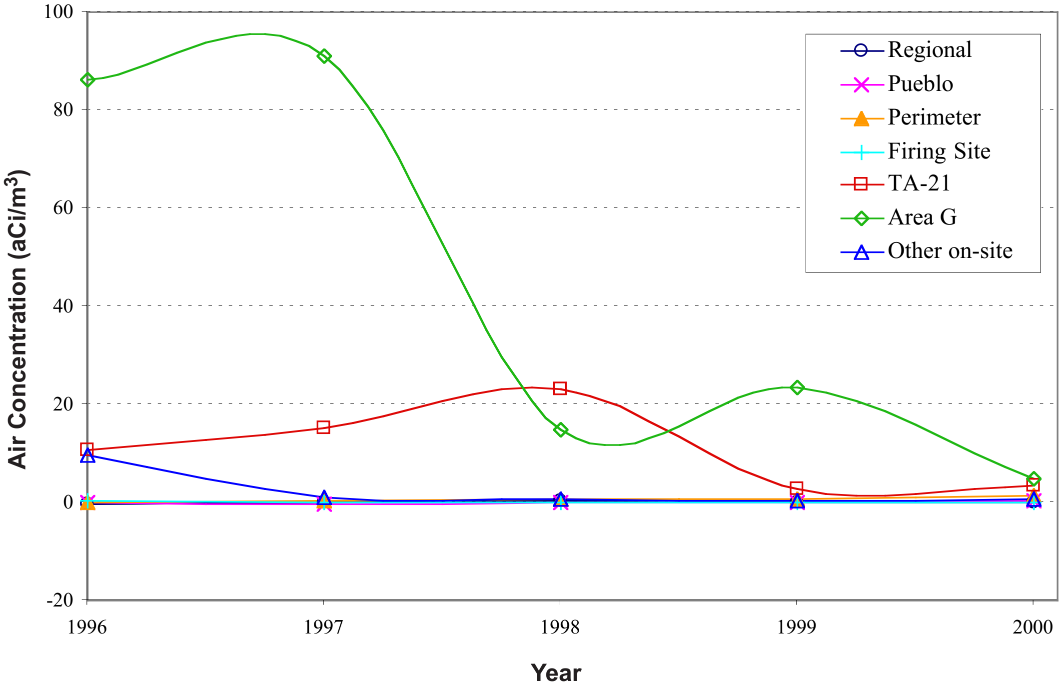


Figure 4-16. Plutonium-239, -240 annual concentrations grouped by general location.

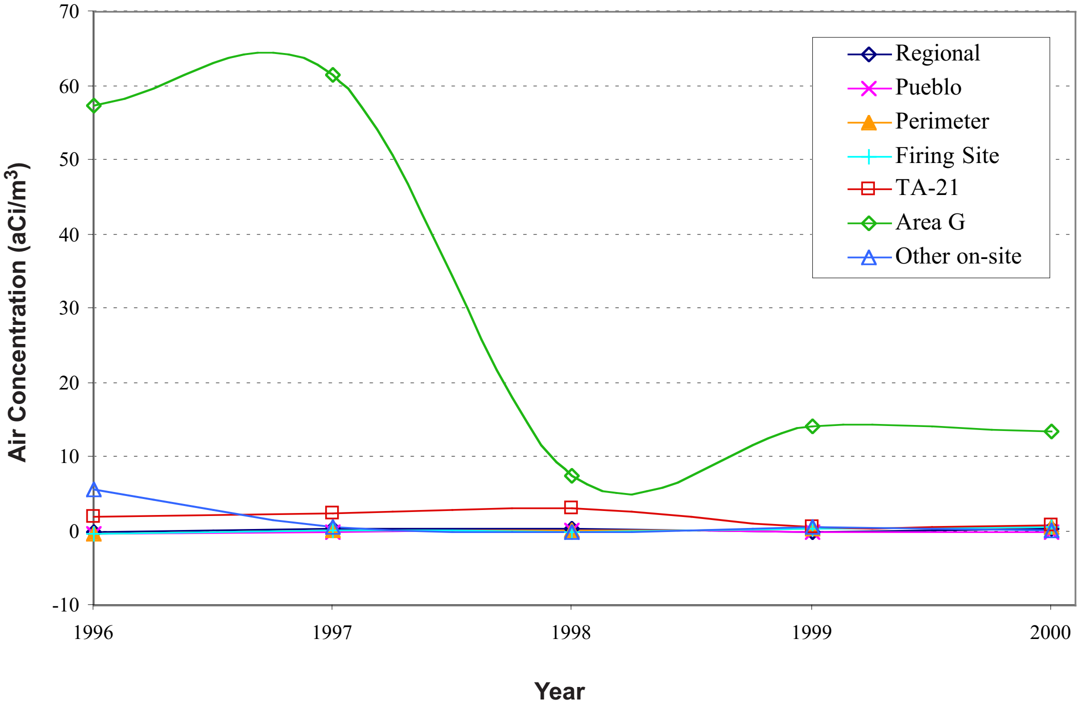


Figure 4-17. Americium-241 annual concentrations grouped by general location.

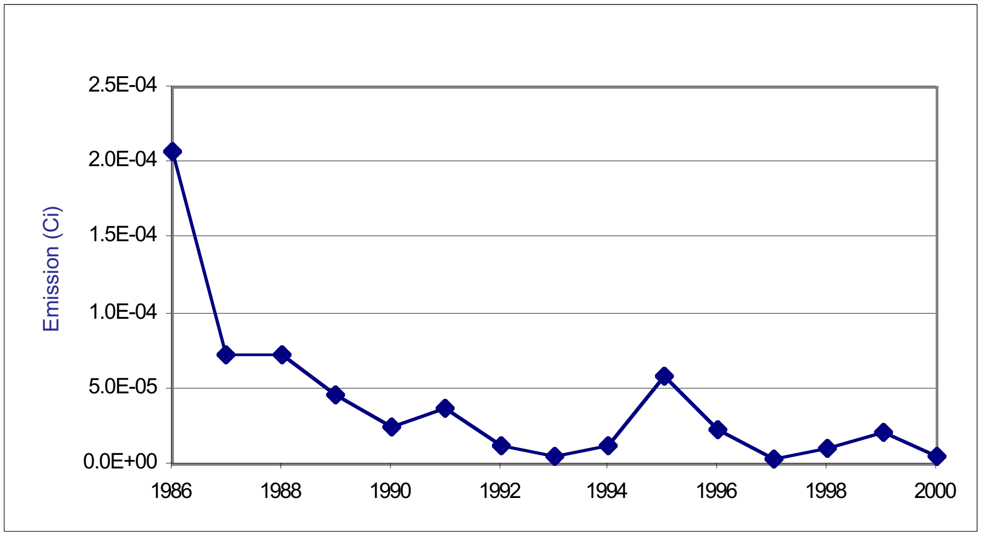


Figure 4-18. Plutonium emissions from sampled Laboratory stacks since 1986.

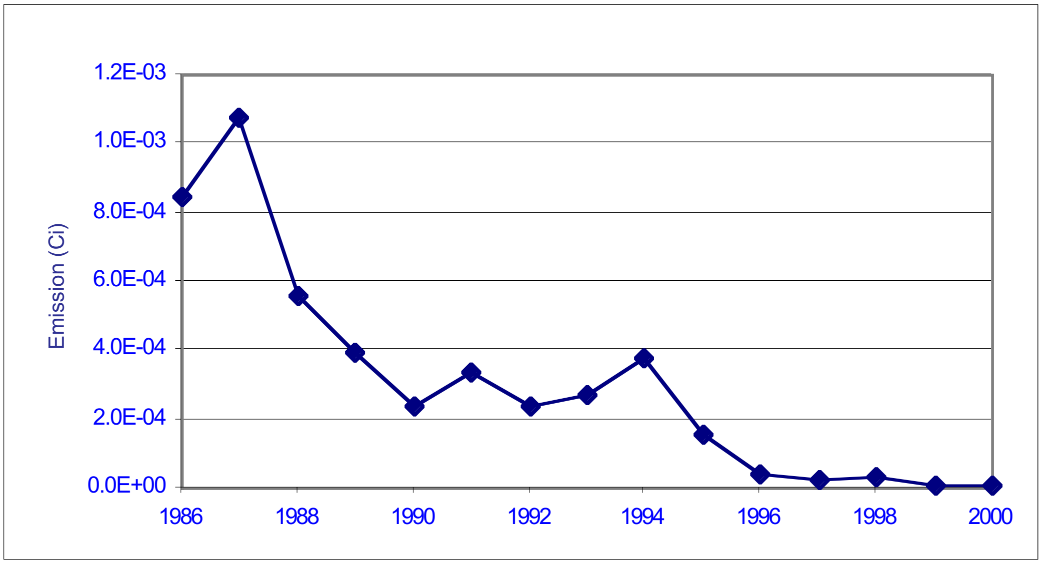


Figure 4-19. Uranium emissions from sampled Laboratory stacks since 1986.

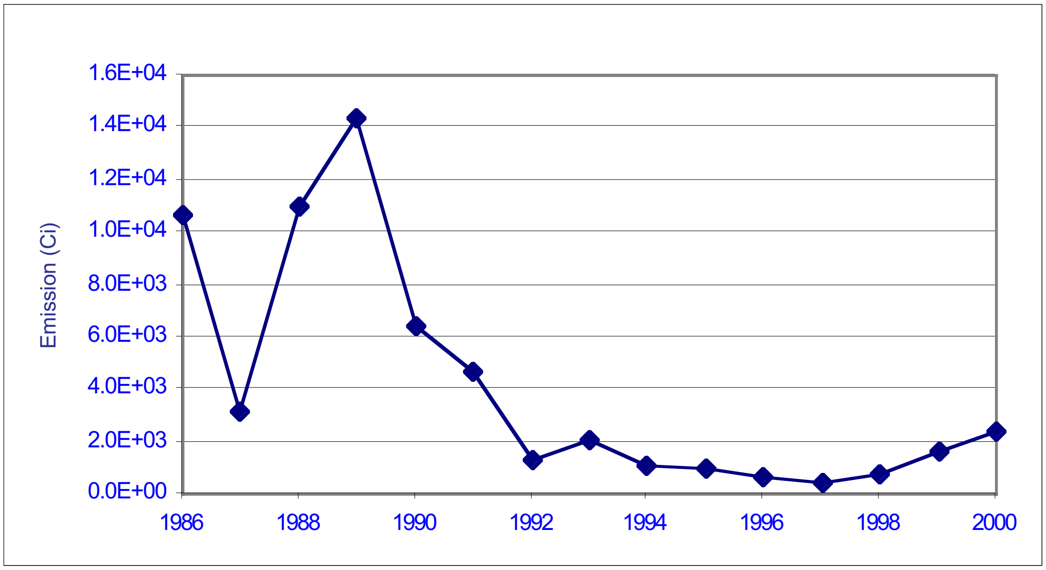


Figure 4-20. Tritium emissions from sampled Laboratory stacks since 1986.

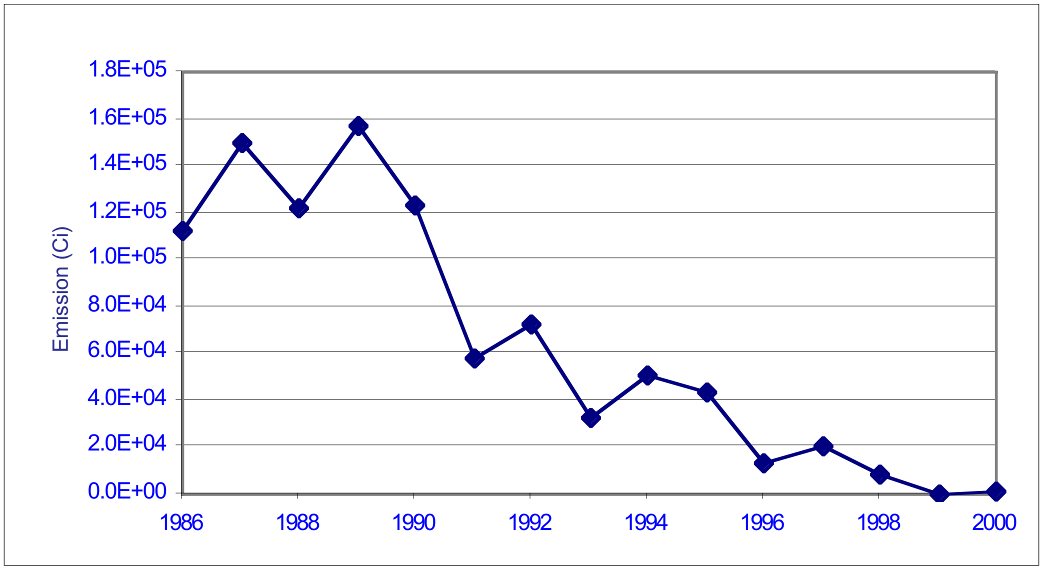


Figure 4-21. G/MAP emissions from sampled Laboratory stacks since 1986.

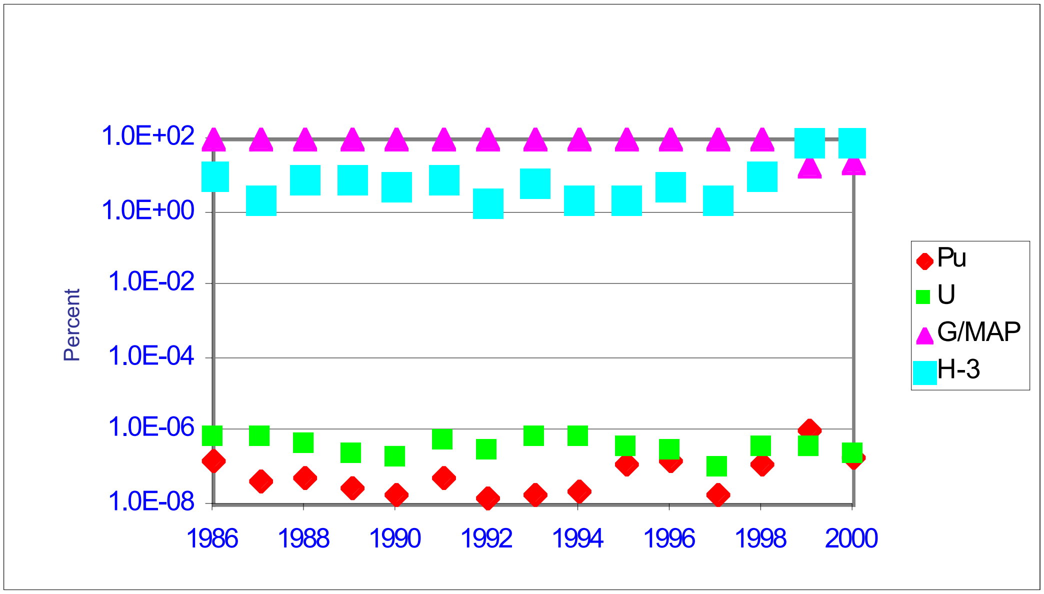


Figure 4-22. Percent of total stack emissions resulting from plutonium, uranium, tritium, and G/MAP.

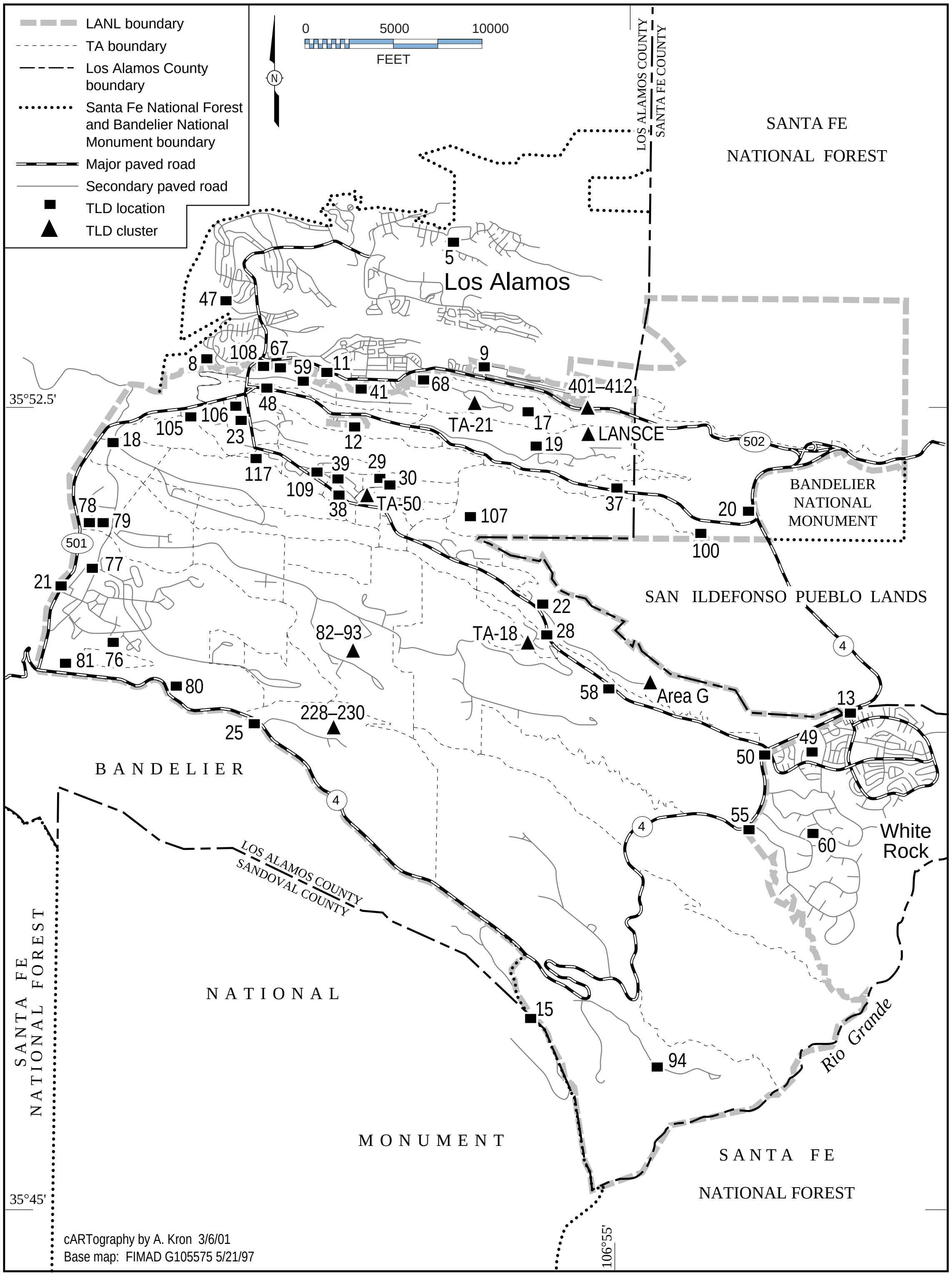


Figure 4-23. Off-site perimeter and on-site Laboratory TLD locations.

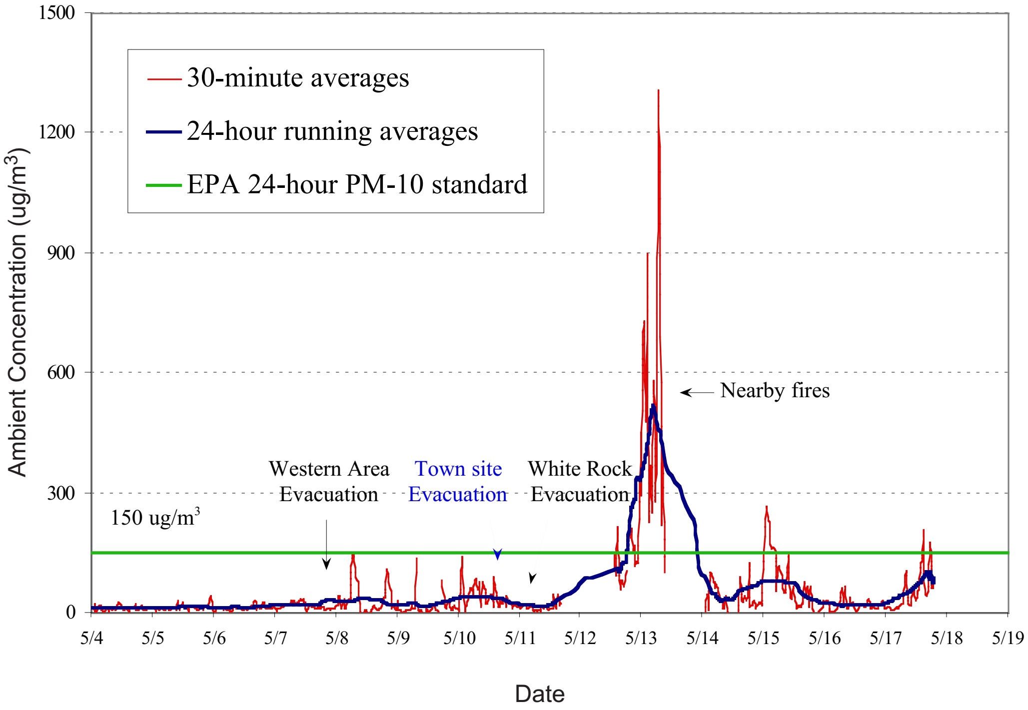


Figure 4-24. Particulate matter concentrations (TEOM measurements at TA-54-1001).

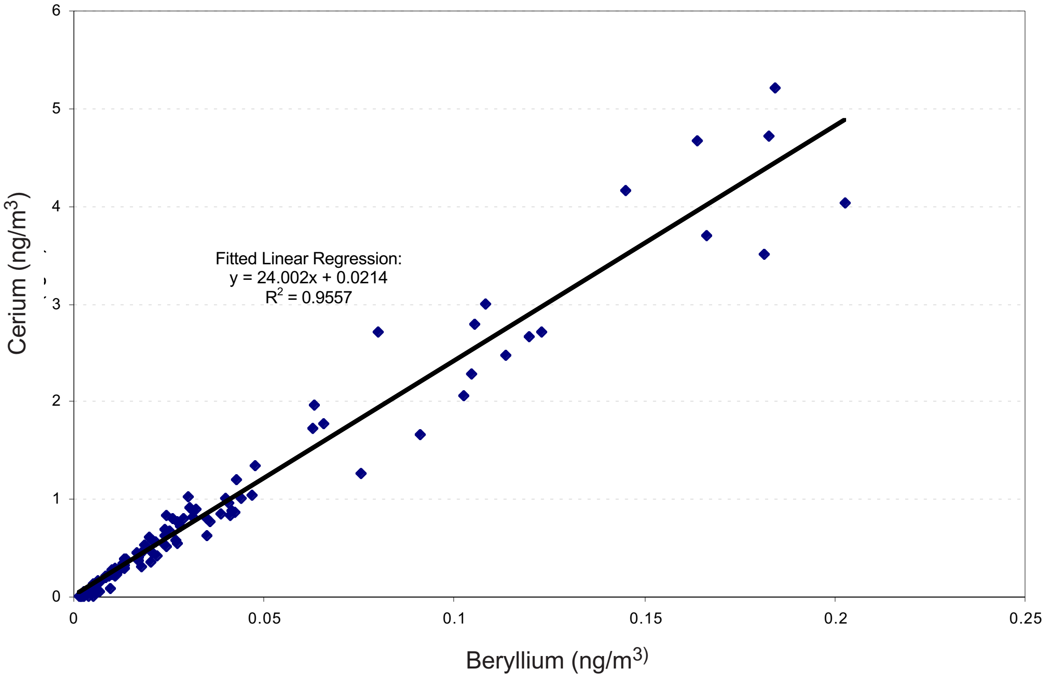


Figure 4-25. Quarterly beryllium and cerium concentrations for 2000.

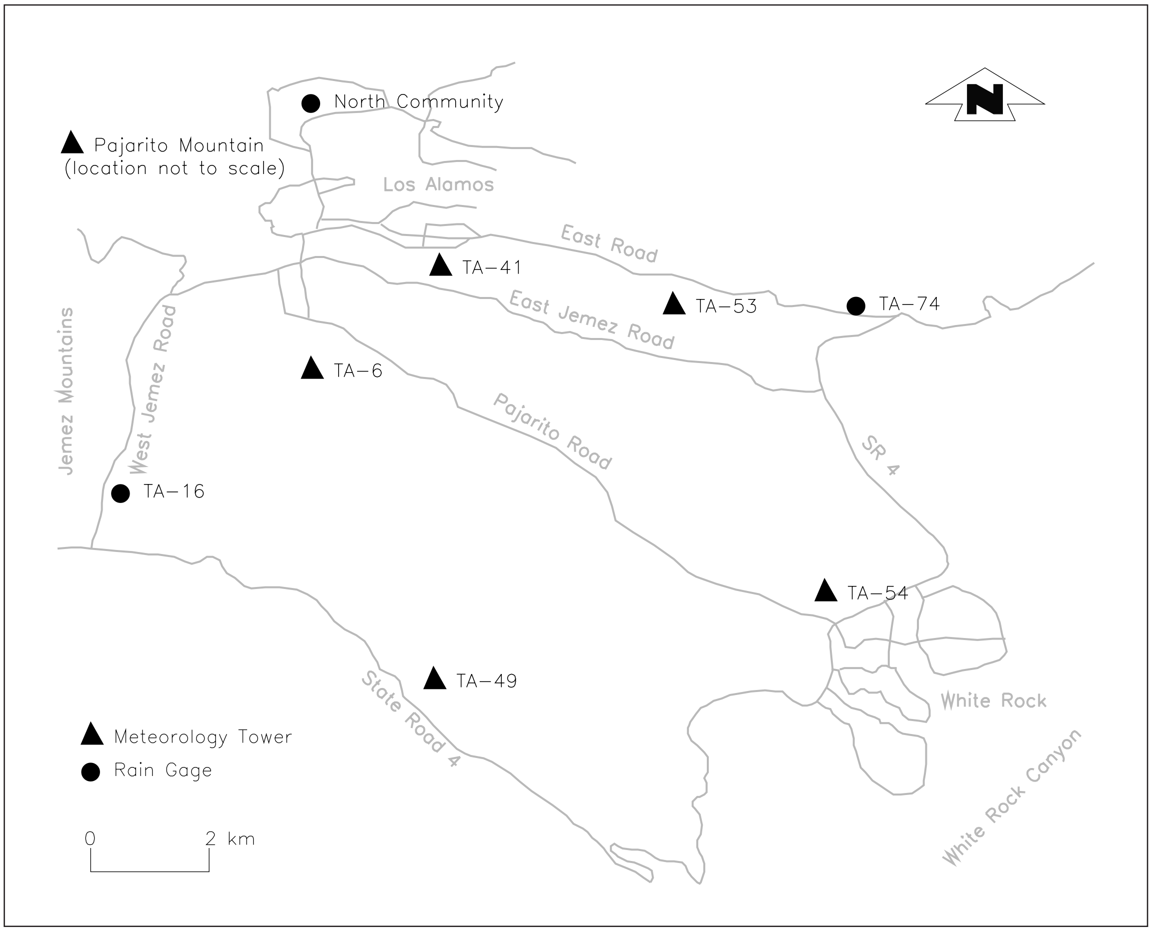


Figure 4-26. Meteorological network.

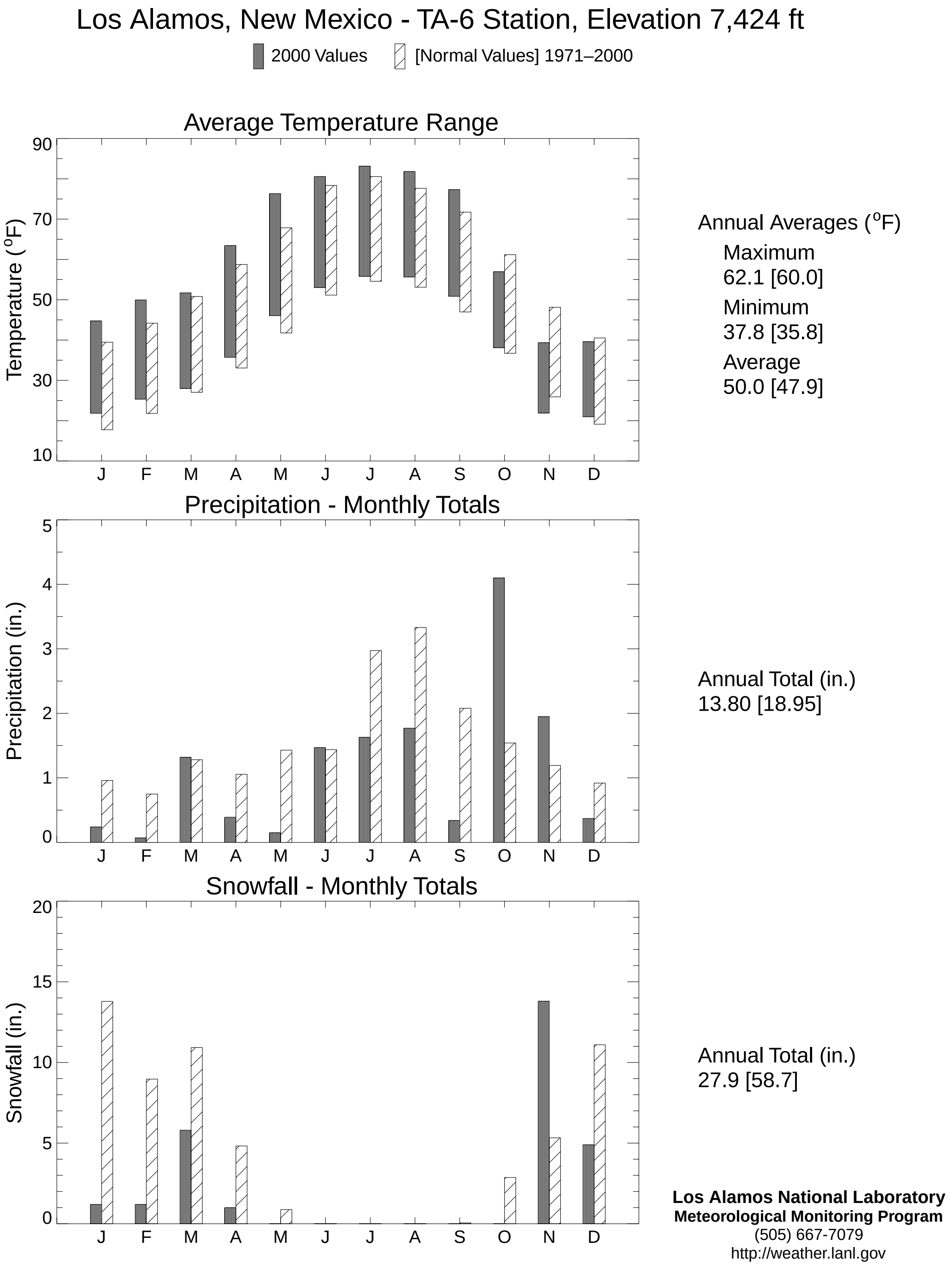
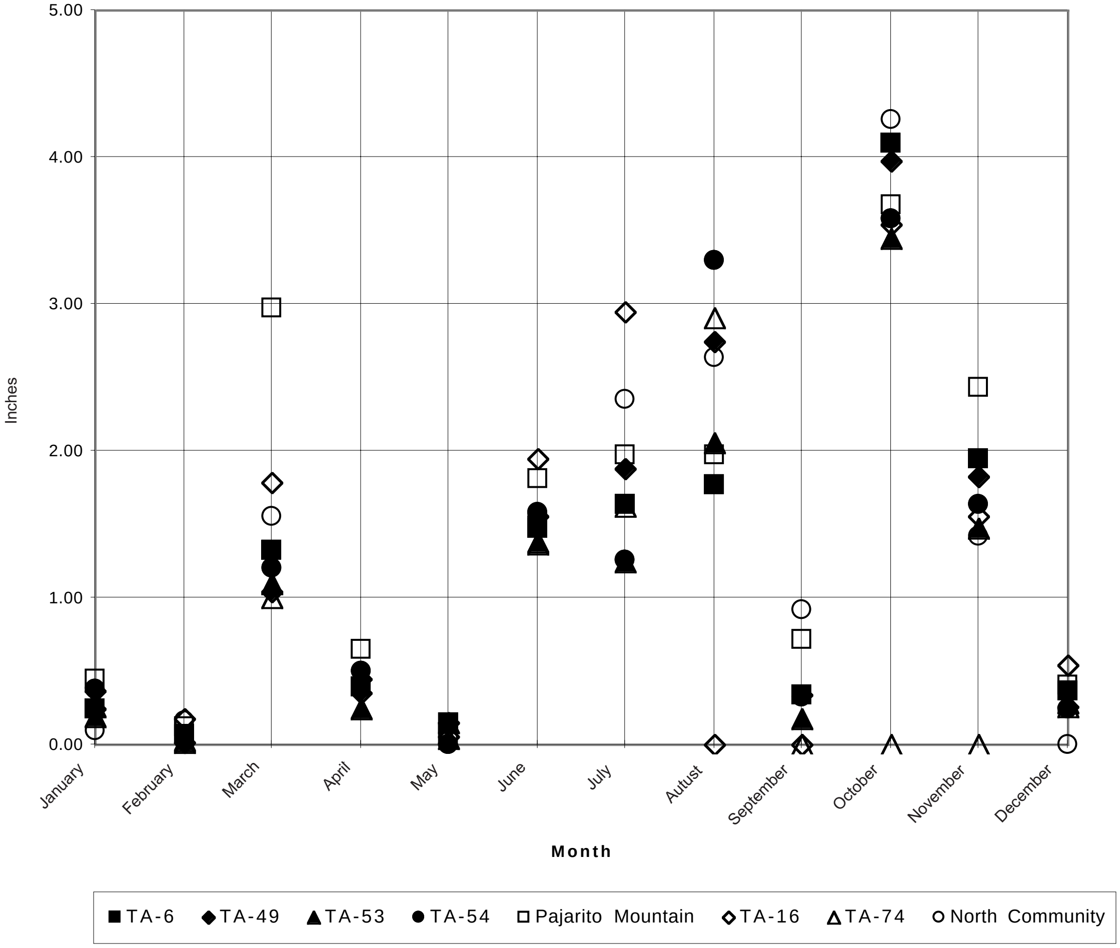


Figure 4-27. 2000 weather summary for Los Alamos.



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.

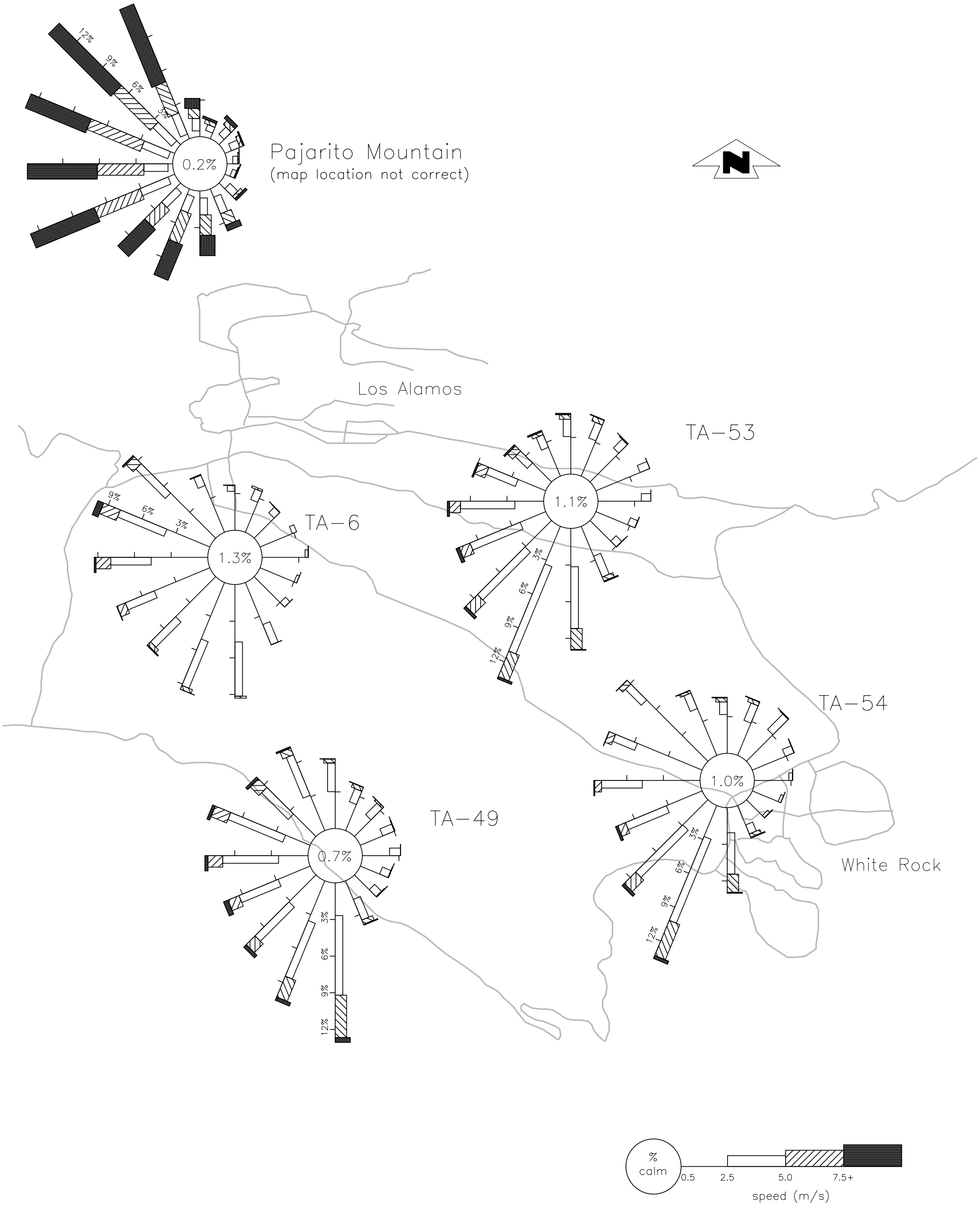


Figure 4-29. 2000 total wind roses.

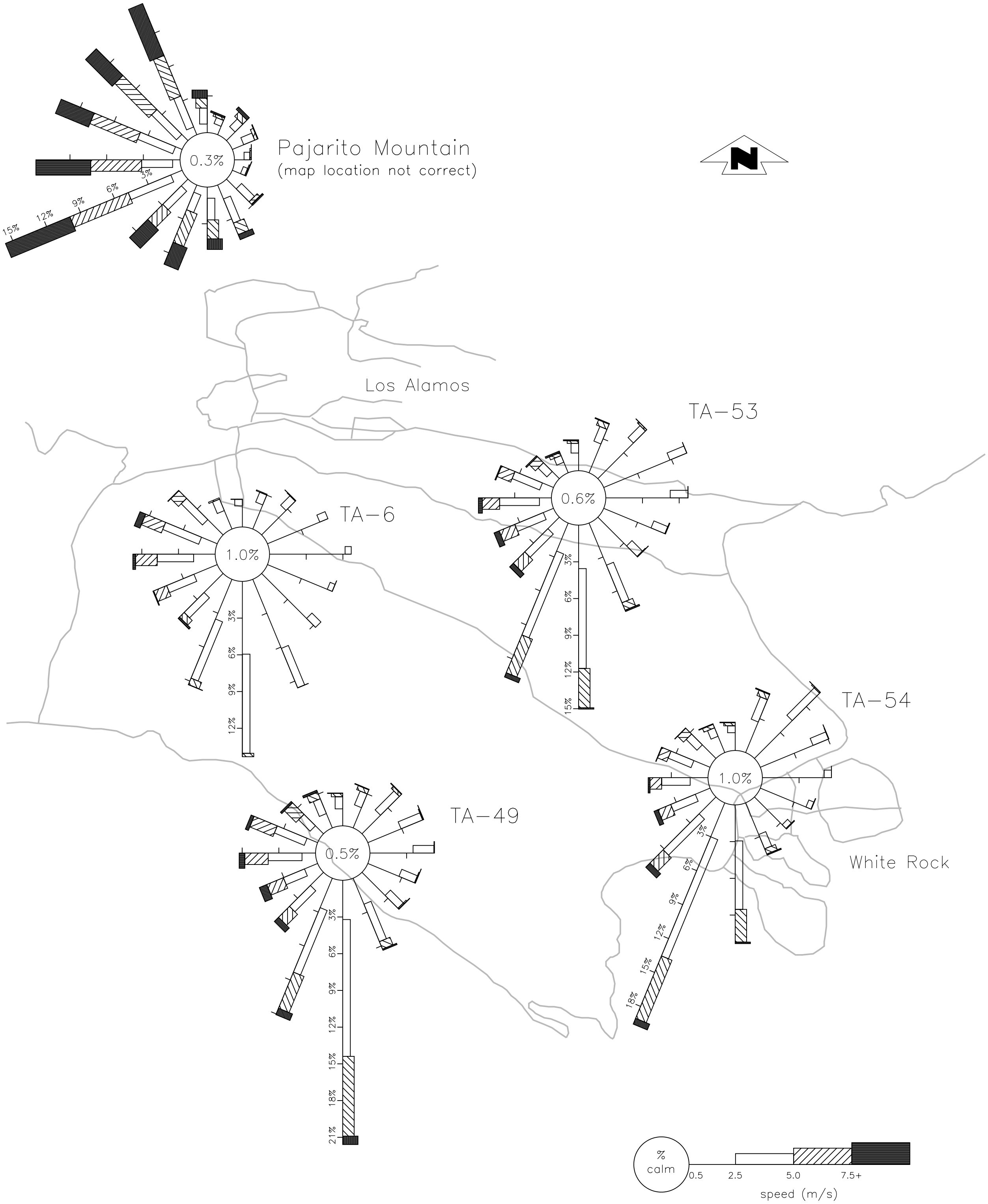


Figure 4-30. Daytime wind roses.

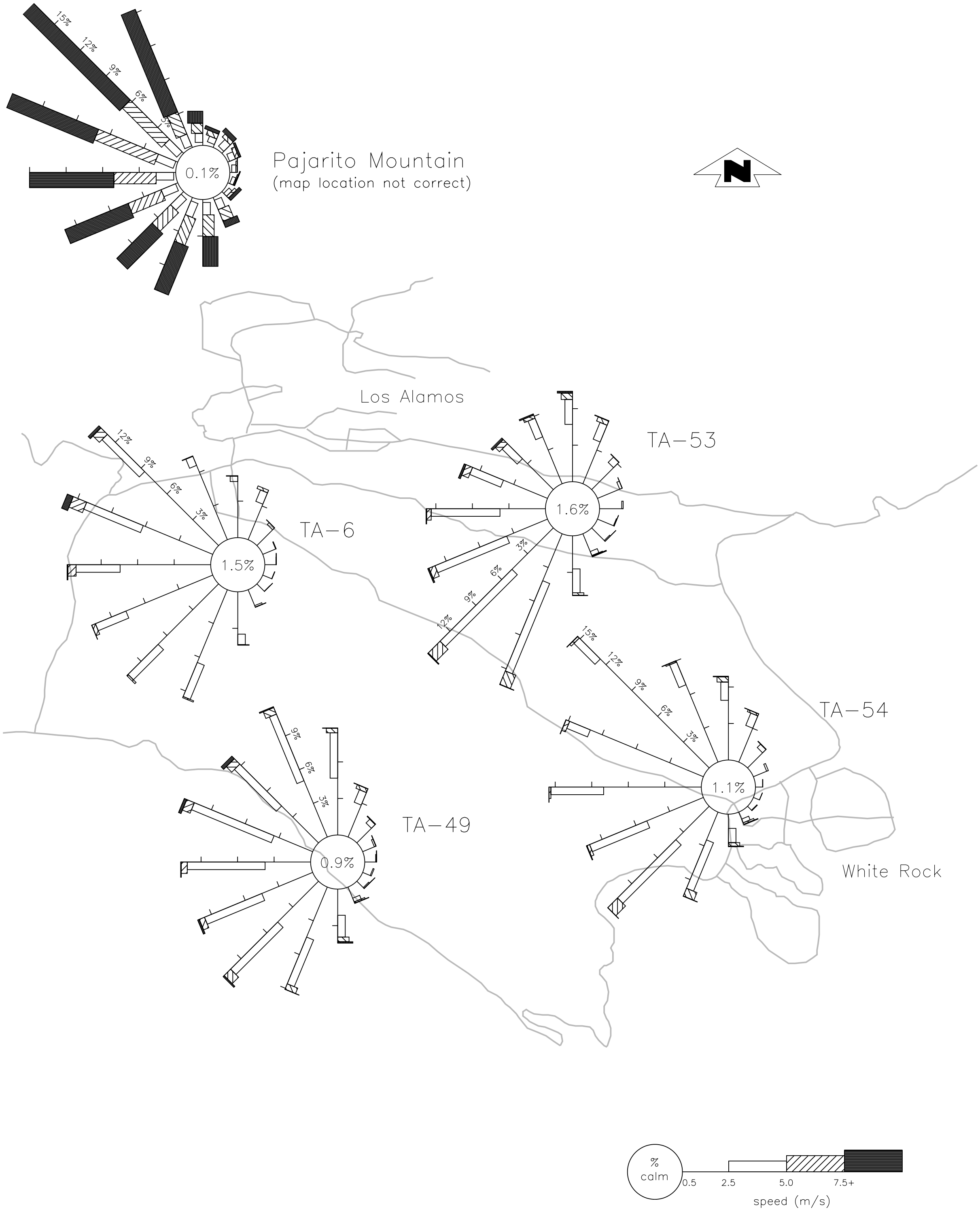


Figure 4-31. Nighttime wind roses.

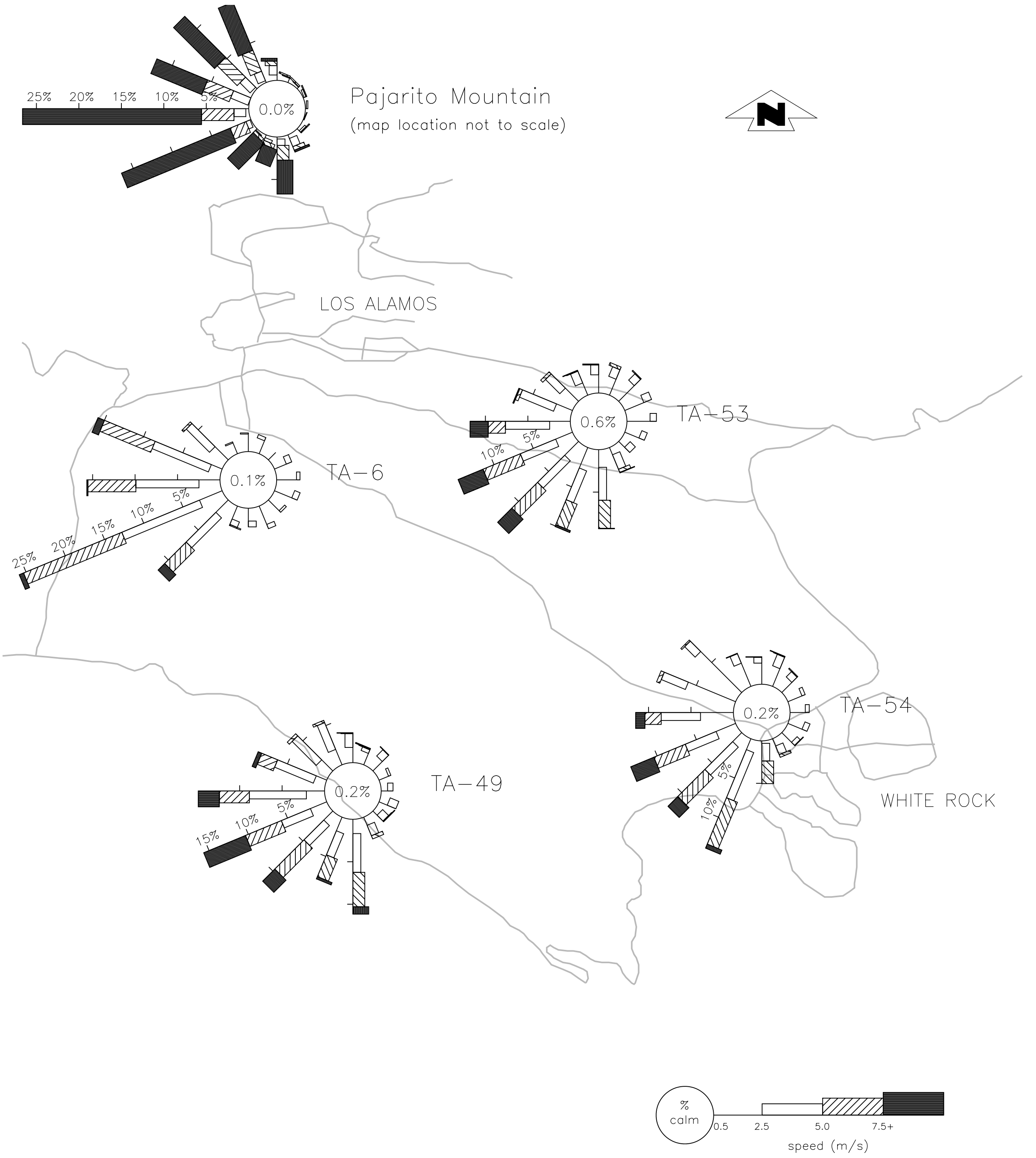


Figure 4-32. Cerro Grande fire wind roses, May 4–21, 24-hour.

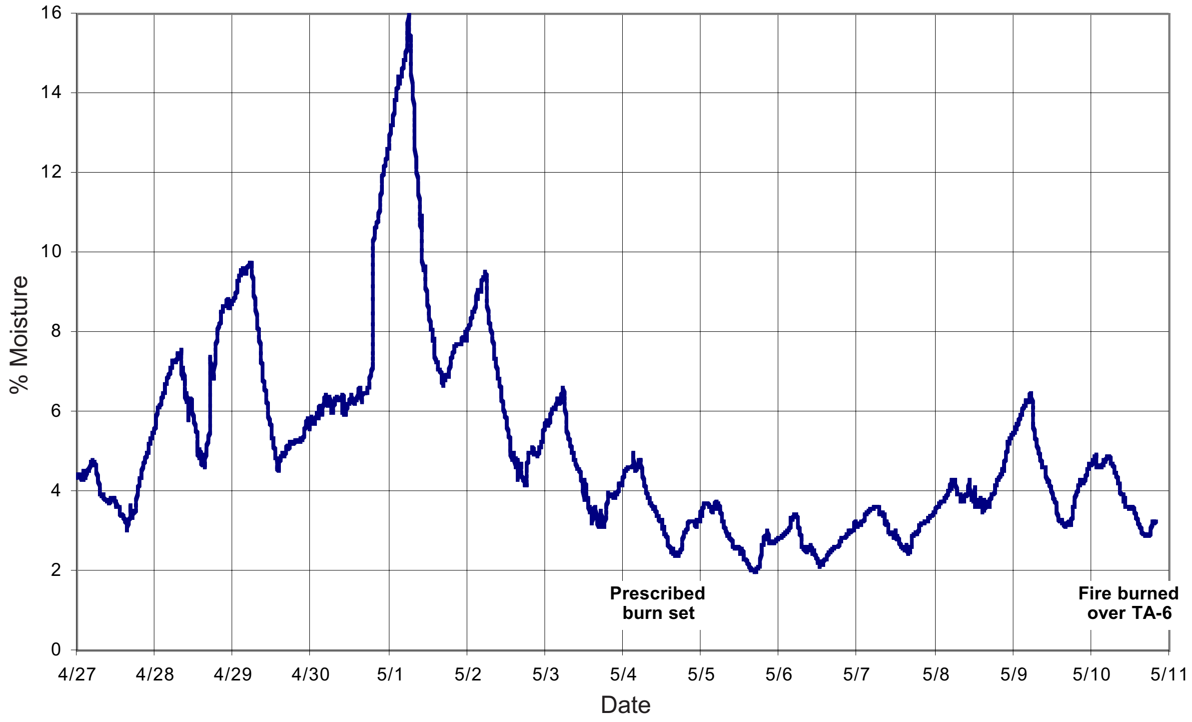


Figure 4-33. 10-hour fuel moisture.

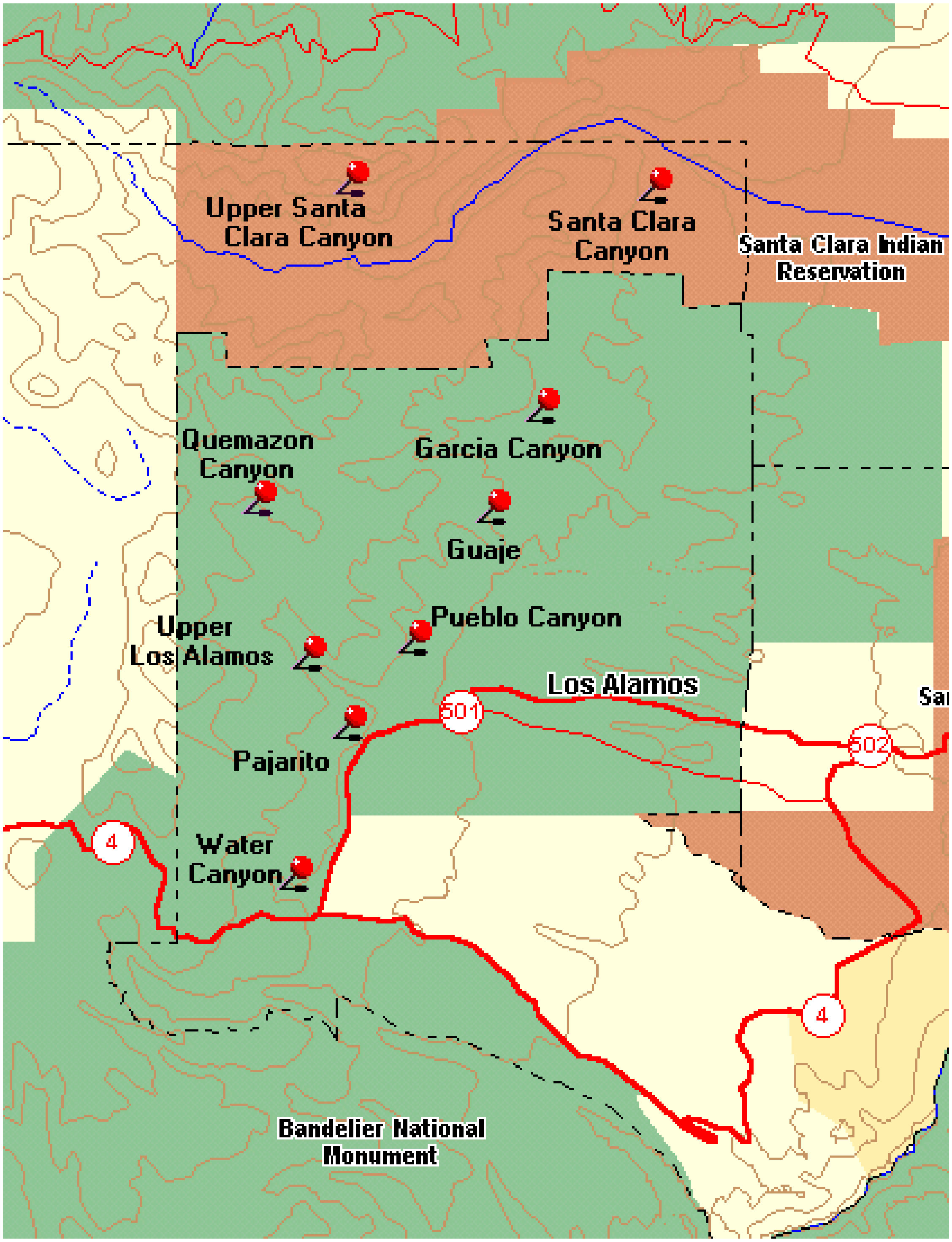


Figure 4-34. LANL Remote Automated Weather Station (RAWS) locations.

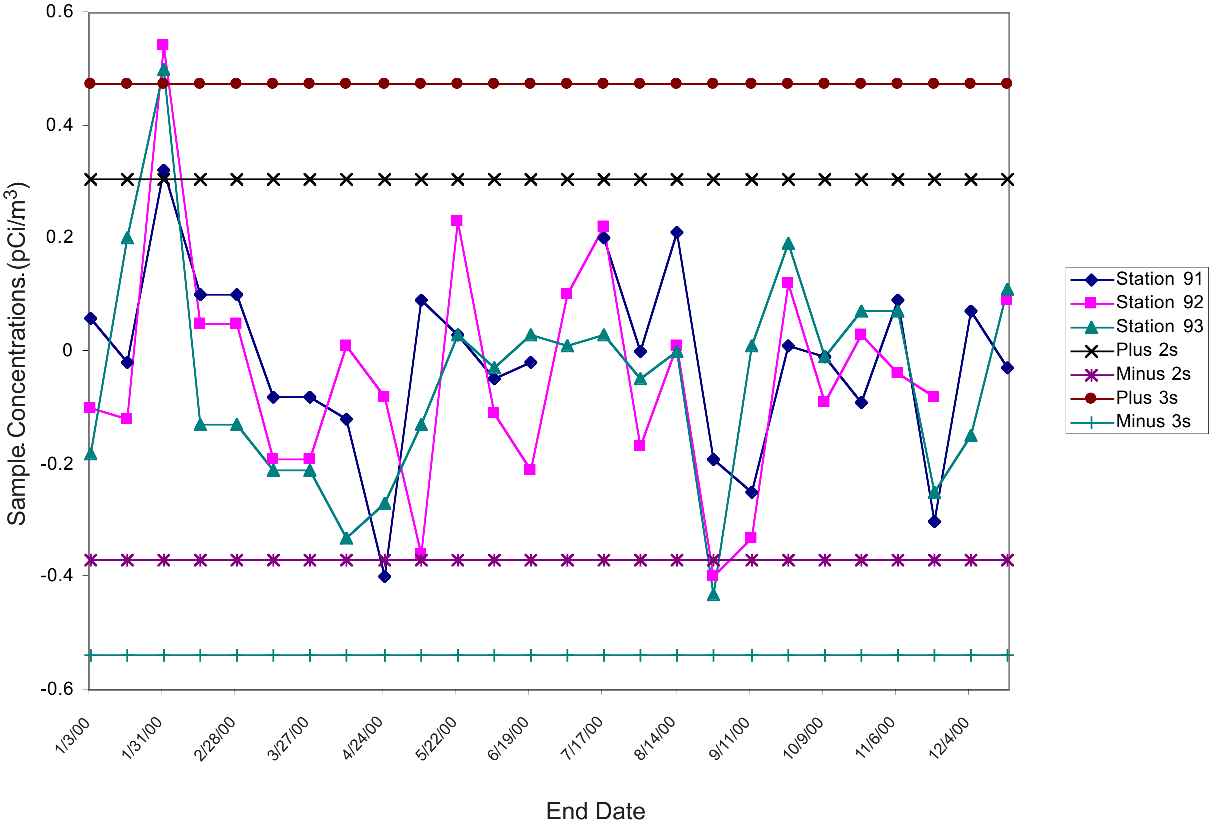


Figure 4-35. Tritium matrix blanks.

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5. Surface Water, Groundwater, and Sediments

5. Surface Water, Groundwater, and Sediments

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Abstract

The Cerro Grande fire caused major physical changes in watersheds crossing the Laboratory boundary and resulted in large impacts on water chemistry. The area of greatest burn intensity was generally in the Jemez Mountains, in watersheds upstream (west) of the Laboratory boundary. 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. Summer runoff events carried these fire-related constituents onto the Laboratory.

Strontium-90 data collected during 1999 were not used because of analytical laboratory method problems. For 2000, strontium-90 data are in keeping with earlier data: the highest values were found in known contaminated areas in Pueblo, Los Alamos, and Mortandad Canyons. Because of the mobilization of ash, the Cerro Grande fire resulted in higher strontium-90 values in many runoff samples.

Surface water samples are collected where effluent discharges or natural runoff maintain stream flow for several weeks or months during the year. For 2000 surface water samples, only one gross alpha measurement exceeded the Department of Energy (DOE) public dose derived concentration guides (DCG) value, at Mortandad at GS-1 below the Technical Area (TA) 50 Radioactive Liquid Waste Treatment Facility (RLWTF) outfall. Radioactivity measurements that exceeded drinking water standards occurred at locations with current or former radioactive liquid waste discharges: Acid/Pueblo Canyon, DP/Los Alamos Canyon, and Mortandad Canyon. In 2000, for the first time in many years, americium-241, plutonium-238, and plutonium-239, -240 in effluent from the TA-50 RLWTF outfall did not exceed the DCGs. The average TA-50 RLWTF effluent nitrate and fluoride concentrations were below the New Mexico groundwater standards. Aluminum, iron, and manganese concentrations in many surface water samples collected after the Cerro Grande fire were much higher than in previous years.

Runoff in otherwise dry drainages results from snowmelt or summer thunderstorms. Levels of most radionuclides and metals in 2000 runoff were higher than previously recorded in the Los Alamos area. In 2000, 28 gross alpha measurements in water runoff samples exceeded by 5 to 10 times the DOE public dose DCG at many locations upstream of and within the Laboratory boundary. One measurement slightly exceeded the DCG for gross beta. We use DCGs to screen runoff samples for cases of larger contaminant transport rather than to evaluate health risk. The DOE DCGs for public dose are determined assuming that two liters per day of water are consumed each year. Most of the gross alpha and gross beta radiation observed in these runoff samples can be attributed to high sediment loads after the fire and to naturally occurring radioactive potassium, thorium, and uranium, along with their daughter products, carried in that sediment. Of specific radionuclides measured, none occurred in runoff samples at levels above their respective DCGs for public dose. Dissolved concentrations of radionuclides and metals in runoff were below all Environmental Protection Agency (EPA) and DOE health-based drinking water standards, except in two samples. Values greater than the EPA drinking water limit for strontium-90 were recorded in lower Los Alamos Canyon at the new low-head weir and for antimony near the perimeter of Area G.

In 2000, because of the Cerro Grande fire, cesium-137 was found in many sediment samples at much higher values than previously noted. The sediment sampling again shows that plutonium occurs above fallout levels in Pueblo and Los Alamos Canyons and extends off-site from the Laboratory. Within Mortandad Canyon, the greatest radionuclide levels in sediments are found between the point where the TA-50 RLWTF effluent enters the drainage and the sediment traps, approximately a 3-km distance.

Sediment samples below the TA-50 RLWTF outfall again showed cesium-137 concentrations that were up to 4.4 times greater than the screening action level (SAL) value. Radionuclide levels near or slightly exceeding background levels are found downstream of the sediment traps, extending to the Laboratory/San Ildefonso Pueblo boundary. A number of sediment samples near and downstream of the TA-54 Solid Waste Operations at Area G contained plutonium-238 and plutonium-239, -240 above background. We also found above-background levels of plutonium and americium in sediments downstream of Area AB, TA-49.

Continued testing of water supply wells in 2000 showed that high-explosives constituents are not present in Los Alamos County drinking water. Perchlorate (no drinking water standard) and tritium (at 1/500 of the drinking water standard) were discovered in water supply well O-1 in Pueblo Canyon during 2000. Other groundwater samples from the regional aquifer were consistent with previous results. Trace levels of tritium are present in the regional aquifer in a few areas where past liquid waste discharges occurred, notably beneath Los Alamos, Pueblo, and Mortandad Canyons. The highest tritium level found in a regional aquifer test well (near water supply well O-1) is about 1/50 of the drinking water standard. Nitrate concentrations in a test well beneath Pueblo Canyon remain elevated, but in 2000, they were only about half the drinking water standard. Except for above-background tritium in O-1, we detected no radionuclides other than naturally occurring uranium in Los Alamos County or San Ildefonso Pueblo water supply wells.

Analytical results for perched alluvial and intermediate-depth groundwater are similar to those of past years. Waters near former or present effluent discharge points show the effects of these discharges. No samples exceeded DOE DCGs for public exposure. Radioactivity measurements in perched alluvial groundwater that exceeded DOE 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 and Los Alamos Canyon, and Mortandad Canyon (these waters are not used as drinking water). The constituents exceeding drinking water DCGs or maximum contaminant levels (MCLs) were tritium, gross beta, strontium-90, and americium-241. Monitoring of fluoride and nitrate in Mortandad Canyon perched alluvial groundwater shows that these levels have dropped below NM groundwater standards during 2000 as a result of their reduction in the TA-50 RLWTF effluent.

During 2000, the Water Quality and Hydrology Group completed a move to send the majority of our environmental samples to external commercial laboratories for chemical analysis. These laboratories participate in programs such as the DOE Quality Assessment Program, which grades them on analysis of blind samples. One laboratory was consistently high in results for plutonium-238, plutonium-239, -240, and americium-241. This finding indicates that numerous apparent detections of plutonium in some groundwater samples are false positives resulting from a systematic analytical laboratory bias.

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

A. Description of Monitoring Program

Studies related to development of groundwater supplies began at Los Alamos in 1945 under the direction of the US Geological Survey (USGS). In about 1949, the Atomic Energy Commission, the Los Alamos Scientific Laboratory, and the USGS jointly initiated studies aimed specifically at environmental monitoring and protecting groundwater quality. These initial efforts focused on Pueblo and DP/Los Alamos Canyons, which received radioactive industrial waste discharges in the early days of the Laboratory.

The current network of annual sampling stations for surface water and sediment surveillance includes a set of regional (or background) stations and a group of stations near or within the Los Alamos National Laboratory (LANL or the Laboratory) boundary. The regional stations establish the background quantities of radionuclides and radioactivity derived from natural minerals and from fallout affecting northern New Mexico and southern Colorado.

The Water Quality and Hydrology Group (ESH-18) takes groundwater samples from wells and springs within or adjacent to the Laboratory and from the nearby San Ildefonso Pueblo. The on-site stations, for the most part, focus on areas of present or former radioactive waste disposal operations, such as canyons (Figure 1-3). To provide a context for discussion of monitoring results, the setting and operational history of currently monitored canyons that have received radioactive or other liquid discharges are briefly summarized below.

For a discussion of sampling procedures, analytical procedures, data management, and quality assurance, see Section H below.

1. Acid Canyon, Pueblo Canyon, and Lower Los Alamos Canyon

Acid Canyon, a small tributary of Pueblo Canyon, was the original disposal site for liquid wastes generated by research on nuclear materials for the World War II Manhattan Engineer District atomic bomb project. Acid Canyon received untreated radioactive industrial effluent from 1943 to 1951. The Technical Area (TA) 45 treatment plant was completed in 1951, and from 1951 to 1964 the plant discharged treated effluents that contained residual radionuclides into nearby Acid Canyon. Several decontamination projects have removed contamination from the area, but remaining residual radioactivity from these releases is now associated with the sediments in Pueblo Canyon (ESP 1981).

The inventory of radioactivity remaining in the Pueblo Canyon system is only approximately known. Several studies (ESP 1981; Ferenbaugh et al., 1994) have concluded that the plutonium in this canyon system does not present a health risk to the public. Based on analysis of radiological sediment survey data, the estimated total plutonium inventory in Acid Canyon, Pueblo Canyon, and Lower Los Alamos Canyon ranges from 246 mCi to 630 ± 300 mCi (ESP 1981). The estimated plutonium releases were about 177 mCi, in satisfactory agreement with the measured inventory considering uncertainties in sampling and release estimates. About two-thirds of this total is in the Department of Energy (DOE)-owned portion of lower Pueblo Canyon.

Pueblo Canyon currently receives treated sanitary effluent from the Los Alamos County Bayo Sewage Treatment Plant in the middle reach of Pueblo Canyon. Perched groundwater occurs seasonally in the alluvium, depending on the volume of surface flow from snowmelt, thunderstorm runoff, and sanitary effluents. Tritium, nitrate, and chloride, apparently derived from these industrial and municipal disposal operations, have infiltrated to the intermediate perched groundwater (at depths of 37 to 58 m [120 to 190 ft]) and to the regional aquifer (at a depth of 180 m [590 ft]) beneath the lower reach of Pueblo Canyon. Except for occasional nitrate values, levels of these constituents are a small fraction of the Environmental Protection Agency (EPA) drinking water standards.

Starting in 1990, increased discharge of sanitary effluent from the county treatment plant resulted in nearly continual flow during most months except June and July in the lower reach of Pueblo Canyon and across DOE land into the lower reach of Los Alamos Canyon on San Ildefonso Pueblo land. From mid-June through early August, higher evapotranspiration and the diversion of sanitary effluent for golf course irrigation eliminate flow from Pueblo Canyon into Los Alamos Canyon. Hamilton Bend Spring, which in the past discharged from alluvium in the lower reach of Pueblo Canyon, has been dry since 1990, probably because there was no upstream discharge from the older, abandoned Los Alamos County Pueblo Sewage Treatment Plant. Farther east, the alluvium is continuously saturated, mainly because of infiltration of effluent from the Los Alamos County Bayo Sewage Treatment Plant. Effluent flow from Pueblo Canyon into Los Alamos Canyon generally extends to somewhere between the DOE/San Ildefonso Pueblo boundary and the confluence of Guaje and Los Alamos Canyons.

2. DP Canyon and Los Alamos Canyon

In the past, Los Alamos Canyon received treated and untreated industrial effluents containing some radionuclides. The upper reach of Los Alamos Canyon experienced releases of treated and untreated radioactive effluents during the earliest Manhattan Project operations at TA-1 (1942–1945) and some release of water and radionuclides from the research reactors at TA-2. An industrial liquid waste treatment plant that served the old plutonium processing facility at TA-21 discharged effluent containing radionuclides into DP Canyon, a tributary to Los Alamos Canyon, from 1952 to 1986. Los Alamos Canyon also received discharges containing radionuclides from the sanitary sewage lagoon system at the Los Alamos Neutron Science Center (LANSCE) at TA-53. The low-level radioactive waste stream was separated from the sanitary system at TA-53 in 1989 and directed into a total retention evaporation lagoon.

The reach of Los Alamos Canyon within the Laboratory boundary presently carries flow from the Los Alamos Reservoir (west of the Laboratory) as well as National Pollutant Discharge Elimination System (NPDES)-permitted effluents from TA-53 and TA-21. Infiltration of effluents and natural runoff from the stream channel maintain a shallow body of perched groundwater in the alluvium of Los Alamos Canyon within the Laboratory boundary west of State Road (SR) 4. Groundwater levels are highest in late spring from snowmelt runoff and in late summer from thundershowers. Water levels decline during the winter and early summer when runoff is at a minimum. Perched groundwater also occurs within alluvium in the lower portion of Los Alamos Canyon on San Ildefonso Pueblo lands. Intermediate-depth perched groundwater occurs in the lower part of the Bandelier tuff and the underlying Puye Formation and Cerros del Rio basalt at depths of a few hundred feet below the canyon bottom. This intermediate groundwater also shows some evidence of contamination from Laboratory sources.

3. Sandia Canyon

Sandia Canyon has a small drainage area that heads at TA-3. The canyon receives water from the cooling tower at the TA-3 power plant. Treated effluents from the TA-46 Sanitary Wastewater Systems (SWS) Facility are rerouted to Sandia Canyon. These effluents support a continuous flow in a short reach of the upper part of the canyon. Only during summer thundershowers does stream flow approach the Laboratory boundary at SR 4, and only during periods of heavy thunderstorms or snowmelt does surface flow extend beyond the Laboratory boundary.

4. Mortandad Canyon

Mortandad Canyon has a small drainage area that heads at TA-3. Its drainage area receives inflow from natural precipitation and a number of NPDES outfalls, including one from the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50. The TA-50 facility began operations in 1963. The effluents infiltrate into the stream channel and maintain a saturated zone in the alluvium extending about 3.5 km (2.2 mi) downstream from the outfall. The easternmost extent of saturation remains on-site, ending about 1.6 km (1 mi) west of the Laboratory boundary with San Ildefonso Pueblo. Over the period of operation, the radionuclides in the RLWTF effluent have often exceeded the DOE derived concentration guides (DCGs) for public dose from drinking water (although this water is not used as drinking water). The effluent also contains nitrate that has caused perched alluvial groundwater concentrations to exceed the New Mexico groundwater standard of 10 mg/L (nitrate as nitrogen). In April 1999, the new reverse osmosis and ultrafiltration system at the RLWTF began operation. This system removes additional radionuclides and nitrate from the effluent, and discharges from the plant now meet the DOE public dose DCGs and the New Mexico groundwater standard for nitrate. The RLWTF effluent has met DOE DCGs continuously since December 10, 1999.

Perchlorate is a nonradioactive chemical compound containing a chlorine atom bound to four oxygen atoms and is used in a variety of industrial processes. At the Laboratory, perchlorate is a byproduct of the perchloric acid used in nuclear chemistry research. Perchlorate is on the EPA’s contaminant candidate list, which under the Safe Drinking Water Act requires background investigations to determine a Maximum Contaminant Level (MCL). Perchlorate is present in the influent to the RLWTF at concentrations up to several thousand parts per billion (ppb). Perchlorate affects hormone production in the human thyroid and is a suspected, but not proven, carcinogen. The California Department of Health Services has issued a health advisory limit of 18 ppb for perchlorate in drinking water. The Laboratory is conducting pilot tests to remove perchlorate from the RLWTF effluent.

Continuous surface flow across the drainage has not reached the San Ildefonso Pueblo boundary since observations began in the early 1960s (Stoker et al., 1991). Three sediment traps located about 3 km (2 mi) downstream from the effluent discharge in Mortandad Canyon dissipate the energy of major thunderstorm runoff events and settle out transported sediments. From the sediment traps, it is approximately 2.3 km (1.4 mi) downstream to the Laboratory boundary with San Ildefonso Pueblo.

The alluvium is less than 1.5 m thick in the upper reach of Mortandad Canyon and thickens to about 23 m at the easternmost extent of saturation. The saturated portion of the alluvium is perched on weathered and unweathered tuff, generally with no more than 3 m of saturation. There is considerable seasonal variation in saturated thickness, depending on the amount of runoff experienced in any given year (Stoker et al., 1991). Velocity of water movement in the alluvium ranges from 18 m/day in the upper reach to about 2 m/day in the lower reach of the canyon (Purtymun 1974; Purtymun et al., 1983). The high turnover rate for water in the alluvial groundwater prevents accumulation of chemicals from the RLWTF effluent (Purtymun et al., 1977). The top of the regional aquifer is about 290 m below the alluvial groundwater.

5. Pajarito Canyon

In Pajarito Canyon, water perched in the alluvium is perched on the underlying tuff and is recharged mainly through snowmelt and thunderstorm runoff. Saturated alluvium does not extend beyond the facility boundary. Three shallow observation wells were constructed in 1985 as part of a compliance agreement with the State of New Mexico to determine whether technical areas in the canyon or solid waste disposal activities on the adjacent mesa were affecting the quality of shallow groundwater. No effects were observed; the alluvial groundwater is contained in the canyon bottom and does not extend under the mesa (Devaurs 1985).

6. Cañada del Buey

Cañada del Buey contains a shallow perched alluvial groundwater system of limited extent. The thickness of the alluvium ranges from 1.2 to 5 m, but the underlying weathered tuff ranges in thickness from 3.7 to 12 m. In 1992, saturation was found within only a 0.8-km-long segment, and only two observation wells have ever contained water (ESP 1994). Because treated effluent from the Laboratory's SWS Facility may at some time be discharged into the Cañada del Buey drainage system, a network of five shallow groundwater monitoring wells and two moisture monitoring holes was installed during the early summer of 1992 within the upper and middle reaches of the drainage (ESP 1994). Construction of the SWS Facility was completed in late 1992.

B. Overview of the Cerro Grande Fire Impacts on Los Alamos Watersheds

The Cerro Grande fire has had, and will continue to have, significant impacts on the landscape around Los Alamos. The impacts include physical, chemical, and hydrologic changes in the major watersheds crossing the Laboratory. These changes affect the monitoring program and our ability to accurately interpret the sampling results for all the media of surface water, groundwater, and sediments. In this section, we present some broad observations about what changes have been observed after other fires across the world and compare those with what changes we have observed after the Cerro Grande fire.

1. General Impacts of Fire on Watersheds

The aftermath of the Cerro Grande fire will be studied for years. Many of the fire impacts observed to date also have been recorded in studies of fires elsewhere, as well as locally with earlier crown fires in the Los Alamos area.

Watersheds undergo significant responses to wildfire in southwest ecosystems. The responses include changes in the runoff characteristics, sediment yield, and water chemistry. The burning of the understory and forest litter triggers many of these changes. Under pre-fire conditions, the grasses and brush within a forest canopy serve to slow and capture precipitation, nutrients, and sediments. In the absence of the vegetative cover, the runoff becomes flashier, with sharper, higher magnitude flood peaks. For example, after the 1977 La Mesa fire and the 1996 Dome fire in the Jemez Mountains, peak flows in Frijoles and Capulin Canyons were estimated to be 164 and 123 times greater than the pre-burn peaks, respectively (Veenhuis 2001). With less vegetative uptake and retention, the total water yields from burned watersheds are higher. Once the runoff begins, loose soils and ash are quickly removed from the steeper slopes. Fire-associated debris can be suddenly delivered directly to streams in large quantities.

Wildfires can also interrupt uptake of anions and cations by vegetation and speed mineral weathering. The concentrations of inorganic ions subsequently increase in streams after a fire (DeBano et al., 1979). The sudden addition of substantial quantities of chemically active carbon and minerals (like calcite) to the watershed initiates geochemical and pH changes.

To understand the chemical water quality changes noted in runoff water after the Cerro Grande fire, Bitner et al. (2001) compiled a summary of the reported effects of fire on runoff water chemistry and soils. For general inorganic parameters, increases of dissolved calcium, magnesium, nitrogen, phosphorous, and potassium and pH in runoff water have been observed as a result of fire. Metals and radionuclides have been much less studied, but manganese, copper, zinc, and cesium-137 have been observed to increase as a result of fire. Purtymun and Adams (1980) focused on water quality perturbations after the La Mesa fire and indicated a slight increase in calcium, bicarbonate, chloride, fluoride, and total dissolved solids (TDS) in the base flow of Frijoles Creek. Runoff samples showed elevated suspended sediment, barium, calcium, iron, bicarbonate, manganese, lead, phenol, and zinc concentrations. Base-flow water quality returned to normal three to five years after the fire.

Of note are studies that describe the concentration of fallout-associated radionuclides in ash and subsequently in runoff at other locations where forest fires have occurred (Amiro et al., 1996; Paliouris et al., 1995). The studies conclude that fire caused the mobilization of fallout radionuclides bound to the forest canopy, or in the forest litter, and concentrated them in the ashy layer of the burned surface soil available for erosion.

Studies indicate that these changes in chemistry and flow conditions are temporary, usually lasting less than five years, unless floods destroy the physical habitat of the streambed and hillsides. Reestablishment of vegetative ground cover appears to be a critical factor controlling the recovery.

2. Erosion and Flooding following the Cerro Grande Fire

The Cerro Grande fire burned major portions of watersheds draining onto LANL from adjacent Santa Fe National Forest lands, where from 20% to 90% of the acreage was considered high severity burn (Table 5-1). On LANL, most of the area burned was considered low severity burn, but numerous small structures burned, and the cover vegetation at some inactive waste sites was least partially burned.

The increases in runoff and sediment yields after the fire were anticipated to be severe because the burned terrain was so steep and the high severity of the burn created water shedding hydrophobic soils (BAER 2000). The Burned Area Emergency Rehabilitation Team (BAER) predicted peak flows (Table 5-2) from the upper watersheds after the fire hundreds of times larger than pre-fire conditions, even with aggressive post-fire rehabilitation treatments.

The recorded hydrologic and water quality responses to the Cerro Grande fire largely mirror those described for fires elsewhere. Comparing post- and pre-fire conditions showed significant changes in the magnitude of flooding, sediment yield, and water quality. This discussion will highlight the flooding and sedimentation changes during the summer runoff season of June through October 2000.

Precipitation in June from localized and brief thunderstorms totaled 1.47 inches, slightly higher than the normal of 1.36 inches. Precipitation in the months of July, August, and September was significantly below normal, with the usual summer monsoons largely absent. Only 50% of normal precipitation was received in July and August, and only 16% of normal precipitation was received in September. October was a relatively wet month with a total precipitation of 4.1 inches, 310% of normal.

Runoff in June and July from areas burned by the Cerro Grande fire was dramatic, although from historically insignificant rainfall amounts. The most destructive runoff event of the summer occurred on June 28 when a short-duration (30-minute), relatively high-intensity thunderstorm occurred over the flanks of the Sierra de los Valles, just west of the Laboratory. Rainfall recorded at TA-16 was 0.43 in., and the Water and Pajarito Canyons Regional Automated Weather Stations (RAWS) stations received 0.79 and 0.69 inches, respectively.

The June 28 precipitation caused flooding in canyons west of and across LANL. The ensuing floodwaters destroyed stream gages in Pajarito, Cañon de Valle, and Water Canyons. Record high discharges were observed in Pajarito, Cañon de Valle, and Water Canyons. The maximum estimated peak flow in Pajarito Canyon upstream of SR 501 was 1020 cfs, an all-time record for watersheds gaged by LANL on the

Pajarito Plateau (previous maximum flow of 520 cfs was from Ancho Canyon in 1993).

The maximum runoff yield before the fire from Pajarito, Cañon de Valle, and Water Canyons west of SR 501 was 1.26 $ft^3/s/mi^2$. The discharge yield on June 28 for these same locations ranged from 250 to 540 $ft^3/s/mi^2$, increasing more than 200 times from pre-fire peaks. These increases are two to four times greater than those estimated by Veenhuis (2001) for Frijoles and Capulin Canyons. Table 5-3a shows a comparison of peak discharges before and after the fire. Peak discharges of approximately 1000 cfs were calculated for several runoff events for the ungaged Rendija and Guaje Canyons to the north of LANL (Table 5-3b).

Post-fire runoff from burned areas was more flashy, more frequent, and with higher magnitude peaks than the runoff from the lesser burned areas. Along the downstream side of the Laboratory, the most pronounced changes were seen in the flow regimes of Pueblo and Water Canyons (Figure 5-1). Total runoff volume for the 2000 summer runoff season in Water Canyon increased two orders of magnitude from pre-fire averages, based on data from Shaull et al. (2000).

A major impact of the Cerro Grande fire was substantially increased transport of sediment onto and across the Laboratory. The initial runoff events of June and July carried abundant ash and sediment on a widespread basis, though fire impacts were seen locally in samples collected in late October.

We estimated changes in total suspended solids (TSS) concentrations by using an averaging technique (flow weighting) designed to account for the variation in sediment associated with a changing streamflow regime (Belillas and Roda 1993; Brown and Krygier 1971). To calculate the mass of sediment (load) carried in each runoff event, we multiplied the appropriate TSS concentrations by the water volumes entering or leaving the Laboratory during a specific storm event. Then we estimated the average sediment load in runoff by dividing the total mass of sediment by the total volume of water in all the sampled storm events. This technique normalized the effect of abnormal flow events after the fire, allowing for comparison with pre-fire conditions.

At most of the upstream monitoring stations above SR 501, the load of TSS per liter of water increased by 100 to 1000 times (Figure 5-2). At the downstream stations, changes in TSS concentrations were highly variable, apparently depending upon sediment deposition patterns and the burn history for the specific drainage. The largest downstream changes occurred in Pueblo and Water Canyons, with TSS concentrations increasing more than 100 times after the fire. The hydrologic and sediment transport regimes were not appreciably altered in the lesser-burned canyons of Cañada del Buey, Potrillo, and Ancho.

The data suggest that sediment deposition occurred between the upstream and downstream gages (Laboratory borders) in Los Alamos and Pajarito Canyons. Deposition has occurred in Los Alamos Reservoir, behind the Pajarito Retention Structure, and in the lower-gradient reaches of the canyons above SR 4.

3. Cerro Grande Ash as a Source of Elevated Radionuclides and Metals

The Cerro Grande fire left a large amount of residual ash in burned areas. We sampled ash and muck (post-fire sediments dominated by reworked ash) in locations representative of background conditions west (upstream) of the Laboratory. We also collected samples in the Viveash fire area (near Pecos, NM) for comparison. These data show that cesium-137; plutonium-239, -240; and strontium-90 concentrations in both areas were higher than pre-fire sediment and soils levels. An increase in the concentrations of several naturally occurring metals (for example, barium, manganese, and calcium) readily taken up into plant tissue was also observed. Radionuclides and metals increased by up to an order of magnitude in ash. This finding is consistent with the scientific literature showing that forest fires can condense and mobilize natural and fallout radionuclides and metals.

Based on a limited data set, the Cerro Grande ash appears to contain relatively higher plutonium-239, -240 levels than does the ash from the Viveash fire (Katzman et al., 2001a). We are attempting to determine whether past Laboratory air emissions are the source of the plutonium by looking at historical soil concentrations and other ash studies (see 6.A.2.g). Our preliminary analyses support the possibility that the elevated plutonium-239, -240 concentrations are partly attributable to Laboratory emissions.

The average concentration of cesium-137 in ash and muck is 4.4 pCi/g, about five times the upper limit of pre-fire background sediments and soils (Katzman et al., 2001b). Flood deposits sampled kilometers from the mountain-front source of ash show persistent elevated concentrations of the radionuclide and inorganic constituents, including flood deposits in watersheds unaffected by Laboratory discharges (Katzman et al., 2001b).

C. Surface Water Sampling

1. Introduction

The Laboratory monitors surface waters from regional and Pajarito Plateau stations to evaluate the environmental effects of its operations. No perennial surface water flows extend completely across the Laboratory in any canyon. Regional surface water samples are collected from rivers or reservoirs. Within and near the Laboratory, we collect surface water samples where effluent discharges or natural runoff maintain stream flow for several weeks or months during the year. Periodic natural surface runoff occurs in two modes: (1) spring snowmelt runoff that occurs over days to weeks at a low discharge rate and sediment load and (2) summer runoff from thunderstorms that occurs over hours at a high discharge rate and sediment load. This section discusses surface water results; runoff results are discussed in section 5.D. The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though wildlife does use the waters. Activities of radionuclides in surface water samples may be compared with either the DOE DCGs or the New Mexico Water Quality Control Commission (NMWQCC 2000) stream standards, which in turn reference the New Mexico Environment Department's (NMED's) New Mexico Radiation Protection Regulations (Part 4, Appendix A). However, New Mexico radiation protection activity levels are in general two orders of magnitude greater than the DOE DCGs for public dose, so we will discuss only the DCGs here. The concentrations of nonradioactive constituents may be compared with the NMWQCC General, Livestock Watering, and Wildlife Habitat Standards. The NMWQCC (NMWQCC 2000) groundwater standards can also be applied in cases where groundwater outflow may affect stream water quality. Appendix A presents information on these standards.

2. Monitoring Network

We collect surface water samples from Pajarito Plateau stations near the Laboratory and from regional stations. We take surface water grab samples annually from locations where effluent discharges or natural runoff maintains stream flow. We collect regional surface water samples (Figure 5-3) from stations on the Rio Grande, Rio Chama, and Jemez River. These waters provide background data from areas beyond the Laboratory boundary.

Figure 5-4 shows surface water monitoring stations located on the Pajarito Plateau. We use samples from the stations to monitor water quality effects of potential contaminant sources such as industrial outfalls or soil contamination sites.

3. Radiochemical Analytical Results

Table 5-4 lists the results of radiochemical analyses for surface water samples for 2000. The table also lists the total propagated one sigma analytical uncertainty and the analysis-specific minimum detectable activity where available. Uranium was analyzed by isotopic methods rather than as total uranium for most samples in 2000; total uranium was calculated from these values using specific activities for each isotope.

To emphasize values that are detections, Table 5-5 lists radionuclides detected in surface water samples. Detections are defined as values exceeding both the analytical method detection limit and three times the individual one-standard-deviation measurement uncertainty. Laboratory qualifier codes are shown because some analytical results that meet the detection criteria are not detections: in some cases, the analyte was found in the blank or was below the method detection limit, but the analytical result was reported as the minimum detectable activity. Because uranium, gross alpha, and gross beta are usually detected, we indicate in Table 5-5 only occurrences of these measurements above threshold values. The specific levels are 5 µg/L for uranium (and do not include uranium isotopes on the list), 5 pCi/L for gross alpha, and 20 pCi/L for gross beta and are lower than the EPA MCLs or screening levels.

The right-hand columns of Table 5-5 indicate radiochemical detections that are greater than one-half of the DOE DCGs for public dose for ingestion of environmental water or the standards shown. Bear in mind that surface waters on the Laboratory are not used for drinking water.

In surface water samples, only one gross alpha measurement exceeded the DOE public dose DCG value in 2000, at Mortandad at GS-1 below the TA-50 RLWTF outfall. Measurements that exceeded drinking water standards occurred at locations with current or former radioactive liquid waste discharges: Acid/Pueblo, DP/Los Alamos, and Mortandad Canyons. Most of the measurements at or above detection limits are also from these locations with previously known contamination. A few of the measurements at or above detection limits were from locations that do not typically show detectable activity. Detections from locations outside the known contaminated areas in Pueblo, DP/Los Alamos, and Mortandad Canyons are discussed below.

Strontium-90 data collected during 1999 were not used because of analytical laboratory method problems. Some of the 1999 data, if correct, would have indicated unusually high levels of strontium-90 at some stations. For 2000, independent commercial laboratories performed the strontium-90 analyses. Detection limits (where given) for strontium-90 analysis ranged from about 0.1 pCi/L to 0.5 pCi/L for samples with smaller analytical results (detection limits for larger results may be higher). The 2000 strontium-90 data are in keeping with earlier data in that larger values are found in known contaminated areas in Pueblo, Los Alamos, and Mortandad Canyons. The Cerro Grande fire mobilized fallout-derived radionuclides such as cesium-137 and strontium-90 that had been associated with plant material. Therefore, levels of these radionuclides in runoff reaching the Laboratory's western boundary from the burned watersheds were higher after the fire than in previous years (Johansen et al., 2001). Detectable strontium-90 was found in post-fire samples from Pueblo Canyon surface water. The Pueblo Canyon watershed was severely burned during the fire.

a. Radiochemical Analytical Results for Surface Water. Several regional and perimeter stations had detections of radiochemical parameters. Because of the uncertainty inherent in sampling and analysis procedures for radionuclides, it is important to base a conclusion about their presence on the body of data from a station rather than on one detection. The regional station Rio Chama at Chamita showed a detection of strontium-90. Rio Grande at Frijoles and Rio Grande at Cochiti had detections of plutonium-238 in samples taken after the Cerro Grande fire. Frijoles at Monument Headquarters showed detectable strontium-90 and americium-241 in post-fire samples. Neither of these radionuclides was detected in analysis of a field duplicate sample. Perimeter stations Pajarito at Rio Grande and Ancho at Rio Grande showed detections of plutonium-238 or plutonium-239, -240. Analysis of a field duplicate sample did not support the plutonium-238 detection for Ancho at Rio Grande; the field duplicate sample showed no plutonium-238.

Stations SCS-1, SCS-2, and SCS-3 in Sandia Canyon showed detections of plutonium-238 or plutonium-239, -240. No apparent source exists in Sandia Canyon for this radioactivity. Cañada del Buey showed a detection of strontium-90, but it was not detected in a duplicate analysis of the sample.

b. Technical Area 50 Discharges. The cumulative discharge of radionuclides from the RLWTF into Mortandad Canyon between 1963 and 1977 and yearly discharge data for 1998 through 2000 appear in Table 5-6. In addition to total annual activity released for 1998 through 2000, Table 5-6 also shows mean annual activities in effluent for each radionuclide and the ratio of this activity to the DOE DCG for public dose. For the first time in many years, americium-241, plutonium-238, and plutonium-239, -240 did not exceed the DCG in 2000. As mentioned above, the new reverse osmosis and ultrafiltration system began operating at the RLWTF in 2000. This system is designed to remove additional radionuclides from the effluent and to ensure that the discharges meet the DOE public dose DCGs.

In response to a letter of noncompliance from the NMED, in March 2000 the RLWTF instituted a program to restrict the discharge of nitrogenous wastes into facility's collection system. Therefore, the nitrate (nitrate as nitrogen) concentration of all effluent discharge from the RLWTF during 2000 was less than 10 mg/L. The average 2000 effluent nitrate concentration (value of 2.5 mg/L, nitrate as nitrogen) was below the New Mexico groundwater standard of 10 mg/L and was much lower than the values for the previous two years.

The fluoride concentration in the discharge also has declined over the last few years. The 2000 effluent fluoride concentration (average value of 0.28 mg/L) was below the New Mexico groundwater standard of 1.6 mg/L.

4. Nonradiochemical Analytical Results

a. Major Chemical Constituents. Table 5-7 lists the results of analyses for major chemical constituents in surface water samples for 2000. The results are generally consistent with those observed in previous years, with some variability. The measurements in waters from areas receiving effluents show the effect of these effluents. None of the results was greater than one-half the standards with the following exceptions. The TDS values at Mortandad at GS-1 and SCS-1, 2, and 3 were over half the New Mexico groundwater limit and exceeded the EPA secondary drinking water standard. Several other TDS values (in Mortandad and Pueblo Canyons) exceeded half the EPA secondary drinking water standard. Sulfate at SCS-2 exceeded half the EPA secondary drinking water standard. The nitrate value for Mortandad at Rio Grande was about 60% of the NMWQCC groundwater standard. These stations are downstream from sanitary sewage or industrial effluent discharges.

Fluoride values at Jemez River and Mortandad at GS-1 were more than half the New Mexico groundwater limit but did not exceed the limit. The thermal waters from the Valles Grande caldera area have been shown to discharge through the Jemez River drainage, and wells and springs in the area have high boron, arsenic, and fluoride levels (Goff et al., 1988). Boron, arsenic, and fluoride are common constituents of water in volcanic areas or in thermal springs (Hem 1989). Fluoride at Mortandad at GS-1 results from effluent discharge from the RLWTF.

The laboratory pH in a sample from Water Canyon at Beta was 1.7, outside the EPA secondary drinking water range of 6.8–8.5. This result is likely a laboratory error and compares to a field measured pH of 7.9.

Perchlorate is a nonradioactive chemical compound containing a chlorine atom bound to four oxygen atoms and is used in a variety of industrial processes. At the Laboratory, perchlorate is a byproduct of the perchloric acid used in nuclear chemistry research. Industrial perchlorate uses also include solid fuels for rockets, high explosives, and fireworks; air-bag inflators; and electroplating, leather tanning, and rubber manufacturing. The EPA has not established a drinking water standard for perchlorate. Perchlorate is on the EPA's contaminant candidate list, which under the Safe Drinking Water Act requires background investigations to determine an MCL. According to an EPA fact sheet, present toxicology information suggests a provisional cleanup level of 4–18 ppb. The State of California, which has perchlorate contamination in drinking water supplies in some areas, has established a perchlorate water-supply action level for concentrations greater than 18 ppb. The State of New Mexico has not established an action level or regulatory standards for perchlorate. In 2000, the Environmental Surveillance Program collected surface water and groundwater samples for perchlorate analysis.

Perchlorate was detected in surface water at Mortandad at GS-1 at 39 ppb, or over twice the upper limit of EPA's provisional cleanup level. The perchlorate source is discharges from the TA-50 RLWTF, which processes wastewater from analytical chemistry facilities that perform actinide chemistry. Perchlorate was also found in surface water at Frijoles at Monument Headquarters and Pajarito at Rio Grande, but the analytical laboratory J-flagged these results, meaning that the quantities were estimated. Laboratory duplicates at both locations did not detect perchlorate.

b. Trace Metals. Table 5-8 lists the results of trace metal analyses on surface water samples for 2000. Samples collected for trace metal analysis were filtered so that they could be compared with the NMWQCC standards that apply to dissolved constituents. Samples collected for mercury and selenium analysis were unfiltered, as the NMWQCC standards for these analytes apply to total metal content. With some exceptions, the levels of trace metals in samples for 2000 are generally consistent with previous observations.

As in 1998 and 1999, several surface water, runoff, and groundwater samples showed detections of selenium in 2000. Typically, selenium has not been detected in surface water or groundwater on the Pajarito Plateau. The analytical detection limit for selenium in 2000 samples was 2.3 to 3.5 μg/L, below the New Mexico Wildlife Habitat Standard of 5 μg/L. New Mexico raised this standard from 2 μg/L to the current value in February 2000. Selenium did not exceed the standard in any surface water samples, but it was present at above half the standard at several stations in Pueblo, Sandia, Mortandad, and Water Canyons, as well as in the Rio Grande at two stations upstream from the Laboratory.

New Mexico raised the New Mexico Wildlife Habitat stream standard for mercury to 0.77 μg/L in February 2000 from 0.012 μg/L. The analytical detection limits in surface water in 2000 ranged from 0.03 to 0.1 μg/L. In 2000, no surface water samples had mercury exceeding half the standard.

Stations Jemez River, Pueblo 3, Pueblo at SR 502, and Mortandad at Rio Grande had boron exceeding half the New Mexico groundwater limit. Except for the Jemez River, these stations are all downstream from sanitary sewage discharges. The thermal waters from the Valles Grande caldera area have been shown to discharge through the Jemez River drainage, and wells and springs in the area have high boron levels (Goff et al., 1988). Boron is a common constituent of water in volcanic areas or in thermal springs (Hem 1989).

Aluminum, iron, and manganese concentrations exceed EPA secondary drinking water standards in surface water and runoff samples at many locations. Several studies (summarized in Bitner et al., 2001) have found that forest fires increase the concentrations of water-soluble manganese in soils. Manganese concentrations in many surface water samples collected after the Cerro Grande fire were much higher than previous values, particularly in Pueblo Canyon during July and August. A few of these manganese concentrations exceeded the New Mexico groundwater limit. Aluminum and iron also increased as a result of the Cerro Grande fire. These results reflect the presence of suspended solids or colloids in the water samples. Some of these cases occur with filtered samples. The results are due to naturally occurring constituents (that is, aluminum, iron, and manganese) of minerals in the suspended solids.

Mortandad at GS-1 had aluminum values that were about 20% of the New Mexico limits for use as irrigation water. Iron levels in SCS-2, Mortandad at GS-1, Cañada del Buey, and Frijoles at Monument Headquarters were about half the New Mexico groundwater limit. Iron values at Pajarito Canyon, Pueblo 3, and Pueblo at SR 502 were below half the New Mexico groundwater limit. Pajarito Canyon, Pueblo 1R, Pueblo 3, and Pueblo at SR 502 had higher than usual manganese concentrations. These concentrations exceeded the New Mexico groundwater limit by factors up to 12. Similar concentrations were found in nearby shallow alluvial groundwater samples in many cases.

c. Organic Constituents in Surface Water. Table 5-9 summarizes the locations where we collected organic samples in 2000. (See Section 5.H.2.c. for analytical methods and analytes.) We analyzed samples for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Some samples were also analyzed for high-explosive (HE) constituents. Table 5-10 shows organic compounds detected above the analytical laboratory's reporting level in 2000, as well as results from blanks. Most of the compounds detected were also found in accompanying blanks. The exception is the finding of acetone at Pueblo 3 on July 25. Acetone is, however, a common analytical contaminant found in samples during laboratory analysis for organic compounds.

5. Long-Term Trends

Long-term trends for surface water are discussed in Section 5.F with groundwater trends.

D. Runoff Sampling

1. Introduction

The Laboratory monitors runoff (storm water) from Pajarito Plateau stations to evaluate the environmental effects of its operations and to demonstrate compliance with permit requirements. Chapter 2 of this report contains a separate discussion of the Laboratory's compliance status. Periodic natural surface runoff occurs in two modes: (1) spring snowmelt runoff that occurs over days to weeks at a low discharge rate and sediment load and (2) summer runoff from thunderstorms that occurs over hours at a high discharge rate and sediment load. With drought conditions in early 2000, spring snowmelt runoff was essentially nonexistent. This section discusses the impacts of the summer runoff. Because of its short-lived nature, summer runoff is not a source of municipal, industrial, or irrigation water, though wildlife and livestock may use the waters. Runoff is important to monitor, however, as it is one of the principal agents for moving Laboratory-derived constituents off-site and possibly into the Rio Grande.

Activities of radionuclides in runoff samples may be compared with either the DOE DCGs or the NMWQCC stream standards, which in turn reference the New Mexico Environmental Improvement Board's New Mexico Radiation Protection Regulations (Part 4, Appendix A). However, New Mexico radiation protection activity levels are in general two orders of magnitude greater than the DOE DCGs for public dose, so we will discuss only the DCGs here.

The concentrations of nonradioactive constituents may be compared with the NMWQCC General, Livestock Watering, and Wildlife Habitat standards. The runoff quality can also be compared against the NMWQCC groundwater standards because of the possibility of seepage of dissolved constituents from the streambed into underlying shallow groundwater.

2. Monitoring Network

Runoff samples have historically been collected as grab samples from usually dry portions of drainages during or shortly after runoff events. As of 1996, we collect runoff samples using stream gaging stations, most with automated samplers (Shaull et al., 2000). Samples are collected when a significant rainfall event causes flow in a monitored portion of a drainage. Many runoff stations are located where drainages cross the Laboratory's boundaries. For the larger drainages, we sample runoff flows where they exit the Laboratory and at upstream locations. In contrast, runoff at several mesa top sites (for example, Material Disposal Area [MDA] G [Figure 5-5], MDA L, TA-55) is sampled at locations that target specific industrial activities, with negligible run-on from other sources. We sampled some events manually (grab samples) to supplement the automated samplers. Figures 5-6 and 5-7 show runoff monitoring stations on the Pajarito Plateau. We use samples from the stations to monitor water quality effects of potential contaminants sources such as industrial outfalls or soil contamination sites.

To document impacts of the Cerro Grande fire, we attempted to sample every runoff event during the runoff season. Unfortunately, the June 28 runoff event destroyed most samplers located along the Laboratory's western boundary (background stations). Between the automated samplers and additional manual grab samples collected after the stations were destroyed, however, a large range in both flow and water quality conditions was sampled along the western boundary. Based on precipitation records, we estimate that four probable light-to-moderate runoff events along the western boundary were not sampled after the destruction of stations in Pajarito, Cañon del Valle, and Water Canyons. We collected over 100 runoff samples from June through October, the majority from on-site locations.

3. Radiochemical Analytical Results for Runoff

Table 5-11 presents radiochemical analytical results for year runoff in 2000. The concentrations of radionuclides we measured in our samples are quite variable by location and through time, principally depending on whether ash from the Cerro Grande fire was present in the drainage at the time of sampling.

Comparison to Historical Levels

We evaluate the data by comparing it with historical levels and relevant standards and by looking for spatial and temporal trends. The benchmarks for comparing with historical levels are the pre-fire, 1995–1999, concentrations from runoff samples collected across the Laboratory. We use the 1995–1999 data set for comparison because, although runoff data were collected before 1995, the post-1995 data sampling methods were similar to those used for the current data. The pre-fire data set mainly includes results from Los Alamos Canyon and Cañada del Buey. For other drainages, pre-fire runoff was limited.

The year 2000 runoff concentrations of many radionuclides were greater than the Laboratory-wide pre-fire levels. Maximum pre-fire radionuclide concentrations in unfiltered runoff were exceeded for americium-241, cesium-137, plutonium-238, plutonium-239, -240, strontium-90, tritium, and uranium. The americium-241 and tritium maximums were seen at locations not impacted by the fire (DP Canyon at Mouth and Area G-6, respectively). In contrast, the high concentrations of cesium-137, plutonium-239, -240, strontium-90, and uranium were widespread and primarily related to the Cerro Grande fire. The most pronounced differences were for cesium-137 and uranium, with many samples exceeding the Laboratory-wide historical maximums by as much as 10 times. The increases in most of the radionuclide concentrations are attributable to two main factors: increased ash and sediment load in runoff and the enhanced constituent concentrations in the ash (see B.3.).

Radionuclide concentrations were significantly lower in filtered samples than in unfiltered samples. About 75% to 95% of the radioactivity in a runoff sample was typically associated with the sediments (ash, clay, silt, etc.) carried by the runoff rather than dissolved in the water.

Sources of Uranium in Runoff

Comprehensive analyses of the runoff samples for uranium isotopes were performed in year 2000. Naturally occurring uranium was present in the majority of the runoff samples, and Laboratory-derived uranium was generally not identifiable. This conclusion is supported by the following observations:

- Concentrations of uranium in unfiltered runoff leaving the Laboratory are similar to those measured in runoff entering the Laboratory in 2000 on days we were able to collect samples from both upstream and downstream locations.
- Median concentrations of uranium we calculated for the suspended sediment carried by the runoff leaving the Laboratory are similar to those measured in runoff entering the Laboratory (Figure 5-8), indicating that Laboratory sources made no distinctive addition as the runoff traversed LANL.
- Historically, LANL-derived uranium composed a small fraction of the total uranium found in Pajarito Plateau stream sediments and was not discernible in Rio Grande stream sediments

(Gallaher et al., 1997, 1999, in preparation). This statement is based on mass spectrometry analyses of stream sediments and of Cochiti Reservoir bottom sediments collected before the fire.

- Runoff samples collected along the Laboratory's downstream boundary were predominantly of a natural uranium isotopic composition. All but two of 18 samples contained uranium of natural composition (within 2σ uncertainty of natural). Enriched uranium was detected in two runoff samples collected in Los Alamos Canyon during the relatively small magnitude runoff events of June 2 and 3.

Fire Impacts on Runoff Quality

Evidence for substantial fire impacts on runoff includes the following:

- Many of the highest radionuclide concentrations were recorded at sample locations located upstream of LANL, above SR 501, and in samples taken from Rendija and Guaje Canyons north of the Laboratory. For example, in Guaje Canyon, calculated concentrations of cesium-137 in the suspended sediment of a July 9 runoff sample were approximately 10 times larger than pre-fire background levels (9.7 vs 1 pCi/g). The largest suspended sediment concentration (76,000 mg/L) measured on the Pajarito Plateau during 2000 was recorded for a sample collected in Guaje Canyon on August 8 and reflected natural sources. Figure 5-9 shows that the runoff flowing onto the Laboratory after the fire contained about 2 orders of magnitude higher levels gross alpha and gross beta activities than before the fire.
- Cesium-137 concentrations generally show a decline through the runoff season, as ash is flushed downstream.

The introduction of fire-derived radionuclides into most of the LANL watercourses masks the Laboratory's contribution of these radionuclides. The levels of many radionuclides changed as a result of ash in the runoff. For most of the canyon runoff samples collected in 2000, LANL impacts are not discernible because of the higher radionuclide concentrations in the ash.

Consistent with pre-fire conditions, Laboratory impacts are indicated in DP Canyon, around MDA G, and in early (June 2 and 3) runoff events in Los Alamos Canyon. The levels of americium-241 and strontium-90 at DP Canyon at Mouth and the tritium in two samples from G-6 have not been recorded before and indicate LANL impacts. Laboratory impacts are also identifiable in the first runoff events of the season in Los Alamos Canyon, June 2 and 3 (Johansen et al., 2001).

To gain a Laboratory-wide picture of how transport of radionuclides along the Laboratory's downstream boundary trended through the runoff season, we aggregated runoff volume and quality data for the individual drainages. On a monthly basis, we compiled average loads of radionuclides (suspended and dissolved) carried in a given volume of runoff. We used an averaging technique (flow weighting) designed to account for the wide variation in stream flow before and after the fire. For each summer runoff month of 2000, we calculated average radionuclide loads by dividing the total quantity (load) of each radionuclide by the total runoff volume recorded for the month. In the end, an average (flow-weighted) concentration (activity per liter of water) for each radionuclide is calculated. This technique normalized the effect of abnormal flow events after the fire, allowing for comparison through the runoff season and with pre-fire levels.

Figure 5-10 shows that peak concentrations occurred in June and July, with 5- to 20-fold increases above pre-fire averages during these months for cesium-137, strontium-90, and uranium. Concentrations of these same analytes dropped considerably during August, September, and October. The decline in runoff concentrations is partly due to flushing of ash from the LANL drainages during June and July and the occurrence of less-intense, late season rainfall events in August, September, and October that largely missed the mountains west of the Laboratory. Evidence for some flushing of ash from the drainages is presented in Figure 5-11, which indicates a general decline in calculated cesium-137 activities in the suspended sediment, particularly in Water Canyon.

Comparison of Radioactivity in Runoff with Standards

Water quality standards have not been established specific to most radionuclides in runoff. We compare the results for unfiltered water samples with DOE DCGs for public exposure and NMWQCC General, Livestock Watering, and Wildlife Habitat standards (Table 5-12). We further compare the results for filtered waters with appropriate EPA drinking water standards or DOE DCGs for drinking water systems (Table 5-13). Lastly, we screen for significant concentrations in the suspended sediment by comparing them with Screening Action Levels (SALs) for sediments.

Gross Alpha and Gross Beta Activity

In unfiltered samples, gross alpha concentrations were greater than public dose DCG levels (30 pCi/L) and State of New Mexico Livestock Watering Standards (15 pCi/L) at many locations upstream of and on the Laboratory. The gross alpha DCG is based on the most restrictive anthropogenic alpha emitters (plutonium-239, -240 and americium-241) and is commonly exceeded by runoff laden with naturally derived alpha emitters (such as from the uranium decay series). The New Mexico Livestock Standard excludes radon and uranium from the alpha limit. The gross beta activity DCG for public dose was slightly exceeded in a sample from Rendija Canyon, north of Laboratory operations.

Figure 5-12 shows that levels of gross alpha and beta radioactivity in unfiltered runoff samples were related to the concentrations of TSS in the water. That is, the most sediment-laden samples contained the highest total radioactivity. This relationship holds for samples collected above (upstream), on-site, and along the downstream side of the Laboratory. A sample of an intense, short-lived runoff event will generally contain higher total alpha and beta radioactivity levels than a sample taken from the same location under slower flows with less sediment carrying power. While some of the gross alpha and gross beta activity in 2000 was associated with ash, the relationship with TSS also was seen in pre-fire samples. The higher waterborne gross alpha and gross beta levels do not indicate that some new contaminant source has contributed to increased levels, but that more sediment is being transported in these events.

In 1999, we were unable to account for gross alpha and beta activities in the runoff samples using the nuclides we measured. For the year 2000 samples, we also analyzed the uranium and thorium isotopes. Our analyses indicate that naturally occurring potassium as well as uranium and thorium isotopes and their daughter decay products accounted for most alpha and beta activity. These daughter products are not observed in our analyses (and often are short-lived) but can be evaluated from the measured uranium and thorium concentrations. Within the accuracy of the analytical methods, the levels of gross alpha and gross beta radiation observed in these runoff samples can be attributed to high sediment loads (caused by erosion) and the naturally occurring levels of potassium, thorium, and uranium, along with their daughter products, carried in that sediment.

Comparison of Specific Radionuclides with Standards

Of the specific alpha and beta emitters measured, none occurred in runoff samples at levels above their respective DCGs for public exposure. Total concentrations of anthropogenic radionuclides greater than 15 pCi/L were seen for plutonium-239, -240 (lower reaches of Guaje, Rendija, Pueblo, and Los Alamos Canyons) and for americium-241 (DP Canyon Mouth). The levels of these individual isotopes exceed the New Mexico Livestock Watering standard for gross alpha activity.

All filtered samples met EPA and DOE drinking water standards, except one. The strontium-90 standard was exceeded in a single sample from the Los Alamos Weir, a structure installed after the fire in lower Los Alamos Canyon as a sediment catchment. The source of the strontium-90 in that sample could be either fire-related or derived from Laboratory operations. Dissolved strontium-90 levels generally were the highest of the individual isotopes, relative to the standards. More than 10 samples contained dissolved strontium-90 levels that were greater than one-half the EPA drinking water standard. We detected dissolved cesium-137 and americium-241 at levels more than half the DOE drinking water DCG in Area G runoff samplers G-2 and G-4, respectively.

Concentrations of Radionuclides in Suspended Sediment

Because the suspended solids make up such a large portion of the total radionuclide load in the runoff samples, we examined the suspended sediment for significant levels of the individual radionuclides. This analysis identified cesium-137 as the radionuclide likely to be of most concern from a public exposure perspective. In approximately 13 runoff samples, the concentrations of cesium-137 in the suspended sediment fraction of the runoff were calculated to be greater than Laboratory soil screening action levels (ER 2000). These measurements commonly occurred in samples taken at the upstream boundary of LANL, where the radionuclides should be primarily derived from worldwide fallout carried by ash. The largest cesium-137 concentration in suspended sediment was seen in a sample from Two Mile Canyon above SR 501, at levels approximately 12 times above the SAL

(Table 5-14). In the majority of the cases, the concentrations of cesium-137 exceeded the SAL by less than a factor of 2. We assume that because of further downstream mixing, the concentrations in sediment found in deposits after the runoff events will likely be substantially lower than those found in the runoff samples.

Long-Term Trends

We have monitored summer runoff quality with the automated samplers for only a few years. The monitoring has not been conducted long enough to evaluate long-term trends quantitatively. We performed an initial broad comparison of how the quality of Laboratory runoff has varied over recent years. First, we combined available flow and analytical measurements since 1997 and calculated the annual average (flow-weighted) concentrations of radionuclides measured in summer runoff events at the downstream LANL stations. We excluded the strontium-90 results for 1999 from this data set because of quality assurance concerns. The flow-weighted average gauges the average load of radioactive material carried in a given volume of runoff. The yearly averages indicate whether off-site transport has changed at the Laboratory's downstream boundary.

Figure 5-13 shows the results of this initial analysis. We saw no discernible trends in the data, except for the obvious increases in cesium-137, strontium-90, and uranium transport during year 2000. For the other isotopes, average concentrations appear to vary within the same order of magnitude over the period of record.

4. Nonradiochemical Analytical Results

a. Major Chemical Constituents. Table 5-15 lists the results of analyses for major chemical constituents in runoff samples for 2000. The concentrations of many constituents were elevated above levels observed in previous years. We noted increases for total alkalinity, calcium, magnesium, potassium, total phosphorous, and cyanide concentrations. Studies at other off-site locations show increases in many minerals and nutrients following fire (DeBano et al., 1979; Helvey et al., 1985; Tiedemann et al., 1978; Belillas and Roda 1993). These increases were generally due to release of these constituents by fire, changes in chemical states and complexation, and changes such as increased pH in the post-fire environment.

None of the LANL results approached or exceeded the standards with the following exceptions. TDS values in most of the major drainages were over half the EPA drinking water standard and exceeded the standard in a single sample of runoff at Guaje Canyon at SR 502.

The values for cyanide in its free (amenable), unbound form were greater than the NMWQCC General, Livestock Watering, and Wildlife Habitat Standards in three samples from Water Canyon and possibly in several other samples where the analytical detection limits were greater than the standard. Cyanide (amenable) is toxic to aquatic biota and wildlife. However, most of the cyanide appears to be in a far less toxic form bound with other elements. There is no surface water standard for total cyanide, and all values are below the NMQCC groundwater standard of 200 μg/L.

One possible source of the cyanide may have been fire retardant used in the Cerro Grande fire that contained a sodium hexaferrocyanide compound added as an anticaking additive and as a corrosion inhibitor. Another possibility is that some cyanide may have been naturally created through slow burning or smoldering of biomass (Yokelson et al., 1997) and then transported in the runoff along with the ash.

Figure 5-14 shows that cyanide levels in runoff declined progressively through the runoff season. Additional monitoring during the 2001 runoff season will determine if a cyanide source(s) remains in the burned area.

b. Trace Metals. Table 5-16 presents trace metals analytical results for year 2000 runoff. Analysis of runoff waters typically was performed for 23 metals. Both filtered and unfiltered samples were analyzed. Samples were filtered so that they could be compared with the NMWQCC standards that apply to dissolved constituents. Samples collected for mercury and selenium were unfiltered, as the NMWQCC standards for these analytes apply to total metal content. In general, metals concentrations in filtered samples were lower than concentrations in unfiltered samples. This relationship indicates that the metals are generally associated with the particulate and sediment carried by the runoff rather than dissolved in the water.

For nearly every metal, the levels in both filtered and unfiltered runoff samples for 2000 were significantly higher than in prior years. Corresponding to the radionuclides, the increase in metals concentrations is due to the increased sediment and ash related to the Cerro Grande fire. The largest increases in dissolved metals concentrations were seen for barium, manganese, strontium, and uranium. Substantial increases in total metal concentrations were recorded for arsenic, boron, barium, chromium, copper, manganese, silver, strontium, uranium, vanadium, and zinc. In general, these increases are consistent with those reported in the scientific literature for fire impacts (see section 5.B.1.). Total manganese, for example, found in plants before fire, is easily reducible by fire processes leading to subsequent increased concentrations in soil and water (Chambers and Attiwill 1994; Parra et al., 1996; Auclair 1997). Similar conclusions were reached in studies on copper and zinc (Auclair 1997).

Dissolved and total metals concentrations in runoff varied through the runoff season, as illustrated in Figure 5-15 for selected dissolved metals. In general, levels recovered to near pre-fire conditions by the end of October.

Comparison with Standards

Selenium exceeded the New Mexico Wildlife Habitat Standard of 5 µg/L in several samples in most of the major Pajarito Plateau drainages. We detected the largest values in Pajarito and Water Canyons during the June 28 runoff event, which carried much ash from the burned area. Selenium values more than 10 times the wildlife standard were detected in samples collected above and across the Laboratory in the flood event. Selenium at levels above the wildlife standard was indicated in several samples collected around MDA G, but the analytical laboratory B-flagged (meaning selenium levels were also detected in the accompanying analytical blanks) these, casting doubt on their reliability.

Mercury was detected at levels exceeding the New Mexico Wildlife Habitat Standard of 0.77 µg/L at three locations, and at two additional locations it was more than half the standard. All of these were detected in samples taken from Pajarito and Water Canyons during the ash-laden June 28 runoff event. One of these exceedances was in a sample taken upstream of the Laboratory in Pajarito Canyon.

Aluminum, iron, and manganese concentrations exceeded EPA secondary drinking water standards in filtered runoff in many locations. Occasionally, these metals concentrations exceeded the New Mexico groundwater limits. It is unlikely that people will directly ingest the runoff; comparisons are made here with drinking water standards because the dissolved constituents in the runoff potentially could affect groundwater quality. In several samples, the filtered aluminum concentrations exceeded the EPA secondary drinking water standard by more than 50 times. A single sample taken upstream of the Laboratory in Starmer's Gulch, a tributary of Pajarito Canyon, exceeded New Mexico Livestock Watering Standards for aluminum. These results reflect naturally occurring constituents of minerals whose levels are enhanced by forest fire effects.

We detected antimony at station G-6 in three filtered runoff samples at levels more than half the EPA primary drinking water standard, with one result slightly above the standard. A 1999 filtered runoff sample from the same station showed similar results. The source of the antimony around MDA G is uncertain. Antimony also exceeded the EPA drinking water standard in a runoff sample from Rendija Canyon, north of LANL operations, and is presumably derived from natural sources.

Concentrations of Metals in Suspended Sediment

Because the suspended solids compose such a large portion of the total metals load in the runoff samples, we examined the suspended sediment for significant levels of the individual metals. Table 5-17 compares screening levels against calculated metals concentrations associated with the suspended sediments for cases where both filtered and unfiltered samples were obtained for runoff samples. We determined the values by subtracting the filtered results from the unfiltered results, using the total suspended solids measured in the samples. The associated uncertainties were calculated using propagation of errors. This is a method of determining how measurement errors affect the results of a calculation using these measurements.

This analysis identified manganese as the metal likely to be of most concern from a public exposure perspective. The concentrations in the suspended sediment fraction of the runoff were calculated to be greater than residential EPA soil screening levels (EPA 2000) for manganese in 8 samples. These measurements commonly occurred in samples taken in Pajarito Canyon and Water Canyons both on-site and along SR 501 upstream of LANL, where the metals should be primarily derived from natural sources. Manganese levels in four samples were more than two times the SAL. We assume that because of further downstream mixing, the concentrations in sediment found in deposits after the runoff events will likely be substantially lower than those found in the runoff samples.

Long-Term Trends

We have monitored summer runoff quality with the automated samplers for only a few years, not long enough to evaluate long-term trends quantitatively. We performed an initial broad comparison of how the quality of Laboratory runoff has varied over recent years. First, we combined available flow and analytical measurements since 1997, when the downstream boundary of the Laboratory became effectively monitored with the automated samplers, and calculated the annual average (flow-weighted) concentrations of metals measured in summer runoff events at the downstream LANL stations. The flow-weighted average gages the average quantity (load) of trace metals carried in a given volume of runoff. The yearly averages indicate whether off-site transport has changed at the Laboratory's downstream boundary.

The results are shown in Figure 5-16. When compared with levels seen in the three years before the fire, substantial increases occurred during 2000 in average metals concentrations of arsenic, boron, barium, chromium, copper, manganese, strontium, uranium, silver, vanadium, and zinc. We saw increases 5 to 10 times above pre-fire levels for most of these metals. In addition, concentrations of antimony, nickel, lead, and tin doubled after the fire.

The pre-fire average concentrations typically varied within about one-half an order of magnitude. Within these limited ranges, however, there is a suggestion of upward trends in some pre-fire metals concentrations. Over the three pre-fire years for which we have summer runoff data, average concentrations progressively increase for barium, beryllium, cobalt, nickel, lead, manganese, strontium, and zinc. The interpretation of this preliminary finding is not clear. More study is needed to determine if the indicated trends can be isolated to individual drainages.

c. Organic Constituents in Runoff. Table 5-9 summarizes the locations where we collected organic samples in 2000. (See Section 5.H.2.c. for analytical methods and analytes.) We analyzed samples for volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Some samples were also analyzed for HE constituents, PCBs, and dioxins/furans. Table 5-18 shows organic compounds detected above the analytical laboratory's reporting level in 2000.

The only VOC detected in 2000 was 1,4-dichlorobenzene. All three detections of this compound were at levels very near the analytical detection limit and were at stations upstream of the Laboratory.

Detections of semivolatile organic chemicals included bis(2-ethylhexyl)phthalate, benzoic acid, benzyl alcohol, 2-methylnapthalene, and pyridine. The benzoic acid, benzyl alcohol, and pyridine are thought to be end products of combustion of forest fuels. Benzoic acid was detected throughout the runoff season in many fire-impacted drainages, and pyridine was detected in Guaje Canyon, north of the Laboratory. There is no definitive source for the bis(2-ethylhexyl)phthalate, but it is commonly recognized as introduced in analytical laboratory analysis.

PCBs and dioxins/furans were not found in runoff above analytical detection limits.

Relatively small concentrations (low parts-per-billion) of HE compounds were detected in runoff in the Water Canyon drainage system. HMX was detected in Indio Canyon at SR 4 on June 28, and HMX and RDX were detected in a runoff sample collected in lower Water Canyon at SR 4 in late October. HMX and RDX are present in surface water and spring discharges in this drainage system at comparable levels.

Several other HE compounds (tetryl and several isomers of nitrobenzene and nitrotoluene) were also possibly detected, but most of these were likely false detections. Because of the high ash content in the samples, there were interference effects with the requested analytical method. Few of these HE detections were confirmed using an alternate analytical method (UV-Diode Array) that is not susceptible to ash effects. The suspect values are shown with an X-qualifier in Table 5-18. These other HE compounds were detected only in the large runoff event of June 28, primarily in samples taken upstream or north of the Laboratory.

Assuming the false HE detections, all of the organic chemical detections were at levels below the EPA Region 6 screening values for tap water (EPA 2000), with two exceptions. A sample from MDA G station G-4 contained bis(2-ethylhexyl)phthalate at a level approximately three times larger than the EPA screening level. The RDX detected in lower Water Canyon slightly exceeds the EPA screening level.

d. Toxicity Monitoring of Runoff Quality. The Laboratory and the NMED DOE Oversight Bureau collected five runoff and two surface water samples in September 2000 for acute and chronic biological toxicity testing. Table 5-19 presents sample locations and test results. The EPA Region 6, Houston Branch, conducted all the toxicity monitoring. In the acute test, a population of daphnia (an aquatic invertebrate, *Ceriodaphnia dubia*) was exposed for 48 hours to various dilutions of water decanted off centrifuged runoff samples. They used runoff dilutions of 0 (lab control), 6.25, 12.5, 25, 50, and 100% (undiluted runoff) to establish a dose-response relationship, if any, for survival of the insect. An acceptable survival rate is 20% lower than the control sample. None of these samples showed significant acute effects.

The chronic tests used two different test organisms. A population of daphnia was exposed for seven days to a control sample and to undiluted water decanted off centrifuged runoff sample to look for survival and reproduction effects, whereas the embryo and larvae of fat head minnows (*Pimephales promelas*) were studied for survival and teratogenicity effects. Five samples showed no significant chronic effects. However, two runoff samples that NMED collected from upper Pueblo Canyon showed 70% and 100% mortality and significantly reduced reproduction in the 7-day Survival and Reproduction daphnia test. These samples were taken near the mountains, upstream of LANL discharges and above most urbanization in Los Alamos. The specific source(s) of the toxicity has not been identified. The Laboratory will expand biological monitoring during 2001 to include other drainages and snowmelt.

E. Sediment Sampling

1. Introduction

Sediment transport associated with surface water runoff is a significant mechanism for contaminant movement. Contaminants originating from airborne deposition, effluent discharges, or unplanned releases can become attached to soils or sediments by adsorption or ion exchange.

There are no federal or state regulatory standards for soil or sediment contaminants that we can use for comparison with the Laboratory's environmental surveillance data. Instead, contaminant levels in sediments may be interpreted in terms of toxicity because of ingestion, inhalation, or direct exposure. The Laboratory's Environmental Restoration (ER) Project uses SALs to identify contaminants at concentrations or activities of concern. SALs are screening levels selected to be less than levels that would constitute a human health risk. SAL values are derived from toxicity values and exposure parameters using data from the EPA. Contaminant levels in sediments may also be compared with residential soil screening levels developed by EPA Region 6 (EPA 2000). These screening levels are derived from toxicity data and are currently used as SALs by the ER Project.

We can also compare the data with activities of radionuclides resulting from atmospheric fallout or from naturally occurring radionuclides. We used radionuclide analyses of sediment samples collected from regional stations for the period 1974 to 1986 to establish background activities from atmospheric fallout of radionuclides and to determine the background concentrations of naturally occurring uranium (Purtymun et al., 1987). McLin et al. (in preparation) developed provisional background levels for data from the period 1974 to 1996. In this study, the authors determined separate values for reservoir sediments and river sediments. Differences in grain size and depositional setting lead to different levels of accumulation for fallout-derived radionuclides in these two environments. We use the 0.95 quantile activity of each of the radionuclides in the regional station samples as an estimate of the upper limit of background values. If the activity of an individual sediment sample is greater than the estimated background value, we consider the Laboratory as a possible source of contamination. Tables summarizing analytical results list the reservoir and river background and SAL values for sediments.

2. Monitoring Network

Sediments are sampled in all major canyons that cross the Laboratory, including those with either perennial or ephemeral flows. We also sample sediments from regional reservoirs and stream channels annually.

Regional sediment sampling stations (Figure 5-3) are located within northern New Mexico and southern Colorado at distances up to 200 km from the Laboratory. Samples from regional stations provide a basis for estimating background activities of radionuclides resulting from atmospheric fallout or from naturally occurring radionuclides. We obtained regional sediment samples from reservoirs on the Rio Grande and the Rio Chama and at stations on the Rio Grande and Jemez River.

Stations on the Pajarito Plateau (Figure 5-17) are located within about 4 km of the Laboratory boundary, with the majority located within the Laboratory boundary. The information gathered from these stations documents conditions in areas potentially affected by Laboratory operations. Many of the sediment sampling stations on the Pajarito Plateau are located within canyons to monitor sediment contamination related to past and/or present effluent release sites. We sampled three major canyons (Pueblo, Los Alamos, and Mortandad Canyons) that have experienced past or present liquid radioactive releases from upstream of the Laboratory to their confluence with the Rio Grande.

We also collected sediments from drainages downstream of two material disposal areas. Area G at TA-54 is an active waste storage and disposal area. Nine sampling stations were established outside its perimeter fence in 1982 (Figure 5-5) to monitor possible transport of radionuclides from the area. The surface drainage changed, and we dropped two sampling stations in 1998 and added four others. G-4 R-1 and G-4 R-2 replaced station G-4. G-6 was located in a channel that received runoff that was not entirely from Area G. G-6R replaced G-6 and is located in a stream channel that receives runoff only from Area G. Station G-0 was added on the north side of Area G in a drainage that flows to Cañada del Buey.

Area AB at TA-49 was the site of underground nuclear weapons testing from 1959 to 1961 (Purtymun and Stoker 1987, ESP 1988). The tests involved high explosives and fissionable material insufficient to produce a nuclear reaction. We established 11 stations in 1972 to monitor surface sediments in drainages adjacent to Area AB (Figure 5-18). We added another station (AB-4A) in 1981 as the surface drainage changed.

3. Radiochemical Analytical Results for Sediments

Table 5-20 shows the results of radiochemical analysis of sediment samples collected in 2000. The table also lists the total propagated one sigma analytical uncertainty and the analysis-specific minimum detectable activity where available. Uranium was analyzed by isotopic methods rather than as total uranium for most samples in 2000; total uranium was calculated from these values using specific activities for each isotope. The sample size for most sediment samples is 100 g. Lower detection limit analysis for plutonium-238 and plutonium-239, -240 in reservoir samples was not done in 2000.

To emphasize values that are detections, Tables 5-21 (river sediments) and 5-22 (reservoir sediments) list radiochemical detections for values that are higher than river or reservoir background levels and identify values that are near or above SALs. Table 5-21 shows all tritium detections regardless of screening levels. Detections are defined as values exceeding both the analytical method detection limit (where available) and three times the individual measurement uncertainty. Qualifier codes are shown because some analytical results that meet the detection criteria are not detections: in some cases, the analyte was found in the lab blank or was below the method detection limit, but the analytical result was reported as the minimum detectable activity. Results from the 2000 sediment sample analysis are generally consistent with historical data.

Because of analytical laboratory delays, many sediment stations did not have results completed for plutonium-238, plutonium-239, -240, and americium-241 in time for the 1999 report; the complete data appear in Table 5-23. As discussed in the 1999 report, the analytical laboratory had data quality problems with analysis of strontium-90 for 1999, so the data are not included in Table 5-23. The report “Environmental Surveillance at Los Alamos during 1999” contained the complete sediment strontium-90 data.

In 1999, strontium-90 was found above fallout levels in all 105 sediment samples where it was detected in samples from the Pajarito Plateau and at regional stations. These high values resulted from problems with a new strontium-90 laboratory technique. Strontium-90 has previously been detected infrequently at most stations. In 2000, strontium-90 was found above background only at Acid Weir below the former TA-45 outfall (a duplicate laboratory analysis detected strontium-90 below background in the sample). We previously used a strontium-90 background value of 0.87 pCi/g (Purtymun et al., 1987). For this report, background levels are 1.02 pCi/g for river sediments and 1.19 pCi/g for reservoir sediments (McLin et al., in preparation).

Cesium-137 was found in many samples at much higher values than previously noted because of the Cerro Grande fire. Several studies (Bitner et al., 2001) have shown that fires concentrate fallout-derived cesium-137 from vegetation into the soil where it is available for redistribution by runoff. Runoff samples taken from upstream of the Laboratory after the fire found cesium-137 levels much above normal (Johansen et al., 2001). Cesium-137 in the suspended sediment portion of the runoff samples discussed in Johansen et al. (2001) was above the sediment SAL. Post-fire sediment samples from several canyons or at stations without previous evidence of radioactive contamination showed high cesium-137 values, some above SALs. These included Water at Rio Grande, Pajarito Retention Pond, Pajarito at Rio Grande, Los Alamos Canyon Reservoir, Rio Grande at Cochiti, Guaje at SR 502, Frijoles at Rio Grande, above Ancho Spring, and Chaquehui at Rio Grande.

For 2000, samples from two stations at Cochiti Reservoir showed cesium-137 at values about 20% to 40% above background. Plutonium-238 was apparently found in one sample well above background, but reanalysis of the sample did not detect any plutonium isotopes. Samples from two locations in Abiquiu Reservoir found plutonium isotopes above background. In one sample, plutonium-238 was found at 15 times the background value. This reservoir is well upstream from Laboratory influence. Gross alpha and beta values at most stations in both Cochiti and Abiquiu Reservoirs were above background. These values may reflect a change in analytical laboratory from previous years.

At regional stations, plutonium isotopes were found above background at Rio Chama at Chamita, Rio Grande at Otowi, and Rio Grande at Bernalillo. Of these four above-background detections, three were not found in analysis of a field duplicate, including apparent detections of both isotopes at Rio Grande at Chamita and of plutonium-239, -240 at Rio Grande at Otowi. The results for plutonium-238 and plutonium-239, -240 at Rio Chama at Chamita were about 40 and 60 times the background (but were not substantiated by analysis of a field duplicate). This location is well upstream from Laboratory influence. Cesium-137 was found in a post-fire sample from the Rio Grande at Cochiti at nearly three times background. Cesium-137 was one of the isotopes found in higher amounts in runoff because of the Cerro Grande fire (Johansen et al., 2001).

Many 2000 sediment samples from the known radioactive effluent release areas in Acid/Pueblo, DP/Los Alamos, and Mortandad Canyons exceeded background levels for tritium, cesium-137, plutonium-238, plutonium-239, -240, americium-241, gross alpha, gross beta, and gross gamma activities. These levels are consistent with historical data.

In both Los Alamos and Pueblo Canyon sediments, above-background levels of plutonium are evident for distances greater than 16 km downstream from the sources in Acid and DP Canyons. The contamination extends off-site across San Ildefonso Pueblo lands and reaches the Rio Grande near the Otowi Bridge. Plutonium-238 and plutonium-239, -240 activities downstream of historical release sites in those canyons have remained relatively constant during the past. These patterns have been documented for several decades in Laboratory reports (ESP 1981).

At station DPS-4 in DP Canyon, activities of americium-241, cesium-137, plutonium-238, and plutonium-239, -240 were above background in 2000, consistent with historical data. In Los Alamos Canyon (extending to Los Alamos at Otowi), activities of americium-241, cesium-137, plutonium-238, and particularly plutonium-239, -240 were above background as in the past. Tritium was detected in sediments at DPS-4, Los Alamos at LAO-1, and Los Alamos at LAO-4.5.

At Acid Weir (at the confluence of Acid and Pueblo Canyons), plutonium-238 was not found above background, which is unusual, and plutonium-239, -240 activity was about 10 times background. The latter value is consistent with historical data.

Plutonium-239, -240 was about 10 times background at Pueblo 1R. In pre-fire samples at Pueblo 2, plutonium-239, -240 activity was 144 times background. Levels above background decrease to 46 times background at Hamilton Bend Spring, 68 times background at Pueblo 3, and, in a post-fire sample, 88 times greater than background at Pueblo at SR 502.

Within Mortandad Canyon, the greatest radionuclide levels in sediments are found between the point where the TA-50 RLWTF effluent enters the drainage (above station Mortandad at GS-1) and the sediment traps (MCO-7), approximately a 3-km distance. Radionuclide levels decrease in the downstream direction from TA-50 to the sediment traps. Radionuclide levels near, or slightly exceeding, background levels are found downstream of the sediment traps, extending to the Laboratory/San Ildefonso Pueblo boundary station A-6. Based on mass spectrometry analysis, Gallaher concluded that off-site plutonium contamination at levels near fallout values might extend two miles beyond the Laboratory boundary (Gallaher et al., 1997).

In 2000, sediment samples from GS-1, MCO-5, and MCO-7 in Mortandad Canyon showed cesium-137 concentrations that were up to 4.4 times greater than the SAL value. Median values since 1980 for cesium-137 at these stations range up to six times greater than the SAL value. Cesium-137 levels at these stations have declined by factors of five to 35 since the early 1980s because of lower cesium-137 discharges from the RLWTF. Tritium in the sediment sample at GS-1 was 16% above the SAL. The plutonium-239, -240 activity at GS-1 was about 73% of the SAL. The americium-241, plutonium-238, and plutonium-239, -240 analyses from MCO-5 were in keeping with most past values, supporting the idea that one of two analyses for these isotopes in 1999 was erroneously high. During 2000, no other sediment samples in Mortandad Canyon showed any values that exceeded SAL values.

Downstream of the sediment traps in Mortandad Canyon at stations MCO-9, MCO-13, A-6, and Mortandad at SR-4 (A9), plutonium-239, -240 activity ranged from 1.3 to 2.6 times background values. Although the data are comparable to previous years, the comparison with background is much higher than given for the last 15 years, reflecting a change in the background value from 0.023 pCi/g to 0.013 pCi/g. Based on the former background value, results at these stations range from 0.7 to 1.5 times background. Other, not yet published, results from these stations based on isotopic ratios support the new smaller background value.

A number of sediment samples in the vicinity and downstream of Area G contained plutonium-238 and plutonium-239, -240 at activities greater than background. Both isotopes were about 35 times background at G-7. G-6R had a plutonium-239, -240 activity more than 18 times background. Americium-241 was 16 times background at G-6 R. Tritium was found at G-4 R-1 and G-4 R-2 above or near the SAL and at G-6R. The station Pajarito at SR 4, which is located more than one km downstream of Area G, had plutonium-239, -240 above background.

We found plutonium-238 and plutonium-239, -240 at activities greater than background in a number of sediment samples collected at Area AB. Station AB-3 is located immediately downstream of a known surface-contamination area dating to 1960 (Purtymun and Stoker 1987). At AB-3, plutonium-239, -240 was again nearly 58 times background, and plutonium-238 was three times background activity. These values are consistent with past results. Although plutonium-239, -240 was found above background in samples at AB-1 and AB-11, analysis of field duplicates did not find this isotope above background.

At Ancho at SR 4, tritium was again detected. The station Above Ancho Spring had tritium above the SAL, as well as above-background cesium-137 and plutonium-239, -240.

Chaquehui at Rio Grande again had a detection of cesium-137 and showed tritium. Potrillo at SR 4, Cañon de Valle at SR 501, Frijoles at Rio Grande, and Fence at SR 4 had detections of plutonium-239, -240 slightly above background.

The remainder of sediment samples collected at locations at the Laboratory in 2000 were near background levels.

4. Nonradiochemical Analytical Results

a. Trace Metals. Beginning in 1992, we have analyzed sediments for trace metals. Table 5-24 presents trace metal results for the sediment samples collected in 2000.

Since 1990, trace metals analysis has indicated the presence of mercury at near detection limit concentrations (0.025 mg/kg) in nearly 200 sediment samples. The largest numbers of those historic samples (from 1990–1998) were from Los Alamos Canyon (22 samples), followed by Mortandad Canyon (21 samples since 1992), Area AB (19 samples), and Area G (15 samples since 1994). In 2000, we found low levels of mercury, far below the SAL of 23 mg/kg, in sediments from Rio Grande at Embudo and Rio Grande at Bernalillo and from Los Alamos at Otowi, MCO-5, Canon de Valle at SR-501, three stations surrounding Area G, and eight stations at Area AB.

Barium and manganese are two metals that may be mobilized by forest fires. Many stations had manganese above SALs, including around Area G and Area AB and samples from Bayo, Guaje, Water, and Los Alamos Canyons. However, much of this sampling occurred before the fire and levels of manganese in 2000 at these stations are in the range of previous values, so the Cerro Grande fire is not the manganese source. Some stations with unusually high manganese (2.5 to 4 times the SAL) were post-fire samples from Frijoles at Rio Grande, Pajarito Retention Pond, and Pajarito at Rio Grande. Barium was near half the SAL at Chaquehui at Rio Grande and exceeded the SAL at Frijoles at Rio Grande, Pajarito at Rio Grande, and Pajarito Retention Pond.

Barium was found at half the SAL at AB-1 and AB-4 in pre-fire samples. A sample collected from AB-1 had unusually high metal content. This sample exceeded SALs for cadmium, chromium, and manganese. A field duplicate collected at AB-1 had metals results in the usual ranges.

b. Organic Analysis. Beginning in 1993, we have analyzed sediments for PCBs and SVOCs. Some sediment samples have been analyzed for HE constituents since 1995. We analyze samples from only a portion of the sediment stations each year. Table 5-25 lists these samples. With exceptions shown in Table 5-26, the analytical results showed no PCBs, SVOCs, or HE constituents detected above the analytical laboratory's reporting limit in any of the sediment samples collected during 2000.

Of the compounds listed in Table 5-26, most were at levels far below ER SALs. Three semivolatile organic compounds were found at Ancho at SR-4 at concentrations that are about 37% to 48% of the EPA Region 6 residential soil screening levels. The compounds are benzo(a)pyrene, benzo(b)fluoranthene, and benzo(a)anthracene. These compounds are polycyclic aromatic hydrocarbon (PAH) compounds that are formed by burning of gasoline, garbage, or animal or plant material and are usually found in smoke and soot. The compounds can come from oil refining and processing of coal, creosote, or tar products or runoff containing grease and oils or asphalt leachate.

5. Long-Term Trends

For the plots discussed in this section, we show only detections of a particular radionuclide in sediments; samples without such detections are not shown.

Figure 5-19a depicts plutonium-238 activities at five stations in Mortandad Canyon from 1976 to 2000. GS-1, MCO-5, and MCO-7 are located downstream of the RLWTF discharge point and upstream of the sediment traps. Plutonium-238 activity at GS-1 has decreased by a factor of about 10 during that time period and, except for a 1999 sample at MCO-5 (which was questionable as a duplicate analysis was in the usual range), has not exceeded the SAL since 1985. MCO-9 and MCO-13 are located downstream of the sediment traps. Plutonium-238 is infrequently above background at those stations and is not regularly detected.

Figure 5-19b shows plutonium-239, -240 levels on Laboratory lands in Mortandad Canyon. Plutonium-239, -240 levels upstream of the sediment traps have declined by approximately a factor of 10 since the 1980s, presumably because of decreased radioactivity in the RLWTF discharges and the dispersal of previously contaminated sediments. Downstream of the sediment traps, plutonium activities have remained relatively constant; the activities are two orders of magnitude less than upstream of the sediment traps and are near background activities.

Figure 5-19c shows that cesium-137 has been present in Mortandad Canyon since the first data collected in the 1970s. Between TA-50 and the sediment traps, cesium-137 levels have often exceeded the SAL but have decreased over the last 25 years. Cesium-137 levels below the sediment traps have gradually declined to near background levels.

F. Groundwater Sampling

1. Introduction

Groundwater resource management and protection efforts at the Laboratory focus on the regional aquifer underlying the region (see Section 1.A.3) but also consider perched groundwater found within canyon alluvium and at intermediate depths above the regional aquifer. The Los Alamos public water supply comes from supply wells drawing water from the regional aquifer.

The early groundwater management efforts by the USGS evolved through the growth of the Laboratory's current Groundwater Protection Management Program, required by DOE Order 5400.1 (DOE 1988). This program addresses environmental monitoring, resource management, aquifer protection, and hydrogeologic investigations. The Laboratory issued formal documentation for the program, the "Groundwater Protection Management Program Plan," in April 1990 and revised it in 1995 (LANL 1996). During 1996, the Laboratory developed and submitted an extended groundwater characterization plan, known as the Hydrogeologic Workplan (LANL 1998), to the NMED. NMED approved the Hydrogeologic Workplan on March 25, 1998. See Chapter 2 for a description of investigations under the Hydrogeologic Workplan.

Concentrations of radionuclides in environmental water samples from the regional aquifer, the perched alluvial groundwater in the canyons, and the intermediate-depth perched systems may be evaluated by comparison with DCGs for ingested water calculated from DOE's public dose limit (see Appendix A for a discussion of standards). The NMWQCC has also established standards for groundwater quality (NMWQCC 1996). Concentrations of radioactivity in drinking water samples from the water supply wells, which draw water from the regional aquifer, are compared with New Mexico Drinking Water Regulations and EPA MCLs or to the DOE DCGs applicable to radioactivity in DOE drinking water systems, which are more restrictive in a few cases.

The concentrations of nonradioactive chemical quality parameters may be evaluated by comparing them with NMWQCC Groundwater Standards (NMWQCC 1996) and with the New Mexico drinking water regulations and EPA drinking water standards, although these latter standards are only directly applicable to the public water supply. Although it is not a source of municipal or industrial water, shallow alluvial groundwater is a source of return flow to surface water and springs used by livestock and wildlife and may be compared with the Standards for Groundwater or the Livestock Watering and Wildlife Habitat Stream Standards established by the NMWQCC (NMWQCC 2000). However, it should be noted that these standards are for the most part based on dissolved concentrations. Many of the results reported here are total concentrations (that is, they include both dissolved and suspended solids concentrations), which may be higher than dissolved concentrations alone.

2. Monitoring Network

Groundwater sampling locations are divided into three principal groups, related to the three modes of groundwater occurrence: the regional aquifer, perched alluvial groundwater in the bottom of some canyons, and localized intermediate-depth perched groundwater systems. Figure 5-20 shows the sampling locations for the regional aquifer and the intermediate-depth perched groundwater systems. Figure 5-21 presents the sampling locations for the canyon alluvial groundwater systems. Purtymun (1995) described the springs and wells.

Sampling locations for the regional aquifer include test wells, supply wells, and springs. New wells, constructed pursuant to implementation of the Hydrogeologic Workplan activities, are not yet part of LANL's Groundwater Monitoring Plan and the monitoring well network. In 2001, the first set of the regional aquifer (R) wells, installed pursuant to implementation of the Hydrogeologic Workplan, will be turned over to ESH-18 for custodianship and possible inclusion in the monitoring network. ESH-18 is working with the NMED and other Laboratory organizations to formulate a protocol for adding these wells to LANL's Groundwater Monitoring Plan to meet site-wide groundwater monitoring needs.

We routinely sample eight deep test wells, completed within the regional aquifer. The USGS drilled these test wells between 1949 and 1960 using the cable tool method. The Laboratory located these test wells where they might detect infiltration of contaminants from areas of effluent disposal operations. These wells penetrate only a few tens or hundreds of feet into the upper part of the regional aquifer. The casings are not cemented, which would seal off surface infiltration along the boreholes.

We collect samples from 12 deep-water supply wells in three well fields that produce water for the Laboratory and community. The wells are part of the Los Alamos water-supply system and are leased and operated by the County of Los Alamos. The well fields include the off-site Guaje well field and the on-site Pajarito and Otowi well fields. The Guaje well field, located northeast of the Laboratory, now contains five producing wells. Four new wells were drilled in this field in 1998. With one exception (G-1A was retained as a backup production well), older wells were retired in 1999 because of their age and declining production. The five wells of the Pajarito well field are located in Sandia and Pajarito Canyons and on mesa tops between those canyons. Two wells make up the Otowi well field, located in Los Alamos and Pueblo Canyons. In 2000, the Laboratory sampled Los Alamos water supply wells for four contaminants of concern: strontium-90, tritium, high explosives, and perchlorate. Additional regional aquifer samples come from wells located on San Ildefonso Pueblo. The frequency of monitoring varies from annual to monthly depending on the contaminant and sampling location.

We sample numerous springs near the Rio Grande because they represent natural discharge from the regional aquifer (Purtymun et al., 1980). As such, the springs serve to detect possible discharge of contaminated groundwater from beneath the Laboratory into the Rio Grande. Based on their chemistry, the springs in White Rock Canyon are divided into four groups, three of which have similar, regional aquifer-related chemical quality. The chemical quality of springs in a fourth group reflects local conditions in the aquifer, probably related to discharge through faults or from volcanics. Sacred Spring is west of the river in lower Los Alamos Canyon.

We sample approximately half of the White Rock Canyon springs each year. Larger springs and springs on San Ildefonso Pueblo lands are sampled annually, with the remainder scheduled for alternate years.

We sample the perched alluvial groundwater in five canyons (Pueblo, Los Alamos, Mortandad, and Pajarito Canyons, and Cañada del Buey) with shallow observation wells to determine the impact of NPDES discharges and past industrial discharges on water quality. In any given year, some of these alluvial observation wells may be dry, and thus we cannot obtain water samples. Observation wells in Water, Fence, and Sandia Canyons have been dry since their installation in 1989. All but two of the wells in Cañada del Buey are generally dry.

Intermediate-depth perched groundwater of limited extent occurs in conglomerates and basalt at depths of several hundred feet beneath the alluvium in portions of Pueblo, Los Alamos, and Sandia Canyons. We obtain samples from two test wells and one spring. The well and spring locations allow us to monitor possible infiltration of effluents beneath Pueblo and Los Alamos Canyons.

Some perched water occurs in volcanics on the flanks of the Jemez Mountains to the west of the Laboratory. This water discharges at several springs (Armstead and American) and yields a significant flow from a gallery in Water Canyon, where this perched water is sampled. Additional perched water extends eastward from the Jemez Mountains beneath TA-16 in the southwestern portion of the Laboratory. The drilling of Hydrogeologic Workplan well R-25 confirmed the existence of this perched water, at a depth of about 750 ft below the mesa top, in 1998. The water was found to contain high-explosives compounds resulting from past Laboratory discharges. The Laboratory is conducting further work to characterize this perched zone.

3. Radiochemical Analytical Results for Groundwater

Table 5-27 lists the results of radiochemical analyses of groundwater samples for 2000. The table also lists the total propagated one sigma analytical uncertainty and the analysis-specific minimum detectable activity where available. Uranium was analyzed by isotopic methods rather than as total uranium for most samples in 2000; total uranium was calculated from these values using specific activities for each isotope.

To emphasize values that are detections, Table 5-28 lists radionuclides detected in groundwater samples. Detections are defined as values exceeding both the analytical method detection limit (where available) and three times the individual measurement uncertainty. Qualifier codes are shown because some analytical results that meet the detection criteria are not detections: in some cases, the analyte was found in the lab blank or was below the method detection limit, but the analytical result was reported as the minimum detectable activity. Because uranium, gross alpha, and gross beta are usually detected, we indicate in Table 5-28 only occurrences of these measurements above threshold values. The specific levels are 5 µg/L for uranium, 5 pCi/L for gross alpha, and 20 pCi/L for gross beta and are lower than the EPA MCLs or screening levels.

The right-hand columns of Table 5-28 indicate radiochemical detections that are greater than one-half of the DOE DCGs for public dose for ingestion of environmental water or the standards shown. No groundwater values exceeded half the DOE public dose DCG values in 2000.

Discussion of results will address the regional aquifer, the perched canyon alluvial groundwater, and the intermediate-depth perched groundwater system.

a. Radiochemical Constituents in the Regional Aquifer. For samples from wells or springs in the regional aquifer, most of the results for radiochemical measurements were below the DOE drinking water DCGs or the EPA or New Mexico standards applicable to a drinking water system. In addition, most of the results were near or below the detection limits of the analytical methods used. The exceptions are discussed below.

The main detected radioactive element in the regional aquifer was uranium, found in springs and wells on San Ildefonso Pueblo land. See Section 5.G for a discussion of these values.

A number of regional aquifer springs and wells had apparent detections of americium-241, plutonium-238, plutonium-239, -240, and other isotopes. In many cases, the analysis of laboratory or field duplicate samples did not support the apparent detections. At values near the detection limit, it is technically difficult to determine whether an analyte has been detected in an individual sample. However, because these measurements are not repeatable, these apparent detections are far more likely to be due to analytical outliers (that is, false positives) than to the presence of the particular isotope in groundwater. Important factors regarding monitoring for radioactivity in groundwater are using detection limits substantially below the drinking water MCL and drawing conclusions based on a large body of data rather than from an individual sample. By observing data trends over time and location, we eliminate false positives potentially associated with any errors arising from chemical analysis or sampling.

Americium-241 was apparently found near the detection limit in Test Well 1, O-1, Spring 3A, and Spring 4A (it was not detected in a duplicate analysis of the Spring 4A sample). Americium-241 has not been regularly found at any of these locations, so it is likely that these results are false positives.

Numerous apparent detections of plutonium isotopes (most near the detection limit) occurred in regional aquifer well and spring waters. None of the apparent detections were supported (and many were contradicted) by analysis of laboratory or field duplicates, which were done for many of the samples. As plutonium isotopes are not regularly found in these waters, it is likely that the results are analytical artifacts. We plan to collect additional samples in 2001 to check for the possibility of plutonium occurrence at these stations. Plutonium-238 was found in Test Well 3 (though not in a duplicate analysis), Sandia Spring, Spring 2, and at San Ildefonso wells LA-5, Pajarito Pump 1 (though not in a duplicate analysis), Don Juan Playhouse, Otowi House, and New Community (though not in a field duplicate). Plutonium-239, -240 was apparently detected in Test Well 3 (though not found in a duplicate analysis) and New Community Well (though not found in a field duplicate).

During 1999 sampling, analytical laboratory problems caused many apparent detections of strontium-90 where it had not been seen previously. Levels of strontium-90 exceeding the drinking water MCL of 8 pCi/L were apparently detected in Test Wells 1, 3, 4, 8, DT-9, DT-10, and Sanchez House Well at San Ildefonso Pueblo. Strontium-90 was also detected in Los Alamos water supply wells G-1, G-1A, O-1, O-4, and PM-4 and San Ildefonso Pueblo water supply wells LA-5, Don Juan Playhouse Well, Pajarito Well (Pump 1), and Eastside Artesian Well. Sacred Spring and Spring 8B also showed strontium-90 detections. LANL believes that none of these 1999 detections are valid and that they are due to analytical laboratory problems. Data collected during 2000 went to outside analytical laboratories, which achieved lower detection limits for strontium-90 analysis. The 2000 data support the conclusion that much of the 1999 strontium-90 data were subject to analytical error.

Regional aquifer test wells were sampled either quarterly or semiannually for strontium-90 in 2000. See Table 5-29. No strontium-90 was detected in these wells.

Strontium-90 was apparently detected in Spring 9A (though not found in a duplicate analysis), Sacred Spring (though not found in a duplicate analysis), and Basalt Spring.

We sampled all Los Alamos water supply wells quarterly for strontium-90 in 2000; this sampling will continue in 2001. Table 5-29 presents the quarterly strontium-90 results for 2000. In 2000, strontium-90 was initially detected in O-1 and G-3A. O-1 is located in lower Pueblo Canyon several miles east-northeast of the Laboratory's main technical area. Although O-1 was constructed in 1990, it did not become operational until 1997. Major water production from the well began in the spring of 2000. G-3A is in Guaje Canyon, on Forest Service land north of Los Alamos. The detection for O-1 occurred in a laboratory duplicate analysis; the original analysis did not yield a detection. Reanalysis of the original samples and subsequent sampling at both wells have not confirmed either of the detections of strontium-90, so we view these detections as analytical outliers.

NMED hydrologists reported in January 2000 that samples taken in June 1999 from the O-1 supply well contained tritium in concentrations of 39.9 pCi/L. LANL found tritium in O-1 in a June 21, 2000, sample at a concentration of 38.3 +/- 1.3 pCi/L. These concentrations are 500 times lower than the federal drinking water standard but are above background concentrations that can be found in groundwater around the Laboratory. We now sample O-1 monthly for tritium. Table 5-30 compiles the water supply well tritium results for 2000. The University of Miami analyzed these samples at a low detection limit of about 1 pCi/L. Tritium was found at background levels in other water supply wells.

Concentrations of tritium in the regional aquifer in other parts of the Laboratory can be found ranging between 1 and 3 pCi/L; tritium concentrations in northern New Mexico surface water and rainwater range from 30 to 40 pCi/L. Tritium also has been seen in the deep aquifer in a test well several hundred yards downstream from the O-1 supply well. The concentration of tritium in Test Well-1 was 360 pCi/L in 1993. The test well just penetrates the top of the regional aquifer about 600 ft beneath the canyon floor. In contrast, the area within the aquifer from which O-1 draws its water begins at just about 1,000 ft below the canyon floor (and about 400 ft lower than the top of the aquifer and Test Well-1) and continues down an additional 1,460 ft.

b. Radiochemical Constituents in Alluvial Groundwater. None of the radionuclide activities in perched alluvial groundwater are above the DOE DCGs for public dose for ingestion of environmental water. Except for americium-241 and strontium-90 values from Mortandad and Los Alamos Canyons, none of the radiochemical measurements exceed DOE DCGs applicable to a drinking water system (that is, exceed 1/25th of the DOE DCGs for public dose for ingestion of environmental water). Levels of tritium; cesium-137; uranium; plutonium-238; plutonium-239, -240; and gross alpha, beta, and gamma are all within the range of values observed in recent years.

In Pueblo Canyon, samples from APCO-1 showed detections of strontium-90 and plutonium-239, -240. This well had plutonium-239, -240 above the detection limit in most years since 1994. We have seen similar values in previous years in surface water and alluvial groundwater in Pueblo Canyon, because of past Laboratory discharges.

The samples of perched alluvial groundwater in Los Alamos and DP Canyons show residual contamination, as we have seen since the original installation of monitoring wells in the 1960s. LAO-C is upstream from known Laboratory sources and showed detections of americium-241, plutonium-238, and strontium-90. This well had one previous detection of americium-241 in 1980 and three previous detections of plutonium-238 during 1973. Strontium-90 was found in LAO-0.7, LAO-2, LAO-3A, and LAO-4. In LAO-1, LAO-2, and LAO-3A, the activity of strontium-90 usually approaches or exceeds the EPA primary drinking water MCL of 8 pCi/L. Plutonium-239, -240 was not detected in LAO-0.7, for the second year since 1993. LAO-2 and LAO-3A showed gross beta activities approaching or exceeding the drinking water screening level of 50 pCi/L.

The perched alluvial groundwater samples from Mortandad Canyon showed activities of radionuclides within the ranges observed previously. Tritium; strontium-90; cesium-137; plutonium-238; plutonium-239, -240; americium-241; and gross alpha, beta, and gamma are usually detected in many of the wells. The radionuclide levels are in general highest nearest to the TA-50 RLWTF outfall at well MCO-3 and decrease down the canyon. The levels of tritium, strontium-90, and gross beta usually exceed EPA drinking water criteria in many of the wells. In some years, the levels (except for tritium) exceed the DOE drinking water system DCGs, but the levels do not exceed the DOE DCGs for public dose for ingestion of environmental water. Tritium in MCO-3 and strontium-90 in MCO-3, MCO-5, and MCO-6 exceeded the EPA MCL. EPA has no drinking water criteria for plutonium-238, plutonium-239, -240, or americium-241. Except for americium-241 in MCO-3, the DOE Drinking Water System DCGs for these latter radionuclides were not exceeded in Mortandad Canyon alluvial groundwater in samples taken in 2000. For MCO-5, MCO-6, and MCO-7, the detections of plutonium-238, plutonium-239, -240, and americium-241 were not always consistent among the samples for a well. For example, in MCO-5 and MCO-7, plutonium-238 was only found in the filtered sample and plutonium-239, -240 only in the unfiltered sample. In MCO-6, plutonium-238 was found in the unfiltered sample but only one of two filtered samples, whereas plutonium-239, -240 was found only in the unfiltered sample.

c. Radiochemical Constituents in Intermediate-Depth Perched Groundwater. In the 1950s, based on measurements of water levels and major inorganic ions, the USGS established that contaminated surface water and perched alluvial groundwater in Pueblo Canyon recharge the intermediate-depth perched zone water that underlies the canyon floor (Weir et al., 1963; Abrahams 1966). Taken over time, the radionuclide activity measurements in samples from Test Well (TW) 1A, TW-2A, and Basalt Spring in Pueblo and Los Alamos Canyons confirm this connection. TW-2A, furthest upstream and closest to the historical discharge area in Acid Canyon, has shown the highest levels. In 2000, we sampled only Basalt Spring and POI-4 (an intermediate-depth well located near TW-1A). Strontium-90 was detected in the Basalt Spring sample. The sample from the Water Canyon Gallery, which lies southwest of the Laboratory, was consistent with previous results, showing no evidence of radionuclides from Los Alamos operations.

4. Nonradiochemical Analytical Results

Table 5-31 lists the results of general chemical analyses of groundwater samples for 2000, and results of trace metal analyses appear in Table 5-32.

a. Nonradiochemical Constituents in the Regional Aquifer. With the exceptions discussed here, values for all parameters measured for environmental surveillance sampling in the water supply wells are within drinking water limits. Separate samples were collected from the public water supply system to determine regulatory compliance with the Safe Drinking Water Act, and these samples were all in compliance for 2000 (see Section 2.B.9).

The test wells in the regional aquifer showed levels of several constituents that approach or exceed standards for drinking water distribution systems. However, it should be noted that the test wells are for monitoring purposes only and are not part of the water supply system. TW-1 had a nitrate value of 5.3 mg/L (nitrate as nitrogen), again below the EPA primary drinking water standard of 10 mg/L. This test well has shown nitrate levels in the range of about 5 to 20 mg/L (nitrate as nitrogen) since the early 1980s. The source of the nitrate might be infiltration from sewage treatment effluent released into Pueblo Canyon or residual nitrates from the now decommissioned TA-45 radioactive liquid waste treatment plant that discharged effluents into upper Pueblo Canyon until 1964. Nitrogen isotope analyses the ER Project made during 1998 indicate that the nitrate is from a sewage source (Nylander et al., 1999).

The average fluoride values since 1951 for TW-4 and since 1960 for TW-8 are about 0.2 mg/L. TW-4 and TW-8 both showed fluoride at 0.88 mg/L, or 55% of the New Mexico groundwater limit. Only a few values near this level were seen in each well during the 1960 to 1964 period, which suggests an analytical laboratory error during that time. The 2000 samples from these wells may also have suffered from a laboratory or sampling error; they were collected on the same date.

Over the past few years, sporadic detections of selenium have apparently occurred in groundwater and surface water samples. The values are near the detection limit and do not occur consistently at a given station. We suspect these results reflect the uncertainties of chemical analysis near the detection limit rather than the presence of selenium. Six groundwater samples and several surface water samples showed an apparent detection of selenium in 1998. Typically, we have not detected selenium in groundwater on the Pajarito Plateau. Selenium was found in Los Alamos Canyon alluvial groundwater and in each of the three DT series test wells at TA-49. We detected no selenium at these sites in 1999, suggesting that the previous year's values, which were close to the detection limit, did not indicate its presence. In 1999, we detected selenium at low levels at Spring 1 and Spring 9. For 2000, selenium was found in regional aquifer samples at TW-2, TW-3, TW-4, Spring 4, Spring 6, and Spring 10 and San Ildefonso wells LA-5 and New Community Well. Selenium was also found in LAO-2, MCO-2, MCO-6, CDBO-6, and one deionized water (DI) blank.

In the last few years, iron, manganese, cadmium, nickel, antimony, and zinc have been high in several of the regional aquifer test wells. Levels of trace metals that approach water quality standards in some of the test wells are believed to be associated with turbidity of samples and with the more than 40-year-old steel casings and pump columns. The lead levels appear to result from flaking of piping installed in the test wells and do not represent lead in solution in the water (ESP 1996). In 2000, iron approached or exceeded the EPA secondary drinking water standard in Test Wells 1, 2, 3, and 4 and exceeded the New Mexico groundwater limit in Test Wells 2 and 4. Manganese approached or exceeded the EPA secondary drinking water standard in Test Wells 1, 2, and 4 and exceeded the New Mexico groundwater limit in Test Well 2. Test Wells 1, 2, and 4 had lead concentrations above the EPA action level, and Test Wells 1, 2, 3, and 4 had antimony concentrations just below the EPA MCL.

Samples collected for metals analysis from most of the White Rock Canyon springs were filtered in 2000. Many of the springs have very low flow rates, and we collected samples in small pools in contact with the surrounding soils. Spring 10 had a manganese concentration exceeding the New Mexico groundwater limit. Except for selenium, none of the springs showed trace metals at levels of concern in 2000.

Perchlorate is a nonradioactive chemical compound containing a chlorine atom bound to four oxygen atoms and is used in a variety of industrial processes. At the Laboratory, perchlorate is a byproduct of the perchloric acid used in nuclear chemistry research. Industrial perchlorate uses also include solid fuels for rockets, high explosives, and fireworks; air-bag inflators; and electroplating, leather tanning, and rubber manufacturing. The EPA has not established a drinking water standard for perchlorate. Perchlorate is on the EPA's contaminant candidate list, which under the Safe Drinking Water Act requires background investigations to determine an MCL. According to an EPA fact sheet, present toxicology information suggests a provisional cleanup level of 4–18 ppb. The State of California, which has perchlorate contamination in drinking water supplies in some areas, has established a perchlorate water-supply action level for concentrations greater than 18 ppb. The State of New Mexico has not established an action level or regulatory standards for perchlorate.

In 2000, surface water and groundwater samples collected by the Environmental Surveillance Program were analyzed for perchlorate. Perchlorate was detected in samples collected during 2000 from the O-1 water-supply well at concentrations of 1.9 to 5 ppb (Table 5-33). The analytical laboratory J-flagged all but one of the analytical results (of 5 ppb), meaning that the results are below the reporting limit and the quantities are estimated. Following the initial discovery, we have sampled O-1 monthly for perchlorate. The chemical was first detected in O-1 in late June during regular sampling that is part of the Laboratory's water quality-assurance activities. Follow-up sampling confirmed its presence. The source of perchlorate may be effluent from the Manhattan Project and early cold-war-era radioactive liquid waste treatment facilities that discharged into Acid Canyon until 1964. Other water supply wells are sampled on a semiannual basis, and none have shown perchlorate in samples.

Perchlorate was also found in Spring 4 at 8.5 ppb. A confirmation sample was collected in 2001, but results are not available. One sample from Test Well 1 showed perchlorate at 2.8 ppb (the analytical laboratory J-flagged the analytical result, meaning that the result was below the reporting limit and the quantity was estimated), but a field duplicate did not detect perchlorate.

b. Nonradiochemical Constituents in Alluvial Groundwater. The canyon bottom perched alluvial groundwater in Pueblo, Los Alamos, and Mortandad Canyons receives effluents. The groundwater shows the effects of those effluents in that values of some constituents are elevated above natural levels.

Many of the Mortandad Canyon alluvial groundwater samples in Table 5-34 had fluoride and nitrate concentrations greater than half the New Mexico groundwater standards. The nitrate source is nitric acid from plutonium processing at TA-55 that enters the TA-50 waste stream. In response to a letter of noncompliance from NMED, in March 1999 the RLWTF instituted a program to restrict the discharge of nitrogenous wastes into the facility's collection system. As shown in Figure 5-22, the nitrate (nitrate as nitrogen) concentration of effluent discharge from the RLWTF after March 1999 has been less than 10 mg/L. The concentration of fluoride in the RLWTF effluent after August 1999 has been less than the 1.6 mg/L standard.

Under the Laboratory's groundwater discharge plan application for the RLWTF, we collected separate samples for nitrate, fluoride, and TDS approximately bimonthly from three alluvial monitoring wells in Mortandad Canyon during 2000: MCO-3, MCO-6, and MCO-7. We reported the analytical results quarterly to the NMED. During 2000, nitrate concentrations in alluvial groundwater wells MCO-3 and MCO-6 were below the New Mexico groundwater standard for nitrate of 10 mg/L (nitrate as nitrogen), as Figure 5-22 shows. The nitrate concentration in MCO-7 has been below the NMWQCC groundwater standard since June 2000. Beginning in June 1999, fluoride concentrations (with the exception of the October 2000 value in MCO-7) at all three wells have been below the NMWQCC groundwater standard for fluoride of 1.6 mg/L, as shown in Figure 5-22.

Six groundwater samples and several surface water samples showed an apparent detection of selenium in 1998. Typically, we have not detected selenium in groundwater on the Pajarito Plateau. For 2000, selenium was found in LAO-2, MCO-2, MCO-6, CDBO-6, and one DI Blank.

LAO-2 continued to show levels of molybdenum just below the New Mexico groundwater limit, and LAO-3A had molybdenum well above the limit. LAO-2 and LAO-3A had beryllium above the EPA drinking water MCL, and MCO-2 had a value below the MCL.

The Cerro Grande fire caused high manganese, aluminum, and iron concentrations in many surface water and shallow alluvial perched groundwater samples. Higher than usual manganese concentrations were also found in APCO-1, LAO-C, and MCO-2. These concentrations exceeded the New Mexico groundwater limit by factors of four to 12. Iron levels in APCO-1, MCO-2, and MCO-7.5 were above the New Mexico groundwater limit. LAO-2, LAO-3A, and CDBO-6 had iron values just below half the New Mexico groundwater limit. LAO-2, LAO-3A, and MCO-7.5 had aluminum values that were about 20% of the New Mexico limits for use as irrigation water.

Perchlorate was detected in groundwater at MCO-3, MCO-5, MCO-6, MCO-7, and MCO-7.5. Perchlorate concentrations ranged from 33 ppb to 400 ppb (see Table 5-34). The perchlorate source is discharges from the TA-50 RLWTF, which processes waste water from analytical chemistry facilities that perform actinide chemistry.

c. Nonradiochemical Constituents in Intermediate-Depth Perched Groundwater. In 2000, the nitrate value for Basalt Spring was 160% of the NMWQCC groundwater and EPA drinking water standards. The source of the nitrate is infiltration of contaminated surface water and shallow groundwater from Pueblo Canyon. Basalt Spring had a low concentration of selenium. Otherwise, the intermediate-depth perched groundwater samples from Basalt Spring, POI-4 in lower Pueblo Canyon, and the Water Canyon gallery did not show any concentrations of nonradiochemical constituents that are of concern.

d. Organic Constituents in Groundwater. We performed analyses for organic constituents on selected springs and test wells in 2000. The stations sampled appear in Table 5-35. Some samples were analyzed for VOCs, SVOCs, and PCBs. We analyzed water supply wells, test wells, and most springs for HE constituents. No HE constituents were found above the analytical laboratory's reporting limit in the groundwater samples listed in Table 5-35. We rejected most of the possible organic detections reported by the analytical laboratory because the compounds were either detected in method blanks (that is, they were introduced during laboratory analysis) or detected in trip blanks. Trip blanks go along during sampling to determine if organic constituents come from sample transportation and shipment. Table 5-36 shows organic compounds detected above the analytical laboratory's reporting level in 2000, as well as results from blanks. Most of the compounds detected were also found in accompanying blanks. The exceptions are the finding of Aroclor-1260 and benzoic acid at Test Well 4; methyl-2-pentanone[4-] and butanone [2-] at LAO-0.7; and toluene in Spring 10. Toluene is often found as a result of contamination during analytical laboratory organic analysis.

In 1998, drilling of characterization well R-25 at TA-16 in the southwest portion of the Laboratory revealed the presence of HE constituents at concentrations above the EPA Health Advisory guidance values for drinking water. Consequently, the Laboratory tested all nearby water supply wells for these compounds. None of the analytical laboratories detected any HE or their degradation products in any of the water samples from any of the supply wells sampled. We sample all water supply wells annually for HE compounds. The three wells nearest to TA-16 (PM-2, PM-4, and PM-5) are sampled quarterly. PM-2, 4, and 5 are closest to R-25 where HE was found in groundwater in 1998. We did not find HE in any of the water supply well samples in 2000.

5. Long-Term Trends

a. Regional Aquifer. The long-term trends of water quality in the regional aquifer have shown limited impact resulting from Laboratory operations. As noted above, in 1998, drilling characterization well R-25 at TA-16 in the southwest portion of the Laboratory revealed the presence of HE constituents. No HE constituents have been found in water supply wells. The extent of high explosives in the regional aquifer is presently unknown. The Laboratory is working in cooperation with regulatory agencies to define the extent of the contamination and ensure that drinking water supplies are adequately protected.

Aside from naturally occurring uranium, the only radionuclide we consistently detected in water samples from production wells or test wells within the regional aquifer is tritium, which is found at trace levels. We have found tritium contamination at four locations in Los Alamos and Pueblo Canyons and one location in Mortandad Canyon. The tritium levels measured range from less than 2% to less than 0.01% of current drinking water standards, and all are below levels detectable by the EPA-specified analytical methods normally used to determine compliance with drinking water regulations. Tritium at about 40 pCi/L was found in water supply well O-1. Other measurements of radionuclides above detection limits in the regional aquifer reflect occasional analytical outliers not confirmed by analysis of subsequent samples.

Nitrate concentrations in TW-1 have been near the EPA MCL since 1980. The source of the nitrate might be infiltration of sewage-effluent-contaminated shallow groundwater and surface water in Pueblo Canyon or residual nitrates from the now decommissioned radioactive liquid waste treatment plants that discharged effluents into upper Pueblo Canyon until 1964. Perchlorate is present in water supply well O-1 at concentrations up to 5 ppb, compared to provisional drinking water limits of 18 ppb. The source of the perchlorate might be residual perchlorate from the now decommissioned radioactive liquid waste treatment plants that discharged effluents into upper Pueblo Canyon until 1964.

b. Surface Water and Alluvial Groundwater in Mortandad Canyon. Figure 5-23 depicts long-term trends of radionuclide concentrations in surface water and shallow perched alluvial groundwater in Mortandad Canyon downstream from the outfall for the RLWTF at TA-50. Because of strong adsorption to sediments, cesium-137 is not detected in groundwater samples. The figure only shows radionuclide detections. If more than one sample was collected in a year, the average value for the year is plotted. The surface water samples are from the station Mortandad at GS-1, a short distance downstream of the TA-50 effluent discharge. Radioactivity levels at this station vary daily depending on whether individual samples are collected shortly after a release from the RLWTF. These samples also vary in response to changes in amount of runoff from other sources in the drainage. The groundwater samples are from observation well MCO-5 in the middle reach of the canyon. Groundwater radioactivity at MCO-5 is more stable than at Mortandad at GS-1 because groundwater responds more slowly to variations in runoff water quality.

Chemical reactions such as adsorption do not delay tritium transport, and high tritium activities are found throughout the groundwater within the Mortandad Canyon alluvium. The tritium level in MCO-5 in 2000 was below the EPA MCL of 20,000 pCi/L, whereas that at Mortandad at GS-1 was above the MCL. The surface water tritium activity at Mortandad at GS-1 reflects diluted values of effluent from TA-50 as the effluent mixes with other stream water. The tritium activity at MCO-5 has fluctuated almost in direct response (with a time lag of about one year) to the average annual activity of tritium in the TA-50 outfall effluent. Tritium values at both stations have decreased since the mid-1980s because of decreased tritium content of the TA-50 effluent.

For all but four years between 1973 and 1999, the americium-241 activity of RLWTF discharges exceeded the DOE DCG for public dose of 30 pCi/L. Americium-241 activity has not been measured regularly at monitoring stations in Mortandad Canyon. Under many environmental conditions, americium is less strongly adsorbed than cesium or strontium and moves more readily in groundwater. Except for MCO-3, americium-241 activity in the shallow alluvial groundwater in 2000 was below the DOE drinking water DCG of 1.2 pCi/L. Americium-241 at Mortandad at GS-1 showed an increase in activity to near the DOE DCG for public dose from 1995 to 1998 but decreased in 1999 and 2000. At MCO-5, the americium-241 activity showed only a slight increase from 1995 to 1998 and a decline over the past few years.

In 2000, we detected strontium-90 in surface water at Mortandad at GS-1 and in all shallow perched alluvial groundwater observation wells upstream of and including MCO-7, as well as at MCO-2 upstream of the TA-50 outfall. The activities at many wells remain at values in the range of the EPA drinking water standard (8 pCi/L) and the DOE DCG for a DOE-maintained drinking water system (40 pCi/L) and range up to 60 pCi/L. Strontium-90 has previously been detected only once downstream of MCO-6B (or MCO-6), in MCO-8 in 1976. It appears that strontium-90 has been retained by adsorption or mineral precipitation within the upstream portion of the alluvium. The level of strontium-90 has risen gradually at downstream wells MCO-5 and MCO-6 over the last 20 years suggesting that the mass of the radionuclide is moving slowly downstream.

We detected plutonium isotopes at Mortandad at GS-1, MCO-3, MCO-5, MCO-6, and MCO-7.5 in 2000. Both isotopes have been detected at Mortandad at GS-1 and MCO-3 at levels near the DOE public dose DCGs (30 pCi/L for plutonium-239, -240 and 40 pCi/L for plutonium-238) over the past few years. Values at other alluvial observation wells except for MCO-4 and MCO-7.5 have been near the detection limit in the 1990s. Plutonium has in general been detected in all alluvial observation wells in Mortandad Canyon but appears to be decreasing in activity at downstream locations.

G. Groundwater and Sediment Sampling at San Ildefonso Pueblo

To document the potential impact of Laboratory operations on lands belonging to San Ildefonso Pueblo, DOE entered into a Memorandum of Understanding (MOU) with the Pueblo and the Bureau of Indian Affairs in 1987 to conduct environmental sampling on pueblo land. This section deals with hydrologic and sediment sampling. Figures 5-24 and 5-25 show the groundwater, surface water, and sediment stations sampled on San Ildefonso Pueblo. Aside from stations shown on those figures, the MOU also specifies collection and analysis of additional water and sediment samples from sites that have long been included in the Laboratory's Environmental Surveillance Program, as well as special sampling of storm runoff in Los Alamos Canyon. These locations appear in Figures 5-3, 5-4, 5-6, 5-7, and 5-17. We discuss the results of these analyses in previous sections.

1. Groundwater

Table 5-27 lists the results of radiochemical analyses of groundwater samples for 2000. The table also lists the total propagated one sigma analytical uncertainty and the analysis-specific minimum detectable activity where available. Uranium was analyzed by isotopic methods rather than as total uranium for most samples in 2000; total uranium was calculated from these values using specific activities for each isotope.

To emphasize values that are detections, Table 5-28 lists radionuclides detected in groundwater samples. Detections are defined as values exceeding both the analytical method detection limit (where available) and three times the individual measurement uncertainty. Qualifier codes are shown because some analytical results that meet the detection criteria are not detections: in some cases, the analyte was found in the lab blank or was below the method detection limit, but the analytical result was reported as the minimum detectable activity. Because uranium, gross alpha, and gross beta are usually detected, we indicate in Table 5-28 only occurrences of these measurements above threshold values. The specific levels are 5 µg/L for uranium, 5 pCi/L for gross alpha, and 20 pCi/L for gross beta and are lower than the EPA MCLs or screening levels.

The right-hand columns of Table 5-28 indicate radiochemical detections that are greater than one-half the DOE DCGs for public dose for ingestion of environmental water or the standards shown. No groundwater values exceeded half the DOE public dose DCG values in 2000.

See Section 5.F for a discussion of most of the groundwater stations (wells and springs) listed in the MOU. The present section focuses on the San Ildefonso Pueblo water supply wells.

Numerous apparent detections of plutonium isotopes (most near the detection limit) occurred in regional aquifer well and spring waters. Analysis of laboratory or field duplicates, which was done for many of the samples, did not support any of the apparent detections (and contradicted many of them). As plutonium isotopes are not regularly found in these waters, it is likely that the results are analytical artifacts. We plan to collect additional samples in 2001 to check for the possibility of plutonium occurrence at these stations. Plutonium-238 was found in Test Well 3 (though not in a duplicate analysis), Sandia Spring, and Spring 2 and at San Ildefonso wells LA-5, Pajarito Well Pump 1 (though not in a duplicate analysis), Don Juan Playhouse, Otowi House, and New Community (though not in a field duplicate). Plutonium-239, -240 was apparently detected in Test Well 3 (though not found in a duplicate analysis) and New Community Well (though not found in a field duplicate).

As in previous years, the groundwater data for San Ildefonso Pueblo indicate the widespread presence of naturally occurring uranium at levels approaching or in excess of the EPA drinking water limit. Naturally occurring uranium concentrations near the EPA MCL of 30 µg/L are prevalent in well water throughout the Pojoaque area and San Ildefonso Pueblo. The high gross alpha readings for these wells are related to uranium occurrence.

In 2000, New Community well had the highest total uranium, with values of 28.9 µg/L and 25.5 µg/L found in duplicate analyses. Uranium concentrations at the Don Juan Playhouse and Sanchez House Wells and Pajarito Well Pump 1 were about 25% of the standard. These measurements are consistent with the levels in previous samples and with the relatively high levels of naturally occurring uranium in other wells and springs in the area.

The usual gross alpha levels in these wells are attributable to the presence of uranium. The gross alpha values in some wells were above the EPA primary drinking water standard of 15 pCi/L but were not detections because of high analytical uncertainties. This standard applies to gross alpha from radionuclides other than radon and uranium. Eastside Artesian well had a gross alpha value of 187 pCi/L, which is far larger than prior values and not supported by analysis of other radionuclides. The value is probably the result of analytical laboratory error, but we could not confirm this by the time of this report.

During the 1999 sampling, analytical laboratory problems caused many apparent detections of strontium-90 where it had not been seen previously. Levels of strontium-90 exceeding the drinking water MCL of 8 pCi/L were apparently detected in Test Wells 1, 3, 4, 8, DT-9, DT-10, and Sanchez House Well at San Ildefonso Pueblo. Strontium-90 was also detected in Los Alamos water supply wells G-1, G-1A, O-1, O-4, and PM-4 and San Ildefonso Pueblo water supply wells LA-5, Don Juan Playhouse Well, Pajarito Well Pump 1, and Eastside Artesian Well. Sacred Spring and Spring 8B also showed strontium-90 detections. LANL believes that none of these 1999 detections are valid and that they are due to analytical laboratory problems. We sent data collected during 2000 to outside analytical laboratories, which achieved lower detection limits for strontium-90 analysis. The 2000 data support the conclusion that much of the 1999 strontium-90 data were subject to analytical error; no strontium-90 was detected in any of these wells.

The chemical quality of the groundwater, shown in Table 5-31, is consistent with previous observations. The sample from the Pajarito Well Pump 1 exceeded the drinking water standard for total dissolved solids; this level is similar to those previously measured. This well also has a chloride concentration at 60% of the New Mexico groundwater limit.

Perchlorate is a nonradioactive chemical compound containing a chlorine atom bound to four oxygen atoms and is used in a variety of industrial processes. At the Laboratory, perchlorate is a byproduct of the perchloric acid used in nuclear chemistry research. Industrial perchlorate uses also include solid fuels for rockets, high explosives, and fireworks; air-bag inflators; and electroplating, leather tanning, and rubber manufacturing. The EPA has not established a drinking water standard for perchlorate. Perchlorate is on the EPA’s contaminant candidate list, which under the Safe Drinking Water Act requires background investigations to determine an MCL. An EPA fact sheet indicates that present toxicology information suggests a provisional cleanup level of 4–18 ppb. The State of California, which has perchlorate contamination in drinking water supplies in some areas, has established a perchlorate water-supply action level for concentrations greater than 18 ppb. The State of New Mexico has not established an action level or regulatory standards for perchlorate. In 2000, the Environmental Surveillance Program collected surface water and groundwater samples for perchlorate analysis.

One sample from New Community Well showed perchlorate at 1.7 ppb (the analytical laboratory J-flagged the analytical result, meaning that the result was below the reporting limit and the quantity was estimated), but a field duplicate did not detect perchlorate. Perchlorate was found at 2.4 ppb in Pajarito Well Pump 1, but the analytical laboratory J-flagged the result.

The fluoride values for some wells (Eastside Artesian and Sanchez House) are near the NMWQCC groundwater standard of 1.6 mg/L, similar to previous values. Several of the wells (Eastside Artesian and Don Juan Playhouse) have alkaline pH values above the EPA secondary standard range of 6.8 to 8.5; these values do not represent a change from those previously observed in the area.

Many of the wells have sodium values significantly above the EPA health advisory limit of 20 mg/L. The values from Pajarito Well Pump 1, Sanchez House, and Eastside Artesian Wells are especially high.

Table 5-32 shows trace metal analyses. The boron value in Pajarito Well Pump 1 was nearly twice the NMWQCC groundwater limit of 750 µg/L. This value was similar to those of past years. Wells LA-5 and New Community Well had detectable selenium. Silver in the Sanchez House well was 90% of the New Mexico groundwater limit.

2. Sediments

We collected sediments from San Ildefonso Pueblo lands in Mortandad Canyon in 2000 from several stations. The results of radiochemical analysis of sediment samples collected in 2000 appear in Table 5-20. The table also lists the total propagated one sigma analytical uncertainty and the analysis-specific minimum detectable activity where available. Uranium was analyzed by isotopic methods rather than as total uranium for most samples in 2000; total uranium was calculated from these values using specific activities for each isotope.

To emphasize values that are detections, Tables 5-21 (river sediments) and 5-22 (reservoir sediments) list radiochemical detections for values that are higher than river or reservoir background levels and identify values that are near or above SALs. Table 5-21 shows all tritium detections regardless of screening levels. Detections are defined as values exceeding both the analytical method detection limit (where available) and three times the individual measurement uncertainty. Lab qualifier codes are shown because some analytical results that meet the detection criteria are not detections: in some cases, the analyte was found in the lab blank or was below the method detection limit, but the analytical result was reported as the minimum detectable activity. Results from the 2000 sediment sample analysis are generally consistent with historical data.

Downstream of the sediment traps in Mortandad Canyon at stations MCO-9, MCO-13, A-6, and Mortandad at SR-4 (A9), plutonium-239, -240 activity ranged from 1.3 to 2.6 times background values. Although the data are comparable to previous years, the comparison with background is much higher than given for the last 15 years, reflecting a change in the background value from 0.023 pCi/g to 0.013 pCi/g. Based on the former background value, results at these stations range from 0.7 to 1.5 times background. Other, not yet published, results from these stations based on isotopic ratios support the new smaller background value.

Sediments from the sampling station located on San Ildefonso Pueblo lands at Los Alamos at Otowi showed the activity of plutonium-239, -240 at 13 times background. This value is within the range of previous measurements at this station.

H. Sampling Procedures, Analytical Procedures, Data Management, and Quality Assurance

1. Sampling

The Draft Quality Assurance Project Plan (ESH-18 1996) is the basic document covering sampling procedures and quality assurance (QA). All sampling is conducted using strict chain-of-custody procedures, as described in Gallaher (1993). The completed chain-of-custody form serves as an analytical request form and includes the requester or owner, sample barcode number, program code, date and time of sample collection, total number of bottles, the list of analytes to be measured, and the bottle sizes and preservatives for each analysis required. In 2000, we sent samples to the Laboratory's Chemical Science and Technology (CST) Division and to two commercial analytical laboratories, Paragon Analytics, Inc. (Paragon), and General Engineering Laboratories (GEL). CST followed the detailed analytical methods published in Gautier (1995). Paragon and GEL were instructed to follow the Model Statement of Work for Analytical Laboratories (SOW) that was prepared for the DOE Albuquerque Operations Office (AQA 2000). An addendum describing specific requirements and guidelines for analysis of runoff, industrial wastewater, surface water, groundwater, and sediment samples accompanied the SOW. Paragon and GEL were audited against the SOW using procedures that were developed by the DOE-AL Analytical Management Program and are described in AGRA (1998). Paragon and GEL were awarded contracts only after they demonstrated that they met the requirements described in the SOW.

The "F/UF" column on the tables of analytical results shows a "UF" for nonfiltered samples and an "F" for samples that were filtered through a 0.45-micron filter. We field filtered radionuclide and metals samples collected at the White Rock Canyon Springs to minimize the effects of surface soils and to represent groundwater surfacing at the springs. We also field filtered surface water samples that were collected for metals analysis. This procedure allows for comparison of analytical results with the NMWQCC standards. These standards are mainly for dissolved concentrations, except mercury and selenium, for which standards are based on total concentrations. Mercury and selenium were not filtered in the field and were analyzed to determine total concentration.

Automated samplers located at recently installed gaging stations (Shaull et al., 2000) collected runoff. The contents of bottles the automated samplers collected were first transferred to a churn splitter. That apparatus agitates the samples to ensure that they are well mixed and that the sediments are suspended. If the automated sampler collected an adequate volume of water, we submitted two sets of samples to the analytical laboratory. One set was unfiltered, preserved, and submitted for total analyte concentration analysis. The other set was filtered, preserved, and submitted for dissolved analyte analysis. If there was insufficient volume, only unfiltered samples were analyzed.

2. Analytical Procedures

a. Metals and Major Chemical Constituents. Runoff samples, surface water, and fire-related runoff samples are analyzed by methods consistent with 40 CFR 136.3. Groundwater samples and sediments are analyzed using EPA SW-846 methods.

b. Radionuclides. Radiochemical analysis is performed using methods as updated in Gautier (1995) or described in the SOW. Radiological detection limits are calculated according to the equations in the SOW. Sources of uncertainty that are included in the total propagated uncertainty associated with radiological results include both counting uncertainties and sample preparation (measurement) contributors.

We field preserve water samples for radiochemical analyses with nitric acid to a pH of 2 or less. Before 1996, the analytical laboratories filtered the preserved water samples. Samples collected in 1996 and after were preserved in the field as before but were not filtered by the laboratories. We collect a separate, unpreserved sample for tritium analysis.

When trace-level tritium analyses are required, we ship samples to the University of Miami Tritium Laboratory. These samples are collected and analyzed according to procedures described in Tritium Laboratory (1996).

Negative values are sometimes reported in radiological measurements. Negative numbers occur because radiochemistry counting instrument backgrounds must be subtracted to obtain net counts. Because of slight background fluctuations, individual values for samples containing little or no activity can be positive or negative numbers. Although negative values do not represent a physical reality, we report them as they are received from the analytical laboratory. Valid long-term averages can be obtained only if negative values are included in the analytical results.

c. Organic Compounds. See Table A-9 for organic methods and analytes of groundwater and sediments analysis. Tables A-10 through A-13 list the specific compounds that are analyzed in each suite. All samples we submit for organic chemistry analyses are collected in brown glass bottles, and the aqueous VOC samples are preserved with hydrochloric acid. A trip blank or field blank always accompanies the VOC samples. In addition, most analytical methods require the analysis of laboratory-prepared method blanks or instrument blanks with each batch of samples. Organic target analytes that are detected in these blanks indicate contamination from the sampling or analytical environments. Certain organic compounds used in analytical laboratories are frequently detected in blanks. That is, contamination introduced by the laboratories is common for these compounds. These compounds include acetone, methylene chloride, toluene, 2-butanone, di-n-butyl phthalate, di-n-octyl phthalate, and bis(2-ethylhexyl)phthalate (Fetter 1993).

3. Data Management and Quality Assurance

a. Data Management. Analytical laboratories submit analytical results to ESH-18 both electronically and in paper report form. The status of analyses is tracked with an internal database, and final analytical results are also stored in a database. New analytical data are validated according to the specifications of the DOE-AL Model Data Validation Procedure (AQA 2001). The ESH-18 technical representative performs technical oversight of analytical laboratories, with the assistance of the DOE-AL Analytical Management Program.

b. Quality Assurance. The SOW for analytical chemistry gives detailed requirements for the content of subcontract laboratory QA plans. That SOW also describes the exact requirements for handling ESH-18 samples, from initial sample receipt to the final data report. All of the applicable requirements for batch quality control (QC), which may include method blanks, matrix spikes, laboratory control samples, calibration verifications, detection limit verifications, etc., are discussed in that document.

In addition to batch QC performed by laboratories, ESH-18 submits occasional performance evaluation (PE) samples to test analytical laboratory proficiency and spot check for analytical problems. These PE samples include blanks and samples spiked with known amounts of analyte (knowns). Also, field quality control samples often include field duplicates.

Tables 5-37 through 5-39 present the radiochemical analytical results for the blanks and knowns. Tables 5-40 and 5-41 present the analytical results for the blanks and knowns submitted for metals analysis. The analytical result tables present the analytical results for the field duplicates. No PE samples were submitted for sediment analyses because soil PE samples are easily recognized by the laboratories. Similarly, PE samples are easily distinguishable from runoff, so we don’t send PE samples with runoff samples.

The analytical laboratories ESH-18 used in 2000 participated in the DOE Quality Assessment Program (QAP), which is an external, independent, performance evaluation program. The QAP is designed to test the quality of the environmental measurements that its contractor laboratories report to DOE. The Environmental Measurements Laboratory (EML) administers the QAP for the DOE Office of Environmental Management (EM). The QAP meets the requirements of DOE Order 414.1A, which requires DOE facilities to substantiate, by an external assessment, the quality of radiochemical analyses by their subcontract analytical laboratories. The QAP Web site describes the history and objectives of the program in detail (*http://www.eml.doe.gov/qap*).

The Mixed Analyte Performance Evaluation Program (MAPEP) is another external, independent program that includes radionuclides and hazardous waste contaminants that are covered by the Resource Conservation and Recovery Act (RCRA).

The SOW for analytical chemistry laboratories requires contributing laboratories to participate in both the QAP and MAPEP. Results from these DOE PE programs are categorized as acceptable (result within the two-sigma acceptance range), acceptable with warning (result within the three-sigma acceptance range), and not acceptable (result outside the three-sigma acceptance range). The laboratories initiate internal corrective actions when PE results are categorized as not acceptable, and those corrective actions are spot checked during various laboratory oversight activities. Tables 5-42 through 5-48 give the

QAP results for each laboratory. Tables 5-49 through 5-54 give the MAPEP results for each laboratory.

PE Sample Results Summaries for Analytical Laboratories

Paragon Analytics

ESH-18 submitted both spiked and blank PE samples to Paragon for strontium-90 analysis (see Table 5-37). All of the results obtained were acceptable.

Paragon scored an acceptable with warning for stronium-90 in water in QAP 52 (see Table 5-43) and an acceptable with warning for selenium in soils in MAPEP-00-S7 (see Table 5-52). All other year 2000 QAP (Tables 5-42–5-44) and MAPEP results (Tables 5-49 and 5-52) for relevant analytes were rated as acceptable.

Paragon analyzed our strontium-90 samples for all matrices. The only other samples we submitted to Paragon were runoff samples. Because QA samples contain no suspended solids, the analytical laboratories would clearly recognized them as QA samples. For this reason, we do not submit spikes or DI blanks to the laboratories with runoff samples.

General Engineering Laboratories

ESH-18 submitted both blank and spiked PE water samples to GEL (see Tables 5-38 and 5-40). The spiked samples included tritium, strontium-90, plutonium-238, plutonium-239, and americium-241. All reported analytical results for the blanks were acceptable. All of the spiked sample results were acceptable or acceptable with warning except for one mercury, one tritium, and one strontium-90.

The unacceptable mercury result was less than the detection limit. However, GEL observed during sample login that the pH of the sample was neutral (7). Mercury will not stay in solution at neutral pH, and analysis of such a compromised water sample is expected to yield extremely low results. Results for improperly preserved samples are not considered in our evaluation and need not initiate corrective action.

For the tritium and strontium-90 results that were not acceptable, no errors in the analytical work could be found and the bracketing PE (see Tables 5-45 through 5-47) results for like matrices were acceptable.

The strontium-90 sample was submitted in September of 2000. The expected value for that sample was 5 pCi/L, and the analytical result was less than the detection limit. Review of the corresponding batch QC showed that all of the QC sample results passed the applicable acceptance criteria. In addition, review of the DOE QAP results for water samples submitted in GEL's QAP rounds 51, 52, and 53 (bracketing the analysis in question) showed that acceptable results were obtained in all cases. Also, review of analysis of PE samples from Environmental Resource Associates (a nationally certified PE provider) for August 2000 and October 2000 (see Tables 5-45 through 5-47) (bracketing the analysis in question) showed acceptable PE results for strontium-90. It is likely in this case that an error in preparation of the PE sample, not an analytical error, was the root cause of the PE sample failure. The preparing laboratory (CST) did not perform any analyses to verify correct preparation; therefore, no corroborating analytical data exist.

We also submitted the tritium sample in September of 2000. The expected value for that sample was 10,000 pCi/L, and the analytical result was less than the detection limit. Review of the corresponding batch QC showed that all of the QC sample results passed the applicable acceptance criteria. In addition, review of the DOE QAP results for water samples submitted in QAP rounds 51, 52, and 53 (bracketing the analysis in question) showed that acceptable results were obtained in all cases (see Tables 5-45 through 5-47). It is likely in this case that an error in preparation of the PE sample, not an analytical error, was the root cause of the PE sample failure. The preparing laboratory (CST) did not perform any analyses to verify correct preparation; therefore, no corroborating analytical data exist.

GEL analyzed two QAP aqueous radionuclide samples in 2000. GEL scored an acceptable with warning in QAP 52 for americium-241 and plutonium-239, -240 (Table 5-46). The laboratory scored a not acceptable for plutonium-238. However, GEL scored acceptable for this parameter in both QAP 51 (Table 5-45) and QAP 53 (Table 5-47). QAP 53 also reports that GEL received acceptable scores for amercium-241 and plutonium-239, -240. In that round, the uranium-234 and uranium-238 analyses were scored at acceptable with warning.

Analysis of QAP soils reported in QAP 52 (Table 5-46) indicate that acceptable scores were achieved for all radionuclides except plutonium-239, -240 and strontium-90. GEL received acceptable with warning for plutonium-239, -240 and stronium-90. Soils analyses reported in QAP 53 (Table 5-47) show that GEL received acceptable with warning for thorium-234, uranium-234, and uranium-235. All other analyses were evaluated as acceptable. The MAPEP-00-S7 strontium-90 result was scored as not acceptable (see Table 5-53). GEL received acceptable evaluations for the other radionuclides mentioned above. GEL also received acceptable evaluations for the reported metals and organic compounds.

CST

ESH-18 did not request any strontium-90 analysis from CST in 2000.

ESH-18 submitted blank and spiked PE water samples to CST for radiochemistry analysis (see Table 5-39). The spiked samples included tritium, plutonium-238, plutonium-239, -240, and americium-241. The blank analysis results were all acceptable. A low-level detection for isotopic uranium was reported, but the associated two-sigma uncertainty window encompasses zero. We also submitted additional samples spiked with tritium, plutonium-238, plutonium-239, -240, and americium-241 to CST. All the results were acceptable, except for one americium-241 result that was acceptable with warning.

Blind PE blank and spiked water samples were submitted to CST for metals analyses (see Table 5-41). The spiked samples contained silver, barium, mercury, and lead. Several of the results obtained in the spikes and blanks fell outside the acceptable range. CST reported detections of barium, zinc, and strontium in two of the PE blanks. The spiked samples associated with the blanks showed less than the detection limit for zinc and strontium. The associated spiked sample was spiked with barium and had acceptable recovery. All of the rest of the detections in the blind PE samples CST analyzed were less than 2 times the MDL (the reporting limit for CST) and less than the quantitation limit.

MAPEP-99-W7 (Table 5-51) reports that CST received not acceptable scores for strontium-90, uranium-234, and uranium-238 in waters. On MAPEP-00-S7 (Table 5-54), CST received not acceptable scores for analysis of plutonium-238 and plutonium-239, -240 in soils.

Analytical Detections

For low-level radiochemical results, data are qualified based upon total propagated uncertainties and the proximity to the detection limits

Radiological detection limits are sample specific and are based on Currie's formula (Currie 1968) and are reported in the tables. The laboratories have determined detection limits for each of the other analytical methods. In deriving the detection limits, the laboratories included the average uncertainties associated with the entire analytical method. Sources of error considered include average counting uncertainties, sample preparation effects, digestion, dilutions, gravimetric and pipetting uncertainties, and spike recoveries.

Although these method detection limits determined by the analytical laboratories give an idea of the average limit of detection for a particular measurement technique, the detection limits do not apply to each individual sample measurement (except for radiological analysis). Instead, the question of whether or not an individual measurement is a detection is evaluated in light of its individual measurement uncertainty. For radiochemical analytical results, the analytical uncertainties are reported in the tables. These uncertainties represent a one standard deviation (one sigma) propagated uncertainty. “It is virtually unanimously accepted that an analyte should be reported as present when it is measured at a concentration three-sigma or more above the corresponding method blank” (Keith 1991). We report radiochemical detections as values greater than three times the reported uncertainty. For sediments, the values reported as detections in the table are also above-background levels determined for fallout (or natural background levels in the case of uranium).

The limit of quantification or LOQ is the level where the concentration of an analyte can be quantified with confidence. Again according to Keith (1991), “When the analyte signal is 10 or more times larger than the standard deviation of the measurements, there is a 99% probability that the true concentration of the analyte is ±30% of the calculated concentration.” Thus, measured values near the detection limit or less than 10 times the analytical uncertainty do not provide a reliable indication of the amount present. The importance of this number is demonstrated when analytical results are compared against standards; the analytical result should be greater than 10 times the analytical uncertainty for the comparison to be meaningful.

I. Unplanned Releases

1. Radioactive Liquid Materials

No unplanned radioactive liquid releases occurred in 2000.

2. Nonradioactive Liquid Materials

There were nine unplanned releases of nonradioactive liquid in 2000. Of the nine unplanned releases, three were directly caused by the Cerro Grande fire. The following is a summary of these discharges.

- One unplanned release of high-explosive wastewater.
- Two unplanned releases of sanitary sewage from the Laboratory's TA-46 SWS Facility's collection system.
- One unplanned release of fire water/foam from a fire-suppression system.
- One release of elemental mercury in a sink trap connected to the SWS Facility's collection system.
- One canyon slope mass wasting from a failed potable water line saturating the soil and causing the failure.
- Three oil or diesel fuel releases caused by the Cerro Grande fire or post-fire remediation efforts.

ESH-18 investigated all unplanned releases of liquids. Upon cleanup, personnel from NMED-DOE Oversight Bureau (DOB) inspected the unplanned release site to ensure adequate cleanup. NMED-DOB recommended that we administratively close out one of the nine unplanned releases that occurred in 2000. It is anticipated that the rest of the unplanned release investigations will be closed when NMED-DOB personnel become available for inspections.

J. Special Studies

1. Surface Water Data at Los Alamos National Laboratory: 2000 Water Year

The Laboratory collected and published surface water discharge data from approximately 23 stream-gaging stations and 3 spring stations that cover most of the Laboratory. Table 5-3a presents a summary of flow data form Water Year 2000. Gaging stations with discharge data in the report, LA-13814-PR, "Surface Water Data at Los Alamos National Laboratory: 2000 Water Year" (Shaull et al., 2001), show higher peak flows than ever recorded. Tables 5-3a and 5-3b present a summary of peak flows following the Cerro Grande fire. Section 5.D., Runoff, summarizes water chemistry data from these storm events.

The Laboratory's annual water data report contains flow data. The data collection network seeks to characterize runoff from all watersheds at the Laboratory. We publish data for gages that have a stage discharge relationship. ESH-18 operates and maintains this network of 62 stations.

The Cerro Grande fire damaged 21 stations to the point of being inoperable. After the fire, the floods on June 28, 2000, destroyed eight additional stations. These stations have been rebuilt.

K. Tables

Table 5-1. Upper Watershed Burn Intensity (%)

	Unburned	Low	Medium	High
Guaje	29	22	26	22
Rendija	0	2	10	88
Pueblo	0	2	1	96
Los Alamos	25	43	0.5	32
Pajarito	0	44	3	53
Water	6	49	5	40

Source: BAER 2000.

Table 5-2. Predicted Peak Flow (cfs) from Upper Watersheds: 25-yr, 1-hr Storm (1.9")

	Pre-Fire	Post-Fire	Treated
Guaje	7	437	NA
Rendija	1	2,398	1,740
Pueblo	9	1,278	983
Los Alamos	24	281	238
Pajarito	1	460	NA
Water	4	504	NA

Source: BAER 2000.

Table 5-3a. Summary of Discharges from Stream-Monitoring Stations at Los Alamos National Laboratory for Water Year 2000 (October 1, 1999–September 30, 2000)

Canyon Sites	Days with Flow	Volume of Water (Acre Feet)	Instantaneous Max (ft^3/s)
E025 Upper Los Alamos	53	97	60
E030 Middle Los Alamos	21	35	13
E040 DP Canyon at Mouth	14	30	117
E042 Lower Los Alamos[a]	22	27	17
E060 Pueblo[a]	365	618	114
E125 Sandia[a]	0	0	0
E200 Middle Mortandad	249	17	12
E202 Mortandad, above Sediment Traps	3	0.4	1.6
E203 Mortandad, below Sediment Traps	0	0	0
E204 Lower Mortandad[a]	0	0	0
E225 Upper Cañada del Buey	0	0	0
E230 Lower Cañada del Buey[a]	5	2.6	33
E240 Upper Pajarito[b]	25	57	1,020
E241 Pajarito at TA-22	276	95	300
E242 Starmer's Gulch at TA-22	365	46	180
E245 Middle Pajarito	8	20	517
E250 Lower Pajarito[a]	2	3.0	14
E252 Upper Water [b]	273	66	840
E253 Cañon de Valle[b]	1	52	740
E263 Water Canyon at State Rd. 4	19	61	306
E265 Lower Water[a]	22	53	271
E267 Potrillo[a]	5	0.7	37
E275 Ancho[a]	6	8.6	349
E350 Frijoles at Bandelier	365	526	40

[a] Station at downstream Laboratory boundary.
[b] Based on partial year of record.

Table 5-3b. Peak Flow at Selected Ungaged Sites

Station No.	Canyon	Drainage Area (mi^2)	Discharge (cfs)	Date 2000	Previous Peak	Record Began
NA	Rendija abv Guaje	9.58	900[a]	07/16	NA	NA
NA	Rendija abv Guaje	9.58	900[a]	07/17	NA	NA
NA	Rendija abv Guaje	9.58	900[a]	08/03	NA	NA
NA	Rendija abv Guaje	9.58	900[a]	09/08	NA	NA
NA	Guaje abv Rendija	14.6	840	07/16	NA	NA
NA	Guaje abv Rendija	14.6	827	07/17	NA	NA
NA	Guaje abv Rendija	14.6	1,350	08/27	NA	NA
NA	Guaje abv Rendija	14.6	1,200[b]	09/08	NA	NA

[a] All these peaks were less than 0.15 ft. difference in stage. Discharge by indirect methods except Sept. 8, which was estimated.
[b] Estimate based on high-water mark compared with indirect measured discharge on Aug. 27 peak.

Table 5-4. Radiochemical Analysis of Surface Water for 2000 (pCi/L[a])

Station Name	Date	Codes[b]		^{3}H			^{90}Sr				^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L, lab)	
Regional Stations																								
Rio Chama at Chamita (bank)	07/12	UF	CS	100	450		0.18	0.05	0.15		0.00	3.63		0.468	0.044		0.0125	0.0114		0.257	0.030			
Rio Grande at Embudo (bank)	07/12	UF	CS	20	440		-0.02	0.04	0.14		0.00	8.63		1.528	0.093		0.0463	0.0188		0.891	0.067			
Rio Grande at Otowi Upper (bank)	08/14	UF	CS	-60	390						-1.11	9.55		0.669	0.051		0.0032	0.0111		0.396	0.038		1.29	0.13
Rio Grande at Otowi Upper (bank)	08/14	UF	CS				-0.03	0.11																
Rio Grande at Otowi (bank)	08/14	UF	CS	30	400						1.74	1.59		0.749	0.068		0.0065	0.0096		0.493	0.044		1.22	0.12
Rio Grande at Otowi (bank)	08/14	UF	CS				0.17	0.12																
Rio Grande at Frijoles (bank)	09/27	UF	CS	-60	56	193	-0.11	0.12	0.44	<	1.44	1.80	2.33	1.020	0.111	0.0588	0.0561	0.0229	0.068	0.602	0.076	0.017	1.73	
Rio Grande at Cochiti	09/27	UF	CS	0	57	192	0.19	0.09	0.31	<	0.18	0.89	3.06	1.020	0.112	0.0599	0.0137	0.0172	0.078	0.730	0.088	0.047		
Jemez River	07/13	UF	CS	-20	440		0.10	0.05	0.15		-3.50	33.93		0.693	0.047		0.0325	0.0112		0.414	0.035			
Pajarito Plateau Stations																								
Acid/Pueblo Canyons:																								
Pueblo 1 R	07/25	UF	CS	510	440		2.37	0.22	0.11		-0.60	3.68		0.775	0.057		0.0531	0.0163		1.005	0.065			
Acid Weir	07/25	UF	CS	690	450		14.00	1.25	0.14		0.00	5.21		0.139	0.029		0.0058	0.0106		0.091	0.020			
Pueblo 3	07/25	UF	CS	510	440		2.05	0.19	0.12		-0.30	2.61		0.411	0.037		0.0107	0.0073		0.416	0.037			
Pueblo at SR-502	08/14	UF	CS	30	400						1.46	1.48		0.030	0.020		-0.0087	0.0067		0.037	0.014		0.20	0.02
Pueblo at SR-502	08/14	UF	CS				0.65	0.14																
Pueblo at SR-502	12/06	UF	CS	-88	57	199	0.82	0.18	0.52		0.62	0.64	2.36	0.278	0.055	0.0831	0.0004	0.0108	0.083	0.143	0.037	0.024		
Pueblo at SR-502	12/06	UF	DUP								1.16	1.43	5.16											
DP/Los Alamos Canyons:																								
DPS-1	10/25	UF	CS	118	60	189	62.30	3.48	1.81		1.90	1.07	2.87	0.112	0.035	0.0866	0.0004	0.0113	0.087	0.037	0.019	0.025		
DPS-1	10/25	UF	DUP																					
Sandia Canyon:																								
SCS-1	08/16	UF	CS	120	410						-2.86	3.33		0.072	0.072		-0.0007	0.0069		0.053	0.014			
SCS-1	08/16	UF	CS				0.00	0.10																
SCS-2	08/16	UF	CS	210	420						-0.67	2.89		0.442	0.043		0.0142	0.0103		0.429	0.038			
SCS-2	08/16	UF	CS				-0.03	0.11																
SCS-3	08/16	UF	CS	30	400						-2.73	9.64		0.548	0.049		0.0507	0.0190		0.499	0.042			
SCS-3	08/16	UF	CS				0.43	0.14																
Mortandad Canyon:																								
Mortandad at GS-1	07/11	UF	CS	52,633	1,964		47.70	5.50	0.74					3.430	0.315	0.0229	0.0731	0.0145	0.013	1.130	0.110	0.018	3.81	
Mortandad at GS-1	07/11	F	CS				45.30	5.50	0.81					3.520	0.032	0.0190	0.0738	0.0135	0.014	1.080	0.105	0.010	3.79	
Mortandad at GS-1	08/16	UF	CS	35,500	2,100						31.40	3.82		0.976	0.078		0.0264	0.0348		0.454	0.046			
Mortandad at GS-1	08/16	UF	CS				11.70	1.10																
Mortandad at Rio Grande (A-11)	09/25	UF	CS	-89	54	191	0.09	0.14	0.48	<	-0.04	0.91	3.35	0.358	0.051	0.0485	-0.0008	0.0099	0.056	0.175	0.034	0.049	0.50	
Cañada del Buey:																								
Cañada del Buey	10/24	UF	CS	-30	56	192	0.02	0.11	0.40		0.98	0.74	2.84	0.270	0.054	0.1010	0.0044	0.0094	0.062	0.156	0.039	0.062		
Cañada del Buey	10/24	UF	DUP				0.66	0.17	0.53															

Table 5-4. Radiochemical Analysis of Surface Water for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{3}H			^{90}Sr				^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L, lab)
Pajarito Plateau Stations (Cont.)																							
Pajarito Canyon:																							
Pajarito Canyon	10/24	UF	CS	-30	56	191	-0.10	0.10	0.36		0.00	1.60	2.41	0.510	0.087	0.1210	0.0342	0.0239	0.104	0.667	0.101	0.082	
Pajarito Retention Pond	08/24	F	CS				2.61	0.46	0.41		0.38	1.26	4.51	0.600	0.085	0.1570	0.0701	0.0292	0.110	0.600	0.082	0.094	2.42
Pajarito Retention Pond	08/24	F	DUP																				
Pajarito Retention Pond	08/24	UF	CS	0	0	0	3.36	0.44	0.38		2.19	1.19	4.44	1.040	0.121	0.1000	0.0627	0.0266	0.090	1.190	0.136	0.178	3.66
Pajarito Retention Pond	08/24	UF	DUP	0	0	0	2.86	0.37	0.37		1.19	1.35	4.80										
Pajarito at Rio Grande	09/26	UF	CS	-61	56	195	-0.06	0.10	0.36	<	1.06	0.64	2.41	0.708	0.079	0.0468	0.0042	0.0108	0.054	0.318	0.048	0.061	1.06
Pajarito at Rio Grande	09/26	UF	DUP																				1.04
Water Canyon:																							
Water Canyon at Beta	08/17	UF	CS	-60	390						1.28	1.21		0.172	0.025		-0.0033	0.0044		0.170	0.023		
Water Canyon at Beta	08/17	UF	CS				0.91	0.16															
Ancho Canyon:																							
Ancho at Rio Grande	09/26	UF	CS	-151	53	193	0.18	0.09	0.29	<	-0.66	0.66	2.26	0.087	0.025	0.0594	0.0055	0.0056	0.015	0.050	0.017	0.015	0.21
Ancho at Rio Grande	09/26	UF	CS	-61	56	194	0.19	0.09	0.31	<	1.08	0.70	2.36	0.069	0.021	0.0474	-0.0023	0.0073	0.048	0.099	0.024	0.038	0.18
Frijoles Canyon:																							
Frijoles at Monument Headquarters	08/22	UF	CS	-201	51	189	0.04	0.22	0.38	<	-0.93	0.93	3.11	0.097	0.027	0.0495	0.0068	0.0068	0.018	0.081	0.024	0.018	
Frijoles at Monument Headquarters	08/22	UF	DUP																				0.09
Frijoles at Monument Headquarters	08/22	UF	CS	-142	52	187	0.67	0.16	0.24	<	0.34	0.98	3.49	0.121	0.030	0.0183	0.0029	0.0114	0.073	0.024	0.014	0.050	
Frijoles at Rio Grande	08/22	UF	CS	-141	51	185	0.94	0.34	0.51	<	-0.70	1.04	3.11	0.018	0.021	0.1100	0.0034	0.0177	0.111	0.029	0.020	0.088	
Water Quality Standards[c]																							
DOE DCG for Public Dose				2,000,000			1,000				3,000			500			600			600			800
DOE Drinking Water System DCG				80,000			40				120			20			24			24			30
EPA Primary Drinking Water Standard				20,000			8																30
EPA Screening Level																							
NMWQCC Groundwater Limit																							5,000

Table 5-4. Radiochemical Analysis of Surface Water for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		U (µg/L, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Regional Stations																						
Rio Chama at Chamita (bank)	07/12	UF	CS	0.77	0.09	-0.001	0.007		0.007	0.007		0.008	0.006		2.5	2.3		4.9	4.5		37.9	51.1
Rio Grande at Embudo (bank)	07/12	UF	CS	2.67	0.20	0.003	0.005		0.010	0.009		-0.018	0.026		3.7	2.7		4.8	4.5		46.5	51.2
Rio Grande at Otowi Upper (bank)	08/14	UF	CS	1.18	0.11	0.003	0.003		0.001	0.004		-0.008	0.007		5.7	3.7		6.8	3.8		6.1	48.9
Rio Grande at Otowi Upper (bank)	08/14	UF	CS																			
Rio Grande at Otowi (bank)	08/14	UF	CS	1.47	0.13	0.011	0.008		0.006	0.006		-0.006	0.005		4.3	3.3		5.5	3.4		16.3	49.0
Rio Grande at Otowi (bank)	08/14	UF	CS																			
Rio Grande at Frijoles (bank)	09/27	UF	CS	1.82	0.23	0.264	0.047	0.022	0.027	0.010	0.008	0.028	0.010	0.010	3.5	1.1	1.8	5.0	1.1	3.4		
Rio Grande at Cochiti	09/27	UF	CS	2.18	0.26	0.188	0.036	0.008	0.022	0.009	0.008	0.081	0.020	0.040	2.5	0.9	2.0	8.1	1.2	2.8		
Jemez River	07/13	UF	CS	1.25	0.10	0.008	0.008		0.008	0.007		0.022	0.009		23.0	10.1		14.8	9.8		49.3	51.2
Pajarito Plateau Stations																						
Acid/Pueblo Canyons:																						
Pueblo 1 R	07/25	UF	CS	3.02	0.19	-0.003	0.003		0.032	0.012		0.158	0.212		6.5	2.8		9.9	3.5		449.8	53.9
Acid Weir	07/25	UF	CS	0.27	0.06	0.016	0.007		0.041	0.012		0.014	0.006		0.2	0.7		15.0	5.9		439.8	53.8
Pueblo 3	07/25	UF	CS	1.24	0.11	0.019	0.009		0.156	0.026		0.015	0.009		1.3	1.4		6.7	2.8		595.7	59.6
Pueblo at SR-502	08/14	UF	CS	0.10	0.04	0.061	0.015		0.097	0.019		0.023	0.011		2.7	3.7		16.2	7.3		34.6	49.1
Pueblo at SR-502	08/14	UF	CS																			
Pueblo at SR-502	12/06	UF	CS	0.43	0.11	0.008	0.010	0.045	0.029	0.012	0.013	0.019	0.009	0.010	-0.2	0.4	0.9	10.5	0.8	1.7		
Pueblo at SR-502	12/06	UF	DUP												0.0	0.3	1.0	10.0	0.8	1.7		
DP/Los Alamos Canyons:																						
DPS-1	10/25	UF	CS	0.11	0.06	0.019	0.009	0.024	0.048	0.014	0.009	0.107	0.021	0.027	1.1	0.4	0.9	43.5	2.4	1.4		
DPS-1	10/25	UF	DUP			0.012	0.006	0.008	0.040	0.013	0.008	0.130	0.024	0.041								
Sandia Canyon:																						
SCS-1	08/16	UF	CS	0.16	0.04	0.110	0.022		0.009	0.009		-0.001	0.002		3.6	6.1		19.6	10.2		266.7	50.3
SCS-1	08/16	UF	CS																			
SCS-2	08/16	UF	CS	1.28	0.11	0.011	0.011		0.119	0.024		-0.009	0.013		15.0	9.4		20.6	10.5		392.3	51.2
SCS-2	08/16	UF	CS																			
SCS-3	08/16	UF	CS	1.51	0.13	0.015	0.009		0.064	0.017		0.008	0.004		8.1	7.3		16.9	9.4		141.1	49.5
SCS-3	08/16	UF	CS																			
Mortandad Canyon:																						
Mortandad at GS-1	07/11	UF	CS	3.40	0.33	2.700	0.230	0.014	1.870	0.160	0.020	1.510	0.135	0.013								
Mortandad at GS-1	07/11	F	CS	3.25	0.31	1.520	0.140	0.025	0.822	0.085	0.009	0.603	0.060	0.011								
Mortandad at GS-1	08/16	UF	CS	1.36	0.14	5.008	0.238		6.754	0.308		6.384	0.244		39.9	13.0		82.4	21.5		262.0	50.3
Mortandad at GS-1	08/16	UF	CS																			
Mortandad at Rio Grande (A-11)	09/25	UF	CS	0.52	0.10	0.000	1.010	0.015	0.005	0.005	0.015	0.032	0.010	0.009	0.4	0.8	3.0	13.8	1.7	3.2		
Cañada del Buey:																						
Cañada del Buey	10/24	UF	CS	0.47	0.12	0.000	1.010	0.008	0.009	0.008	0.027	0.022	0.009	0.010	1.6	0.6	1.5	6.9	0.8	2.2		
Cañada del Buey	10/24	UF	DUP																			

Table 5-4. Radiochemical Analysis of Surface Water for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		U (µg/L, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Pajarito Plateau Stations (Cont.)																						
Pajarito Canyon:																						
Pajarito Canyon	10/24	UF	CS	2.00	0.30	0.024	0.013	0.036	-0.003	0.006	0.031	0.010	0.009	0.032	2.1	0.6	1.0	14.8	1.1	2.1		
Pajarito Retention Pond	08/24	F	CS	1.82	0.25	0.057	0.017	0.034	0.016	0.011	0.034	0.040	0.016	0.043	2.4	0.6	1.2	13.2	1.4	3.0		
Pajarito Retention Pond	08/24	F	DUP			0.025	0.011	0.026	0.011	0.006	0.010	0.012	0.009	0.028								
Pajarito Retention Pond	08/24	UF	CS	3.57	0.40	0.031	0.015	0.038	0.129	0.032	0.038	0.060	0.016	0.026	16.9	3.2	1.5	38.1	2.8	2.9		
Pajarito Retention Pond	08/24	UF	DUP																			
Pajarito at Rio Grande	09/26	UF	CS	0.95	0.14	0.124	0.028	0.011	0.097	0.024	0.028	0.008	0.008	0.029	-0.5	0.4	1.8	0.7	0.7	2.5		
Pajarito at Rio Grande	09/26	UF	DUP												0.3	0.5	1.9	3.1	0.9	2.8		
Water Canyon:																						
Water Canyon at Beta	08/17	UF	CS	0.51	0.07	0.028	0.014		0.002	0.011		0.005	0.004		2.8	2.8		8.5	4.3		29.0	48.7
Water Canyon at Beta	08/17	UF	CS																			
Ancho Canyon:																						
Ancho at Rio Grande	09/26	UF	CS	0.15	0.05	0.032	0.015	0.037	0.012	0.007	0.011	0.022	0.014	0.044	0.4	0.4	1.4	2.4	0.8	2.5		
Ancho at Rio Grande	09/26	UF	CS	0.29	0.07	0.054	0.016	0.010	0.004	0.007	0.028	0.000	1.000	0.028	0.6	0.4	1.4	1.7	0.7	2.2		
Frijoles Canyon:																						
Frijoles at Monument Headquarters	08/22	UF	CS	0.24	0.07	0.024	0.012	0.029	0.016	0.008	0.011	0.171	0.029	0.031	0.6	0.4	1.3	3.8	0.9	2.6		
Frijoles at Monument Headquarters	08/22	UF	DUP												0.5	0.3	1.1	3.4	0.5	1.4		
Frijoles at Monument Headquarters	08/22	UF	CS	0.07	0.04	-0.004	0.007	0.036	0.039	0.015	0.029	0.016	0.008	0.011	1.1	0.6	1.9	3.5	1.0	3.0		
Frijoles at Rio Grande	08/22	UF	CS	0.09	0.06	-0.003	0.004	0.026	0.031	0.011	0.009	0.023	0.010	0.012	1.0	0.5	1.4	3.9	0.9	2.7		
Water Quality Standards[c]																						
DOE DCG for Public Dose				800		40			30			30			30			1,000				
DOE Drinking Water System DCG				30		1.6			1.2			1.2			1.2			40				
EPA Primary Drinking Water Standard				30											15							
EPA Screening Level																		50				
NMWQCC Groundwater Limit				5,000																		

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[a] Except where noted. Three columns are listed: the first is the analytical result, the second is the radioactive counting uncertainty (1 standard deviation), and the third is the analytical laboratory measurement-specific minimum detectable activity.

[b] Codes: UF-unfiltered; F-filtered; CS-customer sample; DUP-laboratory duplicate.

[c] Standards given here for comparison only; see Appendix A.

Table 5-5 Detections of Radionuclides[a] and Comparison to Standards[b] in Surface Water Samples for 2000

Station Name	Date	Code[c,d]		Analyte	Symbol	Result	Uncertainty[e]	MDA[f]	Units	Lab Qual Code[g]	Result/ Min Std	Min Std	Min Std Type	DOE DCG	Result/ DOE DCG
Regional Stations															
Rio Chama at Chamita (bank)	07/12	UF	CS	^{90}Sr		0.18	0.05	0.15	pCi/L						
Rio Grande at Frijoles (bank)	09/27	UF	CS	^{238}Pu		0.264	0.047	0.022	pCi/L						
Rio Grande at Cochiti	09/27	UF	CS	^{241}Am		0.081	0.020	0.040	pCi/L	B					
Rio Grande at Cochiti	09/27	UF	CS	^{238}Pu		0.188	0.036	0.008	pCi/L						
Pajarito Plateau Stations															
Acid/Pueblo Canyons:															
Pueblo 1 R	07/25	UF	CS	^{90}Sr		2.37	0.22	0.11	pCi/L						
Acid Weir	07/25	UF	CS	^{239,240}Pu		0.041	0.012		pCi/L						
Acid Weir	07/25	UF	CS	^{90}Sr		14.00	1.25	0.14	pCi/L		1.75	8	EPA PRIM DW STD		
Pueblo 3	07/25	UF	CS	^{239,240}Pu		0.156	0.026		pCi/L						
Pueblo 3	07/25	UF	CS	^{90}Sr		2.05	0.19	0.12	pCi/L						
Pueblo at SR-502	08/14	UF	CS	^{238}Pu		0.061	0.015		pCi/L						
Pueblo at SR-502	08/14	UF	CS	^{239,240}Pu		0.097	0.019		pCi/L						
Pueblo at SR-502	12/06	UF	CS	^{90}Sr		0.82	0.18	0.52	pCi/L						
DP/Los Alamos Canyons:															
DPS-1	10/25	UF	DUP	^{241}Am		0.130	0.024	0.041	pCi/L						
DPS-1	10/25	UF	CS	^{241}Am		0.107	0.021	0.027	pCi/L						
DPS-1	10/25	UF	CS	Gross Beta		43.5	2.4	1.4	pCi/L		0.87	50	EPA SEC DW LVL		
DPS-1	10/25	UF	CS	^{239,240}Pu		0.048	0.014	0.009	pCi/L						
DPS-1	10/25	UF	DUP	^{239,240}Pu		0.040	0.013	0.008	pCi/L						
DPS-1	10/25	UF	CS	^{90}Sr		62.30	3.48	1.81	pCi/L		7.79	8	EPA PRIM DW STD		
Sandia Canyon:															
SCS-1	08/16	UF	CS	^{238}Pu		0.110	0.022		pCi/L						
SCS-2	08/16	UF	CS	^{239,240}Pu		0.119	0.024		pCi/L						
SCS-3	08/16	UF	CS	^{239,240}Pu		0.064	0.017		pCi/L						
Mortandad Canyon:															
Mortandad at GS-1	07/11	F	CS	^{241}Am		0.603	0.060	0.011	pCi/L		0.50	1.2	DOE DW DCG		
Mortandad at GS-1	07/11	F	CS	^{238}Pu		1.520	0.140	0.025	pCi/L		0.95	1.6	DOE DW DCG		
Mortandad at GS-1	07/11	F	CS	^{239,240}Pu		0.822	0.085	0.009	pCi/L		0.69	1.2	DOE DW DCG		
Mortandad at GS-1	07/11	F	CS	^{90}Sr		45.30	5.50	0.81	pCi/L		5.66	8	EPA PRIM DW STD		
Mortandad at GS-1	07/11	UF	CS	^{241}Am		1.510	0.135	0.013	pCi/L		1.26	1.2	DOE DW DCG		
Mortandad at GS-1	07/11	UF	CS	^{3}H		52,633	1,964		pCi/L		2.63	20,000	EPA PRIM DW STD		
Mortandad at GS-1	07/11	UF	CS	^{238}Pu		2.700	0.230	0.014	pCi/L		1.69	1.6	DOE DW DCG		
Mortandad at GS-1	07/11	UF	CS	^{239,240}Pu		1.870	0.160	0.020	pCi/L		1.56	1.2	DOE DW DCG		
Mortandad at GS-1	07/11	UF	CS	^{90}Sr		47.70	5.50	0.74	pCi/L		5.96	8	EPA PRIM DW STD		
Mortandad at GS-1	08/16	UF	CS	^{241}Am		6.384	0.244		pCi/L		5.32	1.2	DOE DW DCG		
Mortandad at GS-1	08/16	UF	CS	^{137}Cs		31.40	3.82		pCi/L						
Mortandad at GS-1	08/16	UF	CS	Gross Alpha		39.9	13.0		pCi/L		2.66	15	EPA PRIM DW STD	30	1.33
Mortandad at GS-1	08/16	UF	CS	Gross Beta		82.4	21.5		pCi/L		1.65	50	EPA SEC DW LVL		
Mortandad at GS-1	08/16	UF	CS	^{3}H		35,500	2,100		pCi/L		1.78	20,000	EPA PRIM DW STD		
Mortandad at GS-1	08/16	UF	CS	^{238}Pu		5.008	0.238		pCi/L		3.13	1.6	DOE DW DCG		
Mortandad at GS-1	08/16	UF	CS	^{239,240}Pu		6.754	0.308		pCi/L		5.63	1.2	DOE DW DCG		
Mortandad at Rio Grande (A-11)	09/25	UF	CS	^{241}Am		0.032	0.010	0.009	pCi/L	B					

Table 5-5 Detections of Radionuclides[a] and Comparison to Standards[b] in Surface Water Samples for 2000 (Cont.)

Station Name	Date	Code[c,d]	Analyte	Symbol	Result	Uncertainty[e]	MDA[f]	Units	Lab Qual Code[g]	Result/ Min Std	Min Std	Min Std Type	DOE DCG	Result/ DOE DCG
Pajarito Plateau Stations (Cont.)														
Cañada del Buey:														
Cañada del Buey	10/24	UF DUP	^{90}Sr		0.66	0.17	0.53	pCi/L						
Pajarito Canyon:														
Pajarito at Rio Grande	09/26	UF CS	^{241}Am		0.029	0.008	0.029	pCi/L	U					
Pajarito at Rio Grande	09/26	UF CS	^{238}Pu		0.124	0.028	0.011	pCi/L						
Pajarito at Rio Grande	09/26	UF CS	^{239,240}Pu		0.097	0.024	0.028	pCi/L						
Ancho Canyon:														
Ancho at Rio Grande	09/26	UF CS	^{241}Am		0.044	0.014	0.044	pCi/L	U					
Ancho at Rio Grande	09/26	UF CS	^{238}Pu		0.054	0.016	0.010	pCi/L						
Ancho at Rio Grande	09/26	UF CS	^{239,240}Pu		0.028	0.007	0.028	pCi/L	U					
Frijoles Canyon:														
Frijoles at Monument Headquarters	08/22	UF CS	^{241}Am		0.171	0.029	0.031	pCi/L						
Frijoles at Monument Headquarters	08/22	UF CS	^{90}Sr		0.67	0.16	0.24	pCi/L						

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[a] Detection defined as value ≥ 3× uncertainty and ≥ detection limit, except values shown for uranium ≥ 5 µg/L, for gross alpha ≥ 5 pCi/L, and for gross beta ≥ 20 pCi/L. Note that some results in this table were qualified as nondetections by the analytical laboratory.

[b] Values indicated by entries in right-hand columns are greater than half the minimum standard shown. The minimum standard is either a DOE derived concentration guide (DCG) for DOE-administered drinking water systems or an EPA drinking water standard.

[c] UF–unfiltered, F–filtered.

[d] Codes: CS–customer sample; DUP–duplicate; TRP–triplicate; RE–reanalysis; TOTC–value calculated from other results; TOTCD–duplicate calculated value.

[e] One standard deviation radioactivity counting uncertainty.

[f] Minimum detectable activity.

[g] Codes: B–analyte found in lab blank; U–analyte not detected.

Table 5-6. Summary of TA-50 Radionuclide, Nitrate, and Fluoride Discharges[a]

	1963–1977	1998			1999			2000		
Radionuclide	**Total Activity Released (mCi)**[b]	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG**[c]	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG**[c]	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG**[c]
^{3}H	25,150	1,228	52,840	0.03	485	24,252	0.01	907	48,713	0.024
^{241}Am	7	2	99.1	3.30	1.1	55.0	1.83	0.041	2.25	0.075
^{137}Cs	848	1	43.4	0.01	1.5	76.9	0.026	3.1	166.7	0.056
^{238}Pu	51	2	97.9	2.45	2.4	121.3	3.03	0.063	3.39	0.085
^{239,240}Pu	39	0.91	39	1.30	1.40	70.0	2.33	0.035	1.86	0.062
^{89}Sr	<1	2	86.8	0.004	0.36	18.2	0.0009	0.332	17.8	0.0009
^{90}Sr	295	0.82	35.3	0.04	0.52	26.0	0.026	0.170	9.1	0.009
^{234}U	NA	0.12	5.1	0.01	0.17	8.6	0.017	0.037	1.98	0.004
^{235}U	2	0.053	2.3	0.004	0.0047	0.24	0.0004	0.016	0.86	0.0014
Constituent		**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration to MCL**[d]	**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration to MCL**[d]	**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration to MCL**[d]
NO_3-N		1,420	61.1	6.1	486	24.2	2.4	46.6	2.50	0.25
F		37.6	1.62	1.0	22.6	1.12	0.7	5.29	0.28	0.17
Total effluent volume ($\times 10^7$ liters)		2.32			2.00			1.86		

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[a] Compiled from Radioactive Liquid Waste Group (FWO-RLW) Annual Reports. Data for 2000 are preliminary.

[b] DOE 1979; decay corrected through 12/77.

[c] Public dose limit.

[d] New Mexico Groundwater Limit.

Table 5-7. Chemical Quality of Surface Water for 2000 (mg/L[a])

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P
Regional Stations														
Rio Chama at Chamita (bank)	07/12	F	CS	14	35.3	6.4	1.5	11.5	2.0	54.4	<[f] 5	84	0.14	0.06
Rio Chama at Chamita (bank)	07/12	UF	CS											
Rio Grande at Embudo (bank)	07/12	F	CS	26	28.9	6.6	3.1	21.6	6.8	40.5	12	112	0.69	0.06
Rio Grande at Embudo (bank)	07/12	UF	CS											
Rio Grande at Otowi Upper (bank)	08/14	F	CS	16	37.4	6.6	2.4	13.4	2.8	56.6	< 5	94	0.19	0.06
Rio Grande at Otowi Upper (bank)	08/14	UF	CS											
Rio Grande at Otowi (bank)	08/14	F	CS	20	38.3	6.5	2.2	14.8	5.2	53.6	< 5	104	0.16	0.06
Rio Grande at Otowi (bank)	08/14	UF	CS											
Rio Grande at Frijoles (bank)	09/27	F	CS	18	44.7	8.6	2.6	21.3	4.0	69.8	1	99	0.29	< 0.02
Rio Grande at Frijoles (bank)	09/27	F	DUP											
Rio Grande at Frijoles (bank)	09/27	UF	CS											
Rio Grande at Frijoles (bank)	09/27	UF	DUP											
Rio Grande at Cochiti	09/27	F	CS	19	46.0	8.8	2.7	17.8	4.3	69.0	1	98	0.28	< 0.02
Rio Grande at Cochiti	09/27	F	DUP	18	45.2	8.6	2.6	17.5					0.27	< 0.02
Rio Grande at Cochiti	09/27	F	TRP											
Rio Grande at Cochiti	09/27	UF	CS											
Jemez River	07/13	F	CS	50	48.7	5.2	13.9	90.2	126.0	9.6	17	180	1.23	0.06
Jemez River	07/13	UF	CS											
Pajarito Plateau Stations														
Acid/Pueblo Canyons:														
Pueblo 1 R	07/25	F	CS	21	40.1	5.7	6.8	27.3	24.3	16.5	< 5	140	0.15	0.22
Pueblo 1 R	07/25	UF	CS											
Acid Weir	07/25	F	CS	25	33.6	3.3	4.9	29.4	13.8	7.5	< 5	52	0.19	0.16
Acid Weir	07/25	UF	CS											
Pueblo 3	07/25	F	CS	73	37.9	7.5	15.5	64.0	42.1	3.7	< 5	278	0.52	6.42
Pueblo 3	07/25	UF	CS											
Pueblo at SR-502	08/14	F	CS		26.1	5.6	14.9	76.7						
Pueblo at SR-502	08/14	UF	CS											
Pueblo at SR-502	12/06	UF	CS											
DP/Los Alamos Canyons:														
DPS-1	10/25	F	CS	14	24.7	1.5	3.6	17.2	16.0	7.0	< 1	72	0.24	0.03
DPS-1	10/25	F	DUP	12	25.6	1.6	3.7	17.8					0.25	
DPS-1	10/25	UF	CS											
Sandia Canyon:														
SCS-1	08/16	F	CS	125	28.2	9.5	22.3	144.8	30.2	155.0	16	230	0.60	5.50
SCS-1	08/16	UF	CS											
SCS-2	08/16	F	CS	103	25.5	6.2	16.6	174.8	122.0	123.0	11	223	0.69	6.01
SCS-2	08/16	UF	CS											
SCS-3	08/16	F	CS	100	25.2	6.0	16.0	174.9	119.0	124.0	< 5	211	0.67	5.72
SCS-3	08/16	UF	CS											

Table 5-7. Chemical Quality of Surface Water for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P
Pajarito Plateau Stations (Cont.)														
Mortandad Canyon:														
Mortandad at GS-1	07/11	UF	CS		47.4	2.7	9.2	79.1						0.22
Mortandad at GS-1	07/11	F	CS		46.8	2.6	8.6	76.1	8.0	23.0	< 10	240	0.89	0.16
Mortandad at GS-1	08/16	F	CS	59	19.5	1.8	3.0	77.3	4.2	1.0	< 5	< 5	0.50	0.22
Mortandad at GS-1	08/16	UF	CS											
Mortandad at Rio Grande (A-11)	09/25	F	CS	83	31.2	7.4	14.2	92.7	63.4	34.9	3	128	0.34	4.08
Mortandad at Rio Grande (A-11)	09/25	F	DUP											
Mortandad at Rio Grande (A-11)	09/25	UF	CS											
Cañada del Buey:														
Cañada del Buey	10/24	F	CS	21	16.5	3.5	4.2	10.3	14.7	20.5	< 1	93	0.23	0.12
Cañada del Buey	10/24	F	DUP										0.23	
Cañada del Buey	10/24	UF	CS											
Cañada del Buey	10/24	UF	DUP											
Pajarito Canyon:														
Pajarito Canyon	10/24	F	CS	14	34.8	4.7	9.9	9.4	8.9	12.1	< 1	31	0.16	0.50
Pajarito Canyon	10/24	F	DUP											
Pajarito Canyon	10/24	UF	CS											
Pajarito Canyon	10/24	UF	DUP											
Pajarito Retention Pond	08/24	F	CS	21	42.3	7.0	10.4	7.8	5.8	9.4	< 1	133	0.15	0.45
Pajarito Retention Pond	08/24	F	DUP						5.8	9.3	< 1	130	0.16	0.40
Pajarito Retention Pond	08/24	UF	CS											
Pajarito Retention Pond	08/24	F	CS											
Pajarito Retention Pond	08/24	UF	CS			8.9								1.86
Pajarito Retention Pond	08/24	UF	DUP											1.76
Pajarito at Rio Grande	09/26	F	CS	67	22.9	4.8	2.9	15.3	4.7	5.0	< 1	84	0.43	< 0.02
Pajarito at Rio Grande	09/26	F	DUP											< 0.02
Pajarito at Rio Grande	09/26	UF	CS											
Pajarito at Rio Grande	09/26	UF	DUP											
Water Canyon:														
Water Canyon at Beta	08/17	F	CS	47	26.2	7.1	5.6	17.4	7.7	4.9	< 5	131	0.12	0.17
Water Canyon at Beta	08/17	UF	CS											
Ancho Canyon:														
Ancho at Rio Grande	09/26	F	CS	71	15.1	3.7	2.1	12.2	2.3	2.1	1	64	0.35	< 0.02
Ancho at Rio Grande	09/26	F	DUP											
Ancho at Rio Grande	09/26	UF	CS											
Ancho at Rio Grande	09/26	F	CS	72	14.7	3.6	2.0	12.0	2.2	2.0	1	62	0.36	< 0.02
Ancho at Rio Grande	09/26	F	DUP											
Ancho at Rio Grande	09/26	UF	CS											

Table 5-7. Chemical Quality of Surface Water for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P
Pajarito Plateau Stations (Cont.)														
Frijoles Canyon:														
Frijoles at Monument Headquarters	08/22	F	CS	61	9.7	2.9	2.1	10.6	1.9	1.5	< 1	60	0.17	0.09
Frijoles at Monument Headquarters	08/22	F	DUP	64	10.1	3.1	2.2	10.3			< 1			
Frijoles at Monument Headquarters	08/22	UF	CS											
Frijoles at Monument Headquarters	08/22	UF	DUP											
Frijoles at Monument Headquarters	08/22	F	CS	62	10.0	3.0	2.1	10.5	1.8	1.4	< 1	56	0.15	0.09
Frijoles at Monument Headquarters	08/22	UF	CS											
Frijoles at Rio Grande	08/22	F	CS	61	11.0	3.0	2.5	10.8	2.0	1.4	< 1	58	0.17	0.11
Frijoles at Rio Grande	08/22	UF	CS											
Water Quality Standards[g]														
EPA Primary Drinking Water Standard										500			4.0	
EPA Secondary Drinking Water Standard									250	250				
EPA Health Advisory								20						
NMWQCC Groundwater Limit									250	600			1.6	
NMWQCC Wildlife Habitat Standard														

Table 5-7. Chemical Quality of Surface Water for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		NO_3+ NO_2-N	ClO_4 (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Regional Stations													
Rio Chama at Chamita (bank)	07/12	F	CS	0.07				140		114.8		6.7	263
Rio Chama at Chamita (bank)	07/12	UF	CS		< 1.00		0.0300		42.0				
Rio Grande at Embudo (bank)	07/12	F	CS	0.06				166		99.3		8.1	290
Rio Grande at Embudo (bank)	07/12	UF	CS		< 1.00		0.0300		10.0		8.6		
Rio Grande at Otowi Upper (bank)	08/14	F	CS	0.11				216		120.8		7.9	287
Rio Grande at Otowi Upper (bank)	08/14	UF	CS		< 1.00		0.0100		69.0		8.3		
Rio Grande at Otowi (bank)	08/14	F	CS	0.13				230		122.3		8.0	303
Rio Grande at Otowi (bank)	08/14	UF	CS		< 1.00		0.0100		68.0		8.3		
Rio Grande at Frijoles (bank)	09/27	F	CS	0.04				208		147.0			346
Rio Grande at Frijoles (bank)	09/27	F	DUP					220					
Rio Grande at Frijoles (bank)	09/27	UF	CS		< 1.04	< 0.0028	< 0.0028		49.5		8.5		
Rio Grande at Frijoles (bank)	09/27	UF	DUP						56.8				
Rio Grande at Cochiti	09/27	F	CS	0.11				220		151.0			346
Rio Grande at Cochiti	09/27	F	DUP	0.11				224					349
Rio Grande at Cochiti	09/27	F	TRP					229					
Rio Grande at Cochiti	09/27	UF	CS		< 1.04	< 0.0028	< 0.0028		55.8		8.3		
Jemez River	07/13	F	CS	0.01				458		143.0		8.0	700
Jemez River	07/13	UF	CS		< 1.00		0.0300		13.0		8.6		
Pajarito Plateau Stations													
Acid/Pueblo Canyons:													
Pueblo 1 R	07/25	F	CS	0.42				300		123.5		7.5	353
Pueblo 1 R	07/25	UF	CS		< 1.00		0.0200		64.0		7.8		
Acid Weir	07/25	F	CS	1.28				310		97.5		7.3	366
Acid Weir	07/25	UF	CS		< 1.00		0.0100		82.0		6.6		
Pueblo 3	07/25	F	CS	0.02				442		125.4		7.6	642
Pueblo 3	07/25	UF	CS		< 1.00		0.0200		4.0		7.3		
Pueblo at SR-502	08/14	F	CS										
Pueblo at SR-502	08/14	UF	CS		< 1.00				1.0		7.1		
Pueblo at SR-502	12/06	UF	CS		< 1.04				12.6		8.9		
DP/Los Alamos Canyons:													
DPS-1	10/25	F	CS	0.09				136		1,800.0			197
DPS-1	10/25	F	DUP					141					
DPS-1	10/25	UF	CS		< 1.04	< 0.0028	< 0.0028		< 1.0				
Sandia Canyon:													
SCS-1	08/16	F	CS	2.14				610		109.3		8.7	974
SCS-1	08/16	UF	CS		< 1.00		0.0200		3.0		8.5		
SCS-2	08/16	F	CS	0.28				804		89.1		9.0	1,028
SCS-2	08/16	UF	CS		< 1.00		0.0100		14.0		8.3		
SCS-3	08/16	F	CS	0.20				752		87.5		8.5	1,003
SCS-3	08/16	UF	CS		< 1.00		0.0100		19.0		8.3		

Table 5-7. Chemical Quality of Surface Water for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	NO_3+ NO_2-N	ClO_4 (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Pajarito Plateau Stations (Cont.)												
Mortandad Canyon:												
Mortandad at GS-1	07/11	UF CS	3.90			0.0025		14.0				
Mortandad at GS-1	07/11	F CS	3.70									
Mortandad at GS-1	08/16	F CS	4.34				586		56.2		7.4	10
Mortandad at GS-1	08/16	UF CS		39.00		0.0100		2.0		7.9		
Mortandad at Rio Grande (A-11)	09/25	F CS	5.95				402		108.0			597
Mortandad at Rio Grande (A-11)	09/25	F DUP					434					
Mortandad at Rio Grande (A-11)	09/25	UF CS		< 1.04	< 0.0028	< 0.0028		5.8		8.4		
Cañada del Buey:												
Cañada del Buey	10/24	F CS	0.71				147		55.8			159
Cañada del Buey	10/24	F DUP					153					
Cañada del Buey	10/24	UF CS		< 1.04	< 0.0028	0.0037		14.7		6.6		
Cañada del Buey	10/24	UF DUP						16.0				
Pajarito Canyon:												
Pajarito Canyon	10/24	F CS	0.15				195		106.0			230
Pajarito Canyon	10/24	F DUP					202					231
Pajarito Canyon	10/24	UF CS		< 1.04	< 0.0028	0.0059		90.0		8.1		
Pajarito Canyon	10/24	UF DUP						98.7				
Pajarito Retention Pond	08/24	F CS	< 0.01				222					282
Pajarito Retention Pond	08/24	F DUP					228					
Pajarito Retention Pond	08/24	UF CS								7.3		
Pajarito Retention Pond	08/24	F CS					283					
Pajarito Retention Pond	08/24	UF CS	< 0.01		0.0046	0.0080		216.0				296
Pajarito Retention Pond	08/24	UF DUP	< 0.01		0.0032	0.0073		198.0				299
Pajarito at Rio Grande	09/26	F CS	0.74				167		77.1			196
Pajarito at Rio Grande	09/26	F DUP	0.74				169					
Pajarito at Rio Grande	09/26	UF CS		1.25	< 0.0028	< 0.0028		1.8		7.8		
Pajarito at Rio Grande	09/26	UF DUP		< 1.04	< 0.0028	< 0.0028						
Water Canyon:												
Water Canyon at Beta	08/17	F CS	0.13				286		94.7		1.7	273
Water Canyon at Beta	08/17	UF CS		< 1.00		0.0100		18.0		7.9		
Ancho Canyon:												
Ancho at Rio Grande	09/26	F CS	0.03				140		52.8			138
Ancho at Rio Grande	09/26	F DUP					163					
Ancho at Rio Grande	09/26	UF CS		< 1.04	< 0.0028	< 0.0028		3.0		8.2		
Ancho at Rio Grande	09/26	F CS	0.03				110		51.3			139
Ancho at Rio Grande	09/26	F DUP					135					
Ancho at Rio Grande	09/26	UF CS		< 1.04	< 0.0028	< 0.0028		< 0.7				

Table 5-7. Chemical Quality of Surface Water for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		NO_3+ NO_2-N	ClO_4 (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Pajarito Plateau Stations (Cont.)													
Frijoles Canyon:													
Frijoles at Monument Headquarters	08/22	F	CS	0.05				134					100
Frijoles at Monument Headquarters	08/22	F	DUP					123					101
Frijoles at Monument Headquarters	08/22	UF	CS		1.24		< 0.0028		22.0				
Frijoles at Monument Headquarters	08/22	UF	DUP		< 1.04		< 0.0028		18.8				
Frijoles at Monument Headquarters	08/22	F	CS	0.04				123					100
Frijoles at Monument Headquarters	08/22	UF	CS		< 1.04		< 0.0028		19.8		8.0		
Frijoles at Rio Grande	08/22	F	CS	< 0.01				126					103
Frijoles at Rio Grande	08/22	UF	CS		< 1.04		< 0.0028		2.6		8.2		
Water Quality Standards[g]													
EPA Primary Drinking Water Standard				10			0.20						
EPA Secondary Drinking Water Standard								500			6.8-8.5	6.8-8.5	
EPA Health Advisory													
NMWQCC Groundwater Limit				10			0.20	1,000			6-9	6-9	
NMWQCC Wildlife Habitat Standard						0.0052							

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[a] Except where noted.

[b] Codes: UF–unfiltered; F–filtered; CS–customer sample; DUP–laboratory duplicate; TRP–laboratory triplicate.

[c] Total dissolved solids.

[d] Total suspended solids.

[e] Standard units.

[f] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[g] Standards given here for comparison only; see Appendix A.

Table 5-8. Trace Metals in Surface Water for 2000 (μg/L)

Station Name	Date	Code[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations															
Rio Chama at Chamita (bank)	07/12	F	CS	<[b] 6.0	< 51.0	< 2.0	27.0	71.0	< 1.00	< 3.0	9.0	< 5.0	< 4.0	< 30.0	
Rio Chama at Chamita (bank)	07/12	UF	CS												< 0.10
Rio Grande at Embudo (bank)	07/12	F	CS	< 6.0	< 88.0	< 3.0	56.0	40.0	< 5.00	< 3.0	16.0	14.0	< 4.0	82.0	
Rio Grande at Embudo (bank)	07/12	UF	CS												< 0.10
Rio Grande at Otowi Upper (bank)	08/14	F	CS	< 6.0	44.0	2.0	< 30.0	80.0	< 1.00	< 3.0	< 8.0	< 5.0	< 4.0	< 30.0	
Rio Grande at Otowi Upper (bank)	08/14	UF	CS												< 0.10
Rio Grande at Otowi (bank)	08/14	F	CS	< 6.0	92.0	< 4.0	< 30.0	85.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	50.0	
Rio Grande at Otowi (bank)	08/14	UF	CS												< 0.10
Rio Grande at Frijoles (bank)	09/27	F	CS	< 0.5	38.7	< 2.6	39.4	104.0	0.51	< 0.1	4.6	< 1.1	< 1.8	< 19.9	
Rio Grande at Frijoles (bank)	09/27	UF	CS												< 0.06
Rio Grande at Cochiti	09/27	F	DUP	< 0.5	25.0	< 2.6	35.0	106.0	< 0.47		< 0.6	< 1.1	< 1.8	< 19.9	
Jemez River	07/13	F	CS	< 6.0	< 56.0		1,047.0	79.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	45.0	
Pajarito Plateau Stations															
Acid/Pueblo Canyons:															
Pueblo 1 R	07/25	F	CS	< 12.0	< 270.0	3.0	49.0	100.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	92.0	
Pueblo 1 R	07/25	UF	CS												< 0.10
Acid Weir	07/25	F	CS	7.0	< 270.0	< 3.0	33.0	54.0	< 2.00	< 3.0	< 6.0	< 5.0	< 4.0	< 30.0	
Acid Weir	07/25	UF	CS												< 0.10
Pueblo 3	07/25	F	CS	6.0	< 270.0	5.0	380.0	75.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	477.0	
Pueblo 3	07/25	UF	CS												< 0.10
Pueblo at SR-502	08/14	F	CS	< 6.0	< 40.0	12.0	308.0	10.0	< 1.00	< 3.0	15.0	< 5.0	< 4.0	370.0	
Pueblo at SR-502	08/14	UF	CS												< 0.10
Pueblo at SR-502	12/06	F	CS	1.4	427.3	8.5	722.0	61.6	0.51	< 0.1	15.0	< 1.1	16.1	515.0	
Pueblo at SR-502	12/06	F	DUP	< 0.5	71.2	3.8	366.0	29.4	0.51	< 0.1	5.8	< 1.1	7.1	148.0	
Pueblo at SR-502	12/06	UF	CS												< 0.06
Pueblo at SR-502	12/06	UF	DUP												< 0.06
DP/Los Alamos Canyons:															
DPS-1	10/25	F	CS	< 0.5	266.0	< 2.6	23.6	57.6	0.51	< 0.1	4.6	< 1.1	2.9	132.0	
DPS-1	10/25	F	DUP	< 0.5	263.0	< 2.6	24.6	58.5	< 0.47		4.8	< 1.1	3.0	131.0	
DPS-1	10/25	UF	CS												< 0.06
Sandia Canyon:															
SCS-2	08/16	F	CS	< 6.0	356.0	4.0	115.0	43.0	< 1.00	< 3.0	< 6.0	18.0	10.0	540.0	
SCS-2	08/16	UF	CS												0.10
Mortandad Canyon:															
Mortandad at GS-1	07/11	UF	CS	0.1	1,010.0	2.6		42.3	0.13	0.3	1.4	8.7	18.8	644.0	< 0.03
Mortandad at GS-1	07/11	F	CS	0.1	40.0	2.4		38.5	0.02	0.2	0.9	7.2	16.3	19.7	< 0.03
Mortandad at GS-1	08/16	F	CS	< 6.0	1,021.0	< 2.0	66.0	19.0	< 1.00	< 3.0	< 6.0	7.0	10.0	564.0	
Mortandad at GS-1	08/16	UF	CS												0.10
Mortandad at Rio Grande (A-11)	09/25	F	CS	< 0.5	32.7	< 2.6	572.0	61.1	0.49	< 0.1	2.6	< 1.1	16.7	< 19.9	
Mortandad at Rio Grande (A-11)	09/25	UF	CS												< 0.06
Cañada del Buey:															
Cañada del Buey	10/24	F	CS	0.6	929.0	< 2.6	32.3	72.2	0.49	< 0.1	7.4	1.1	5.7	569.0	
Cañada del Buey	10/24	UF	CS												< 0.06

Table 5-8. Trace Metals in Surface Water for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Pajarito Plateau Stations (Cont.)															
Pajarito Canyon:															
Pajarito Canyon	10/24	F	CS	0.6	659.0	3.1	41.6	80.5	0.51	< 0.1	4.3	0.8	2.6	452.0	
Pajarito Canyon	10/24	UF	CS												< 0.06
Pajarito Retention Pond	08/24	F	CS	< 0.5	57.0	5.5	48.5	152.0	0.51	< 0.1	< 0.6	< 1.1	2.4	136.0	
Pajarito Retention Pond	08/24	UF	CS	< 0.5	14,900.0	9.1	47.3	468.0	1.12	0.4	6.8	6.6	14.0	8,430.0	0.14
Pajarito at Rio Grande	09/26	F	CS	< 0.5	< 23.4	< 2.6	29.6	41.3	0.51	< 0.1	1.6	3.6	< 1.8	< 19.9	
Pajarito at Rio Grande	09/26	F	DUP						< 0.03	< 0.1					
Pajarito at Rio Grande	09/26	UF	CS												< 0.06
Pajarito at Rio Grande	09/26	UF	DUP												
Water Canyon:															
Water Canyon at Beta	08/17	F	CS	< 6.0	61.0	< 2.0	24.0	211.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	41.0	
Water Canyon at Beta	08/17	UF	CS												< 0.10
Ancho Canyon:															
Ancho at Rio Grande	09/26	F	CS	< 0.5	< 23.4	< 2.6	< 4.7	30.0	0.49	< 0.1	< 0.6	< 1.1	< 1.8	10.3	
Ancho at Rio Grande	09/26	UF	CS												< 0.06
Ancho at Rio Grande	09/26	F	CS	< 0.5	< 23.4	< 2.6	7.3	29.2	0.51	< 0.1	< 0.6	< 1.1	< 1.8	< 19.9	
Ancho at Rio Grande	09/26	UF	CS												
Frijoles Canyon:															
Frijoles at Monument Headquarters	08/22	F	CS	< 0.5	23.4	< 2.6	5.1	17.6	0.51	< 0.1	1.2	< 1.1	< 1.8	86.1	
Frijoles at Monument Headquarters	08/22	F	DUP	< 0.5	609.0	< 2.6	27.9	25.4	0.51	< 0.1	12.9	< 1.1	< 1.8	562.0	
Frijoles at Monument Headquarters	08/22	UF	CS												< 0.06
Frijoles at Monument Headquarters	08/22	UF	DUP												< 0.06
Frijoles at Monument Headquarters	08/22	F	CS	< 0.5	15.6	3.3	8.0	17.9	0.51	< 0.1	< 0.6	< 1.1	< 1.8	93.9	
Frijoles at Monument Headquarters	08/22	UF	CS												< 0.06
Frijoles at Rio Grande	08/22	F	CS	< 0.5	23.4	3.5	4.9	20.4	0.51	< 0.1	< 0.6	< 1.1	< 1.8	82.6	
Frijoles at Rio Grande	08/22	UF	CS												< 0.06
Water Quality Standards[c]															
EPA Primary Drinking Water Standard						50		2,000	4	5		100			2
EPA Secondary Drinking Water Standard					50-200									300	
EPA Action Level													1,300		
EPA Health Advisory															
NMWQCC Livestock Watering Standard					5,000	200	5,000			50	1,000	1,000	500		10
NMWQCC Groundwater Limit				50	5,000	100	750	1,000		10	50	50	1,000	1,000	2
NMWQCC Wildlife Habitat Standard															0.77

Table 5-8. Trace Metals in Surface Water for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Stations														
Rio Chama at Chamita (bank)	07/12	F	CS	5.0	< 10.0	< 20.0	< 2.00	< 3.00		< 60.0	289.0		< 7.0	< 10.0
Rio Chama at Chamita (bank)	07/12	UF	CS						< 3.0					
Rio Grande at Embudo (bank)	07/12	F	CS	30.0	13.0	20.0	< 10.00	< 3.00		< 60.0	243.0		7.0	38.0
Rio Grande at Embudo (bank)	07/12	UF	CS						< 3.0					
Rio Grande at Otowi Upper (bank)	08/14	F	CS	3.0	< 130.0	< 40.0	< 2.00	< 3.00		< 60.0	294.0		< 7.0	< 10.0
Rio Grande at Otowi Upper (bank)	08/14	UF	CS						3.0					
Rio Grande at Otowi (bank)	08/14	F	CS	15.0	< 130.0	< 40.0	< 2.00	3.00		< 60.0	302.0		< 7.0	< 10.0
Rio Grande at Otowi (bank)	08/14	UF	CS						3.0					
Rio Grande at Frijoles (bank)	09/27	F	CS	7.6	3.6	1.5	0.12	< 0.11		< 2.0	366.0	0.03	3.1	2.8
Rio Grande at Frijoles (bank)	09/27	UF	CS						< 2.4					
Rio Grande at Cochiti	09/27	F	DUP	39.8	3.5	< 3.1			< 2.4	< 2.0	362.0		3.7	< 3.9
Jemez River	07/13	F	CS	9.0	< 10.0	< 20.0				< 60.0	198.0		< 7.0	< 10.0
Pajarito Plateau Stations														
Acid/Pueblo Canyons:														
Pueblo 1 R	07/25	F	CS	842.0	< 10.0	< 20.0	< 2.00	3.00		< 60.0	196.0		< 7.0	< 10.0
Pueblo 1 R	07/25	UF	CS						< 3.0					
Acid Weir	07/25	F	CS	58.0	< 10.0	< 20.0	< 2.00	3.00		< 60.0	169.0		< 7.0	< 10.0
Acid Weir	07/25	UF	CS						< 3.0					
Pueblo 3	07/25	F	CS	2,326.0	< 10.0	< 52.0	< 2.00	< 3.00		< 60.0	179.0		< 7.0	< 10.0
Pueblo 3	07/25	UF	CS						< 3.0					
Pueblo at SR-502	08/14	F	CS	2,240.0	< 130.0	< 40.0	< 5.00	< 3.00		< 60.0	136.0		< 13.0	18.0
Pueblo at SR-502	08/14	UF	CS						4.0					
Pueblo at SR-502	12/06	F	CS	284.0	11.5	12.8	0.46	0.76		< 2.0	214.0	0.13	14.3	56.4
Pueblo at SR-502	12/06	F	DUP	141.0	5.5	6.2	0.41	0.56		< 2.0	111.0	< 0.01	7.3	26.9
Pueblo at SR-502	12/06	UF	CS						< 2.4					
Pueblo at SR-502	12/06	UF	DUP						< 2.4					
DP/Los Alamos Canyons:														
DPS-1	10/25	F	CS	11.8	1.9	2.2	0.44	0.80		< 2.0	95.7	< 0.01	2.0	14.1
DPS-1	10/25	F	DUP	10.5	1.5	2.1				< 2.0	98.3		1.9	13.0
DPS-1	10/25	UF	CS						< 2.4					
Sandia Canyon:														
SCS-2	08/16	F	CS	21.0	304.0	< 20.0	< 5.00	3.00		60.0	117.0		12.0	42.0
SCS-2	08/16	UF	CS						4.0					
Mortandad Canyon:														
Mortandad at GS-1	07/11	UF	CS	16.0		14.4	0.53	< 0.68	1.4			0.22	5.8	29.4
Mortandad at GS-1	07/11	F	CS	3.0		13.0	0.06	< 0.68	1.6			0.22	4.5	21.3
Mortandad at GS-1	08/16	F	CS	7.0	97.0	< 20.0	< 2.00	3.00		60.0	42.0		< 7.0	17.0
Mortandad at GS-1	08/16	UF	CS						3.0					
Mortandad at Rio Grande (A-11)	09/25	F	CS	13.4	< 1.1	3.3	0.37	< 0.11		< 2.0	123.0	0.03	7.9	39.7
Mortandad at Rio Grande (A-11)	09/25	UF	CS						< 2.4					
Cañada del Buey:														
Cañada del Buey	10/24	F	CS	85.5	84.5	4.0	0.46	0.18		2.4	87.2	0.02	2.6	12.0
Cañada del Buey	10/24	UF	CS						< 2.4					

Table 5-8. Trace Metals in Surface Water for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Pajarito Plateau Stations (Cont.)														
Pajarito Canyon:														
Pajarito Canyon	10/24	F	CS	142.0	1.5	3.3	0.44	0.36		2.4	175.0	0.02	4.1	7.7
Pajarito Canyon	10/24	UF	CS						< 2.4					
Pajarito Retention Pond	08/24	F	CS	1,080.0	3.5	2.1	0.09	< 0.68		2.2	235.0	< 0.01	6.9	2.8
Pajarito Retention Pond	08/24	UF	CS	1,860.0	2.7	8.5	23.70	< 0.68	2.4	< 2.0	301.0	0.13	19.6	49.5
Pajarito at Rio Grande	09/26	F	CS	2.4	< 1.1	< 3.1	< 0.08	< 0.11		< 2.0	129.0	0.26	9.9	6.5
Pajarito at Rio Grande	09/26	F	DUP				< 0.08	< 0.11				< 0.01		
Pajarito at Rio Grande	09/26	UF	CS						< 2.4					
Pajarito at Rio Grande	09/26	UF	DUP						< 2.4					
Water Canyon:														
Water Canyon at Beta	08/17	F	CS	43.0	< 10.0	< 20.0	< 2.00	< 3.00		< 60.0	172.0		< 7.0	< 10.0
Water Canyon at Beta	08/17	UF	CS						3.0					
Ancho Canyon:														
Ancho at Rio Grande	09/26	F	CS	2.1	< 1.1	< 3.1	< 0.08	< 0.11		< 2.0	70.4	0.38	5.1	2.3
Ancho at Rio Grande	09/26	UF	CS						< 2.4					
Ancho at Rio Grande	09/26	F	CS	< 1.2	< 1.1	< 3.1	< 0.08	< 0.11		< 2.0	68.8	0.05	5.0	< 3.9
Ancho at Rio Grande	09/26	UF	CS						< 2.4					
Frijoles Canyon:														
Frijoles at Monument Headquarters	08/22	F	CS	14.2	< 1.1	< 3.1	< 0.08	0.11		< 2.0	52.3	0.30	4.0	< 3.9
Frijoles at Monument Headquarters	08/22	F	DUP	57.8	< 1.1	< 3.1	< 0.08	< 0.11		< 2.0	55.1	< 0.01	4.6	3.5
Frijoles at Monument Headquarters	08/22	UF	CS						< 2.4					
Frijoles at Monument Headquarters	08/22	UF	DUP						< 2.4					
Frijoles at Monument Headquarters	08/22	F	CS	10.0	< 1.1	< 3.1	< 0.08	0.11		< 2.0	53.1	0.08	4.2	< 3.9
Frijoles at Monument Headquarters	08/22	UF	CS						< 2.4					
Frijoles at Rio Grande	08/22	F	CS	16.9	< 1.1	< 3.1	< 0.08	0.11		< 2.0	57.6	0.36	3.4	< 3.9
Frijoles at Rio Grande	08/22	UF	CS						< 2.4					
Water Quality Standards[c]														
EPA Primary Drinking Water Standard						100		6	50			2		
EPA Secondary Drinking Water Standard				50										5,000
EPA Action Level							15							
EPA Health Advisory											25,000–90,000		80–110	
NMWQCC Livestock Watering Standard							100		50				100	25,000
NMWQCC Groundwater Limit				200	1,000	200	50		50					10,000
NMWQCC Wildlife Habitat Standard									5					

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[a] Codes: UF–unfiltered; F–filtered; CS–customer sample; DUP–laboratory duplicate.

[b] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[c] Standards given here for comparison only; see Appendix A. Note that New Mexico Livestock Watering and Groundwater limits are based on dissolved concentrations, whereas many of these analyses are of unfiltered samples; thus, concentrations may include suspended sediment quantities.

Table 5-9. Number of Samples Collected for Each Suite of Organic Compounds in Surface Water and Runoff Samples in 2000

		Organic Suite[a]			
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**	**Volatile**
Surface Water Samples:					
Acid Weir	07/25		1	1	1
Ancho at Rio Grande	09/26	2	2	1	2
Cañada del Buey	10/24		1	1	1
DI Blank	07/26		1	1	1
DPS-1	10/25		1	1	1
Frijoles at Monument Headquarters	08/22	2	2	2	2
Frijoles at Rio Grande	08/22	1	1	1	1
Mortandad at GS-1	07/11		1		
Organics Trip Blank	07/25				1
Organics Trip Blank	09/25				1
Organics Trip Blank	09/26				1
Organics Trip Blank	09/27				1
Organics Trip Blank	10/24				1
Pajarito at Rio Grande	09/26	1	1	1	1
Pajarito Canyon	10/24	1	1	1	1
Pajarito Retention Pond	10/11	1	1	1	
Pueblo 1 R	07/25		1	1	1
Pueblo 3	07/25		1	1	1
Runoff Samples:					
Area J	08/09		1		
Area L	07/17		1	2	
Area L	10/07		1		
Cañada del Buey at White Rock, NM	07/29		1	1	
Cañada del Buey at White Rock, NM	10/23	1		1	
Cañada del Buey at White Rock, NM	10/28	1			
Cañon del Valle above Highway 501	06/28	1	1	1	
Cañon del Valle above Highway 501	10/23	1	1	1	1
DP Canyon at Mouth	06/02		1	1	
DP Canyon below Meadow at TA-21	07/25			1	
G-1	10/11		1		
G-2	07/29	1	1		
G-2	08/09	1	1	1	
G-2	10/11		1		
G-3	08/09		1		
G-3	08/18	1	1	1	1
G-3	10/11		1		
G-4	10/12			1	
G-6	07/29	1	1	1	
G-6	08/09		1		
Guaje at SR-502	07/09	1	1	1	
Guaje at SR-502	09/08	1	1	1	1
Los Alamos Canyon at Los Alamos, NM	06/03		1	1	
Los Alamos Canyon at Los Alamos, NM	07/18		1	1	
Los Alamos Canyon at Los Alamos, NM	09/12	1	1	1	1
Los Alamos Canyon below Laboratory Technical Area (TA) 2 near Los Alamos, NM	06/02		1	1	
Los Alamos Canyon near Los Alamos, NM	06/03		1	1	
Los Alamos Canyon near Los Alamos, NM	07/09	1	1	1	
Los Alamos Canyon near Los Alamos, NM	10/23			1	

Table 5-9. Number of Samples Collected for Each Suite of Organic Compounds in Surface Water and Runoff Samples in 2000 (Cont.)

		Organic Suite[a]			
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**	**Volatile**
Los Alamos Reservoir	08/31	1	1	1	
Los Alamos Weir	07/21		1	1	
Pajarito Canyon above Highway 4 near White Rock, NM	06/28	1	1	1	
Pajarito Canyon above Highway 4 near White Rock, NM	10/24	1	1	1	1
Pajarito Canyon above Highway 4 near White Rock, NM	10/27	1			
Pajarito Canyon above Highway 501 near Los Alamos, NM	06/28	1	1	1	
Pajarito Canyon above Highway 501 near Los Alamos, NM	09/08	1	1	1	1
Pajarito Canyon above Highway 501 near Los Alamos, NM	10/23	1	1	1	1
Pajarito Canyon at TA-22	06/28		1		
Pajarito SR-4 Culvert	06/28	1	1	1	
Potrillo Canyon near White Rock, NM	08/09		1		
Sandia Canyon near Roads & Grounds at TA-3	07/16		1		
Starmer’s Gulch above Highway 501	10/23	1		1	1
Starmers Gulch at TA-22	06/28		1	1	
TA-18 Culvert	06/28		1	1	
Two-Mile at Highway 501	10/23	1	1	1	1
Upper Los Alamos Reservoir	08/31	1	1	1	
Water Canyon above Highway 501 near Los Alamos, NM	06/28			1	
Water Canyon above Highway 501 near Los Alamos, NM	10/23	1	1	1	1
Water Canyon at Highway 4	06/28	1	1	1	
Water Canyon at Highway 4	10/27	1		1	
Water Canyon below Highway 4 near White Rock, NM	06/28	1	1	1	
Water Canyon below Highway 4 near White Rock, NM	07/29	1	1		
Water Canyon below Highway 4 near White Rock, NM	08/12	1			
Water Canyon below Highway 4 near White Rock, NM	08/18	1	1	1	1
Water Canyon below Highway 4 near White Rock, NM	10/23	1	1	1	1

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[a] High explosives, polychlorinated biphenyls, semivolatiles, and volatiles.

Table 5-10. Organic Compounds Detected in Surface Water Samples in 2000

Detect[a]	Station Name	Date	Code[b]	Suite[c]	Analyte	Result	MDL[d]	Units	Lab Code
	Organics Trip Blank	07/25	UF	VOA	Toluene	2.20		µg/L	PARA
	Pueblo 3	07/25	UF	VOA	Toluene	1.20		µg/L	PARA
Detect	Pueblo 3	07/25	UF	VOA	Acetone	10.00		µg/L	PARA
	Acid Weir	07/25	UF	VOA	Chloroform	0.33		µg/L	PARA
	Organics Trip Blank	07/25	UF	VOA	Chloroform	2.80		µg/L	PARA
	Organics Trip Blank	07/25	UF	VOA	Chloroethane	4.60		µg/L	PARA
	Organics Trip Blank	07/25	UF	VOA	Methylene chloride	16.00		µg/L	PARA
	Pueblo 1	07/25	UF	VOA	Methylene chloride	14.00		µg/L	PARA
	Pueblo 3	07/25	UF	VOA	Methylene chloride	1.30		µg/L	PARA
	Acid Weir	07/25	UF	VOA	Methylene chloride	15.00		µg/L	PARA
	Organics Trip Blank	07/25	UF	VOA	Bromodichloromethane	0.74		µg/L	PARA
	DI Blank	07/26	UF	SVOA	Bis(2-ethylhexyl)phthalate	2.80		µg/L	PARA
	DI Blank	07/26	UF	VOA	Methylene chloride	15.00		µg/L	PARA
	Organics Trip Blank	09/25	UF	VOA	Chloroform	6.10	0.198	µg/L	GELC
	Organics Trip Blank	09/25	UF	VOA	Bromodichloromethane	1.60	0.024	µg/L	GELC
	Organics Trip Blank	09/26	UF	VOA	Chloroform	6.10	0.198	µg/L	GELC
	Organics Trip Blank	09/26	UF	VOA	Bromodichloromethane	1.50	0.024	µg/L	GELC
	Organics Trip Blank	09/27	UF	VOA	Chloroform	5.30	0.198	µg/L	GELC
	Organics Trip Blank	09/27	UF	VOA	Bromodichloromethane	1.30	0.024	µg/L	GELC
	Organics Trip Blank	10/24	UF	VOA	Chloroform	6.70	0.198	µg/L	GELC
	Organics Trip Blank	10/24	UF	VOA	Bromodichloromethane	1.60	0.024	µg/L	GELC

[a] Indicates compound was not detected in associated blank. Results are sorted by analyte and date to show association of field blanks with samples.

[b] UF–unfiltered; F–filtered.

[c] PEST/PCB–pesticides and polychlorinated biphenyls; SVOA–semivolatile organics; VOA–volatile organics.

[d] Method detection limit.

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a])

Station Name	Date	Codes[b]		^{3}H			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L)
Runoff Stations																						
Los Alamos Canyon (includes Pueblo, DP Canyons):																						
Los Alamos Canyon at Los Alamos	06/03	F	CS	80	30	190	3.04	0.15	0.29	-0.10	0.73	5.00	1.040	0.053	0.058	0.041	0.008	0.016	1.090	0.055	0.033	3.50
Los Alamos Canyon at Los Alamos	06/03	UF	CS	120	30	190	4.34	0.21	0.33	5.00	0.58	2.30	1.450	0.065	0.048	0.067	0.011	0.057	1.580	0.070	0.041	4.48
Los Alamos Canyon at Los Alamos	07/18	F	CS																			4.74
Los Alamos Canyon at Los Alamos	07/18	UF	CS																			21.50
Los Alamos Canyon at Los Alamos	07/18	UF	DUP																			26.00
Los Alamos Canyon at Los Alamos	07/18	F	CS				4.24	0.43	0.39	0.00	2.00	3.00	2.000	0.195	0.070	0.460	0.070	0.061	2.000	0.195	0.061	
Los Alamos Canyon at Los Alamos	07/18	F	DUP										2.000			0.203			1.000			
Los Alamos Canyon at Los Alamos	07/18	UF	CS	20	55	180																
Los Alamos Canyon at Los Alamos	07/18	UF	TOTC				19.80			34.00	3.00		16.000	1.000		2.000			18.000	1.000		
Los Alamos Canyon at Los Alamos	07/18	UF	CS																			
Los Alamos Canyon at Los Alamos	07/18	UF	TOTC				38.90			102.00	10.00		47.000	3.500		4.000	0.500		52.000	4.000		
Los Alamos Canyon at Los Alamos	09/12	F	CS				3.40	0.36	0.21	1.75	1.93	7.06	0.661	0.100	0.101	0.011	0.011	0.030	0.634	0.097	0.080	1.51
Los Alamos Canyon at Los Alamos	09/12	F	DUP				3.33	0.13	0.24				0.730	0.105	0.110	0.026	0.023	0.110	0.603	0.093	0.095	
Los Alamos Canyon at Los Alamos	09/12	UF	CS	-91	57	199	2.98	0.20	0.40	5.42	2.81	7.49	1.940	0.183	0.097	0.072	0.029	0.091	1.780	0.171	0.051	2.82
Los Alamos Canyon at Los Alamos	09/12	UF	DUP	-122	56	201																
Los Alamos Canyon below TA 2	06/02	UF	CS	100	30	190	1.63	0.09	0.33	0.00	0.35	2.50	3.830	0.150	0.063	0.360	0.025	0.034	3.460	0.138	0.056	6.94
Los Alamos Canyon below TA 2	10/23	UF	CS																			0.99
DP Canyon below Meadow at TA-21	07/25	F	CS																			0.08
DP Canyon below Meadow at TA-21	07/25	UF	CS																			0.67
DP Canyon below Meadow at TA-21	10/23	UF	CS																			1.62
DP Canyon below Meadow at TA-21	10/27	F	CS																			0.08
DP Canyon below Meadow at TA-21	10/27	F	DUP																			0.05
DP Canyon below Meadow at TA-21	10/27	UF	CS																			2.05
DP Canyon at Mouth	06/02	UF	CS	140	30	190	23.90	1.08	0.35	14.20	1.23	5.50	3.540	0.145	0.053	0.258	0.022	0.018	2.280	0.100	0.038	4.82
DP Canyon at Mouth	10/12	UF	CS				23.80	1.04	0.55	6.21	1.90	4.58	4.320	0.423	0.106	0.115	0.042	0.039	2.700	0.292	0.133	
DP Canyon at Mouth	10/23	UF	CS																			2.62
DP Canyon at Mouth	10/27	F	CS				7.33	0.31	0.48	0.41	1.56	2.19	0.052	0.022	0.075	0.000	0.009	0.065	0.017	0.013	0.051	0.05
DP Canyon at Mouth	10/27	F	DUP																			
DP Canyon at Mouth	10/27	UF	CS	-29	57	193																5.40
Los Alamos Canyon near Los Alamos	06/02	UF	CS	130	30	190	25.20	1.15	0.42	13.90	0.88	4.30	7.900	0.325	0.110	0.560	0.040	0.092	6.200	0.250	0.087	10.20
Los Alamos Canyon near Los Alamos	06/03	F	CS	30	28	190	3.54	0.17	0.32	0.20	0.75	5.20	1.060	0.053	0.066	0.099	0.013	0.052	1.120	0.055	0.066	3.44
Los Alamos Canyon near Los Alamos	06/03	UF	CS	150	30	190	6.80	0.33	0.33	21.80	1.95	6.00	2.550	0.108	0.057	0.235	0.021	0.057	2.610	0.110	0.061	6.35
Los Alamos Canyon near Los Alamos	06/03	UF	DUP																			
Los Alamos Canyon near Los Alamos	07/09	UF	CS	-100	55	190																68.40
Los Alamos Canyon near Los Alamos	07/09	UF	DUP	-90	55	190																
Los Alamos Canyon near Los Alamos	07/09	UF	TOTC							106.58			26.042			1.731			36.411			
Los Alamos Canyon near Los Alamos	07/09	F	CS							-1.00	1.55	2.60	1.040	0.080	0.023	0.096	0.017	0.018	1.320	0.100	0.026	4.05
Los Alamos Canyon near Los Alamos	07/09	F	DUP										1.140	0.085	0.006	0.061	0.015	0.033	1.340	0.100	0.006	
Los Alamos Canyon near Los Alamos	10/17	UF	CS				10.90	0.63	0.88	4.25	2.10	4.50	0.771	0.096	0.071	0.054	0.021	0.021	0.500	0.073	0.082	
Los Alamos Canyon near Los Alamos	10/23	F	CS				4.60	0.47	1.23	3.33	1.46	2.52	0.045	0.021	0.069	0.000	1.000	0.020	0.015	0.011	0.020	0.03
Los Alamos Canyon near Los Alamos	10/23	F	DUP																			
Los Alamos Canyon near Los Alamos	10/23	UF	CS	30	59	194	9.94	1.29	0.56	18.80	1.99	3.47	5.860	0.471	0.084	0.214	0.042	0.052	5.770	0.465	0.019	2.98
Los Alamos Canyon near Los Alamos	10/27	F	CS																			0.22
Los Alamos Canyon near Los Alamos	10/27	UF	CS	-29	56	190	11.20	0.44	0.54	15.00	2.25	4.23	8.720	0.951	0.312	0.851	0.216	0.511	8.920	0.967	0.115	
Los Alamos Canyon near Los Alamos	10/27	UF	DUP	-29	56	191																
Pueblo Canyon near Los Alamos	10/23	F	CS																			1.34
Pueblo Canyon near Los Alamos	10/23	UF	CS				10.80	0.52	0.99	9.14	1.58	3.81	14.100	1.280	0.254	0.673	0.148	0.202	15.700	1.410	0.386	9.78
Pueblo Canyon near Los Alamos	10/23	UF	DUP																			
Pueblo Canyon near Los Alamos	10/27	F	CS				1.62	0.18	0.54	1.12	0.84	3.10	0.297	0.057	0.102	0.013	0.013	0.063	0.276	0.053	0.063	
Pueblo Canyon near Los Alamos	10/27	UF	CS	-89	56	195	5.40	0.31	0.55	4.43	2.06	3.22	17.000	1.760	0.418	1.080	0.265	0.155	18.000	1.850	0.528	

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L^a) (Cont.)

Station Name	Date	Codes^b		^{3}H			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L)
Runoff Stations (Cont.)																						
Sandia Canyon:																						
Sandia Canyon at TA-3	07/17	UF	CS																			0.87
Sandia Canyon at TA-3	07/17	UF	CS	100	55	180	0.15	0.12	0.39	0.00	2.50	4.00	0.760	0.065	0.032	0.064	0.014	0.024	0.860	0.070	0.017	
Sandia Canyon at TA-3	07/17	UF	DUP																			
Sandia Canyon at TA-3	10/17	UF	CS				0.51	0.18	0.58	0.58	1.62	5.01	0.058	0.023	0.074	0.017	0.012	0.051	0.051	0.020	0.050	
Sandia Canyon at TA-3	10/17	UF	DUP										0.055	0.018	0.015	-0.003	0.007	0.060	0.042	0.016	0.041	
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey):																						
TA-55	07/17	UF	CS																			0.46
TA-55	07/17	UF	CS	10	55	180	0.00	0.12	0.40	2.00	2.50	4.00	0.205	0.028	0.023	0.075	0.016	0.019	0.286	0.034	0.019	
TA-55	10/07	F	CS							4.23	1.53	2.06										
TA-55	10/07	F	DUP										0.053	0.031	0.147	-0.018	0.015	0.118	0.000	0.012	0.085	
TA-55	10/07	UF	CS	-69	47	161				0.39	0.72	2.69										0.15
TA-55	10/07	UF	DUP				0.32	0.21	0.69	0.53	0.87	3.34										0.15
Cañada del Buey near TA-46	10/23	UF	CS																			18.00
TA-54 MDA J	08/09	UF	CS																			3.21
TA-54 MDA J	08/09	UF	DUP																			3.33
TA-54 MDA J	07/15	UF	CS																			0.21
TA-54 MDA J	07/17	F	CS																			0.04
TA-54 MDA J	07/17	UF	CS																			0.15
TA-54 MDA J	07/17	UF	CS	110	55	180	0.04	0.12	0.40	0.00	2.00	3.00	0.091	0.037	0.094	0.010	0.018	0.065	0.059	0.029	0.077	
TA-54 MDA J	10/07	UF	CS	-79	51	175				1.12	1.61	2.21										0.11
TA-54 MDA G-6	07/29	F	CS				0.21	0.10	0.16	0.25	0.62	2.24	0.069	0.021	0.016	-0.003	0.008	0.054	0.021	0.014	0.054	0.20
TA-54 MDA G-6	07/29	F	DUP										0.094	0.023	0.014	0.016	0.009	0.014	0.047	0.016	0.014	
TA-54 MDA G-6	07/29	UF	CS	500	67	183	0.75	0.39	0.63	0.00	0.76	2.95	7.770	0.580	0.044	0.365	0.050	0.044	7.920	0.591	0.044	5.37
TA-54 MDA G-6	07/29	UF	DUP	388	64	182																
TA-54 MDA G-6	08/18	F	CS				0.27	0.20	0.33	0.12	0.93	3.26	0.029	0.025	0.128	0.000	0.013	0.089	0.048	0.022	0.079	0.14
TA-54 MDA G-6	08/18	UF	CS	1,730	147	369	0.26	0.17	0.27	7.05	1.64	3.40	0.584	0.078	0.130	0.026	0.019	0.092	0.662	0.082	0.078	2.61
TA-54 MDA G-6	08/18	UF	DUP	1,710	141	349																2.61
TA-54 MDA G-6	10/11	F	CS				3.34	0.46	0.50	0.55	0.62	2.29	0.073	0.026	0.098	-0.003	0.008	0.063	0.041	0.017	0.055	0.11
TA-54 MDA G-6	10/11	F	DUP										0.045	0.018	0.044	-0.003	0.003	0.045	0.060	0.021	0.056	
TA-54 MDA G-6	10/11	UF	CS	1,870	101	209	0.17	0.18	0.59	5.70	2.03	3.65	9.160	1.140	0.839	0.544	0.226	0.246	7.650	1.010	0.665	2.50
TA-54 MDA G-6	10/11	UF	DUP										10.700	1.260	0.667	0.191	0.165	0.978	10.600	1.260	0.975	2.54
Cañada del Buey at White Rock	07/29	UF	CS	-112	52	185																15.70
Cañada del Buey at White Rock	07/29	F	CS																			0.31
Cañada del Buey at White Rock	08/09	UF	CS				-0.14	0.27	0.46	0.79	0.91	3.25	25.900	2.320	0.414	1.450	0.308	0.415	26.900	2.400	0.522	
Cañada del Buey at White Rock	08/18	F	CS				0.30	0.24	0.39	-0.72	0.81	2.70	0.003	0.016	0.101	-0.022	0.008	0.091	0.036	0.017	0.056	0.07
Cañada del Buey at White Rock	08/18	F	DUP							0.83	0.83	2.91										
Cañada del Buey at White Rock	08/18	UF	CS	-69	103	351	0.34	0.19	0.30	-0.14	1.20	4.19	9.840	0.977	0.487	0.430	0.126	0.286	10.400	1.020	0.226	9.58
Cañada del Buey at White Rock	08/18	UF	DUP				0.89	0.25	0.38													
Cañada del Buey at White Rock	10/11	UF	CS																			2.80
Cañada del Buey at White Rock	10/23	UF	CS	-61	57	196	0.63	0.31	1.03	4.39	1.89	3.33	14.400	1.200	0.204	0.942	0.152	0.140	14.200	1.190	0.140	4.01
Cañada del Buey at White Rock	10/28	F	CS																			0.11
Cañada del Buey at White Rock	10/28	UF	CS																			1.76

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{3}H			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L)
Runoff Stations (Cont.)																						
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):																						
Pajarito Canyon above Highway 501	06/28	F	CS				3.42	0.35	0.41	-0.20	2.65	4.50	1.370	0.155	0.033	0.161	0.046	0.076	1.320	0.155	0.057	3.74
Pajarito Canyon above Highway 501	06/28	UF	CS	-10	60	190																
Pajarito Canyon above Highway 501	06/28	UF	TOTC				59.20	4.50		109.00			31.200	2.150		1.982			33.104			
Pajarito Canyon above Highway 501	09/08	F	CS				1.53	0.14	0.32	2.34	1.93	7.03	0.249	0.046	0.086	0.036	0.019	0.066	0.173	0.040	0.097	0.43
Pajarito Canyon above Highway 501	09/08	F	DUP							0.94	2.05	7.35										
Pajarito Canyon above Highway 501	09/08	UF	CS	-120	56	198	6.09	0.67	0.29	31.60	5.93	7.71	8.030	0.679	0.150	0.245	0.065	0.129	7.910	0.671	0.167	12.70
Pajarito Canyon above Highway 501	09/08	UF	DUP							30.50	2.62	3.00										13.90
Pajarito Canyon above Highway 501	10/23	F	CS				1.36	0.24	0.71	-0.90	0.50	1.67	0.167	0.047	0.144	0.014	0.019	0.103	0.134	0.039	0.089	0.41
Pajarito Canyon above Highway 501	10/23	F	DUP				1.95	0.17	0.46													
Pajarito Canyon above Highway 501	10/23	UF	CS	-30	57	194	2.93	0.32	0.87	0.00	1.68	3.50	0.408	0.079	0.093	0.000	0.016	0.117	0.352	0.074	0.117	1.21
Pajarito Canyon above Highway 501	10/23	UF	DUP							1.87	2.82	3.90										1.20
Pajarito Canyon at TA-22	06/28	F	CS				2.42	0.25	0.34	0.30	2.65	4.40	1.010	0.110	0.058	0.148	0.037	0.058	0.790	0.095	0.058	2.60
Pajarito Canyon at TA-22	06/28	UF	CS	0	60	190																
Pajarito Canyon at TA-22	06/28	UF	DUP	60	60	190																
Pajarito Canyon at TA-22	06/28	UF	TOTC				8.11	0.67		1.56			5.120	0.300		0.387			4.509			
Starmers Gulch at TA-22	06/28	F	CS				3.18	0.32	0.36	1.20	2.70	4.40	1.060	0.115	0.052	0.260	0.049	0.043	0.950	0.105	0.052	3.24
Starmers Gulch at TA-22	06/28	UF	CS	-10	60	190																
Starmers Gulch at TA-22	06/28	UF	TOTC				15.33	1.25		1.2			4.540	0.280		0.619			5.037			
TA-54 MDA G-1	10/11	F	CS																			0.06
TA-54 MDA G-1	10/11	UF	CS	-180	57	209	0.59	0.18	0.60	0.68	1.03	3.68	0.364	0.060	0.072	0.043	0.020	0.057	0.441	0.068	0.093	1.91
TA-54 MDA G-2	07/29	F	CS				0.38	0.16	0.25	0.04	0.64	2.28	0.108	0.025	0.043	0.028	0.012	0.013	0.061	0.018	0.034	0.16
TA-54 MDA G-2	07/29	F	DUP																			
TA-54 MDA G-2	07/29	UF	CS	303	62	182	1.00	0.22	0.32	0.00	0.98	3.76	4.240	0.353	0.111	0.261	0.052	0.111	4.370	0.363	0.122	2.95
TA-54 MDA G-2	08/09	F	CS				0.31	0.24	0.39	-0.57	0.82	2.80	0.038	0.024	0.100	-0.007	0.005	0.127	0.079	0.034	0.100	0.13
TA-54 MDA G-2	08/09	F	DUP										0.140	0.048	0.187	-0.006	0.005	0.124	0.090	0.036	0.098	
TA-54 MDA G-2	08/09	UF	CS	0	54	180	0.87	0.29	0.46	-1.85	1.21	3.86	12.400	1.300	0.169	0.251	0.127	0.170	12.900	1.340	0.169	5.35
TA-54 MDA G-2	08/09	UF	DUP				0.10	0.32	0.53	-0.40	0.97	3.35										
TA-54 MDA G-2	10/11	F	CS				1.14	0.23	0.72	62.40	2.33	2.33	0.056	0.028	0.113	0.000	0.017	0.114	0.064	0.029	0.113	0.20
TA-54 MDA G-2	10/11	UF	CS	864	81	207	0.78	0.17	0.55	2.92	1.15	4.25	0.344	0.070	0.138	0.017	0.017	0.085	0.327	0.068	0.124	1.61
TA-54 MDA G-3	07/29	UF	CS																			11.10
TA-54 MDA G-3	08/09	UF	CS				2.11	0.33	0.45	1.18	0.85	3.05	77.700	6.910	0.935	3.360	0.549	1.040	72.900	6.500	0.380	
TA-54 MDA G-3	08/18	F	CS				0.21	0.21	0.34	4.15	1.51	3.13	0.099	0.032	0.109	0.005	0.017	0.109	0.109	0.032	0.087	0.26
TA-54 MDA G-3	08/18	F	DUP																			
TA-54 MDA G-3	08/18	UF	CS	493	0	371	0.80	0.24	0.36		1.01	3.50	21.100	1.940	0.418	0.819	0.189	0.375	19.400	1.800	0.741	1.16
TA-54 MDA G-3	08/18	UF	DUP																			
TA-54 MDA G-3	10/11	F	CS																			0.50
TA-54 MDA G-3	10/11	UF	CS	603	77	209	0.79	0.19	0.58	0.46	1.15	4.11	0.515	0.076	0.095	0.032	0.019	0.074	0.460	0.071	0.112	1.58
TA-54 MDA G-3	10/25	F	CS																			0.15
TA-54 MDA G-3	10/25	UF	CS																			1.19
TA-54 MDA G-3	10/28	F	CS				0.01	0.20	0.69	0.75	0.77	2.86	0.068	0.022	0.057	0.025	0.012	0.017	0.025	0.015	0.057	0.11
TA-54 MDA G-3	10/28	F	DUP										0.075	0.023	0.018	0.027	0.014	0.018	0.010	0.010	0.050	
TA-54 MDA G-3	10/28	UF	CS	292	65	192	0.08	0.21	0.72	-1.39	1.11	3.63	0.335	0.067	0.084	0.000	0.014	0.106	0.176	0.048	0.084	
TA-54 MDA G-5	10/23	F	CS																			0.03
TA-54 MDA G-5	10/23	UF	CS	179	62	191	0.83	0.20	0.54	-0.45	1.03	3.49	0.263	0.051	0.074	0.004	0.009	0.059	0.179	0.041	0.059	0.37
TA-54 MDA G-4	08/15	UF	CS	-68	133	454				1.09	1.17	3.73										1.15
TA-54 MDA G-4	08/15	UF	DUP	86	154	510				-0.63	1.10	3.79										1.16
TA-54 MDA G-4	10/12	F	CS				1.28	0.20	0.59	0.00	1.44	6.05	0.089	0.025	0.055	0.057	0.020	0.044	0.065	0.020	0.016	0.18
TA-54 MDA G-4	10/12	F	DUP																			
TA-54 MDA G-4	10/12	UF	CS	440	71	204	1.28	0.29	0.62	2.02	0.90	3.05	0.174	0.038	0.086	-0.010	0.010	0.087	0.220	0.044	0.099	0.36
TA-54 MDA G-4	10/12	UF	DUP	122	66	211																

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{3}H			^{90}Sr				^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L)
Runoff Stations (Cont.)																							
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)																							
Pajarito Canyon above Highway 4	06/28	F	CS				6.10	0.60	0.35		0.10	2.75	4.60	2.240	0.175	0.058	0.253	0.040	0.055	2.120	0.170	0.040	6.65
Pajarito Canyon above Highway 4	06/28	F	DUP				6.00	0.55	0.32														
Pajarito Canyon above Highway 4	06/28	UF	CS	-100	55	190					1.10	1.35	2.20				0.140	0.027	0.046	1.880	0.145	0.038	5.28
Pajarito Canyon above Highway 4	06/28	UF	TOTC				43.90	3.75			15.98			5.320	0.290		0.325			5.454			
Pajarito Canyon above Highway 4	10/24	F	CS				1.49	0.21	0.62	<	0.67	0.52	1.92	0.650	0.101	0.086	0.012	0.018	0.109	0.844	0.120	0.141	2.19
Pajarito Canyon above Highway 4	10/24	UF	CS				2.44	0.35	1.03	<	2.07	1.74	3.34	1.340	0.152	0.103	0.092	0.032	0.071	1.610	0.174	0.089	4.64
Pajarito Canyon above Highway 4	10/24	UF	DUP	-148	55	200								1.320	0.146	0.065	0.079	0.027	0.024	1.380	0.150	0.082	
Pajarito Canyon above Highway 4	10/27	F	CS				2.30	0.19	0.51		-0.15	0.75	2.69	0.855	0.097	0.048	0.032	0.017	0.060	0.968	0.106	0.078	3.63
Pajarito Canyon above Highway 4	10/27	UF	CS	-58	56	192	2.28	0.27	0.60		0.72	0.88	3.11	2.120	0.216	0.106	0.128	0.037	0.027	3.060	0.288	0.073	11.40
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):																							
Water Canyon above Highway 501	06/28	UF	CS	-40	55	190																	
Water Canyon above Highway 501	06/28	UF	TOTC				38.80	3.50			7.30			2.749	0.153		0.338			2.739			
Water Canyon above Highway 501	10/23	F	CS				5.07	0.55	1.35		1.26	1.48	1.97	0.336	0.054	0.050	0.020	0.017	0.082	0.234	0.046	0.089	0.75
Water Canyon above Highway 501	10/23	UF	CS	-60	56	193	13.30	0.96	1.59		14.30	2.38	3.48	32.300	3.010	0.790	1.450	0.319	0.691	29.800	2.800	0.143	1.54
Water Canyon above Highway 501	10/23	UF	DUP																				
Cañon del Valle above Highway 501	06/28	UF	CS	20	60	190																	
Cañon del Valle above Highway 501	06/28	UF	TOTC				48.20	4.20			15.38			4.380	0.295		0.276			4.511			
Cañon del Valle above Highway 501	10/23	F	CS				2.77	0.46	1.38		0.71	0.78	2.82	0.233	0.044	0.064	0.010	0.013	0.074	0.182	0.038	0.051	0.40
Cañon del Valle above Highway 501	10/23	UF	CS	0	57	192	10.00	0.80	0.60		11.70	2.31	3.44	10.400	0.930	0.144	0.441	0.101	0.144	11.900	1.040	0.182	2.99
Water Canyon above Highway 4	06/28	UF	CS																				
Water Canyon above Highway 4	06/28	UF	TOTC				30.90	2.25			26.55			9.940	0.565		0.454			10.791			
Water Canyon above Highway 4	10/27	F	CS																				3.06
Water Canyon above Highway 4	10/27	UF	CS	0	57	192																	12.40
Water Canyon above Highway 4	10/27	UF	DUP																				12.90
Indio Canyon at Highway 4	06/28	F	CS				5.01	0.49	0.36		-2.10	3.05	5.00	1.510	0.150	0.057	0.178	0.042	0.048	1.480	0.150	0.025	
Indio Canyon at Highway 4	06/28	F	DUP								-0.80	2.80	4.70										
Indio Canyon at Highway 4	06/28	UF	CS	40	60	190																	3.87
Water Canyon below Highway 4	06/28	F	CS				5.40	0.55	0.38		0.10	2.70	4.60	1.500	0.150	0.073	0.124	0.036	0.078	1.290	0.135	0.062	4.13
Water Canyon below Highway 4	06/28	F	DUP								-0.10	1.35	2.20										
Water Canyon below Highway 4	06/28	UF	CS	100	60	190																	
Water Canyon below Highway 4	06/28	UF	TOTC				62.10	4.45			61.36			18.630	1.305		1.540			20.581			
Water Canyon below Highway 4	07/29	F	CS				2.26	0.57	0.80		-0.37	0.89	2.96	3.800	0.309	0.054	0.205	0.038	0.043	4.970	0.393	0.016	
Water Canyon below Highway 4	07/29	UF	CS	-84	52	184	13.30	1.03	0.31		4.71	1.62	2.58	45.900	3.830	0.154	2.740	0.310	0.155	63.100	5.220	0.122	115.00
Water Canyon below Highway 4	07/29	UF	DUP				13.00	1.27	0.58		2.03	1.11	2.14										146.00
Water Canyon below Highway 4	08/12	UF	CS								1.09	1.17	4.22										7.82
Water Canyon below Highway 4	08/18	F	CS				1.05	0.33	0.51			0.84	2.83	0.139	0.041	0.126	-0.005	0.019	0.127	0.126	0.037	0.101	0.55
Water Canyon below Highway 4	08/18	F	DUP											0.199	0.042	0.085	-0.004	0.010	0.077	0.192	0.040	0.066	
Water Canyon below Highway 4	08/18	UF	CS	223	0	374	1.01	0.19	0.24			1.49	5.15	0.359	0.068	0.165	0.009	0.018	0.106	0.337	0.067	0.182	1.42
Water Canyon below Highway 4	10/23	F	CS																				0.92
Water Canyon below Highway 4	10/23	UF	CS																				4.37
Water Canyon below Highway 4	10/23	UF	DUP																				4.47
Water Canyon below Highway 4	10/27	F	CS				0.61	0.18	0.52		0.71	0.95	3.06	0.359	0.057	0.086	0.010	0.017	0.099	0.428	0.062	0.061	1.35
Water Canyon below Highway 4	10/27	UF	CS	-30	58	197	8.59	0.52	0.54		8.62	2.77	3.11	43.100	3.940	0.137	1.890	0.351	0.372	53.600	4.830	0.137	29.60
Potrillo Canyon near White Rock	08/09	UF	CS	-138	50	182	1.91	0.37	0.54		-0.33	0.86	2.92	9.380	0.877	0.366	0.344	0.093	0.155	10.300	0.947	0.253	5.83
Potrillo Canyon near White Rock	10/23	F	CS																				0.07
Potrillo Canyon near White Rock	10/23	F	DUP																				
Potrillo Canyon near White Rock	10/23	UF	CS	30	57	189																	2.37

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{3}H			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (µg/L)
Runoff Stations (Cont.)																						
Ancho Canyon:																						
Ancho Canyon at TA-39	08/18	UF	CS																			18.50
Ancho Canyon at TA-39	10/28	UF	CS																			3.57
Ancho Canyon near Bandelier NP	08/18	UF	CS																			14.40
Ancho Canyon near Bandelier NP	08/18	UF	DUP																			15.40
Ancho Canyon near Bandelier NP	10/23	UF	CS																			3.17
Ancho Canyon near Bandelier NP	10/28	UF	CS																			3.06
Runoff Grab Samples																						
Upper Los Alamos Reservoir	08/31	F	CS				0.87	0.29	0.33	1.16	1.15	4.18	0.290	0.049	0.070	0.006	0.013	0.079	0.143	0.033	0.061	0.40
Upper Los Alamos Reservoir	08/31	F	DUP										0.195	0.041	0.081	0.007	0.011	0.063	0.141	0.034	0.063	
Upper Los Alamos Reservoir	08/31	UF	CS				0.92	0.30	0.44	-0.80	1.01	3.44	0.214	0.044	0.110	-0.010	0.013	0.099	0.178	0.038	0.061	0.37
Upper Los Alamos Reservoir	08/31	UF	DUP	-57	54	186																
Los Alamos Reservoir	08/31	F	CS				3.20	0.43	0.38	0.00	1.12	4.23	0.453	0.070	0.122	0.031	0.018	0.072	0.234	0.046	0.057	0.88
Los Alamos Reservoir	08/31	UF	CS				3.63	0.41	0.37	0.79	1.02	3.57	0.452	0.076	0.157	0.082	0.032	0.109	0.339	0.062	0.097	1.10
Los Alamos Reservoir	08/31	UF	DUP							0.27	0.97	3.43										1.11
Los Alamos Canyon at SR-4 Weir	07/21	F	CS				26.60	4.42	2.69	1.14	0.67	2.51	2.060	0.172	0.037	0.088	0.020	0.011	1.920	0.162	0.037	6.01
Los Alamos Canyon at SR-4 Weir	07/21	F	DUP																			
Los Alamos Canyon at SR-4 Weir	07/21	UF	CS	0	40	136	1.95	1.21	1.96	0.00	1.54	2.38	2.950	0.295	0.101	0.131	0.041	0.101	2.430	0.253	0.080	8.23
Los Alamos Canyon at SR-4 Weir	07/21	UF	DUP	-60	39	136				1.58	0.80	2.96	2.890	0.278	0.069	0.132	0.038	0.087	2.440	0.243	0.025	8.25
Rendija Canyon at 3rd Crossing	07/17	F	CS																			2.74
Rendija Canyon at 3rd Crossing	07/17	F	CS				4.50	0.45	0.38	0.00	2.50	4.00	0.730	0.085	0.080	0.037	0.023	0.080	0.920	0.100	0.047	
Rendija Canyon at 3rd Crossing	07/17	UF	CS	100	55	180	72.00	6.50	0.39													
Rendija Canyon at 3rd Crossing	07/17	UF	DUP	60	55	180	73.00	6.50	0.42													
Rendija Canyon at 3rd Crossing	07/17	UF	TOTC							267.00	18.50		87.000	6.000		10.000	1.000		94.000	7.000		
Rendija Canyon at 3rd Crossing	07/17	UF	TOTCD				73.00															
Guaje Canyon at SR-502	07/09	F	CS							-0.40	1.45	2.40	1.490	0.110	0.022	0.101	0.017	0.022	1.960	0.140	0.007	5.89
Guaje Canyon at SR-502	07/09	UF	CS	-50	55	190																92.70
Guaje Canyon at SR-502	07/09	UF	TOTC							359.29			103.070			8.456			118.436			
Guaje Canyon at SR-502	09/08	F	CS				2.92	0.18	0.27	2.44	2.00	7.33	0.937	0.100	0.079	0.023	0.017	0.067	1.040	0.106	0.041	2.48
Guaje Canyon at SR-502	09/08	UF	CS	-120	56	198	80.80	9.49	9.19	221.78	14.63	8.50	136.000	24.800	2.070	3.800	1.140	0.606	134.000	24.300	0.604	10.00
Starmer's Gulch above Highway 501	10/23	F	CS				1.47	0.42	1.23	0.04	0.45	1.57	0.205	0.040	0.058	0.009	0.012	0.067	0.205	0.039	0.017	0.76
Starmer's Gulch above Highway 501	10/23	F	DUP										0.167	0.038	0.094	-0.014	0.007	0.081	0.214	0.042	0.062	
Starmer's Gulch above Highway 501	10/23	UF	CS	-61	56	194	12.10	0.77	0.83	17.10	2.32	3.48	18.700	1.560	0.148	0.695	0.131	0.148	19.800	1.650	0.148	2.67
Two-Mile Canyon at Highway 501	10/23	F	CS				2.70	0.66	1.80	-0.78	0.79	2.70	0.067	0.042	0.134	0.067	0.031	0.089	0.133	0.033	0.020	0.42
Two-Mile Canyon at Highway 501	10/23	F	DUP										0.095	0.040	0.116	0.022	0.016	0.054	0.029	0.025	0.088	
Two-Mile Canyon at Highway 501	10/23	UF	CS	-30	56	189	15.10	0.72	0.70	511.00	10.80	4.35	10.300	0.892	0.233	0.446	0.098	0.166	11.600	0.989	0.282	4.23
Pajarito Canyon at TA-18 Culvert	06/28	F	CS				5.40	0.50	0.34	0.10	2.25	3.80	2.280	0.175	0.051	0.182	0.030	0.028	2.370	0.180	0.028	6.34
Pajarito Canyon at TA-18 Culvert	06/28	UF	CS	40	60	190																
Pajarito Canyon at TA-18 Culvert	06/28	UF	TOTC				75.40	5.40		95.73			24.480	1.425		1.186			26.184			
Pajarito Canyon at G-1	06/28	F	CS				5.60	0.55	0.34	1.40	2.80	4.60	2.360	0.185	0.035	0.165	0.032	0.015	2.210	0.175	0.043	
Pajarito Canyon at G-1	06/28	UF	CS	-20	60	190																
Pajarito Canyon at G-1	06/28	UF	TOTC				51.20	4.35		13.47			12.640	0.630		0.676			13.265			
Pajarito Canyon at SR-4 Culvert	06/28	F	CS				6.30	0.60	0.37	0.80	2.60	4.30	2.520	0.190	0.028	0.288	0.041	0.040	2.480	0.185	0.035	8.37
Pajarito Canyon at SR-4 Culvert	06/28	F	DUP																			
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS	0	60	190																
Pajarito Canyon at SR-4 Culvert	06/28	UF	TOTC				36.80	2.65		38.09			11.020	0.695		0.631			11.318			

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	^{234}U	^{235,236}U	^{238}U	U (µg/L)
Water Quality Standards[d]									
DOE DCG for Public Dose			2,000,000	1,000	3,000	500	600	600	800
DOE Drinking Water System DCG			80,000	40	120	20	24	24	30
EPA Primary Drinking Water Standard			20,000	8					30
EPA Screening Level									
NMWQCC Groundwater Limit									5,000
Historical Maximum for UF data			1,120	25	42.3				170
Historical Maximum for F data				15.9	29.4				3.01

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Runoff Stations																				
Los Alamos Canyon (includes Pueblo, DP Canyons):																				
Los Alamos Canyon at Los Alamos	06/03	F	CS	0.003	0.003	0.024	0.011	0.004	0.024				1.7	0.33	1.9	18.30	0.85	3.0		
Los Alamos Canyon at Los Alamos	06/03	UF	CS	-0.006	0.003	0.044	0.194	0.016	0.012				13.8	0.68	1.9	44.80	1.63	2.5		
Los Alamos Canyon at Los Alamos	07/18	F	CS																	
Los Alamos Canyon at Los Alamos	07/18	UF	CS																	
Los Alamos Canyon at Los Alamos	07/18	UF	DUP																	
Los Alamos Canyon at Los Alamos	07/18	F	CS	0.009	0.010	0.038	0.004	0.008	0.038	0.008	0.007	0.026	3.0	0.50	2.0	26.00	2.00	2.0		
Los Alamos Canyon at Los Alamos	07/18	F	DUP	-0.003	0.004		0.022	0.008		0.012	0.010									
Los Alamos Canyon at Los Alamos	07/18	UF	CS																	
Los Alamos Canyon at Los Alamos	07/18	UF	TOTC	0.001			1.000			1.000			118.0	8.50		192.00	10.50		383.00	18.5
Los Alamos Canyon at Los Alamos	07/18	UF	CS																	
Los Alamos Canyon at Los Alamos	07/18	UF	TOTC	0.300			5.000	0.500		1.000			324.0	27.50		447.00	29.00		746.00	43.5
Los Alamos Canyon at Los Alamos	09/12	F	CS	0.017	0.010	0.015	0.006	0.006	0.015				3.3	0.49	0.7	21.50	1.60	1.5		
Los Alamos Canyon at Los Alamos	09/12	F	DUP																	
Los Alamos Canyon at Los Alamos	09/12	UF	CS	0.032	0.019	0.029	0.116	0.039	0.029				21.8	27.10	16.0	52.40	64.50	32.5		
Los Alamos Canyon at Los Alamos	09/12	UF	DUP																	
Los Alamos Canyon below TA 2	06/02	UF	CS	0.080	0.011	0.046	13.500	0.475	0.014				268.0	10.75	21.0	310.00	11.75	27.0		
Los Alamos Canyon below TA 2	10/23	UF	CS																	
DP Canyon below Meadow at TA-21	07/25	F	CS																	
DP Canyon below Meadow at TA-21	07/25	UF	CS																	
DP Canyon below Meadow at TA-21	10/23	UF	CS																	
DP Canyon below Meadow at TA-21	10/27	F	CS																	
DP Canyon below Meadow at TA-21	10/27	F	DUP																	
DP Canyon below Meadow at TA-21	10/27	UF	CS																	
DP Canyon at Mouth	06/02	UF	CS	0.640	0.035	0.039	3.300	0.125	0.026				328.0	13.25	24.0	403.00	15.00	32.0		
DP Canyon at Mouth	10/12	UF	CS	0.878	0.133	0.008	3.720	0.530	0.008	20.700	1.420	0.069	14.4	2.11	1.4	67.40	4.82	2.3		
DP Canyon at Mouth	10/23	UF	CS																	
DP Canyon at Mouth	10/27	F	CS	0.004	0.007	0.030	0.012	0.009	0.030	0.044	0.014	0.031	0.6	0.40	1.3	16.30	1.31	2.2		
DP Canyon at Mouth	10/27	F	DUP	0.004	0.004	0.011	0.016	0.008	0.011	0.069	0.015	0.008	0.5	0.45	1.6	17.50	1.52	2.7		
DP Canyon at Mouth	10/27	UF	CS																	
Los Alamos Canyon near Los Alamos	06/02	UF	CS	0.780	0.043	0.040	10.900	0.400	0.016				570.0	23.75	50.0	930.00	35.00	70.0		
Los Alamos Canyon near Los Alamos	06/03	F	CS	0.018	0.005	0.012	0.015	0.005	0.031				1.9	0.33	1.9	19.10	0.85	2.5		
Los Alamos Canyon near Los Alamos	06/03	UF	CS	0.074	0.010	0.025	1.260	0.055	0.025				109.0	4.50	9.7	177.00	6.50	11.0		
Los Alamos Canyon near Los Alamos	06/03	UF	DUP										81.0	3.25	7.6	157.00	5.75	12.0		
Los Alamos Canyon near Los Alamos	07/09	UF	CS																	
Los Alamos Canyon near Los Alamos	07/09	UF	DUP																	
Los Alamos Canyon near Los Alamos	07/09	UF	TOTC	0.346			24.773			3.257										
Los Alamos Canyon near Los Alamos	07/09	F	CS	0.016	0.009	0.028	0.055	0.015	0.031	0.027	0.012	0.014								
Los Alamos Canyon near Los Alamos	07/09	F	DUP	0.007	0.007	0.026	0.070	0.016	0.023	0.025	0.013	0.017								
Los Alamos Canyon near Los Alamos	10/17	UF	CS	0.814	0.167	0.048	7.370	1.120	0.048	1.680	0.129	0.012	10.3	1.52	1.6	31.20	2.81	3.3		
Los Alamos Canyon near Los Alamos	10/23	F	CS	0.004	0.007	0.028	0.027	0.013	0.036	0.043	0.013	0.024	0.6	0.35	1.1	9.46	0.96	1.9		
Los Alamos Canyon near Los Alamos	10/23	F	DUP							0.051	0.017	0.041								
Los Alamos Canyon near Los Alamos	10/23	UF	CS	0.293	0.039	0.012	2.920	0.195	0.074	3.320	0.219	0.009	139.0	43.50	4.4	207.00	63.00	6.6		
Los Alamos Canyon near Los Alamos	10/27	F	CS																	
Los Alamos Canyon near Los Alamos	10/27	UF	CS	0.362	0.045	0.039	3.610	0.231	0.031	3.440	0.228	0.027	25.7	4.74	2.0	39.80	2.31	2.6		
Los Alamos Canyon near Los Alamos	10/27	UF	DUP																	
Pueblo Canyon near Los Alamos	10/23	F	CS																	
Pueblo Canyon near Los Alamos	10/23	UF	CS	0.210	0.052	0.081	22.800	1.410	0.081	0.748	0.087	0.055								
Pueblo Canyon near Los Alamos	10/23	UF	DUP	0.132	0.035	0.068	20.700	1.200	0.068											
Pueblo Canyon near Los Alamos	10/27	F	CS	0.111	0.030	0.016	0.169	0.041	0.043	0.024	0.009	0.009	1.2	0.45	1.0	10.20	1.08	2.4		
Pueblo Canyon near Los Alamos	10/27	UF	CS	0.163	0.027	0.027	15.100	0.836	0.010	0.749	0.068	0.027	22.4	4.26	1.8	24.90	1.63	2.4		

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma
Runoff Stations (Cont.)																			
Sandia Canyon:																			
Sandia Canyon at TA-3	07/17	UF	CS																
Sandia Canyon at TA-3	07/17	UF	CS	0.013	0.006	0.016	0.012	0.007	0.019	0.012	0.010	0.041	3.0	0.50	2.0	17.00	1.50	2.0	
Sandia Canyon at TA-3	07/17	UF	DUP										3.0	0.50	2.0	17.00	1.50	2.0	
Sandia Canyon at TA-3	10/17	UF	CS	0.000	1.010	0.012	0.027	0.011	0.012	0.009	0.006	0.012	1.2	0.51	1.4	4.21	0.98	2.9	
Sandia Canyon at TA-3	10/17	UF	DUP										0.1	0.31	1.1	5.06	0.75	1.9	
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey):																			
TA-55	07/17	UF	CS																
TA-55	07/17	UF	CS	0.019	0.085	0.022	0.024	0.085	0.018	0.084	0.025	0.057	2.0	0.50	2.0	14.00	1.00	2.0	
TA-55	10/07	F	CS										0.6	0.30	0.9	3.93	0.60	1.6	
TA-55	10/07	F	DUP	0.007	0.011	0.041	0.017	0.012	0.037	0.047	0.016	0.039							
TA-55	10/07	UF	CS				0.004	0.008	0.034				1.1	0.41	0.9	9.85	1.59	1.8	
TA-55	10/07	UF	DUP				0.025	0.011	0.026				0.6	0.42	1.4	7.35	0.89	2.0	
Cañada del Buey near TA-46	10/23	UF	CS																
TA-54 MDA J	08/09	UF	CS																
TA-54 MDA J	08/09	UF	DUP																
TA-54 MDA J	07/15	UF	CS																
TA-54 MDA J	07/17	F	CS																
TA-54 MDA J	07/17	UF	CS																
TA-54 MDA J	07/17	UF	CS	0.003	0.006	0.028	0.007	0.005	0.010	0.012	0.010	0.040	1.0	0.50	2.0	8.00	1.00	2.0	
TA-54 MDA J	10/07	UF	CS										1.0	0.36	1.0	10.80	1.10	2.1	
TA-54 MDA G-6	07/29	F	CS	0.008	0.006	0.021	0.008	0.009	0.030	0.102	0.022	0.012	1.2	0.50	1.3	5.19	0.79	1.9	
TA-54 MDA G-6	07/29	F	DUP																
TA-54 MDA G-6	07/29	UF	CS	0.150	0.032	0.032	0.422	0.070	0.025	3.980	0.290	0.046	236.0	153.00	11.9	271.00	165.00	21.9	
TA-54 MDA G-6	07/29	UF	DUP										239.0	182.00	11.1	284.00	181.00	21.0	
TA-54 MDA G-6	08/18	F	CS	0.036	0.015	0.014	0.005	0.005	0.014	0.028	0.010	0.010	0.6	0.21	0.5	5.42	0.56	1.3	
TA-54 MDA G-6	08/18	UF	CS	0.173	0.034	0.028	0.188	0.036	0.022	0.082	0.021	0.047	14.4	3.71	1.2	23.50	1.68	1.7	
TA-54 MDA G-6	08/18	UF	DUP																
TA-54 MDA G-6	10/11	F	CS	0.009	0.008	0.028	0.024	0.009	0.008	0.023	0.012	0.035	1.1	0.32	0.8	2.57	0.44	1.3	
TA-54 MDA G-6	10/11	F	DUP																
TA-54 MDA G-6	10/11	UF	CS	0.208	0.072	0.149	0.400	0.105	0.172	0.150	0.037	0.058	172.0	55.30	3.8	196.00	47.90	5.9	
TA-54 MDA G-6	10/11	UF	DUP																
Cañada del Buey at White Rock	07/29	UF	CS																
Cañada del Buey at White Rock	07/29	F	CS																
Cañada del Buey at White Rock	08/09	UF	CS	2.860	0.419	0.049	0.325	0.061	0.049	0.200	0.064	0.054	71.3	20.00	3.6	90.70	13.20	4.7	
Cañada del Buey at White Rock	08/18	F	CS	0.004	0.004	0.012	0.009	0.006	0.012	0.012	0.009	0.028	-0.1	0.28	1.0	2.83	0.53	1.6	
Cañada del Buey at White Rock	08/18	F	DUP																
Cañada del Buey at White Rock	08/18	UF	CS	0.142	0.035	0.045	0.152	0.035	0.036	0.060	0.030	0.041	78.9	49.10	8.2	91.30	56.00	18.9	
Cañada del Buey at White Rock	08/18	UF	DUP																
Cañada del Buey at White Rock	10/11	UF	CS																
Cañada del Buey at White Rock	10/23	UF	CS	0.116	0.039	0.035	0.308	0.066	0.035	0.137	0.040	0.072	194.0	90.60	7.7	248.00	101.00	9.8	
Cañada del Buey at White Rock	10/28	F	CS																
Cañada del Buey at White Rock	10/28	UF	CS																

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L^a) (Cont.)

Station Name	Date	Codes^b		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma
Runoff Stations (Cont.)																			
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):																			
Pajarito Canyon above Highway 501	06/28	F	CS	0.005	0.005	0.020	0.009	0.007	0.025	0.044	0.014	0.035	3.6	0.75	1.9	28.80	2.30	2.6	
Pajarito Canyon above Highway 501	06/28	UF	CS																
Pajarito Canyon above Highway 501	06/28	UF	TOTC	0.224	0.106		4.400	0.525		1.610	0.375		221.0	27.50		670.00	47.00		
Pajarito Canyon above Highway 501	09/08	F	CS	0.029	0.011	0.010	0.014	0.008	0.010				0.7	0.27	0.8	11.80	0.99	1.6	
Pajarito Canyon above Highway 501	09/08	F	DUP	0.006	0.010	0.042	0.035	0.015	0.016										
Pajarito Canyon above Highway 501	09/08	UF	CS	0.079	0.024	0.041	1.050	0.163	0.032				33.2	40.80	10.5	75.70	92.50	30.0	
Pajarito Canyon above Highway 501	09/08	UF	DUP										35.1	43.70	10.3	91.80	113.00	27.8	
Pajarito Canyon above Highway 501	10/23	F	CS	0.004	0.004	0.011	0.013	0.007	0.011	0.030	0.011	0.024	0.5	0.41	1.4	10.10	1.15	2.3	
Pajarito Canyon above Highway 501	10/23	F	DUP	0.004	0.004	0.012	0.000	1.000	0.033										
Pajarito Canyon above Highway 501	10/23	UF	CS	0.009	0.016	0.068	0.174	0.043	0.067	0.056	0.016	0.012	13.4	2.99	1.6	32.70	2.86	2.7	
Pajarito Canyon above Highway 501	10/23	UF	DUP																
Pajarito Canyon at TA-22	06/28	F	CS	0.009	0.005	0.008	0.017	0.007	0.008	0.032	0.011	0.022	3.4	0.80	2.3	24.40	2.00	2.7	
Pajarito Canyon at TA-22	06/28	UF	CS																
Pajarito Canyon at TA-22	06/28	UF	DUP																
Pajarito Canyon at TA-22	06/28	UF	TOTC	0.053	0.018		0.694	0.067		0.313	0.041		56.5	4.80		104.70	5.65		
Starmers Gulch at TA-22	06/28	F	CS	0.009	0.009	0.034	0.028	0.010	0.025	0.029	0.010	0.010	3.0	0.70	1.9	29.60	2.35	2.6	
Starmers Gulch at TA-22	06/28	UF	CS																
Starmers Gulch at TA-22	06/28	UF	TOTC	0.032	0.017		0.932	0.087		0.423	0.051		95.7	8.30		228.90	12.55		
TA-54 MDA G-1	10/11	F	CS																
TA-54 MDA G-1	10/11	UF	CS	0.160	0.037	0.036	0.063	0.020	0.013	0.030	0.012	0.012	35.5	5.13	1.5	59.80	3.80	1.4	
TA-54 MDA G-2	07/29	F	CS	-0.010	0.007	0.039	0.003	0.003	0.009	0.027	0.011	0.012	0.8	0.38	1.2	6.13	0.74	1.9	
TA-54 MDA G-2	07/29	F	DUP	0.003	0.003	0.008	0.017	0.007	0.008	0.058	0.016	0.029							
TA-54 MDA G-2	07/29	UF	CS	0.524	0.085	0.025	1.360	0.202	0.009	0.695	0.068	0.012	36.3	13.20	2.1	48.00	3.41	3.0	
TA-54 MDA G-2	08/09	F	CS	0.005	0.006	0.015	0.011	0.008	0.015	0.052	0.016	0.013	0.3	0.36	1.2	4.80	0.88	2.5	
TA-54 MDA G-2	08/09	F	DUP	0.006	0.006	0.017	-0.004	0.004	0.045	0.033	0.012	0.011							
TA-54 MDA G-2	08/09	UF	CS	0.211	0.044	0.034	0.232	0.047	0.050	0.204	0.063	0.050	123.0	71.90	3.1	151.00	34.90	4.3	
TA-54 MDA G-2	08/09	UF	DUP										131.0	57.30	2.5	141.00	26.80	4.3	
TA-54 MDA G-2	10/11	F	CS	0.025	0.010	0.023	0.028	0.010	0.008	0.020	0.012	0.037	0.7	0.27	0.8	3.29	0.48	1.4	
TA-54 MDA G-2	10/11	UF	CS	0.020	0.012	0.036	0.026	0.011	0.024	0.087	0.020	0.011	34.8	3.56	1.4	41.70	2.70	1.3	
TA-54 MDA G-3	07/29	UF	CS																
TA-54 MDA G-3	08/09	UF	CS	7.610	1.110	0.051	1.670	0.260	0.019	0.250	0.083	0.167	166.0	53.40	3.8	157.00	20.90	4.7	
TA-54 MDA G-3	08/18	F	CS	0.034	0.017	0.041	0.017	0.015	0.052	0.006	0.004	0.008	0.7	0.26	0.6	5.13	0.57	1.3	
TA-54 MDA G-3	08/18	F	DUP	0.016	0.008	0.011	0.004	0.004	0.011	0.010	0.014	0.050							
TA-54 MDA G-3	08/18	UF	CS	0.179	0.043	0.081	0.326	0.061	0.048	0.324	0.088	0.149	194.0	69.30	194.0	176.00	54.30	176.0	
TA-54 MDA G-3	08/18	UF	DUP										192.0	78.00	6.0	166.00	50.70	10.1	
TA-54 MDA G-3	10/11	F	CS																
TA-54 MDA G-3	10/11	UF	CS	0.022	0.011	0.027	0.241	0.045	0.027	0.242	0.035	0.030	41.5	13.50	0.9	48.50	3.78	1.5	
TA-54 MDA G-3	10/25	F	CS																
TA-54 MDA G-3	10/25	UF	CS																
TA-54 MDA G-3	10/28	F	CS	0.000	1.000	0.024	-0.003	0.006	0.031	0.043	0.013	0.024	0.4	0.28	0.9	3.56	0.73	2.1	
TA-54 MDA G-3	10/28	F	DUP																
TA-54 MDA G-3	10/28	UF	CS	0.032	0.012	0.030	0.181	0.026	0.024	0.149	0.026	0.011	12.4	3.10	2.1	17.90	1.82	2.5	
TA-54 MDA G-5	10/23	F	CS																
TA-54 MDA G-5	10/23	UF	CS	0.023	0.011	0.013	0.080	0.020	0.013	0.035	0.012	0.023	35.9	10.50	1.9	45.90	4.55	2.8	
TA-54 MDA G-4	08/15	UF	CS										6.7	1.11	0.7	20.10	1.07	1.6	
TA-54 MDA G-4	08/15	UF	DUP										5.6	0.73	0.7	17.70	0.98	1.6	
TA-54 MDA G-4	10/12	F	CS	0.006	0.005	0.009	0.048	0.014	0.009	0.863	0.074	0.026	2.0	0.39	0.8	5.39	0.53	1.3	
TA-54 MDA G-4	10/12	F	DUP	0.022	0.012	0.032	0.052	0.017	0.012	0.851	0.076	0.011							
TA-54 MDA G-4	10/12	UF	CS	0.017	0.008	0.009	0.118	0.026	0.009	1.340	0.105	0.048	9.2	2.56	1.0	15.40	1.11	1.4	
TA-54 MDA G-4	10/12	UF	DUP																

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma
Runoff Stations (Cont.)																			
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)																			
Pajarito Canyon above Highway 4	06/28	F	CS	-0.001	0.004	0.022	0.022	0.009	0.022	0.024	0.012	0.030	4.5	0.65	1.4	45.00	3.20	1.8	
Pajarito Canyon above Highway 4	06/28	F	DUP																
Pajarito Canyon above Highway 4	06/28	UF	CS										28.8	2.85	4.7	173.00	12.00	4.6	
Pajarito Canyon above Highway 4	06/28	UF	TOTC	0.042	0.017		1.163	0.094		0.466	0.058		71.5	5.15		239.20	13.10		
Pajarito Canyon above Highway 4	10/24	F	CS	0.000	1.010	0.009	0.017	0.008	0.009	0.000	1.000	0.034							
Pajarito Canyon above Highway 4	10/24	UF	CS	0.011	0.009	0.033	0.169	0.027	0.033	0.072	0.018	0.012							
Pajarito Canyon above Highway 4	10/24	UF	DUP																
Pajarito Canyon above Highway 4	10/27	F	CS	0.087	0.022	0.011	0.064	0.019	0.029	0.031	0.012	0.026	2.1	0.75	1.8	12.50	1.27	2.5	
Pajarito Canyon above Highway 4	10/27	UF	CS	0.014	0.011	0.037	0.096	0.021	0.037	0.052	0.017	0.032	14.4	4.72	1.2	17.60	2.71	2.3	
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):																			
Water Canyon above Highway 501	06/28	UF	CS																
Water Canyon above Highway 501	06/28	UF	TOTC	0.039	0.011		0.840	0.060		0.594	0.057		46.6	3.50		211.80	11.85		
Water Canyon above Highway 501	10/23	F	CS	0.000	0.006	0.030	0.008	0.008	0.030	0.015	0.008	0.023	2.4	0.81	1.4	14.50	1.55	2.3	
Water Canyon above Highway 501	10/23	UF	CS	0.113	0.051	0.061	1.150	0.180	0.166	0.425	0.088	0.044	337.0	432.00	14.9	580.00	710.00	30.6	
Water Canyon above Highway 501	10/23	UF	DUP							0.465	0.088	0.039							
Cañon del Valle above Highway 501	06/28	UF	CS																
Cañon del Valle above Highway 501	06/28	UF	TOTC	0.042	0.020		0.808	0.081		0.311	0.048		118.1	9.45		306.00	16.00		
Cañon del Valle above Highway 501	10/23	F	CS	-0.010	0.007	0.048	0.015	0.012	0.038	0.009	0.007	0.023	0.5	0.38	1.2	9.53	1.08	2.4	
Cañon del Valle above Highway 501	10/23	UF	CS	0.360	0.111	0.089	2.450	0.331	0.089	0.412	0.060	0.019	273.0	332.00	19.7	514.00	624.00	29.1	
Water Canyon above Highway 4	06/28	UF	CS																
Water Canyon above Highway 4	06/28	UF	TOTC	0.044	0.029		1.223	0.127		0.420	0.075		80.2	7.65		244.20	13.30		
Water Canyon above Highway 4	10/27	F	CS																
Water Canyon above Highway 4	10/27	UF	CS																
Water Canyon above Highway 4	10/27	UF	DUP																
Indio Canyon at Highway 4	06/28	F	CS	0.014	0.008	0.021	0.013	0.007	0.009	0.020	0.011	0.034	3.0	0.80	2.1	34.60	2.65	2.5	
Indio Canyon at Highway 4	06/28	F	DUP																
Indio Canyon at Highway 4	06/28	UF	CS																
Water Canyon below Highway 4	06/28	F	CS	0.006	0.008	0.034	0.025	0.009	0.009	0.022	0.014	0.041	3.1	0.80	2.2	40.90	3.10	3.0	
Water Canyon below Highway 4	06/28	F	DUP																
Water Canyon below Highway 4	06/28	UF	CS																
Water Canyon below Highway 4	06/28	UF	TOTC	0.243	0.079		3.220	0.340		0.818	0.158		214.0	21.50		483.00	28.50		
Water Canyon below Highway 4	07/29	F	CS	0.011	0.007	0.010	0.023	0.010	0.010	0.053	0.016	0.012	6.1	1.01	1.4	17.60	1.59	2.9	
Water Canyon below Highway 4	07/29	UF	CS	0.296	0.057	0.014	2.950	0.434	0.047	4.200	0.365	0.033	63.3	18.50	8.6	121.00	12.10	12.2	
Water Canyon below Highway 4	07/29	UF	DUP										69.6	21.10	8.7	148.00	14.30	10.1	
Water Canyon below Highway 4	08/12	UF	CS																
Water Canyon below Highway 4	08/18	F	CS	0.025	0.015	0.046	0.005	0.009	0.037	0.019	0.010	0.030	1.1	0.35	0.7	7.17	0.67	1.5	
Water Canyon below Highway 4	08/18	F	DUP										0.4	0.28	0.8	6.59	0.95	1.3	
Water Canyon below Highway 4	08/18	UF	CS	0.011	0.013	0.050	0.075	0.026	0.058	0.033	0.013	0.031	8.3	1.93	1.0	19.20	1.41	1.5	
Water Canyon below Highway 4	10/23	F	CS																
Water Canyon below Highway 4	10/23	UF	CS										212.0	99.30	9.4	303.00	123.00	10.5	
Water Canyon below Highway 4	10/23	UF	DUP																
Water Canyon below Highway 4	10/27	F	CS	0.069	0.020	0.012	0.017	0.009	0.012	0.032	0.011	0.024	0.6	0.41	1.3	8.07	1.00	2.4	
Water Canyon below Highway 4	10/27	UF	CS	0.064	0.015	0.009	0.465	0.047	0.025	0.211	0.037	0.053	457.0	558.00	18.9	675.00	821.00	39.1	
Potrillo Canyon near White Rock	08/09	UF	CS	0.017	0.010	0.030	0.139	0.031	0.030	0.160	0.057	0.054	40.7	7.38	2.1	55.80	7.23	4.0	
Potrillo Canyon near White Rock	10/23	F	CS										0.9	0.34	0.9	3.41	0.57	1.5	
Potrillo Canyon near White Rock	10/23	F	DUP										1.6	0.69	0.8	2.78	0.75	1.6	
Potrillo Canyon near White Rock	10/23	UF	CS										148.0	65.00	3.9	171.00	52.80	7.3	

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma		
Runoff Stations (Cont.)																					
Ancho Canyon:																					
Ancho Canyon at TA-39	08/18	UF	CS																		
Ancho Canyon at TA-39	10/28	UF	CS																		
Ancho Canyon near Bandelier NP	08/18	UF	CS																		
Ancho Canyon near Bandelier NP	08/18	UF	DUP																		
Ancho Canyon near Bandelier NP	10/23	UF	CS																		
Ancho Canyon near Bandelier NP	10/28	UF	CS																		
Runoff Grab Samples																					
Upper Los Alamos Reservoir	08/31	F	CS	0.036	0.012	0.010	0.004	0.006	0.026	0.004	0.008	0.035									
Upper Los Alamos Reservoir	08/31	F	DUP																		
Upper Los Alamos Reservoir	08/31	UF	CS	0.004	0.004	0.011	0.008	0.009	0.031	0.022	0.009	0.010									
Upper Los Alamos Reservoir	08/31	UF	DUP																		
Los Alamos Reservoir	08/31	F	CS	0.038	0.015	0.031	0.013	0.008	0.011	0.026	0.009	0.009									
Los Alamos Reservoir	08/31	UF	CS	0.000	1.010	0.014	0.005	0.009	0.039	0.020	0.010	0.025									
Los Alamos Reservoir	08/31	UF	DUP																		
Los Alamos Canyon at SR-4 Weir	07/21	F	CS	0.125	0.027	0.009	0.028	0.011	0.009	0.084	0.019	0.028	5.7	1.11	1.2	33.50	2.37	2.3			
Los Alamos Canyon at SR-4 Weir	07/21	F	DUP										4.2	0.71	1.4	37.00	2.57	2.1			
Los Alamos Canyon at SR-4 Weir	07/21	UF	CS	0.042	0.016	0.031	0.386	0.068	0.031	0.180	0.029	0.034	27.1	9.47	5.0	69.10	21.50	11.6			
Los Alamos Canyon at SR-4 Weir	07/21	UF	DUP	0.062	0.017	0.009	0.455	0.075	0.025	0.179	0.027	0.009									
Rendija Canyon at 3rd Crossing	07/17	F	CS																		
Rendija Canyon at 3rd Crossing	07/17	F	CS	0.007	0.055	0.020	0.030	0.085	0.007	0.020	0.011	0.029	1.0	0.50	2.0	19.00	1.50	2.0			
Rendija Canyon at 3rd Crossing	07/17	UF	CS																		
Rendija Canyon at 3rd Crossing	07/17	UF	DUP																		
Rendija Canyon at 3rd Crossing	07/17	UF	TOTC	1.000	0.000		15.000	1.500		2.000	0.000		480.0	38.00		1,054.00	64.00		1,249.00	36.0	
Rendija Canyon at 3rd Crossing	07/17	UF	TOTC																		
Guaje Canyon at SR-502	07/09	F	CS	0.003	0.005	0.024	0.022	0.008	0.008	0.038	0.017	0.044									
Guaje Canyon at SR-502	07/09	UF	CS																		
Guaje Canyon at SR-502	07/09	UF	TOTC	1.228			17.727			5.552											
Guaje Canyon at SR-502	09/08	F	CS	0.004	0.009	0.036	0.015	0.010	0.028				3.3	0.60	0.6	14.90	1.18	1.5			
Guaje Canyon at SR-502	09/08	UF	CS	0.354	0.127	0.237	7.630	1.220	0.237				367.0	2,230.00	81.2	685.00	4,160.00	153.0			
Starmer's Gulch above Highway 501	10/23	F	CS	0.008	0.010	0.039	0.025	0.012	0.031	0.020	0.012	0.037	2.9	0.66	0.6	20.10	1.19	1.4			
Starmer's Gulch above Highway 501	10/23	F	DUP																		
Starmer's Gulch above Highway 501	10/23	UF	CS	0.219	0.079	0.074	3.070	0.338	0.074	0.373	0.058	0.021	161.0	72.10	7.1	268.00	109.00	10.2			
Two-Mile Canyon at Highway 501	10/23	F	CS	0.015	0.009	0.014	0.025	0.013	0.037	0.028	0.015	0.041	3.3	0.82	1.3	21.20	1.45	2.0			
Two-Mile Canyon at Highway 501	10/23	F	DUP																		
Two-Mile Canyon at Highway 501	10/23	UF	CS	0.078	0.032	0.035	1.090	0.135	0.035	0.473	0.070	0.023	246.0	315.00	14.5	443.00	542.00	28.7			
Pajarito Canyon at TA-18 Culvert	06/28	F	CS	0.005	0.005	0.020	0.013	0.007	0.009	0.040	0.015	0.030	5.7	0.70	1.3	38.60	2.75	1.8			
Pajarito Canyon at TA-18 Culvert	06/28	UF	CS																		
Pajarito Canyon at TA-18 Culvert	06/28	UF	TOTC	0.197	0.097		3.760	0.430		1.180	0.235		203.0	22.50		593.00	36.00				
Pajarito Canyon at G-1	06/28	F	CS	0.015	0.007	0.008	0.016	0.007	0.018	0.040	0.013	0.024	4.1	0.65	1.5	47.20	3.35	1.7			
Pajarito Canyon at G-1	06/28	UF	CS																		
Pajarito Canyon at G-1	06/28	UF	TOTC	0.075	0.024		0.837	0.091		0.259	0.053		48.2	4.85		254.20	14.35				
Pajarito Canyon at SR-4 Culvert	06/28	F	CS	-0.004	0.008	0.039	0.016	0.007	0.009	0.009	0.007	0.024	5.6	0.75	1.6	44.50	3.20	1.9			
Pajarito Canyon at SR-4 Culvert	06/28	F	DUP										7.0	0.90	1.9	47.30	3.35	1.9			
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS																		
Pajarito Canyon at SR-4 Culvert	06/28	UF	TOTC	0.117	0.044		2.250	0.200		0.975	0.131		125.1	11.30		339.00	18.50				

Table 5-11. Radiochemical Analysis of Runoff Samples for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Water Quality Standards[d]								
DOE DCG for Public Dose			40	30	30	30	1,000.00	
DOE Drinking Water System DCG			1.6	1.2	1.2	1.2	40.00	
EPA Primary Drinking Water Standard						15		
EPA Screening Level							50.00	
NMWQCC Groundwater Limit								
Historical Maximum for UF data			1.5308	15.778	15.168	640.8	1,637.00	622.50
Historical Maximum for F data			0.105	0.99	3.509	27.5	40.00	499.20

[a] Except where noted. Three columns are listed: the first is the analytical result, the second is the radioactive counting uncertainty (1 standard deviation), and the third is the analytic laboratory measurement-specific minimum detectable activity.

[b] Codes: UF–Unfiltered sample; F–Filttered Sample; CS–Customer Sample; DUP–Laboratory Duplicate; TOTC–Total Concentration Calculated from Laboratory Data; TOTC D–Total Concentration Calculated from Laboratory Duplicate.

[c] Less than symbol (<) means measurement was below the specified limit of detection of the anytical method.

[d] Standards given here for comparison only; see Appendix A.

Table 5-12. Comparison of Radionuclides in Unfiltered Runoff Samples for 2000 to Standards[a]

Station Name	Date	Codes[b]	Analyte	Result[c]	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Value/ Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Runoff Stations													
Los Alamos Canyon (includes Pueblo, DP Canyons):													
Los Alamos Canyon at Los Alamos	06/03	UF CS	Gross Alpha	13.8	0.7	1.9	pCi/L		0.92	15	NM LVSTK WTR STD		
Los Alamos Canyon at Los Alamos	07/18	UF TOTC	Gross Alpha	118.0	8.5		pCi/L		7.87	15	NM LVSTK WTR STD	30	3.93
Los Alamos Canyon at Los Alamos	07/18	UF TOTC	Gross Alpha	324.0	27.5		pCi/L		21.60	15	NM LVSTK WTR STD	30	10.80
Los Alamos Canyon below TA-2	06/02	UF CS	Gross Alpha	268.0	10.8	21.0	pCi/L		17.87	15	NM LVSTK WTR STD	30	8.93
DP Canyon at Mouth	10/12	UF CS	^{241}Am	20.700	1.420	0.069	pCi/L		0.69	30	DOE DCG		
DP Canyon at Mouth	10/12	UF CS	Gross Alpha	14.4	2.1	1.4	pCi/L		0.96	15	NM LVSTK WTR STD		
DP Canyon at Mouth	06/02	UF CS	Gross Alpha	328.0	13.3	24.0	pCi/L		21.87	15	NM LVSTK WTR STD	30	10.93
Los Alamos Canyon near Los Alamos	10/17	UF CS	Gross Alpha	10.3	1.5	1.6	pCi/L		0.69	15	NM LVSTK WTR STD		
Los Alamos Canyon near Los Alamos	10/23	UF CS	Gross Alpha	139.0	43.5	4.4	pCi/L		9.27	15	NM LVSTK WTR STD	30	4.63
Los Alamos Canyon near Los Alamos	10/27	UF CS	Gross Alpha	25.7	4.7	2.0	pCi/L		1.71	15	NM LVSTK WTR STD		
Los Alamos Canyon near Los Alamos	06/02	UF CS	Gross Alpha	570.0	23.8	50.0	pCi/L		38.00	15	NM LVSTK WTR STD	30	19.00
Los Alamos Canyon near Los Alamos	06/02	UF CS	Gross Beta	930.0	35.0	70.0	pCi/L		0.93	1,000	DOE DCG		
Los Alamos Canyon near Los Alamos	06/03	UF CS	Gross Alpha	109.0	4.5	9.7	pCi/L		7.27	15	NM LVSTK WTR STD	30	3.63
Los Alamos Canyon near Los Alamos	06/03	UF DUP	Gross Alpha	81.0	3.3	7.6	pCi/L		5.40	15	NM LVSTK WTR STD	30	2.70
Los Alamos Canyon near Los Alamos	07/09	UF TOTC	^{239,240}Pu	24.773			pCi/L		0.83	30	DOE DCG		
Pueblo Canyon near Los Alamos	10/23	UF CS	^{239,240}Pu	22.800	1.410	0.081	pCi/L		0.76	30	DOE DCG		
Pueblo Canyon near Los Alamos	10/23	UF DUP	^{239,240}Pu	20.700	1.200	0.068	pCi/L		0.69	30	DOE DCG		
Pueblo Canyon near Los Alamos	10/27	UF CS	Gross Alpha	22.4	4.3	1.8	pCi/L		1.49	15	NM LVSTK WTR STD		
Pueblo Canyon near Los Alamos	10/27	UF CS	^{239,240}Pu	15.100	0.836	0.010	pCi/L		0.50	30	DOE DCG		
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey):													
TA-54 MDA G-6	08/18	UF CS	Gross Alpha	14.4	3.7	1.2	pCi/L		0.96	15	NM LVSTK WTR STD		
TA-54 MDA G-6	10/11	UF CS	Gross Alpha	172.0	55.3	3.8	pCi/L		11.47	15	NM LVSTK WTR STD	30	5.73
Cañada del Buey at White Rock	08/09	UF CS	Gross Alpha	71.3	20.0	3.6	pCi/L		4.75	15	NM LVSTK WTR STD	30	2.38
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):													
Pajarito Canyon above Highway 501	10/23	UF CS	Gross Alpha	13.4	3.0	1.6	pCi/L		0.89	15	NM LVSTK WTR STD		
Pajarito Canyon above Highway 501	06/28	UF CS	Gross Alpha	18.8	2.1	4.1	pCi/L		1.25	15	NM LVSTK WTR STD		
Pajarito Canyon above Highway 501	06/28	UF TOTC	Gross Alpha	221.0	27.5		pCi/L		14.73	15	NM LVSTK WTR STD	30	7.37
Pajarito Canyon above Highway 501	06/28	UF TOTC	Gross Beta	670.0	47.0		pCi/L		0.67	1,000	DOE DCG		
Pajarito Canyon at TA-22	06/28	UF CS	Gross Alpha	7.9	1.0	1.9	pCi/L		0.53	15	NM LVSTK WTR STD		
Pajarito Canyon at TA-22	06/28	UF DUP	Gross Alpha	7.8	1.0	1.9	pCi/L		0.52	15	NM LVSTK WTR STD		
Pajarito Canyon at TA-22	06/28	UF TOTC	Gross Alpha	56.5	4.8		pCi/L		3.77	15	NM LVSTK WTR STD	30	1.88
Starmers Gulch at TA-22	06/28	UF CS	Gross Alpha	11.7	1.3	2.3	pCi/L		0.78	15	NM LVSTK WTR STD		
Starmers Gulch at TA-22	06/28	UF TOTC	Gross Alpha	95.7	8.3		pCi/L		6.38	15	NM LVSTK WTR STD	30	3.19
TA-54 MDA G-1	10/11	UF CS	Gross Alpha	35.5	5.1	1.5	pCi/L		2.37	15	NM LVSTK WTR STD	30	1.18
TA-54 MDA G-2	10/11	UF CS	Gross Alpha	34.8	3.6	1.4	pCi/L		2.32	15	NM LVSTK WTR STD	30	1.16
TA-54 MDA G-3	08/09	UF CS	Gross Alpha	166.0	53.4	3.8	pCi/L		11.07	15	NM LVSTK WTR STD	30	5.53
TA-54 MDA G-3	10/11	UF CS	Gross Alpha	41.5	13.5	0.9	pCi/L		2.77	15	NM LVSTK WTR STD	30	1.38
TA-54 MDA G-3	10/28	UF CS	Gross Alpha	12.4	3.1	2.1	pCi/L		0.83	15	NM LVSTK WTR STD		
TA-54 MDA G-5	10/23	UF CS	Gross Alpha	35.9	10.5	1.9	pCi/L		2.39	15	NM LVSTK WTR STD	30	1.20

Table 5-12. Comparison of Radionuclides in Unfiltered Runoff Samples for 2000 to Standards[a] (Cont.)

Station Name	Date	Codes[b]		Analyte	Result[c]	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Value/ Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Runoff Stations (Cont.)														
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)														
TA-54 MDA G-4	10/12	UF	CS	Gross Alpha	9.2	2.6	1.0	pCi/L		0.62	15	NM LVSTK WTR STD		
Pajarito Canyon above Highway 4	10/27	UF	CS	Gross Alpha	14.4	4.7	1.2	pCi/L		0.96	15	NM LVSTK WTR STD		
Pajarito Canyon above Highway 4	06/28	UF	CS	Gross Alpha	28.8	2.9	4.7	pCi/L		1.92	15	NM LVSTK WTR STD		
Pajarito Canyon above Highway 4	06/28	UF	TOTC	Gross Alpha	71.5	5.2		pCi/L		4.77	15	NM LVSTK WTR STD	30	2.38
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):														
Water Canyon above Highway 501	06/28	UF	CS	Gross Alpha	18.4	2.3	4.9	pCi/L		1.23	15	NM LVSTK WTR STD		
Water Canyon above Highway 501	06/28	UF	TOTC	Gross Alpha	46.6	3.5		pCi/L		3.11	15	NM LVSTK WTR STD	30	1.55
Canon del Valle above Highway 501	06/28	UF	CS	Gross Alpha	25.0	2.9	5.7	pCi/L		1.67	15	NM LVSTK WTR STD		
Canon del Valle above Highway 501	06/28	UF	TOTC	Gross Alpha	118.1	9.5		pCi/L		7.87	15	NM LVSTK WTR STD	30	3.94
Water Canyon at Highway 4	06/28	UF	CS	Gross Alpha	13.2	1.6	3.2	pCi/L		0.88	15	NM LVSTK WTR STD		
Water Canyon at Highway 4	06/28	UF	TOTC	Gross Alpha	80.2	7.7		pCi/L		5.35	15	NM LVSTK WTR STD	30	2.67
Water Canyon below Highway 4	07/29	UF	CS	Gross Alpha	63.3	18.5	8.6	pCi/L		4.22	15	NM LVSTK WTR STD	30	2.11
Water Canyon below Highway 4	07/29	UF	DUP	Gross Alpha	69.6	21.1	8.7	pCi/L		4.64	15	NM LVSTK WTR STD	30	2.32
Water Canyon below Highway 4	08/18	UF	CS	Gross Alpha	8.3	1.9	1.0	pCi/L		0.55	15	NM LVSTK WTR STD		
Water Canyon below Highway 4	06/28	UF	CS	Gross Alpha	12.6	2.5	6.8	pCi/L		0.84	15	NM LVSTK WTR STD		
Water Canyon below Highway 4	06/28	UF	TOTC	Gross Alpha	214.0	21.5		pCi/L		14.27	15	NM LVSTK WTR STD	30	7.13
Potrillo Canyon near White Rock	08/09	UF	CS	Gross Alpha	40.7	7.4	2.1	pCi/L		2.71	15	NM LVSTK WTR STD	30	1.36
Runoff Grab Samples														
Rendija Canyon at 3rd Crossing	07/17	UF	TOTC	Gross Alpha	480.0	38.0		pCi/L		32.00	15	NM LVSTK WTR STD	30	16.00
Rendija Canyon at 3rd Crossing	07/17	UF	TOTC	Gross Beta	1054.0	64.0		pCi/L		1.05	1,000	DOE DCG	1,000	1.05
Rendija Canyon at 3rd Crossing	07/17	UF	TOTC	^{239,240}Pu	15.000	1.500		pCi/L		0.50	30	DOE DCG		
Guaje Canyon at SR-502	07/09	UF	TOTC	^{239,240}Pu	17.727			pCi/L		0.59	30	DOE DCG		
Pajarito Canyon at TA-18 Culvert	06/28	UF	TOTC	Gross Alpha	203.0	22.5		pCi/L		13.53	15	NM LVSTK WTR STD	30	6.77
Pajarito Canyon at TA-18 Culvert	06/28	UF	TOTC	Gross Beta	593.0	36.0		pCi/L		0.59	1,000	DOE DCG		
Pajarito Canyon at G-1	06/28	UF	CS	Gross Alpha	16.5	3.0	8.0	pCi/L		1.10	15	NM LVSTK WTR STD		
Pajarito Canyon at G-1	06/28	UF	TOTC	Gross Alpha	48.2	4.9		pCi/L		3.21	15	NM LVSTK WTR STD	30	1.61
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS	Gross Alpha	16.9	2.0	4.1	pCi/L		1.13	15	NM LVSTK WTR STD		
Pajarito Canyon at SR-4 Culvert	06/28	UF	TOTC	Gross Alpha	125.1	11.3		pCi/L		8.34	15	NM LVSTK WTR STD	30	4.17

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[a] Values shown in the val/min std column are greater than 50% of the minimum standard used for comparison purposes. The minimum standard is either the DOE derived concentration guide (DCG) or the New Mexico Livestock Watering Standard, which contain applicable radionuclide standards for unfiltered storm water runoff.

[b] Codes: UF–Unfiltered Sample; F–Filtered Samples; CS–Customer Sample; DUP–Duplicate; TOTC–Value Calculated from Other Results; TOTCD–Duplicate Calculated Value.

[c] Values shown in the results column are >50% of the referenced standards. Not all data are shown.

[d] One standard deviation radioactivity counting uncertainty.

[e] Minimum detectable activities.

[f] Codes: B–analyte found in lab blank; U–analyte not detected.

Table 5-13. Comparison of Radionuclides in Filtered Runoff Water Samples for 2000 to Standards[a]

Station Name	Date	Codes[b]	Analyte	Result[c]	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Value Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Runoff Stations													
Los Alamos Canyon (includes Pueblo, DP Canyons):													
Los Alamos Canyon at Los Alamos	07/18	F CS	^{90}Sr	4.24	0.43	0.39	pCi/L		0.53	8	EPA PRIM DW STD		
DP Canyon at Mouth	10/27	F CS	^{90}Sr	7.33	0.31	0.48	pCi/L		0.92	8	EPA PRIM DW STD		
Los Alamos Canyon near Los Alamos	10/23	F CS	^{90}Sr	4.60	0.47	1.23	pCi/L		0.58	8	EPA PRIM DW STD		
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):													
TA-54 MDA G-2	10/11	F CS	^{137}Cs	62.40	2.33	2.33	pCi/L		0.52	120	DOE DW DCG		
TA-54 MDA G-4	10/12	F CS	^{241}Am	0.863	0.074	0.026	pCi/L		0.72	1.2	DOE DW DCG		
TA-54 MDA G-4	10/12	F DUP	^{241}Am	0.851	0.076	0.011	pCi/L		0.71	1.2	DOE DW DCG		
Pajarito Canyon above Highway 4	06/28	F CS	^{90}Sr	6.10	0.60	0.35	pCi/L		0.76	8	EPA PRIM DW STD		
Pajarito Canyon above Highway 4	06/28	F DUP	^{90}Sr	6.00	0.55	0.32	pCi/L		0.75	8	EPA PRIM DW STD		
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):													
Water Canyon above Highway 501	10/23	F CS	^{90}Sr	5.07	0.55	1.35	pCi/L		0.63	8	EPA PRIM DW STD		
Indio Canyon at Highway 4	06/28	F CS	^{90}Sr	5.01	0.49	0.36	pCi/L		0.63	8	EPA PRIM DW STD		
Water Canyon below Highway 4	06/28	F CS	^{90}Sr	5.40	0.55	0.38	pCi/L		0.68	8	EPA PRIM DW STD		
Los Alamos Canyon at SR-4 Weir	07/21	F CS	^{90}Sr	26.60	4.42	2.69	pCi/L		3.33	8	EPA PRIM DW STD		
Rendija Canyon at 3rd Crossing	07/17	F CS	^{90}Sr	4.50	0.45	0.38	pCi/L		0.56	8	EPA PRIM DW STD		
Pajarito Canyon at TA-18 Culvert	06/28	F CS	^{90}Sr	5.40	0.50	0.34	pCi/L		0.68	8	EPA PRIM DW STD		
Pajarito Canyon at G-1	06/28	F CS	^{90}Sr	5.60	0.55	0.34	pCi/L		0.70	8	EPA PRIM DW STD		
Pajarito Canyon at SR-4 Culvert	06/28	F CS	^{90}Sr	6.30	0.60	0.37	pCi/L		0.79	8	EPA PRIM DW STD		

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[a] Values shown in the val/min std column are greater than 50% of the minimum standard used for comparison purposes. The minimum standard is either the DOE derived concentration guide (DCG), the DOE drinking water DCG, the EPA primary DW standard, or the New Mexico Groundwater Limit, which contain applicable radionuclide standards for filtered storm water runoff.

[b] Codes: UF–Unfiltered Sample; F–Filtered Samples; CS–Customer Sample; DUP–Duplicate.

[c] Values shown in the results column are >50% of the referenced standards. Not all data are shown.

[d] One standard deviation radioactivity counting uncertainty.

[e] Minimum detectable activities.

[f] Codes: B–analyte found in lab blank; U–analyte not detected.

Table 5-14. Calculated Radionuclides Concentrations and Uncertainties for Suspended Sediments in Runoff Samples (pCi/g unless otherwise noted)[a]

Station Name	Date	TSS[b] (mg/L)	Analyte	Radionuclide Concentration	Uncertainty[c]	SAL[d]	Ratio Concentration/ SAL
Twomile above Hwy 501	10/23	9,010	^{137}Cs	56.7	5.8	4.4	12.9
Guaje Canyon at SR-502	07/09	37,000	^{137}Cs	9.7		4.4	2.2
Los Alamos near Los Alamos	06/03	2,300	^{137}Cs	9.4	1.3	4.4	2.1
Los Alamos near Los Alamos	07/09	14,900	^{137}Cs	7.2		4.4	1.6
Rendija Canyon 3rd Crossing	07/17	38,000	^{137}Cs	7.0	0.9	4.4	1.6
Pajarito above Hwy 4	06/28	2,400	^{137}Cs	6.6		4.4	1.5
Pajarito at Hwy 4 Culvert	06/28	5,700	^{137}Cs	6.5		4.4	1.5
Water below Hwy 4	06/28	9,400	^{137}Cs	6.5		4.4	1.5
Water below Hwy 4	06/28	9,400	^{137}Cs	6.5		4.4	1.5
Pajarito at TA-18	06/28	16,000	^{137}Cs	6.0		4.4	1.4
G-6	08/18	1,333	^{137}Cs	5.2	1.3	4.4	1.2
Los Alamos near Los Alamos	10/23	3,030	^{137}Cs	5.1	1.4	4.4	1.2
Los Alamos at Los Alamos	07/18	20,900	^{137}Cs	4.9	0.7	4.4	1.1

[a] Table shows radionuclides found at levels greater than SALs.

[b] Samples with total suspended solids (TSS) concentrations less than 1000 mg/L not included because of larger uncertainty in the calculated concentrations.

[c] Unable to calculate total propogated uncertainty for some samples because of missing estimates of measurement uncertainty.

[d] Screening Action Level; Environmental Restoration 1997; see text for details.

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a])

Station Name	Date	Codes[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations																						
Los Alamos Canyon (includes Pueblo, DP Canyons):																						
Los Alamos Canyon at Los Alamos	06/03	F	CS		42.0	6.2	12.0	6.7														
Los Alamos Canyon at Los Alamos	06/03	UF	CS																	250		
Los Alamos Canyon at Los Alamos	06/03	UF	CS		59.0	7.1	13.0	6.8							1.80	0.07	<[a] 0.0100	0.0180		240		
Los Alamos Canyon at Los Alamos	07/18	F	CS		58.0	11.0	18.0	4.0														
Los Alamos Canyon at Los Alamos	07/18	UF	CS		240.0	20.0	30.0	5.0							0.94	0.67	< 0.0100			9,800		
Los Alamos Canyon at Los Alamos	07/18	UF	TOTC															0.1300				
Los Alamos Canyon at Los Alamos	07/18	UF	CS																	32,000		
Los Alamos Canyon at Los Alamos	07/19	UF	CS																	35,000		
Los Alamos Canyon at Los Alamos	07/19	UF	CS																	36,000		
Los Alamos Canyon at Los Alamos	09/12	F	CS			10.9			3.6	8.5	185	< 1	186									
Los Alamos Canyon at Los Alamos	09/12	F	CS																346			
Los Alamos Canyon at Los Alamos	09/12	F	DUP																350			
Los Alamos Canyon at Los Alamos	09/12	UF	CS			12.0									0.84	0.06	< 0.0028	< 0.0028				320
Los Alamos Canyon at Los Alamos	09/12	UF	DUP														< 0.0028	< 0.0028				
Los Alamos Canyon at Los Alamos	09/12	UF	CS																	221		
Los Alamos Canyon at Los Alamos	09/12	UF	DUP																	226		
Los Alamos Canyon below TA-2	06/02	UF	CS		34.0	5.9	7.6	14.0							0.24	0.09		< 0.0100		4,500		
Los Alamos Canyon below TA-2	06/02	UF	CS																	3,400		
Los Alamos Canyon below TA-2	10/23	UF	CS			4.7									0.23	< 0.01	< 0.0028	< 0.0028				
Head of DP Canyon	10/23	UF	CS														< 0.0028	< 0.0028				
DP Canyon below Meadow at TA-21	07/25	F	CS			0.8																
DP Canyon below Meadow at TA-21	07/25	UF	CS			1.7											< 0.0028	< 0.0028		302		
DP Canyon below Meadow at TA-21	07/25	UF	CS																	298		
DP Canyon below Meadow at TA-21	10/23	F	CS																60			
DP Canyon below Meadow at TA-21	10/23	F	DUP																66			
DP Canyon below Meadow at TA-21	10/23	UF	CS			4.0									0.23	0.12	< 0.0028	< 0.0028				70
DP Canyon below Meadow at TA-21	10/27	F	CS			0.5			1.4	2.1	19	< 1	19									
DP Canyon below Meadow at TA-21	10/27	F	DUP			0.5																
DP Canyon below Meadow at TA-21	10/27	UF	CS			3.7											< 0.0028	< 0.0028		1,700		
DP Canyon below Meadow at TA-21	10/27	UF	DUP																	1,840		
DP Canyon at Mouth	06/02	UF	CS		35.0	3.0	6.4	6.7							0.81	0.29		< 0.0100		3,300		
DP Canyon at Mouth	06/02	UF	CS																	5,800		
DP Canyon at Mouth	10/12	UF	CS																	2,750		
DP Canyon at Mouth	10/12	UF	DUP																	3,550		
DP Canyon at Mouth	10/12	UF	CS																	1,800		
DP Canyon at Mouth	10/12	UF	DUP																	4,300		
DP Canyon at Mouth	10/23	F	CS																66			
DP Canyon at Mouth	10/23	F	DUP																68			
DP Canyon at Mouth	10/23	UF	CS			5.9									0.40	0.08	< 0.0028	< 0.0028				69
DP Canyon at Mouth	10/23	UF	DUP														< 0.0028	< 0.0028				
DP Canyon at Mouth	10/27	F	CS			0.7			2.4	2.8	24.5	< 1	25									
DP Canyon at Mouth	10/27	F	CS																104			
DP Canyon at Mouth	10/27	F	DUP																92			
DP Canyon at Mouth	10/27	UF	CS			9.0											< 0.0028	< 0.0028		4,150		94
DP Canyon at Mouth	10/27	UF	DUP																	5,320		
DP Canyon at Mouth	10/27	UF	CS																	4,670		
DP Canyon at Mouth	10/27	UF	DUP																	5,890		
DP Canyon at Mouth	10/27	UF	TRP																	6,110		
Los Alamos Canyon near Los Alamos	06/02	UF	CS		61.0	7.7	11.0	11.0							0.82	0.34		< 0.0100		8,800		
Los Alamos Canyon near Los Alamos	06/02	UF	CS																	23,000		
Los Alamos Canyon near Los Alamos	06/03	F	CS		45.0	6.8	12.0	12.0														
Los Alamos Canyon near Los Alamos	06/03	UF	CS																	1,900		

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Los Alamos Canyon (includes Pueblo, DP Canyons): (Cont.)																					
Los Alamos Canyon near Los Alamos	06/03	UF CS		96.0	9.5	15.0	12.0							3.70	< 0.05	< 0.0100	0.0280		2,300		
Los Alamos Canyon near Los Alamos	07/09	UF CS		410.0	23.0	32.0	13.0							1.30	1.00	< 0.0100			15,000		
Los Alamos Canyon near Los Alamos	07/09	UF DUP		409.0	22.8	31.6	12.8									< 0.0100			14,800		
Los Alamos Canyon near Los Alamos	07/09	UF TOTC															0.0700				
Los Alamos Canyon near Los Alamos	07/09	F CS		41.0	6.1	14.0	9.4														
Los Alamos Canyon near Los Alamos	07/09	UF CS																	12,000		
Los Alamos Canyon near Los Alamos	10/17	UF CS																	1,680		
Los Alamos Canyon near Los Alamos	10/17	UF DUP																	1,820		
Los Alamos Canyon near Los Alamos	10/17	UF CS																	1,670		
Los Alamos Canyon near Los Alamos	10/17	UF DUP																	1,710		
Los Alamos Canyon near Los Alamos	10/17	UF TRP																	1,790		
Los Alamos Canyon near Los Alamos	10/23	F CS			1.0			4.8	1.6	28.8	< 1	29									
Los Alamos Canyon near Los Alamos	10/23	F CS																102			
Los Alamos Canyon near Los Alamos	10/23	F DUP																110			
Los Alamos Canyon near Los Alamos	10/23	UF CS			6.5											< 0.0028	0.0038		2,880		82
Los Alamos Canyon near Los Alamos	10/23	UF DUP														< 0.0028	0.0051		3,180		
Los Alamos Canyon near Los Alamos	10/23	UF CS																	14,000		
Los Alamos Canyon near Los Alamos	10/23	UF DUP																	15,100		
Los Alamos Canyon near Los Alamos	10/27	F CS			2.6			7.9	4.1	48.9	< 1	49									
Los Alamos Canyon near Los Alamos	10/27	UF CS														< 0.0028	0.0080		3,340		
Los Alamos Canyon near Los Alamos	10/27	UF DUP																	3,480		
Los Alamos Canyon near Los Alamos	10/27	UF TRP																	3,660		
Los Alamos Canyon near Los Alamos	10/30	UF CS														< 0.0028	0.0061		290		
Los Alamos Canyon near Los Alamos	10/30	UF DUP														< 0.0028	< 0.0028		298		
Pueblo Canyon near Los Alamos	10/23	F CS			5.1																
Pueblo Canyon near Los Alamos	10/23	F CS																324			
Pueblo Canyon near Los Alamos	10/23	F DUP																332			
Pueblo Canyon near Los Alamos	10/23	UF CS			20.8									4.38	0.64	0.0032	0.0033				308
Pueblo Canyon near Los Alamos	10/27	UF CS														< 0.0028	0.0153		3,910		
Pueblo Canyon near Los Alamos	10/27	UF DUP																	5,780		
Pueblo Canyon near Los Alamos	10/27	UF CS																	4,110		
Pueblo Canyon near Los Alamos	10/27	UF DUP																	4,120		
Sandia Canyon:																					
Sandia Canyon near TA-3	07/16	UF CS																	270		
Sandia Canyon near TA-3	07/17	UF CS																	740		
Sandia Canyon near TA-3	07/17	UF CS		12.0	2.0	3.0	8.0							0.16	0.53	< 0.0100	< 0.0100		570		
Sandia Canyon near TA-3	10/17	UF CS																	100		
Sandia Canyon near TA-3	10/17	UF DUP																	90		
Sandia Canyon near TA-3	10/17	UF CS																	100		
Sandia Canyon near TA-3	10/17	UF DUP																	110		
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey):																					
TA-55	07/17	UF CS																	250		
TA-55	07/17	UF CS		8.0	0.8	1.0	1.0							0.14	0.71	< 0.0100	< 0.0100		150		
TA-55	10/07	F CS																< 6			
TA-55	10/07	UF CS			0.6									0.08	0.58	< 0.0028	< 0.0028		58		28
TA-55	10/07	UF DUP			0.6											< 0.0028	< 0.0028				28
TA-55	10/07	UF CS																	111		
TA-55	10/07	UF DUP																	113		
Cañada del Buey near TA-46	10/23	UF CS			6.0											< 0.0028	< 0.0028				
TA-54 MDA J	08/09	F CS																106			

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey): (Cont.)																					
TA-54 MDA J	08/09	F DUP																106			
TA-54 MDA J	08/09	UF CS			18.0														4,290		45
TA-54 MDA J	08/09	UF DUP			17.8																
TA-54 MDA J	08/09	UF CS																	2,310		
TA-54 MDA J	07/15	UF CS																	50		
TA-54 MDA J	07/15	UF CS		18.0	1.0	1.0	1.0							0.09	1.00				70		93
TA-54 MDA J	07/15	UF DUP																	73		94
TA-54 MDA J	07/17	UF CS																	87		
TA-54 MDA J	07/17	UF CS														< 0.0100	< 0.0100		37		
TA-54 MDA J	10/07	F CS																17			
TA-54 MDA J	10/07	F DUP																19			
TA-54 MDA J	10/07	UF CS			0.5									0.10	0.81	< 0.0028	< 0.0028		32		34
TA-54 MDA J	10/07	UF DUP																	35		
TA-54 MDA J	10/07	UF CS																	75		
TA-54 MDA J	10/07	UF DUP																	90		
TA-54 MDA G-6	07/29	F CS			14.2																
TA-54 MDA G-6	07/29	F CS																254			
TA-54 MDA G-6	07/29	F DUP																264			
TA-54 MDA G-6	07/29	UF CS			31.5									1.03	0.47				3,810		306
TA-54 MDA G-6	07/29	UF CS																	4,260		
TA-54 MDA G-6	08/09	F CS																161			
TA-54 MDA G-6	08/09	UF CS														< 0.0028	0.0031		6,230		22,100
TA-54 MDA G-6	08/09	UF DUP														< 0.0028	0.0038				
TA-54 MDA G-6	08/09	UF CS																	5,560		
TA-54 MDA G-6	08/18	F CS			7.9																
TA-54 MDA G-6	08/18	F CS																210			
TA-54 MDA G-6	08/18	F DUP																205			
TA-54 MDA G-6	08/18	F TRP																217			
TA-54 MDA G-6	08/18	UF CS			16.3			32.8	1.6					0.49	0.24	0.0030	0.0097		1,390		132
TA-54 MDA G-6	08/18	UF DUP														< 0.0028	0.0081		1,340		132
TA-54 MDA G-6	08/18	UF CS																	1,250		
TA-54 MDA G-6	08/18	UF DUP																	1,350		
TA-54 MDA G-6	10/11	F CS			2.7			10.0	1.0	19.5	< 1	20									
TA-54 MDA G-6	10/11	F DUP						9.9	1.1	19	< 1	19									
TA-54 MDA G-6	10/11	F CS																137			76
TA-54 MDA G-6	10/11	F DUP																144			
TA-54 MDA G-6	10/11	F TRP																142			
TA-54 MDA G-6	10/11	UF CS			10.1									0.43	0.07	< 0.0028	< 0.0028		3,000		
TA-54 MDA G-6	10/11	UF DUP			10.0											< 0.0028	< 0.0028		3,290		
TA-54 MDA G-6	10/11	UF TRP																	3,100		
TA-54 MDA G-6	10/11	UF CS																	6,020		
TA-54 MDA G-6	10/11	UF DUP																	7,080		
Cañada del Buey at White Rock	07/29	F CS																312			
Cañada del Buey at White Rock	07/29	UF CS			86.9									5.67	0.15	< 0.0028	< 0.0028		19,600		10,600
Cañada del Buey at White Rock	07/29	UF DUP																			10,600
Cañada del Buey at White Rock	07/29	F CS			1.8																
Cañada del Buey at White Rock	07/29	UF CS																	38,300		
Cañada del Buey at White Rock	08/09	UF CS																	15,300		
Cañada del Buey at White Rock	08/09	UF DUP																	16,700		
Cañada del Buey at White Rock	08/09	UF CS																	18,900		
Cañada del Buey at White Rock	08/18	F CS																210			
Cañada del Buey at White Rock	08/18	F DUP																214			

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey): (Cont.)																					
Cañada del Buey at White Rock	08/18	UF CS												3.12	0.33	< 0.0028	< 0.0028		15,700		125
Cañada del Buey at White Rock	08/18	UF DUP																	16,400		
Canada del Buey at White Rock	08/18	UF QUD																	16,300		
Canada del Buey at White Rock	08/18	UF TRP																	10,500		
Canada del Buey at White Rock	08/18	F CS			0.9																
Canada del Buey at White Rock	08/18	UF CS			31.6											< 0.0028	< 0.0028		9,160		
Cañada del Buey at White Rock	08/18	UF DUP																	9,910		
Cañada del Buey at White Rock	08/18	UF CS																	14,500		
Cañada del Buey at White Rock	08/18	UF DUP																	8,520		
Cañada del Buey at White Rock	10/11	UF CS			20.7									2.31	0.11	< 0.0028	< 0.0028		13,700		
Cañada del Buey at White Rock	10/11	UF DUP																	15,100		
Cañada del Buey at White Rock	10/11	UF CS																	10,600		
Cañada del Buey at White Rock	10/11	UF DUP																	14,800		
Cañada del Buey at White Rock	10/23	F CS																252			
Cañada del Buey at White Rock	10/23	F DUP																254			
Cañada del Buey at White Rock	10/23	UF CS			24.8									1.45	0.09	< 0.0028	0.0036		11,300		66
Cañada del Buey at White Rock	10/23	UF DUP																	9,500		
Cañada del Buey at White Rock	10/23	UF CS																	19,600		
Cañada del Buey at White Rock	10/23	UF DUP																	25,100		
Cañada del Buey at White Rock	10/28	F CS			1.4			0.3	0.4	17.6	< 0.3	18									
Cañada del Buey at White Rock	10/28	F CS																240			
Cañada del Buey at White Rock	10/28	F DUP																252			
Cañada del Buey at White Rock	10/28	UF CS			7.0									0.90	0.02	< 0.0028	0.0038		6,360		57
Cañada del Buey at White Rock	10/28	UF DUP																	6,400		
Cañada del Buey at White Rock	10/28	UF CS																	7,080		
Cañada del Buey at White Rock	10/28	UF DUP																	7,930		
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):																					
Pajarito Canyon above Highway 501	06/28	F CS		63.0	12.0	21.0	5.1														
Pajarito Canyon above Highway 501	06/28	UF CS												2.50	0.38	< 0.0500			25,000		
Pajarito Canyon above Highway 501	06/28	UF TOTC		1,110.0	112.8	111.3	11.7										0.1460				
Pajarito Canyon above Highway 501	06/28	UF CS																	35,000		
Pajarito Canyon above Highway 501	09/08	F CS			4.8			2.2	9.8	70.3	< 1	70									
Pajarito Canyon above Highway 501	09/08	F CS																273			215
Pajarito Canyon above Highway 501	09/08	F DUP																281			214
Pajarito Canyon above Highway 501	09/08	UF CS			30.9									8.45	0.85	< 0.0028	0.0218		9,740		
Pajarito Canyon above Highway 501	09/08	UF DUP			31.4									8.70							
Pajarito Canyon above Highway 501	09/08	UF CS																	8,200		
Pajarito Canyon above Highway 501	10/23	F CS			5.4			1.5	4.6	78.2	< 1	78									
Pajarito Canyon above Highway 501	10/23	F CS																171			
Pajarito Canyon above Highway 501	10/23	F DUP																349			
Pajarito Canyon above Highway 501	10/23	UF CS			7.8									1.71	0.31	< 0.0028	0.0072		414		182
Pajarito Canyon above Highway 501	10/23	UF DUP	20	35.9	7.7	11.3	3.2							1.81		0.0031	0.0078		470		182
Pajarito Canyon above Highway 501	10/23	UF TRP																	414		
Pajarito Canyon above Highway 501	10/23	UF CS																	442		
Pajarito Canyon above Highway 501	10/23	UF CS														< 0.0028	0.0173		7,640		
Pajarito Canyon above Highway 501	10/23	UF DUP																	6,380		
Pajarito Canyon above Highway 501	10/23	UF TRP																	6,380		
Pajarito Canyon at TA-22	06/28	F CS		54.0	11.0	18.0	5.2														
Pajarito Canyon at TA-22	06/28	UF CS												0.89	1.10	< 0.0500			2,600		
Pajarito Canyon at TA-22	06/28	UF DUP																	2,620		
Pajarito Canyon at TA-22	06/28	UF TOTC		157.2	24.1	34.9	8.0										0.1150				

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO$_2$	Ca	Mg	K	Na	Cl	SO$_4$		CO$_3$ Alkalinity	Total Alkalinity	F	PO$_4$-P	NO$_3$+ NO$_2$-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)																					
Pajarito Canyon at TA-22	06/28	UF CS																	2,000		
Starmer's Gulch at TA-22	06/28	F CS		62.0	10.0	22.0	8.6														
Starmer's Gulch at TA-22	06/28	UF CS												5.90	0.52	< 0.0500			3,100		
Starmer's Gulch at TA-22	06/28	UF TOTC		291.6	26.7	41.9	10.9										0.0840				
Starmer's Gulch at TA-22	06/28	UF CS																	2,900		
TA-54 MDA G-1	08/09	F CS																105			
TA-54 MDA G-1	08/09	UF CS												2.22	0.31				13,300		15,300
TA-54 MDA G-1	08/09	UF DUP												2.16	0.34						
TA-54 MDA G-1	08/09	UF CS																	12,900		
TA-54 MDA G-1	10/11	F CS			0.6			0.5	0.5	8.24	< 1	8									
TA-54 MDA G-1	10/11	F CS																84			
TA-54 MDA G-1	10/11	F DUP																87			
TA-54 MDA G-1	10/11	UF CS			7.4									0.31	0.06	< 0.0028	< 0.0028		1,040		29
TA-54 MDA G-1	10/11	UF DUP																	1,090		
TA-54 MDA G-1	10/11	UF CS																	677		
TA-54 MDA G-1	10/11	UF DUP																	760		
TA-54 MDA G-2	07/29	F CS			39.3																
TA-54 MDA G-2	07/29	F CS																280			
TA-54 MDA G-2	07/29	UF CS			46.9									0.73	0.53	< 0.0028	< 0.0028		1,640		573
TA-54 MDA G-2	07/29	UF DUP																	1,730		
TA-54 MDA G-2	07/29	UF CS																	1,490		
TA-54 MDA G-2	08/09	F CS			8.7																
TA-54 MDA G-2	08/09	UF CS			23.9														4,830		
TA-54 MDA G-2	08/09	UF CS																	4,860		
TA-54 MDA G-2	10/11	F CS			11.4			53.2	1.3	29.3	< 1	29									
TA-54 MDA G-2	10/11	F CS																231			
TA-54 MDA G-2	10/11	F DUP																232			
TA-54 MDA G-2	10/11	UF CS			17.7									0.22	0.20	< 0.0028	< 0.0028		570		159
TA-54 MDA G-2	10/11	UF DUP																	582		
TA-54 MDA G-2	10/11	UF CS																	510		
TA-54 MDA G-2	10/11	UF DUP																	514		
TA-54 MDA G-3	07/29	F CS																346			
TA-54 MDA G-3	07/29	UF CS			33.6									2.14	0.87	< 0.0028	< 0.0028		10,300		315
TA-54 MDA G-3	08/09	UF CS																	35,800		
TA-54 MDA G-3	08/09	UF CS																	37,800		
TA-54 MDA G-3	08/18	F CS			13.8																
TA-54 MDA G-3	08/18	F CS																333			
TA-54 MDA G-3	08/18	F DUP																345			
TA-54 MDA G-3	08/18	UF CS			20.0									0.86	0.67	< 0.0028	< 0.0028		5,560		357
TA-54 MDA G-3	08/18	UF DUP																	5,270		
TA-54 MDA G-3	08/18	UF CS																	6,040		
TA-54 MDA G-3	08/18	UF DUP																	7,110		
TA-54 MDA G-3	10/11	F CS			3.0			13.0	3.9	25.2	< 1	25									
TA-54 MDA G-3	10/11	F CS																162			
TA-54 MDA G-3	10/11	F DUP																166			
TA-54 MDA G-3	10/11	UF CS			6.5									0.41	0.26	< 0.0028	< 0.0028		610		102
TA-54 MDA G-3	10/11	UF DUP																	638		
TA-54 MDA G-3	10/11	UF CS																	620		
TA-54 MDA G-3	10/11	UF DUP																	620		
TA-54 MDA G-3	10/11	UF TRP																	628		
TA-54 MDA G-3	10/25	F CS			2.1			6.7	2.5	21.6	< 1	22									
TA-54 MDA G-3	10/25	UF CS			11.1									0.18	0.81	< 0.0028	< 0.0028				

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)																					
TA-54 MDA G-3	10/28	F CS			2.4																
TA-54 MDA G-3	10/28	UF CS														< 0.0028	< 0.0028		392		
TA-54 MDA G-3	10/28	UF DUP																	402		
TA-54 MDA G-3	10/28	UF CS																	444		
TA-54 MDA G-3	10/28	UF DUP																	448		
TA-54 MDA G-5	10/23	F CS			0.5																
TA-54 MDA G-5	10/23	F CS																49			
TA-54 MDA G-5	10/23	F DUP																50			
TA-54 MDA G-5	10/23	UF CS			1.5									0.13	0.08	< 0.0028	< 0.0028		214		22
TA-54 MDA G-5	10/23	UF DUP												0.15					270		
TA-54 MDA G-5	10/23	UF CS																	2,640		
TA-54 MDA G-5	10/23	UF DUP																	2,670		
TA-54 MDA G-4	08/15	F CS																90			
TA-54 MDA G-4	08/15	F DUP																87			
TA-54 MDA G-4	08/15	UF CS			3.4									0.36	1.27	0.0035	0.0060		1,410		96
TA-54 MDA G-4	08/15	UF DUP			3.3									0.32		< 0.0028	0.0051		1,450		95
TA-54 MDA G-4	08/15	UF CS																	2,930		
TA-54 MDA G-4	10/12	F CS			2.7			8.8	4.3	50.9	< 1	51									
TA-54 MDA G-4	10/12	F CS																146			
TA-54 MDA G-4	10/12	F DUP																153			
TA-54 MDA G-4	10/12	F TRP																153			
TA-54 MDA G-4	10/12	UF CS			3.4									0.20	0.15	< 0.0028	< 0.0028		80		139
TA-54 MDA G-4	10/12	UF DUP																	82		
TA-54 MDA G-4	10/12	UF CS																	70		
TA-54 MDA G-4	10/12	UF DUP																	76		
Pajarito Canyon above Highway 4	06/28	F CS		97.0	16.0	32.0	7.4														
Pajarito Canyon above Highway 4	06/28	UF CS												0.98	0.11	< 0.0500			2,400		
Pajarito Canyon above Highway 4	06/28	UF TOTC		706.0	52.9	65.6	10.4										0.0850				
Pajarito Canyon above Highway 4	06/28	UF CS																	6,000		
Pajarito Canyon above Highway 4	10/24	F CS			4.6			6.7	11.0	84.4	< 1	85									
Pajarito Canyon above Highway 4	10/24	F DUP						6.6	10.7												
Pajarito Canyon above Highway 4	10/24	F CS																264			
Pajarito Canyon above Highway 4	10/24	F DUP																276			
Pajarito Canyon above Highway 4	10/24	F TRP																268			
Pajarito Canyon above Highway 4	10/24	UF CS			9.6									1.34	0.94	< 0.0028	< 0.0028				226
Pajarito Canyon above Highway 4	10/27	F CS			5.0			6.4	13.9	80.1	< 1	80									
Pajarito Canyon above Highway 4	10/27	F CS																250			
Pajarito Canyon above Highway 4	10/27	F DUP																252			
Pajarito Canyon above Highway 4	10/27	UF CS			10.5									0.97	0.41	< 0.0028	0.0072		752		210
Pajarito Canyon above Highway 4	10/27	UF DUP														< 0.0028	0.0070		772		
Pajarito Canyon above Highway 4	10/28	UF CS																	1,700		
Pajarito Canyon above Highway 4	10/28	UF DUP																	1,710		
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):																					
Water Canyon above Highway 501	06/28	UF CS												0.74	0.60	0.0620			1,000		
Water Canyon above Highway 501	06/28	UF TOTC		573.7	33.7	43.3	4.7										0.0660				
Water Canyon above Highway 501	06/28	UF CS																	1,600		
Water Canyon above Highway 501	10/23	F CS			3.8			1.4	3.9	61.8	< 1	62									
Water Canyon above Highway 501	10/23	F CS																436			
Water Canyon above Highway 501	10/23	F DUP																438			
Water Canyon above Highway 501	10/23	UF CS			29.2									6.90	0.21	< 0.0028	0.0176		15,600		253
Water Canyon above Highway 501	10/23	UF DUP																	16,400		

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																					
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons): (Cont.)																					
Water Canyon above Highway 501	10/23	UF CS																	11,100		
Water Canyon above Highway 501	10/23	UF DUP																	13,100		
Cañon del Valle above Highway 501	06/28	UF CS												0.85	0.78	< 0.0500			3,400		
Cañon del Valle above Highway 501	06/28	UF TOTC		666.0	46.4	55.8	7.0										0.0920				
Cañon del Valle above Highway 501	06/28	UF CS																	3,100		
Cañon del Valle above Highway 501	10/23	F CS			3.4			1.2	4.0	64.9	< 1	65									
Cañon del Valle above Highway 501	10/23	F CS																292			
Cañon del Valle above Highway 501	10/23	F DUP																298			
Cañon del Valle above Highway 501	10/23	UF CS			17.0									7.40	0.36	< 0.0028	0.0145		4,970		245
Cañon del Valle above Highway 501	10/23	UF DUP																	7,610		
Cañon del Valle above Highway 501	10/23	UF CS																	2,840		
Cañon del Valle above Highway 501	10/23	UF DUP																	5,350		
Water Canyon at Highway 4	06/28	UF CS												0.72	0.69	< 0.0500			5,000		
Water Canyon at Highway 4	06/28	UF TOTC		688.4	58.4	64.9	8.9										0.0720				
Water Canyon at Highway 4	10/27	F CS			5.4			2.4	7.1	39.1	< 1	39									
Water Canyon at Highway 4	10/27	F DUP								38.1	< 1	38									
Water Canyon at Highway 4	10/27	F CS																486			
Water Canyon at Highway 4	10/27	F DUP																492			
Water Canyon at Highway 4	10/27	UF CS			37.4									5.10	0.09	< 0.0028	0.0495		51,400		357
Water Canyon at Highway 4	10/27	UF DUP			37.6									5.05					52,800		355
Water Canyon at Highway 4	10/27	UF TRP																	53,500		
Water Canyon at Highway 4	10/28	UF CS																	61,900		
Water Canyon at Highway 4	10/28	UF DUP																	62,400		
Water Canyon at Highway 4	10/28	UF TRP																	65,800		
Indio Canyon at Highway 4	06/28	UF CS																	12,000		
Water Canyon below Highway 4	06/28	F CS		80.0	14.0	28.0	5.9														
Water Canyon below Highway 4	06/28	UF CS												0.63	0.56	< 0.0500			13,000		
Water Canyon below Highway 4	06/28	UF TOTC		971.7	87.3	95.2	11.1										0.1030				
Water Canyon below Highway 4	06/28	UF CS																	5,800		
Water Canyon below Highway 4	07/29	UF CS			55.0									14.40	< 0.01	0.0393	0.0639		20,300		
Water Canyon below Highway 4	07/29	UF DUP			61.4									14.50	< 0.01	0.0457	0.0738				
Water Canyon below Highway 4	07/29	UF CS																	21,300		
Water Canyon below Highway 4	08/12	UF CS			37.5														59,600		
Water Canyon below Highway 4	08/12	UF CS																	46,000		
Water Canyon below Highway 4	08/18	F CS			1.8																
Water Canyon below Highway 4	08/18	F CS																126			
Water Canyon below Highway 4	08/18	F DUP																138			
Water Canyon below Highway 4	08/18	UF CS			3.9									0.93	0.43	0.0058	0.0066		284		102
Water Canyon below Highway 4	08/18	UF DUP			3.9														294		
Water Canyon below Highway 4	08/18	UF CS																	334		
Water Canyon below Highway 4	08/18	UF DUP																	322		
Water Canyon below Highway 4	08/18	UF QUD																	332		
Water Canyon below Highway 4	08/18	UF TRP																	344		
Water Canyon below Highway 4	10/23	F CS			4.9			5.0	6.8	84.3	< 1	85									
Water Canyon below Highway 4	10/23	F CS																362			
Water Canyon below Highway 4	10/23	F DUP																372			
Water Canyon below Highway 4	10/23	UF CS			28.6									5.10	0.06	< 0.0028	< 0.0028		23,500		288
Water Canyon below Highway 4	10/23	UF DUP			29.0											< 0.0028	< 0.0028		24,100		
Water Canyon below Highway 4	10/23	UF CS																	54,700		
Water Canyon below Highway 4	10/23	UF DUP																	54,700		
Water Canyon below Highway 4	10/23	UF TRP																	71,400		
Water Canyon below Highway 4	10/27	F CS			3.1			1.8	6.8	47.9	< 1	48									

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Stations (Cont.)																						
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons): (Cont.)																						
Water Canyon below Highway 4	10/27	UF	CS			22.0											< 0.0028	0.0352		11,200		
Water Canyon below Highway 4	10/27	UF	DUP																	13,700		
Water Canyon below Highway 4	10/27	UF	TRP																	13,900		
Water Canyon below Highway 4	10/27	UF	CS																	9,340		
Water Canyon below Highway 4	10/27	UF	DUP																	9,860		
Potrillo Canyon near White Rock	08/09	UF	CS			19.7									1.72	0.44	< 0.0028	0.0037		6,970		
Potrillo Canyon near White Rock	08/09	UF	CS																	14,000		
Potrillo Canyon near White Rock	10/23	F	CS			0.7			0.4	0.5	25.7	< 1	26									
Potrillo Canyon near White Rock	10/23	F	CS																194			
Potrillo Canyon near White Rock	10/23	F	DUP																390			
Potrillo Canyon near White Rock	10/23	UF	CS			9.0									0.58	0.10	< 0.0028	< 0.0028		5,170		25
Potrillo Canyon near White Rock	10/23	UF	DUP																	5,610		
Potrillo Canyon near White Rock	10/23	UF	CS																	13,500		
Potrillo Canyon near White Rock	10/23	UF	DUP																	9,760		
Ancho Canyon:																						
Ancho Canyon at TA-39	08/18	UF	CS			73.5														19,400		
Ancho Canyon at TA-39	08/18	UF	DUP																	20,600		
Ancho Canyon at TA-39	08/18	UF	CS																	30,000		
Ancho Canyon at TA-39	08/18	UF	DUP																	30,200		
Ancho Canyon at TA-39	10/28	F	CS						0.9	1.4	12.7	< 1	13									
Ancho Canyon at TA-39	10/28	F	CS																170			
Ancho Canyon at TA-39	10/28	F	DUP																196			
Ancho Canyon at TA-39	10/28	F	TRP																187			
Ancho Canyon at TA-39	10/28	UF	CS			17.0											< 0.0028	< 0.0028		2,750		57
Ancho Canyon at TA-39	10/28	UF	DUP																	2,790		
Ancho Canyon at TA-39	10/28	UF	CS																	1,990		
Ancho Canyon at TA-39	10/28	UF	DUP																	2,000		
Ancho Canyon near Bandelier NP	08/18	UF	CS			52.7														7,420		
Ancho Canyon near Bandelier NP	08/18	UF	DUP			51.6														8,610		
Ancho Canyon near Bandelier NP	08/18	UF	CS																	10,500		
Ancho Canyon near Bandelier NP	08/18	UF	DUP																	11,500		
Ancho Canyon near Bandelier NP	10/23	F	CS																152			
Ancho Canyon near Bandelier NP	10/23	UF	CS			12.4			0.4	1.1	21.6	< 1	22		0.55	0.14	< 0.0028	< 0.0028		4,230		53
Ancho Canyon near Bandelier NP	10/23	UF	DUP																	5,300		
Ancho Canyon near Bandelier NP	10/23	UF	CS																	4,220		
Ancho Canyon near Bandelier NP	10/23	UF	DUP																	4,840		
Ancho Canyon near Bandelier NP	10/28	F	CS																138			
Ancho Canyon near Bandelier NP	10/28	F	DUP																141			
Ancho Canyon near Bandelier NP	10/28	UF	CS			9.3											< 0.0028	0.0036		2,540		45
Ancho Canyon near Bandelier NP	10/28	UF	DUP																	2,700		
Ancho Canyon near Bandelier NP	10/28	UF	CS																	2,870		
Ancho Canyon near Bandelier NP	10/28	UF	DUP																	2,880		
Runoff Grab Samples																						
Upper Los Alamos Reservoir	08/31	F	CS	38	62.3	12.7	14.7	7.8	3.1	3.0	101	1	102	0.10	0.16	0.15			180			196
Upper Los Alamos Reservoir	08/31	F	DUP																187			
Upper Los Alamos Reservoir	08/31	UF	CS			7.8									0.18	0.10	< 0.0028	< 0.0028		< 7		
Upper Los Alamos Reservoir	08/31	UF	DUP																	< 7		
Los Alamos Reservoir	08/31	F	CS	42	26.7	7.6	5.6	6.6	3.4	0.6	229	< 1	230	0.10	0.42	0.08			333			365
Los Alamos Reservoir	08/31	F	DUP																335			364
Los Alamos Reservoir	08/31	F	TRP																359			

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a]) (Cont.)

Station Name	Date	Codes[b]	SiO_2	Ca	Mg	K	Na	Cl	SO_4		CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N	CN (amen)[c]	CN (Total)	TDS[d]	TSS[e]	Lab pH[f]	Conductance (µS/cm)
Runoff Grab Samples (Cont.)																					
Los Alamos Reservoir	08/31	UF CS																		7.2	
Los Alamos Reservoir	08/31	UF CS			12.4									0.60	0.02	< 0.0028	< 0.0028		38	7.2	
Los Alamos Reservoir	08/31	UF DUP			12.5											< 0.0028	< 0.0028				
Los Alamos Canyon at SR-4 Weir	07/21	F CS			13.1																
Los Alamos Canyon at SR-4 Weir	07/21	UF CS			18.0											< 0.0028	0.0101		885		
Los Alamos Canyon at SR-4 Weir	07/21	UF DUP			18.2											< 0.0028	0.0120		890		
Los Alamos Canyon at SR-4 Weir	07/21	UF CS																	935		
Rendija Canyon at 3rd Crossing	07/17	UF CS																	38,000		
Rendija Canyon at 3rd Crossing	07/17	F CS		36.0	6.0	10.0	2.0														
Rendija Canyon at 3rd Crossing	07/17	UF CS		250.0	22.0	25.0	3.0							0.58	0.50						
Rendija Canyon at 3rd Crossing	07/17	UF DUP		300.0	26.0	30.0	4.0														
Guaje Canyon at SR-502	07/09	F CS		51.0	9.0	14.0	4.1														
Guaje Canyon at SR-502	07/09	UF CS		620.0	39.0	38.0	7.3							0.71	0.93	< 0.0100			37,000		
Guaje Canyon at SR-502	07/09	UF TOTC															0.1760				
Guaje Canyon at SR-502	07/09	UF CS																	33,000		
Guaje Canyon at SR-502	09/08	F CS			7.1			2.4	16.7	118	< 1	118									
Guaje Canyon at SR-502	09/08	F CS																570			
Guaje Canyon at SR-502	09/08	UF CS			188.0									8.60	0.39	< 0.0028	0.0196				427
Guaje Canyon at SR-502	09/08	UF CS																	76,000		
Starmer's Gulch above Highway 501	10/23	F CS			4.7			2.0	4.3	50.5	< 1	51									
Starmer's Gulch above Highway 501	10/23	F CS																426			
Starmer's Gulch above Highway 501	10/23	F DUP																436			
Starmer's Gulch above Highway 501	10/23	UF CS			19.4									7.26	0.10	< 0.0028	0.0103		6,240		274
Starmer's Gulch above Highway 501	10/23	UF DUP												7.35	0.10				6,260		
Starmer's Gulch above Highway 501	10/23	UF TRP																	8,930		
Starmer's Gulch above Highway 501	10/23	UF CS																	1,740		
Starmer's Gulch above Highway 501	10/23	UF DUP																	2,590		
Two-Mile Canyon at Highway 501	10/23	F CS			2.8			1.8	4.2	62.8	< 1	63									
Two-Mile Canyon at Highway 501	10/23	F DUP								63.8	< 1	64									
Two-Mile Canyon at Highway 501	10/23	F CS																312			
Two-Mile Canyon at Highway 501	10/23	F DUP																314			
Two-Mile Canyon at Highway 501	10/23	UF CS			19.4									8.15	0.14	< 0.0028	0.0111		8,080		270
Two-Mile Canyon at Highway 501	10/23	UF DUP																	7,080		
Two-Mile Canyon at Highway 501	10/23	UF CS																	10,900		
Two-Mile Canyon at Highway 501	10/23	UF DUP																	9,980		
Pajarito Canyon at TA-18 Culvert	06/28	F CS		85.0	14.0	29.0	7.0														
Pajarito Canyon at TA-18 Culvert	06/28	F DUP		84.7	14.2	28.7	7.0														
Pajarito Canyon at TA-18 Culvert	06/28	UF CS												0.98	0.52	< 0.0500			16,000		
Pajarito Canyon at TA-18 Culvert	06/28	UF TOTC		877.3	81.1	96.2	11.8										0.1750				
Pajarito Canyon at TA-18 Culvert	06/28	UF CS																	18,000		
Pajarito Canyon at TA-18 Culvert	06/28	UF DUP																	27,500		
Pajarito Canyon at G-1	06/28	UF CS																	3,200		
Pajarito Canyon at G-1	06/28	UF CS																	21,000		
Pajarito Canyon at SR-4 Culvert	06/28	F CS		99.0	17.0	32.0	7.8														
Pajarito Canyon at SR-4 Culvert	06/28	UF CS												3.70	0.67	< 0.0500			5,700		
Pajarito Canyon at SR-4 Culvert	06/28	UF TOTC		774.9	73.4	91.5	11.8										0.0970				
Pajarito Canyon at SR-4 Culvert	06/28	UF CS																	1,600		
Water Quality Standards[h]																					
EPA Primary Drinking Water Standard									500				4.0		10		0.2000				
EPA Secondary Drinking Water Standard								250	250									500		6.8-8.5	
EPA Health Advisory							20														
NMWQCC Groundwater Limit								250	500				1.6		10		0.2000	1,000		6-9	
NMWQCC Wildlife Habitat Standard																0.0052					

Table 5-15. Chemical Quality of Runoff Samples for 2000 (mg/L[a])

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[a] Except where noted.

[b] Codes: UF–Unfiltered; F–Filtered; CS–Customer Sample; DUP–Laboratory Duplicate; TRP–Laboratory Triplicate; TOTC–Total Concentration Calculated from Laboratory Data.

[c] Amenable cyanide.

[d] Total dissolved solids.

[e] Total suspended solids.

[f] Standard units.

[g] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[h] Standards given here for comparison only; see Appendix A.

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L)

Station Name	Date	Code[a,b]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe
Runoff Stations														
Los Alamos Canyon (includes Pueblo, DP Canyons):														
Los Alamos Canyon at Los Alamos	06/03	F	CS	<[c] 0.9	89	3.4	67.0	120.0	0.1	0.3	3.9	< 0.4	2.5	87
Los Alamos Canyon at Los Alamos	06/03	UF	CS	< 0.9	2,900	7.1	74.0	370.0	1.0	0.8	6.1	1.4	6.8	2,000
Los Alamos Canyon at Los Alamos	07/18	F	CS						0.0	< 0.1				332
Los Alamos Canyon at Los Alamos	07/18	UF	CS						17.6	8.5				121,000
Los Alamos Canyon at Los Alamos	07/18	UF	DUP						20.7	9.1				166,000
Los Alamos Canyon at Los Alamos	07/18	F	CS	10.0	220	4.4	87.0	170.0	< 5.0	< 5.0	6.7	0.8	6.9	130
Los Alamos Canyon at Los Alamos	07/18	UF	CS	1.1	18,000	14.0	317,000.0	2,000.0	9.1	3.7	43.0	4.3	17.0	5,000
Los Alamos Canyon at Los Alamos	09/12	F	CS	< 0.5	377	5.0	54.1	157.0	0.5	< 0.1	6.4	< 1.1	1.6	375
Los Alamos Canyon at Los Alamos	09/12	UF	CS	< 0.5	8,660	7.2	48.7	287.0	1.3	0.7	8.1	2.6	9.2	4,560
Los Alamos Canyon below TA- 2	06/02	UF	CS	< 0.9	4,300	6.6	31.0	530.0	9.9	4.1	17.0	6.8	64.0	5,200
Los Alamos Canyon below TA- 2	10/23	UF	CS	< 0.5	6,090	< 2.6	23.9	98.7	0.9	0.3	0.8	3.1	5.6	3,830
DP Canyon below Meadow at TA-21	07/25	F	CS	< 0.5	86	< 2.6	24.9	16.7	0.5	0.2	< 0.6	< 1.1	9.5	75
DP Canyon below Meadow at TA-21	07/25	UF	CS	< 0.5	5,090	< 2.6	19.6	75.3	0.9	0.5	3.6	6.2	25.9	3,860
DP Canyon below Meadow at TA-21	10/23	UF	CS	< 0.5	20,400	5.7		230.0	2.7	1.2	6.3	20.9	55.4	17,000
DP Canyon below Meadow at TA-21	10/27	F	CS	< 0.5	679	3.8	11.2	16.6	0.5	< 0.1	< 0.6	1.7	3.1	401
DP Canyon below Meadow at TA-21	10/27	F	DUP	< 0.5	665	< 2.6	10.6	16.4	0.5	< 0.1	< 0.6	1.6	2.7	397
DP Canyon below Meadow at TA-21	10/27	UF	CS	0.7	18,600	4.4	18.7	293.0	3.9	1.4	9.0	15.8	48.8	13,000
DP Canyon at Mouth	06/02	UF	CS	< 0.9	5,400	5.3	28.0	510.0	11.8	4.3	17.0	6.3	58.0	3,600
DP Canyon at Mouth	10/23	UF	CS	< 0.5	33,000	10.1		363.0	6.3	2.0	10.1	28.8	64.0	26,900
DP Canyon at Mouth	10/27	F	CS	< 0.5	1,040	< 2.6	15.2	22.9	0.6	< 0.1	< 0.6	1.0	2.1	584
DP Canyon at Mouth	10/27	UF	CS	0.8	48,800	10.4	40.4	760.0	14.2	3.5	25.2	41.9	108.0	37,500
Los Alamos Canyon near Los Alamos	06/02	UF	CS	< 0.9	8,800	6.4	40.0	890.0	20.5	8.0	30.0	11.0	95.0	5,900
Los Alamos Canyon near Los Alamos	06/03	F	CS	< 0.9	59	< 3.0	66.0	110.0	0.1	0.3	1.1	< 0.4	2.0	76
Los Alamos Canyon near Los Alamos	06/03	UF	CS	< 0.9	8,700	8.1	81.0	830.0	5.0	3.5	15.0	4.6	13.0	4,700
Los Alamos Canyon near Los Alamos	07/09	UF	CS	< 0.5	29,000	22.0	220.0	3,600.0	32.6	24.1	28.0	12.0	35.0	240,000
Los Alamos Canyon near Los Alamos	07/09	UF	DUP	< 0.4	28,600	22.0	215.0	3,540.0	6.7	5.2	27.6	11.4	34.9	13,300
Los Alamos Canyon near Los Alamos	07/09	F	CS	< 0.5	220	5.7	93.0	110.0	0.2	0.2	3.3	1.1	6.7	407
Los Alamos Canyon near Los Alamos	10/23	F	CS	0.6	617	< 2.6	13.5	17.3	0.5	< 0.1	11.3	1.1	< 1.8	368
Los Alamos Canyon near Los Alamos	10/23	UF	CS	0.6	30,900	8.6	21.0	513.0	7.8	2.1	28.9	23.0	50.9	25,000
Los Alamos Canyon near Los Alamos	10/27	F	CS	< 0.5	772	< 2.6	18.4	41.7	0.5	0.1	< 0.6	< 1.1	< 1.8	415
Pueblo Canyon near Los Alamos	10/23	F	CS	< 0.5	2,700	4.6	91.9	99.1	0.7	0.1	1.9	0.9	4.4	1,680
Pueblo Canyon near Los Alamos	10/23	UF	CS	< 0.5	90,600	29.1		2,360.0	19.4	6.0	54.5	43.8	84.7	64,900
Sandia Canyon:														
Sandia Canyon at TA-3	07/17	UF	CS						0.9	1.5				12,700
Sandia Canyon at TA-3	07/17	UF	CS	0.8	5,000	4.3	38.0	140.0	0.4	1.0	8.5	9.5	45.0	5,000
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey):														
TA-55	07/17	UF	CS						0.3	1.6				4,120
TA-55	07/17	UF	CS	0.8	1,000	< 10.0	100.0	44.0	< 5.0	0.4	6.2	2.3	84.0	1,000
TA-55	10/07	UF	CS	< 0.5	1,940	< 2.6	16.2	25.3	0.6	0.3	4.6	2.0	57.5	1,310
TA-55	10/07	UF	DUP	< 0.5	1,880	< 2.6	15.5	24.8	0.6	0.3	4.5	2.0	56.9	1,260
Cañada del Buey near TA-46	10/23	UF	CS	0.7	19,900	3.8	16.3	147.0	5.4	2.3	3.0	14.5	25.2	13,200
Area J	08/09	UF	CS	< 0.5	102,000	16.4	20.9	1,030.0	14.2	1.0	33.0	59.3	49.4	64,200
Area J	08/09	UF	DUP	< 0.5	103,000	17.1	24.3	1,010.0	14.1	1.0	32.5	59.9	47.9	64,600
Area L	07/15	UF	CS						0.1	1.0				1,630
Area L	07/15	UF	CS	0.6	1,000	< 10.0	620.0	71.0	< 5.0	0.8	9.1	3.2	22.0	920

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a,b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe
Runoff Stations (Cont.)													
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey): (Cont.)													
Area L	07/17	F CS						0.1	0.1				45
Area L	07/17	UF CS						0.1	0.9				1,350
Area L	10/07	UF CS	< 0.5	1,130	< 2.6	21.1	43.1	0.5	0.4	1.3	2.0	13.1	792
G-6	07/29	F CS	< 0.5	18	< 2.6	73.0	51.3	0.5	0.1	1.2	< 1.1	2.4	25
G-6	07/29	UF CS	< 0.5	59,200	13.8	82.5	509.0	8.9	1.3	16.6	36.8	46.6	38,800
G-6	08/18	F CS	< 0.5	143	< 2.6	72.8	45.2	0.5	< 0.1	1.0	< 1.1	4.7	66
G-6	08/18	UF CS	< 0.5	34,800	7.9	113.0	257.0	4.5	0.7	19.9	21.0	26.5	24,300
G-6	08/18	UF DUP						2.3	0.6				
G-6	10/11	F CS	< 0.5	531	< 2.6	24.5	23.9	0.5	< 0.1	< 0.6	< 1.1	< 1.8	301
G-6	10/11	UF CS	< 0.5	23,400	< 2.6	55.8	339.0	6.7	0.6	7.7	16.3	21.4	15,800
G-6	10/11	UF DUP	< 0.5	23,000	< 2.6	53.1	334.0	5.5	0.7	7.6	14.1	19.7	14,800
Cañada del Buey at White Rock	07/29	UF CS	< 0.5	417,000	64.1	90.4	5,180.0	72.3	5.3	150.0	247.0	270.0	285,000
Cañada del Buey at White Rock	07/29	F CS	< 0.5	232	3.0	29.1	49.0	0.5	< 0.1	2.7	< 1.1	2.4	116
Cañada del Buey at White Rock	08/18	F CS	0.9	264	< 2.6	19.9	32.3	0.5	< 0.1	2.8	< 1.1	< 1.8	97
Cañada del Buey at White Rock	08/18	UF CS	< 0.5	164,000	27.0	50.7	2,520.0	29.8	3.1	89.0	85.7	100.0	103,000
Cañada del Buey at White Rock	10/11	UF CS	< 0.5	67,900	< 2.6	51.3	3,140.0	33.5	2.9	62.9	25.5	32.2	33,700
Cañada del Buey at White Rock	10/23	UF CS	0.6	118,000	17.8	32.2	2,010.0	25.6	2.9	56.3	66.1	52.6	77,000
Cañada del Buey at White Rock	10/28	F CS	< 0.5	4,830	< 2.6	8.3	40.7	0.7	< 0.1	< 0.6	1.9	1.9	2,510
Cañada del Buey at White Rock	10/28	UF CS	< 0.5	21,000	3.2	19.2	1,190.0	13.8	1.7	26.0	6.3	14.3	8,010
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):													
Pajarito Canyon above Highway 501	06/28	F CS	< 0.9	300	4.2	130.0	210.0	0.1	0.4	6.0	0.5	7.2	190
Pajarito Canyon above Highway 501	06/28	UF TOTC	6.1	375,947	99.9	600.4	16,116.7	25.1	6.7	206.8	301.9	607.1	375,572
Pajarito Canyon above Highway 501	09/08	F CS	< 0.5	427	4.1	27.4	80.5	0.5	< 0.1	4.2	< 1.1	3.5	444
Pajarito Canyon above Highway 501	09/08	UF CS	< 0.5	166,000	35.9	57.0	3,890.0	15.0	5.9	71.9	88.7	135.0	103,000
Pajarito Canyon above Highway 501	09/08	UF DUP	< 0.5	170,000	37.6	67.9	3,930.0	15.0	5.7	72.7	89.8	139.0	101,000
Pajarito Canyon above Highway 501	10/23	F CS	0.6	100	< 2.6	23.9	67.3	0.5	< 0.1	< 0.6	< 1.1	< 1.8	136
Pajarito Canyon above Highway 501	10/23	UF CS	0.6	13,400	4.7	32.0	433.0	1.1	0.4	8.7	6.9	11.5	9,620
Pajarito Canyon above Highway 501	10/23	UF DUP	< 0.5	12,800	3.9	32.3	429.0	0.9	0.4	8.6	6.7	11.1	9,120
Pajarito Canyon at TA-22	06/28	F CS	< 0.9	420	< 3.0	98.0	190.0	0.1	0.4	5.7	1.1	7.3	260
Pajarito Canyon at TA-22	06/28	UF TOTC	12.0	70,784	48.6	274.6	2,520.1	2.7	3.6	32.1	61.9	106.4	57,392
Starmer's Gulch at TA-22	06/28	F CS	< 0.9	280	3.8	120.0	180.0	0.1	0.4	3.0	0.4	6.6	180
Starmer's Gulch at TA-22	06/28	UF TOTC	6.8	64,574	35.2	252.4	3,188.8	4.3	3.0	47.9	41.4	99.8	61,296
G-1	10/11	F CS	< 0.5	859	< 2.6	13.7	12.8	0.5	< 0.1	1.1	0.7	< 1.8	470
G-1	10/11	UF CS	< 0.5	42,200	8.9	35.8	367.0	5.5	0.4	13.1	26.2	19.8	29,200
G-2	07/29	F CS	< 0.5	< 23	< 2.6	139.0	95.8	0.5	0.2	1.9	< 1.1	3.4	< 20
G-2	07/29	UF CS	< 0.5	30,900	8.6	127.0	334.0	3.9	0.8	8.2	19.6	24.9	19,700
G-2	08/09	F CS	< 0.5	51	< 2.6	49.8	40.5	0.5	< 0.1	3.0	< 1.1	2.9	30
G-2	08/09	UF CS	< 0.5	56,400	11.7	60.0	596.0	10.4	1.3	17.6	30.7	43.7	36,600
G-2	10/11	F CS	< 0.5	126	< 2.6	71.7	54.6	0.5	< 0.1	3.5	< 1.1	4.2	103
G-2	10/11	UF CS	< 0.5	21,500	5.7	80.3	193.0	2.9	0.2	7.1	12.7	15.9	16,000
G-3	07/29	UF CS	2.9	130,000	26.4	74.7	1,470.0	27.7	3.0	40.8	81.7	76.8	77,600
G-3	08/18	F CS	< 0.5	135	< 2.6	92.3	75.0	0.5	< 0.1	3.0	1.4	3.8	37
G-3	08/18	UF CS	< 0.5	13,700	3.5	136.0	141.0	2.2	0.3	2.3	6.2	9.9	5,700
G-3	10/11	F CS	< 0.5	516	< 2.6	37.8	27.8	0.5	< 0.1	< 0.6	2.3	4.6	291
G-3	10/11	UF CS	0.7	17,700	4.4	43.2	166.0	2.9	0.1	10.8	13.2	12.1	12,400
G-3	10/25	F CS	< 0.5	195	< 2.6	21.4	25.4	0.5	0.2	< 0.6	1.2	2.3	116

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a,b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe
Runoff Stations (Cont.)													
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)													
G-3	10/25	UF CS	< 0.5	54,700	12.7	20.2	845.0	6.2	1.5	26.0	30.5	48.6	42,200
G-3	10/28	F CS	< 0.5	206	< 2.6	26.8	29.0	0.5	< 0.1	< 0.6	1.9	< 1.8	120
G-3	10/28	UF CS											
G-5	10/23	F CS	0.6	362	< 2.6	27.0	7.8	0.5	< 0.1	< 0.6	< 1.1	< 1.8	201
G-5	10/23	UF CS	0.6	6,940	< 2.6	22.2	46.6	0.9	< 0.1	2.2	4.3	3.6	4,590
G-4	08/15	UF CS	< 0.5	11,700	< 2.6	31.8	146.0	2.2	0.6	5.6	5.6	18.6	7,860
G-4	08/15	UF DUP	< 0.5	11,000	< 2.6	30.1	142.0	2.1	0.6	5.7	5.3	18.1	6,920
G-4	10/12	F CS	< 0.5	586	< 2.6	29.5	56.1	0.5	< 0.1	1.8	< 1.1	4.3	410
G-4	10/12	UF CS	< 0.5	4,660	3.6	32.7	83.9	0.8	0.1	4.1	2.6	8.9	2,940
Pajarito Canyon above Highway 4	06/28	F CS	< 0.9	140	8.3	190.0	310.0	0.1	0.5	3.9	0.7	6.0	130
Pajarito Canyon above Highway 4	06/28	UF CS						0.2	1.0				
Pajarito Canyon above Highway 4	06/28	UF TOTC	6.2	80,069	40.5	407.1	4,817.7	5.6	3.2	52.4	62.0	150.9	79,500
Pajarito Canyon above Highway 4	10/24	F CS	< 0.5	1,070	3.6	32.1	73.8	0.6	< 0.1	< 0.6	1.6	3.1	605
Pajarito Canyon above Highway 4	10/24	UF CS	1.7	43,300	11.2		690.0	6.0	1.7	9.4	20.0	27.7	25,900
Pajarito Canyon above Highway 4	10/27	F CS	< 0.5	323	< 2.6	39.7	76.7	0.6	0.1	< 0.6	< 1.1	1.6	192
Pajarito Canyon above Highway 4	10/27	UF CS	1.4	47,700	11.9	63.0	529.0	7.7	1.6	11.1	20.6	31.3	27,500
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):													
Water Canyon above Highway 501	06/28	UF TOTC	1.1	19,099	16.0	321.8	2,019.3	1.4	0.6	16.5	13.7	34.1	18,200
Water Canyon above Highway 501	10/23	F CS	0.6	3,510	4.3	29.3	80.5	0.7	< 0.1	< 0.6	1.3	3.1	1,820
Water Canyon above Highway 501	10/23	UF CS	0.6	116,000	20.4	81.5	4,880.0	37.1	1.2	79.6	50.2	56.7	63,900
Cañon del Valle above Highway 501	06/28	UF TOTC	2.6	51,898	24.4	286.7	3,827.8	3.8	1.1	38.2	39.4	86.6	58,119
Cañon del Valle above Highway 501	10/23	F CS	0.6	165	4.4	31.7	56.8	0.5	< 0.1	3.7	< 1.1	2.0	162
Cañon del Valle above Highway 501	10/23	UF CS	0.6	70,300	15.8	74.5	3,440.0	14.3	4.9	65.0	26.9	34.9	35,700
Water Canyon at Highway 4	06/28	UF TOTC	39.4	85,529	41.0	359.2	7,192.2	6.7	2.1	50.9	61.3	150.6	95,249
Water Canyon at Highway 4	10/27	F CS	< 0.5	3,700	< 2.6	34.9	134.0	0.6	0.1	1.4	< 1.1	3.7	1,820
Water Canyon at Highway 4	10/27	UF CS	3.0	142,000	24.0	105.0	5,450.0	32.4	5.9	68.0	50.5	71.9	74,200
Water Canyon at Highway 4	10/27	UF DUP	2.8	143,000	22.8	106.0	5,430.0	32.4	6.1	67.9	51.1	73.9	74,900
Indio Canyon at Highway 4	06/28	UF CS						0.2	0.5				
Water Canyon below Highway 4	06/28	F CS	< 0.9	140	8.9	130.0	550.0	0.1	0.5	3.0	0.4	6.2	110
Water Canyon below Highway 4	06/28	UF TOTC	171.1	208,933	73.6	470.6	17,368.2	15.8	5.0	121.2	144.8	370.0	234,477
Water Canyon below Highway 4	07/29	UF CS	12.0	251,000	77.0	226.0	7,520.0	43.4	11.7	108.0	130.0	290.0	173,000
Water Canyon below Highway 4	07/29	UF DUP	14.0	299,000	86.5	224.0	8,180.0	51.0	14.2	121.0	157.0	337.0	205,000
Water Canyon below Highway 4	08/12	UF CS	1.4	98,000	25.3	160.0	5,120.0	23.0	4.5	76.4	41.5	54.8	65,700
Water Canyon below Highway 4	08/18	F CS	< 0.5	424	3.3	41.2	41.8	0.5	< 0.1	1.3	< 1.1	2.0	166
Water Canyon below Highway 4	08/18	UF CS	< 0.5	17,600	3.4	27.5	292.0	1.9	0.3	4.3	8.3	12.2	9,280
Water Canyon below Highway 4	08/18	UF DUP	< 0.5	17,600	3.0	28.6	297.0	0.9		4.3	8.5	12.5	9,350
Water Canyon below Highway 4	10/23	F CS	< 0.5	862	4.0	30.6	97.2	0.5	< 0.1	2.3	< 1.1	2.5	499
Water Canyon below Highway 4	10/23	UF CS	< 0.5	54,400	13.4	69.4	5,300.0	27.0	6.1	79.5	13.7	26.2	25,400
Water Canyon below Highway 4	10/23	UF DUP	< 0.5	54,900	14.3	67.5	5,310.0	27.2	5.9	80.5	13.4	26.1	25,700
Water Canyon below Highway 4	10/27	F CS	< 0.5	1,560	< 2.6	27.8	96.1	0.5	< 0.1	< 0.6	< 1.1	1.9	816
Water Canyon below Highway 4	10/27	UF CS	3.9	96,000	22.2	80.8	4,040.0	27.8	6.1	63.0	42.9	69.9	60,800
Potrillo Canyon near White Rock	08/09	UF CS	< 0.5	99,600	17.1	22.7	1,710.0	23.4	2.8	48.8	49.9	56.5	59,300
Potrillo Canyon near White Rock	10/23	F CS	< 0.5	1,620	< 2.6	11.3	18.1	0.6	< 0.1	< 0.6	0.8	< 1.8	881
Potrillo Canyon near White Rock	10/23	UF CS	< 0.5	36,200	7.7	< 4.7	869.0	12.8	1.9	27.5	17.5	23.6	22,900

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a,b]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe
Runoff Stations (Cont.)													
Ancho Canyon:													
Ancho Canyon at TA-39	08/18	UF CS	< 0.5	319,000	63.0	80.8	3,430.0	65.1	7.2	135.0	201.0	218.0	229,000
Ancho Canyon at TA-39	10/28	UF CS	< 0.5	93,500	13.5	35.9	652.0	12.4	1.2	27.3	57.7	76.6	63,500
Ancho Canyon near Bandelier NP	08/18	UF CS	< 0.5	278,000	48.9	81.5	2,250.0	41.7	6.3	86.0	162.0	165.0	185,000
Ancho Canyon near Bandelier NP	08/18	UF DUP	< 0.5	262,000	43.7	71.0	2,280.0	44.0	7.9	84.7	148.0	161.0	169,000
Ancho Canyon near Bandelier NP	10/23	UF CS	< 0.5	60,700	9.6	5.6	771.0	12.9	2.4	22.0	30.6	35.9	38,200
Ancho Canyon near Bandelier NP	10/28	UF CS	< 0.5	49,100	5.8	26.9	526.0	9.6	1.2	17.2	24.8	26.7	28,600
Runoff Grab Samples													
Upper Los Alamos Reservoir	08/31	F CS	< 0.5	2,720	3.1	52.3	227.0	0.5	< 0.1	2.3	0.9	4.0	1,660
Upper Los Alamos Reservoir	08/31	UF CS	< 0.5	73	< 2.6	24.6	61.6	0.5	< 0.1	2.6	< 1.1	2.7	283
Los Alamos Reservoir	08/31	F CS	< 0.5	19	3.2	19.4	58.9	0.5	< 0.1	2.5	< 1.1	< 1.8	186
Los Alamos Reservoir	08/31	UF CS	< 0.5	2,540	3.0	58.3	222.0	0.7	0.2	4.1	1.1	3.7	1,630
Los Alamos Reservoir	08/31	UF DUP	< 0.5	2,260	4.2	58.3	220.0	0.7	0.2	3.7	< 1.1	3.5	1,480
Los Alamos Weir	07/21	F CS	< 0.5	96	3.2	71.6	191.0	0.5	< 0.1	4.4	< 1.1	3.4	267
Los Alamos Weir	07/21	UF CS	< 0.5	39,400	10.4	80.0	856.0	5.5	1.3	14.1	16.2	41.0	19,400
Los Alamos Weir	07/21	UF DUP	< 0.5	39,800	8.9	80.7	863.0	5.5	1.4	14.2	16.6	41.6	19,900
Rendija Canyon 3rd Crossing	07/17	F CS						0.1	0.3				139
Rendija Canyon 3rd Crossing	07/17	F CS	0.9	280	12.0	75.0	77.0	< 5.0	< 5.0	9.7	0.7	2.9	160
Rendija Canyon 3rd Crossing	07/17	UF CS	0.5	24,000	44.0	2,300.0	2,000.0	13.0	5.9	56.0	5.7	7.8	3,000
Rendija Canyon 3rd Crossing	07/17	UF DUP	1.0	28,000	50.9	2,700.0	2,000.0	15.6	7.0	65.9	7.1	9.1	4,000
Guaje at SR-502	07/09	F CS	< 0.5	110	11.0	120.0	86.0	0.1	0.2	8.6	0.7	4.5	341
Guaje at SR-502	07/09	UF CS	< 0.5	7,400	24.0	290.0	1,700.0	59.4	34.0	12.0	4.3	15.0	192,900
Guaje at SR-502	09/08	F CS	< 0.5	463	6.5	46.1	108.0	0.5	< 0.1	1.9	< 1.1	4.4	273
Guaje at SR-502	09/08	UF CS	< 0.5	995,000	137.0	136.0	20,700.0	136.2	27.3	475.0	510.0	605.0	560,000
Starmer's Gulch above Highway 501	10/23	F CS	0.6	11,500	6.7	47.9	179.0	0.7	0.1	2.9	5.7	7.6	6,910
Starmer's Gulch above Highway 501	10/23	UF CS	0.6	63,700	14.2	71.0	3,840.0	16.0	4.3	65.6	22.0	26.3	32,700
Two-Mile at Highway 501	10/23	F CS	0.6	363	4.0	54.1	75.7	0.5	< 0.1	< 0.6	< 1.1	3.4	261
Two-Mile at Highway 501	10/23	UF CS	0.6	82,500	23.0	90.5	3,940.0	13.0	4.7	53.3	35.2	51.6	49,400
TA-18 Culvert	06/28	F CS	< 0.9	140	4.4	150.0	230.0	0.0	0.5	5.7	1.0	9.8	130
TA-18 Culvert	06/28	F DUP	< 0.9	138	7.3	152.0	227.0	< 0.0	< 0.2	5.7	0.8	9.5	136
TA-18 Culvert	06/28	UF TOTC	13.1	241,784	74.9	495.4	11,528.4	16.4	10.4	140.9	194.2	455.4	256,436
Pajarito Canyon at SR-4 Culvert	06/28	F CS	< 0.9	380	8.0	180.0	290.0	0.1	0.2	4.4	0.4	9.1	260
Pajarito Canyon at SR-4 Culvert	06/28	UF TOTC	16.9	252,359	90.0	480.0	10,615.3	18.0	12.9	143.9	187.5	447.0	240,696
Water Quality Standards[d]													
EPA Primary Drinking Water Standard					50		2,000	4	5	100			
EPA Secondary Drinking Water Standard				50-200									300
EPA Action Limit												1,300	
EPA Health Advisory													
NMWQCC Livestock Watering Standard				5,000	200	5,000			50	1,000	1,000	500	
NMWQCC Groundwater Limit			50	5,000	100	750			10	50	50	1,000	1,000
NMWQCC Wildlife Habitat Standard							1,000						

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code^{a,b}		Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Runoff Stations															
Los Alamos Canyon (includes Pueblo, DP Canyons):															
Los Alamos Canyon at Los Alamos	06/03	F	CS	< 0.01	340.0	< 4.8	2.9	1.08	4.32	< 3.5	< 16.0	230.0	3.41	3.3	2.9
Los Alamos Canyon at Los Alamos	06/03	UF	CS	< 0.01	1,500.0	< 4.8	6.8	45.80	4.53	< 3.5	< 16.0	310.0	3.62	8.7	54.0
Los Alamos Canyon at Los Alamos	07/18	F	CS					0.05	1.06				0.81		
Los Alamos Canyon at Los Alamos	07/18	UF	CS					319.00	1.55				3.71		
Los Alamos Canyon at Los Alamos	07/18	UF	DUP					409.00	1.35				3.86		
Los Alamos Canyon at Los Alamos	07/18	F	CS	< 0.20	1,000.0	7.2	6.0	< 3.00	20.00	< 5.0	< 50.0	320.0	< 10.00	4.7	10.0
Los Alamos Canyon at Los Alamos	07/18	UF	CS	0.02	20,000.0	< 10.0	40.0	54.00	< 20.00	9.3	< 50.0	1,000.0	< 20.00	40.0	480.0
Los Alamos Canyon at Los Alamos	09/12	F	CS		1,670.0	2.5	4.8	1.09	0.68		< 2.0	329.0	0.24	2.1	4.5
Los Alamos Canyon at Los Alamos	09/12	UF	CS	< 0.06	2,160.0	1.8	9.4	14.80	0.69	< 2.4	< 2.0	361.0	0.24	8.8	35.6
Los Alamos Canyon below TA- 2	06/02	UF	CS	< 0.01	2,500.0	< 4.8	19.0	381.00	3.93	< 3.5	< 16.0	190.0	4.08	33.0	430.0
Los Alamos Canyon below TA- 2	10/23	UF	CS		215.0	< 1.1	3.8	8.21	0.22	< 2.4	< 2.0	131.0	0.03	7.0	64.2
DP Canyon below Meadow at TA-21	07/25	F	CS		5.3	1.7	1.4	0.48	< 0.68	< 2.4	< 3.1	46.8	< 0.01	3.3	48.6
DP Canyon below Meadow at TA-21	07/25	UF	CS	< 0.06	188.0	1.8	5.4	29.70	1.12	< 2.4	< 3.1	56.4	0.05	10.5	200.0
DP Canyon below Meadow at TA-21	10/23	UF	CS		652.0	< 1.1	15.8	81.50	1.29	< 2.4	3.0	79.2	0.17	28.7	508.0
DP Canyon below Meadow at TA-21	10/27	F	CS		5.0	< 1.1	< 3.1	0.89	0.42		< 2.0	24.5	0.11	2.3	17.9
DP Canyon below Meadow at TA-21	10/27	F	DUP		5.2	< 1.1	< 3.1	0.90	0.36		< 2.0	24.3	< 0.01	2.0	17.7
DP Canyon below Meadow at TA-21	10/27	UF	CS		779.0	< 1.1	14.3	101.00	1.12		2.4	81.1	0.17	29.7	546.0
DP Canyon at Mouth	06/02	UF	CS	< 0.01	1,900.0	< 4.8	18.0	395.00	4.43	< 3.5	< 16.0	150.0	3.88	33.0	620.0
DP Canyon at Mouth	10/23	UF	CS		1,240.0	< 1.1	22.8	123.00	1.71	< 2.4	< 2.0	110.0	0.19	44.6	554.0
DP Canyon at Mouth	10/27	F	CS		9.1	< 1.1	< 3.1	1.50	0.54		2.7	34.8	< 0.01	2.3	19.9
DP Canyon at Mouth	10/27	UF	CS		2,610.0	2.8	39.1	246.00	1.40	3.4	2.4	188.0	0.42	75.1	1,070.0
Los Alamos Canyon near Los Alamos	06/02	UF	CS	< 0.01	4,100.0	< 4.8	33.0	591.00	4.53	< 3.5	< 16.0	300.0	4.51	55.0	850.0
Los Alamos Canyon near Los Alamos	06/03	F	CS	< 0.01	390.0	6.7	3.0	1.03	4.38	< 3.5	< 16.0	240.0	3.41	3.0	4.6
Los Alamos Canyon near Los Alamos	06/03	UF	CS	< 0.01	4,800.0	< 4.8	18.0	164.00	4.35	4.3	< 16.0	480.0	3.94	21.0	210.0
Los Alamos Canyon near Los Alamos	07/09	UF	CS	< 0.01	25,000.0	5.4	31.0	1,110.00	6.21	12.0	< 20.0	1,700.0	20.42	40.0	810.0
Los Alamos Canyon near Los Alamos	07/09	UF	DUP	< 0.01	24,600.0	< 4.2	30.4	101.00	< 2.79	12.2	< 20.4	1,650.0	< 11.00	40.0	811.0
Los Alamos Canyon near Los Alamos	07/09	F	CS	< 0.01	390.0	9.4	4.2	2.45	4.05	< 2.6	< 20.0	190.0	3.77	4.7	7.6
Los Alamos Canyon near Los Alamos	10/23	F	CS		8.8	< 1.1	3.2	0.68	0.41		2.4	33.9	0.02	1.9	4.8
Los Alamos Canyon near Los Alamos	10/23	UF	CS	< 0.06	3,010.0	< 1.1	28.2	124.00	0.76	< 2.4	2.4	144.0	0.22	43.7	470.0
Los Alamos Canyon near Los Alamos	10/27	F	CS		38.1	5.4	1.3	1.15	0.85		2.4	81.6	< 0.01	1.8	12.3
Pueblo Canyon near Los Alamos	10/23	F	CS		1,360.0	3.3	3.4	4.05	3.62		< 2.0	145.0	< 0.01	6.7	164.0
Pueblo Canyon near Los Alamos	10/23	UF	CS	0.25	14,900.0	2.6	76.8	216.00	0.60	4.0	< 2.0	643.0	0.76	132.0	692.0
Sandia Canyon:															
Sandia Canyon at TA-3	07/17	UF	CS					46.80	1.44				0.40		
Sandia Canyon at TA-3	07/17	UF	CS	0.08	390.0	< 10.0	9.7	43.00	2.90	< 5.0	< 50.0	55.0	< 10.00	13.0	500.0
Mortandad Canyon (includes Ten Site Canyon, Cañada del]Buey):															
TA-55	07/17	UF	CS					12.70	< 0.11				0.35		
TA-55	07/17	UF	CS	0.03	120.0	< 10.0	4.6	8.30	< 20.00	< 5.0	< 50.0	28.0	< 10.00	6.6	240.0
TA-55	10/07	UF	CS	< 0.06	62.0	2.0	2.5	4.06	0.26	< 2.4		17.9	0.46	3.9	201.0
TA-55	10/07	UF	DUP		60.5	< 1.1	2.2	4.19	< 0.11	< 2.4		17.5	0.13	3.8	198.0
Cañada del Buey near TA-46	10/23	UF	CS		328.0	< 1.1	11.9	93.20	0.46	< 2.4	< 2.0	72.9	0.47	22.2	358.0
Area J	08/09	UF	CS	< 0.06	1,880.0	2.1	50.4	70.30	< 0.68	5.8	3.2	201.0	1.23	132.0	392.0
Area J	08/09	UF	DUP	< 0.06	1,880.0	1.5	49.6	74.30	< 0.11	3.0	< 2.0	198.0	0.91	135.0	386.0
Area L	07/15	UF	CS					3.93	4.84				0.24		
Area L	07/15	UF	CS	0.06	180.0	< 10.0	5.9	3.30	5.00	< 5.0	< 50.0	59.0	< 10.00	6.4	320.0

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a,b]	Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Runoff Stations (Cont.)														
Mortandad Canyon (includes Ten Site Canyon, Cañada del]Buey): (Cont.)														
Area L	07/17	F CS					0.22	2.59				0.26		
Area L	07/17	UF CS					3.34	10.90				0.24		
Area L	10/07	UF CS	< 0.06	60.6	< 1.1	1.9	2.01	1.10	< 2.4		25.4	0.32	3.0	249.0
G-6	07/29	F CS		51.1	< 1.5	< 3.1	0.05	3.39	< 2.4	< 3.1	155.0	< 0.01	3.1	< 2.2
G-6	07/29	UF CS	< 0.06	1,390.0	2.4	32.3	45.70	1.70	< 2.4	< 3.1	283.0	0.53	75.0	364.0
G-6	08/18	F CS		27.6	< 1.1	< 3.1	< 0.08	8.61		< 2.0	103.0	0.34	2.9	2.7
G-6	08/18	UF CS	< 0.06	676.0	3.8	18.1	20.10	6.41	4.0	3.7	158.0	0.48	41.5	204.0
G-6	08/18	UF DUP					20.50	6.04				0.20		
G-6	10/11	F CS		12.5	< 1.1	1.0	0.18	5.34	< 2.4	< 2.0	46.5	< 0.01	2.3	6.6
G-6	10/11	UF CS	< 0.06	907.0	< 1.1	14.9	24.60	4.02	< 2.4	< 2.0	126.0	0.27	34.2	188.0
G-6	10/11	UF DUP		879.0	< 1.1	14.5	24.60	3.71	< 2.4	< 2.0	124.0	< 0.01	32.2	185.0
Cañada del Buey at White Rock	07/29	UF CS	< 0.06	9,200.0	2.0	259.0	305.00	< 3.41	< 2.4	6.2	991.0	5.43	452.0	983.0
Cañada del Buey at White Rock	07/29	F CS		228.0	< 1.5	1.6	0.26	< 0.68	< 2.4	< 3.1	79.2	< 0.01	7.7	< 2.2
Cañada del Buey at White Rock	08/18	F CS		7.7	< 1.1	< 3.1	0.02	< 0.11		< 2.0	43.4	< 0.01	5.4	< 3.9
Cañada del Buey at White Rock	08/18	UF CS	< 0.06	5,660.0	2.2	106.0	206.00	< 0.11	7.8	5.2	450.0	2.69	201.0	348.0
Cañada del Buey at White Rock	10/11	UF CS	< 0.06	5,940.0	< 1.1	85.4	43.50	0.41	< 2.4	< 2.0	659.0	0.53	76.2	188.0
Cañada del Buey at White Rock	10/23	UF CS	< 0.06	4,410.0	< 1.1	86.1	62.70	0.30	3.2	2.4	380.0	0.44	133.0	213.0
Cañada del Buey at White Rock	10/28	F CS		32.9	< 1.1	2.0	1.65	0.59		2.4	32.3	< 0.01	6.6	9.9
Cañada del Buey at White Rock	10/28	UF CS		2,190.0	< 1.1	31.2	20.60	0.17	4.4	2.4	227.0	0.44	32.4	51.5
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons):														
Pajarito Canyon above Highway 501	06/28	F CS	< 0.01	450.0	5.9	3.6	1.41	5.73	4.1	< 16.0	420.0	3.56	3.9	6.1
Pajarito Canyon above Highway 501	06/28	UF TOTC	1.33	53,277.8	39.7	255.1	851.87	25.08	41.7	290.8	6,944.4	26.36	654.2	1,883.5
Pajarito Canyon above Highway 501	09/08	F CS		307.0	< 1.1	2.1	0.33	0.68		< 2.0	150.0	0.03	2.7	5.7
Pajarito Canyon above Highway 501	09/08	UF CS	< 0.06	19,000.0	2.2	92.4	227.00	1.37	< 2.4	4.6	953.0	1.48	189.0	557.0
Pajarito Canyon above Highway 501	09/08	UF DUP		19,000.0	2.9	93.3	248.00	< 0.11	< 2.4	< 2.0	955.0	1.17	185.0	564.0
Pajarito Canyon above Highway 501	10/23	F CS		90.0	< 1.1	< 3.1	< 0.08	< 0.11		2.4	149.0	0.02	1.8	0.5
Pajarito Canyon above Highway 501	10/23	UF CS	0.26	2,150.0	< 1.1	8.7	21.40	0.20	< 2.4	2.4	228.0	0.02	17.0	49.8
Pajarito Canyon above Highway 501	10/23	UF DUP		2,140.0	< 1.1	8.6	21.80	< 0.11	< 2.4	< 2.0	226.0	0.03	16.5	54.1
Pajarito Canyon at TA-22	06/28	F CS	< 0.01	320.0	8.2	3.9	1.46	4.86	< 3.5	< 16.0	360.0	3.57	4.2	9.0
Pajarito Canyon at TA-22	06/28	UF TOTC	0.45	5,984.9	82.8	76.4	157.55	47.70	50.3	562.0	1,022.1	47.60	105.1	491.7
Starmer's Gulch at TA-22	06/28	F CS	< 0.01	530.0	7.5	6.0	2.22	5.76	< 3.5	< 16.0	340.0	3.58	1.7	11.0
Starmer's Gulch at TA-22	06/28	UF TOTC	0.18	14,186.6	24.9	56.3	135.89	15.74	22.3	143.1	1,524.7	17.23	101.7	588.1
G-1	10/11	F CS		8.4	< 1.1	1.4	0.25	0.39	< 2.4	< 2.0	15.1	< 0.01	2.3	3.1
G-1	10/11	UF CS	< 0.06	858.0	< 1.1	19.1	35.80	0.32	< 2.4	< 2.0	88.9	0.14	51.3	122.0
G-2	07/29	F CS		83.9	< 1.5	< 3.1	0.02	< 0.68	2.9	< 3.1	379.0	< 0.01	3.1	< 2.2
G-2	07/29	UF CS	< 0.06	867.0	1.5	16.4	24.80	< 0.68	< 2.4	< 3.1	431.0	0.26	42.8	211.0
G-2	08/09	F CS		24.4	< 1.1	< 3.1	< 0.08	< 0.68		3.5	108.0	0.12	4.1	< 3.9
G-2	08/09	UF CS	< 0.06	1,790.0	3.4	29.6	52.30	0.69	< 2.4	7.2	253.0	0.77	75.0	379.0
G-2	10/11	F CS		25.2	< 1.1	1.5	< 0.08	1.74	< 2.4	< 2.0	160.0	< 0.01	2.4	3.5
G-2	10/11	UF CS	< 0.06	437.0	< 1.1	12.0	12.10	0.98	< 2.4	< 2.0	195.0	< 0.02	27.3	115.0
G-3	07/29	UF CS	< 0.06	3,700.0	5.2	68.1	142.00	< 0.68	< 2.4	3.9	465.0	1.21	149.0	570.0
G-3	08/18	F CS		25.6	5.4	< 3.1	< 0.08	< 0.11		< 2.0	182.0	< 0.01	5.4	< 3.9
G-3	08/18	UF CS	< 0.06	207.0	2.5	4.8	9.33	1.00	< 2.4	< 2.0	214.0	< 0.01	15.4	44.1
G-3	10/11	F CS		21.0	4.0	1.3	0.11	1.36	< 2.4	< 2.0	57.5	< 0.01	5.5	7.3
G-3	10/11	UF CS	< 0.06	349.0	3.9	10.0	13.20	0.78	< 2.4	< 2.0	88.8	< 0.02	23.5	149.0
G-3	10/25	F CS		28.4	< 1.1	2.4	0.30	0.52		< 2.0	44.4	< 0.01	2.7	149.0

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a,b]	Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Runoff Stations (Cont.)														
Pajarito Canyon (includes Two-Mile, Three-Mile Canyons): (Cont.)														
G-3	10/25	UF CS		3,080.0	4.1	36.7	13.60	0.52	3.9	< 2.0	200.0	0.07	77.0	322.0
G-3	10/28	F CS		15.9	3.8	< 3.1	0.20	0.52		2.4	47.8	< 0.01	2.9	9.1
G-3	10/28	UF CS	< 0.06											
G-5	10/23	F CS		15.5	< 1.1	< 3.1	0.10	< 0.11		2.4	10.5	0.02	1.0	12.4
G-5	10/23	UF CS	< 0.06	160.0	< 1.1	3.8	6.32	< 0.11	3.2	2.4	19.4	0.02	7.2	36.9
G-4	08/15	UF CS	< 0.06	355.0	4.1	5.8	11.10	2.00	2.9	< 2.0	71.1	0.39	15.2	125.0
G-4	08/15	UF DUP		336.0	1.5	5.9	10.80	1.99	2.4	< 2.0	69.7	0.20	14.4	122.0
G-4	10/12	F CS		15.9	< 1.1	2.3	0.32	1.90	< 2.4	< 2.0	89.7	< 0.01	2.7	23.9
G-4	10/12	UF CS	< 0.06	71.2	< 1.1	4.3	3.39	1.96	< 2.4	< 2.0	95.2	< 0.02	6.7	61.6
Pajarito Canyon above Highway 4	06/28	F CS	< 0.01	1,100.0	14.0	9.6	1.21	8.15	< 3.5	< 16.0	590.0	5.04	4.2	8.1
Pajarito Canyon above Highway 4	06/28	UF CS					3.34	3.06				0.26		
Pajarito Canyon above Highway 4	06/28	UF TOTC	0.20	28,652.0	18.0	89.0	209.30	8.54	17.5	73.6	3,823.6	14.07	125.7	540.9
Pajarito Canyon above Highway 4	10/24	F CS		112.0	< 1.1	2.7	1.03	0.45		< 2.0	152.0	< 0.01	3.9	141.0
Pajarito Canyon above Highway 4	10/24	UF CS	< 0.06	2,020.0	< 1.1	22.6	55.00	0.48	4.2	< 2.0	271.0	0.42	40.6	163.0
Pajarito Canyon above Highway 4	10/27	F CS		15.7	2.1	1.8	0.44	0.67		2.4	162.0	< 0.01	2.2	4.5
Pajarito Canyon above Highway 4	10/27	UF CS	< 0.06	1,540.0	2.9	20.0	65.10	0.62	< 2.4	2.4	237.0	0.56	41.4	184.0
Water Canyon (includes Cañon del Valle, Potrillo, Fence, Indio Canyons):														
Water Canyon above Highway 501	06/28	UF TOTC	0.05	16,991.7	6.4	20.2	53.90	5.60	8.3	29.0	2,908.4	7.44	30.7	155.0
Water Canyon above Highway 501	10/23	F CS		168.0	< 1.1	2.1	1.72	0.47		2.4	124.0	0.02	4.7	7.5
Water Canyon above Highway 501	10/23	UF CS	< 0.06	26,600.0	2.0	73.8	21.40	< 0.11	3.1	2.4	1,510.0	0.49	114.0	696.0
Cañon del Valle above Highway 501	06/28	UF TOTC	0.21	31,369.0	11.6	43.0	135.50	6.52	20.1	56.8	3,311.7	12.91	84.4	374.2
Cañon del Valle above Highway 501	10/23	F CS		73.2	< 1.1	1.7	< 0.08	< 0.11		2.4	123.0	0.02	1.2	4.6
Cañon del Valle above Highway 501	10/23	UF CS	< 0.06	17,900.0	< 1.1	50.0	86.40	0.52	< 2.4	2.4	955.0	0.85	73.3	506.0
Water Canyon at Highway 4	06/28	UF TOTC	0.45	22,469.4	17.3	70.6	238.89	8.19	19.9	66.0	3,541.9	11.23	137.6	522.9
Water Canyon at Highway 4	10/27	F CS		448.0	3.2	2.1	3.18	0.81		2.4	166.0	0.06	5.4	12.0
Water Canyon at Highway 4	10/27	UF CS		21,400.0	3.4	62.9	121.00	0.59	17.3	2.4	1,860.0	1.46	135.0	600.0
Water Canyon at Highway 4	10/27	UF DUP		21,400.0	2.9	65.0	126.00	0.52	17.4	< 2.0	1,850.0	1.18	136.0	599.0
Indio Canyon at Highway 4	06/28	UF CS					3.92	2.81				0.25		
Water Canyon below Highway 4	06/28	F CS	0.01	670.0	12.0	6.0	1.56	5.62	< 3.5	< 16.0	470.0	3.56	1.9	7.5
Water Canyon below Highway 4	06/28	UF TOTC	1.06	45,170.0	25.3	175.7	599.89	17.71	45.0	197.9	5,134.0	18.61	341.3	1,316.8
Water Canyon below Highway 4	07/29	UF CS	< 0.06	24,500.0	5.9	152.0	471.00	< 3.41	23.3	9.3	1,860.0	4.62	266.0	1,520.0
Water Canyon below Highway 4	07/29	UF DUP		26,900.0	6.8	179.0	612.00	< 0.11	< 2.4	11.2	1,910.0	3.33	308.0	1,710.0
Water Canyon below Highway 4	08/12	UF CS	< 0.06	29,800.0	5.1	55.7	113.00	< 0.11	7.8	3.7	1,900.0	1.59	111.0	634.0
Water Canyon below Highway 4	08/18	F CS		26.5	2.1	< 3.1	0.04	< 0.11		< 2.0	79.0	< 0.01	3.9	< 3.9
Water Canyon below Highway 4	08/18	UF CS	0.09	754.0	1.7	7.0	19.00	< 0.11	< 2.4	< 2.0	132.0	0.08	17.9	49.8
Water Canyon below Highway 4	08/18	UF DUP		771.0	< 1.1	7.5			< 2.4	< 2.0	134.0		18.1	51.2
Water Canyon below Highway 4	10/23	F CS		205.0	< 1.1	1.7	0.45	2.44		< 2.0	165.0	0.04	5.1	25.3
Water Canyon below Highway 4	10/23	UF CS	< 0.06	30,600.0	< 1.1	51.9	72.20	0.81	< 2.4	< 2.0	1,650.0	1.15	79.4	589.0
Water Canyon below Highway 4	10/23	UF DUP		29,900.0	< 1.1	52.1	74.60	0.47	< 2.4	< 2.0	1,660.0	0.64	79.9	591.0
Water Canyon below Highway 4	10/27	F CS		44.4	2.0	1.6	1.08	0.54		2.4	93.0	< 0.01	2.7	6.0
Water Canyon below Highway 4	10/27	UF CS	< 0.06	12,100.0	2.5	59.9	144.00	0.77	11.1	2.4	799.0	1.07	110.0	556.0
Potrillo Canyon near White Rock	08/09	UF CS	< 0.06	4,170.0	1.5	62.2	106.00	< 0.68	2.3	< 3.1	334.0	1.17	127.0	247.0
Potrillo Canyon near White Rock	10/23	F CS		13.9	< 1.1	1.3	0.85	0.69		< 2.0	15.0	0.02	2.6	13.3
Potrillo Canyon near White Rock	10/23	UF CS	< 0.06	2,680.0	< 1.1	33.4	44.50	0.86	3.5	< 2.0	176.0	0.29	50.6	151.0

Table 5-16. Trace Metals in Runoff Samples for 2000 (µg/L) (Cont.)

Station Name	Date	Code[a,b]	Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Runoff Stations (Cont.)														
Ancho Canyon:														
Ancho Canyon at TA-39	08/18	UF CS	< 0.06	7,360.0	2.6	233.0	356.00	< 3.41	5.2	12.1	788.0	5.72	360.0	922.0
Ancho Canyon at TA-39	10/28	UF CS		1,440.0	1.5	49.9	75.10	0.40	4.2	2.4	155.0	0.92	96.9	262.0
Ancho Canyon near Bandelier NP	08/18	UF CS	0.11	4,810.0	2.6	156.0	240.00	< 3.41	6.2	7.9	505.0	5.37	249.0	716.0
Ancho Canyon near Bandelier NP	08/18	UF DUP		4,830.0	1.7	151.0	261.00	< 0.11	5.0	7.2	513.0	3.27	227.0	674.0
Ancho Canyon near Bandelier NP	10/23	UF CS	< 0.06	1,800.0	< 1.1	37.9	62.40	0.46	< 2.4	< 2.0	187.0	0.61	63.7	181.0
Ancho Canyon near Bandelier NP	10/28	UF CS		1,110.0	< 1.1	26.1	46.10	0.29	< 2.4	2.4	125.0	0.47	48.4	106.0
Runoff Grab Samples														
Upper Los Alamos Reservoir	08/31	F CS		2,000.0	2.5	5.5	< 0.08	< 0.11		< 2.0	385.0	< 0.03	4.2	10.3
Upper Los Alamos Reservoir	08/31	UF CS	0.05	701.0	3.3	2.6	0.09	< 0.11	< 2.4	< 2.0	183.0	0.39	1.6	2.9
Los Alamos Reservoir	08/31	F CS		676.0	2.4	1.8	0.50	< 0.11		< 2.0	179.0	0.05	1.6	2.2
Los Alamos Reservoir	08/31	UF CS	0.05	2,010.0	3.5	5.9	4.42	< 0.11	< 2.4	< 2.0	378.0	0.27	4.5	19.2
Los Alamos Reservoir	08/31	UF DUP		1,980.0	2.5	5.7	4.20	< 0.11	2.2	< 2.0	377.0	< 0.01	4.2	10.1
Los Alamos Weir	07/21	F CS		1,870.0	10.9	5.1	0.37	1.09	< 2.4	< 2.0	416.0	0.36	3.4	4.5
Los Alamos Weir	07/21	UF CS	0.07	3,900.0	9.2	30.4	58.30	0.78	< 2.4	< 2.0	598.0	0.87	33.2	171.0
Los Alamos Weir	07/21	UF DUP	0.06	3,940.0	7.9	29.9	58.10	0.74	< 2.4	< 2.0	602.0	0.84	33.7	165.0
Rendija Canyon 3rd Crossing	07/17	F CS					0.72	10.70				0.34		
Rendija Canyon 3rd Crossing	07/17	F CS	< 0.20	480.0	< 10.0	5.0	< 3.00	280.00	< 5.0	< 50.0	160.0	< 10.00	3.7	6.8
Rendija Canyon 3rd Crossing	07/17	UF CS	< 0.20	16,000.0	< 10.0	39.0	160.00	21.00	10.0	< 50.0	1,000.0	< 7.30	35.0	560.0
Rendija Canyon 3rd Crossing	07/17	UF DUP	< 0.20	19,000.0	< 4.2	45.8	191.00	25.50	10.3	< 20.4	1,000.0	< 7.32	41.6	659.0
Guaje at SR-502	07/09	F CS	< 0.01	530.0	13.0	6.9	2.34	5.61	< 2.6	< 20.0	210.0	3.71	3.8	5.3
Guaje at SR-502	07/09	UF CS	< 0.01	17,000.0	5.8	14.0	1,209.00	6.21	8.8	< 20.0	2,400.0	11.24	13.0	93.0
Guaje at SR-502	09/08	F CS		765.0	5.1	2.9	0.36	0.68		< 2.0	212.0	0.03	2.1	3.2
Guaje at SR-502	09/08	UF CS	< 0.06	102,000.0	5.3	826.0	91.50	1.37	< 2.4	12.7	4,780.0	4.24	536.0	3,610.0
Starmer's Gulch above Highway 501	10/23	F CS		576.0	< 1.1	5.9	6.99	0.21		2.4	134.0	0.02	12.2	37.3
Starmer's Gulch above Highway 501	10/23	UF CS	< 0.06	22,800.0	< 1.1	44.6	64.90	0.26	< 2.4	2.4	1,030.0	0.29	66.4	454.0
Two-Mile at Highway 501	10/23	F CS		269.0	< 1.1	1.2	0.15	0.20		2.4	124.0	0.02	1.5	0.6
Two-Mile at Highway 501	10/23	UF CS	< 0.06	18,800.0	< 1.1	50.2	124.00	0.39	< 2.4	2.4	1,140.0	0.81	83.3	538.0
TA-18 Culvert	06/28	F CS	< 0.01	670.0	13.0	10.0	1.45	5.93	3.9	< 16.0	490.0	3.55	2.9	4.7
TA-18 Culvert	06/28	F DUP	< 0.01	659.0	12.0	8.9	< 0.95	< 3.48	< 3.5	< 15.7	491.0	< 3.37	2.5	5.0
TA-18 Culvert	06/28	UF TOTC	1.19	47,248.9	27.4	240.8	689.88	25.16	56.7	223.9	4,916.0	20.24	408.1	1,574.9
Pajarito Canyon at SR-4 Culvert	06/28	F CS	< 0.01	930.0	16.0	10.0	3.54	6.35	3.8	< 16.0	590.0	3.41	3.6	9.1
Pajarito Canyon at SR-4 Culvert	06/28	UF TOTC	0.38	43,163.5	30.3	245.8	629.89	14.32	48.3	168.1	4,501.1	20.23	385.0	1,592.9
Water Quality Standards[d]														
EPA Primary Drinking Water Standard			2			100		6	50					
EPA Secondary Drinking Water Standard				50										5,000
EPA Action Limit							15							
EPA Health Advisory											25,000-90,000		80-110	
NMWQCC Livestock Watering Standard			10				100		50					25,000
NMWQCC Groundwater Limit			2	200	1,000	200	50		50					10,000
NMWQCC Wildlife Habitat Standard			0.77						5					

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[a] Codes: UF–Unfiltered; F–Filtered.

[b] Sample Type: CS–Customer Sample; DUP–Laboratory Duplicate; TOTC–Total Concentration Calculated from Laboratory Data.

[c] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[d] Standards given here for comparison only; see Appendix A. Note that New Mexico Livestock Watering and Groundwater Limits are based on dissolved concentrations, whereas many of these analyses are of unfiltered samples; thus, concentration may include suspended sediment quantities.

Table 5-17. Calculated Metals Concentrations and Uncertainties for Suspended Sediments in Runoff Samples (mg/kg unless otherwise noted)[a]

Station Name	Date	Analyte	TSS (mg/L)	Metal Concentration	Uncertainty	Screening Level[b]	Ratio Concentration/ Screening Level
Pajarito Canyon above Highway 4	06/28	Mn	2,400	11,480	1,718	3,200	3.6
Water Canyon below Highway 4	06/28	Mn	5,800	7,672	1,099	3,200	2.4
Pajarito Canyon at Highway 4 Culvert	06/28	Mn	5,700	7,409	1,072	3,200	2.3
Cañon de Valle above Highway 501	10/23	Mn	2,840	6,277	890	3,200	2.0
Starmers Gulch at TA-22	06/28	Mn	3,100	4,405	658	3,200	1.4
Starmers Gulch above Highway 501	10/23	Mn	6,240	3,562	519	3,200	1.1
Water Canyon below Highway 4	06/28	Mn	13,000	3,423	490	3,200	1.1
Cañon de Valle above Highway 501	10/23	Mn	5,350	3,332	472	3,200	1.0

[a] Table shows metals found at levels greater than EPA soil screening levels. Samples with TSS concentrations less than 1000 mg/L not included because of larger uncertainty in the calculated concentrations.

[b] EPA Region 6 Human Health Medium-Specific Screening Levels for residential exposures.

Table 5-18. Organic Chemicals Detected in Runoff Samples in 2000 (μg/L)

Station Name	Date	Field Prep[a]	Lab Sample[a]	Suite[b]	Analyte	Result	MDL	Lab Qual[c]	Lab Code[d]
Pajarito Canyon above Highway 501	06/28	UF	CS	HEXP	2,4,6-Trinitrotoluene	0.44	0.035	X	PARA
Indio Canyon at Highway 4	06/28	UF	CS	HEXP	2,4,6-Trinitrotoluene	0.38	0.035	X	PARA
Cañon del Valle above Highway 501	06/28	UF	CS	HEXP	4-Amino-2,6-dinitrotoluene	1.3	0.08	X	PARA
Water Canyon below Highway 4	06/28	UF	CS	HEXP	4-Amino-2,6-dinitrotoluene	1.3	0.08	X	PARA
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS	HEXP	4-Amino-2,6-dinitrotoluene	1.9	0.08	X	PARA
Indio Canyon at Highway 4	06/28	UF	CS	HEXP	4-Amino-2,6-dinitrotoluene	1.2	0.08	X	PARA
Pajarito Canyon above Highway 501	06/28	UF	CS	HEXP	4-Amino-2,6-dinitrotoluene	2.8	0.08	X	PARA
Indio Canyon at Highway 4	06/28	UF	CS	HEXP	HMX	2.2	0.041		PARA
Indio Canyon at Highway 4	06/28	UF	RE	HEXP	HMX	2.2	0.041		PARA
Cañon del Valle above Highway 501	06/28	UF	CS	HEXP	2-Amino-4,6-dinitrotoluene	1	0.061	X	PARA
Pajarito Canyon above Highway 501	06/28	UF	CS	HEXP	2-Amino-4,6-dinitrotoluene	1.3	0.061	X	PARA
Cañon del Valle above Highway 501	06/28	UF	CS	HEXP	Tetryl	8.1	0.076	X	PARA
Indio Canyon at Highway 4	06/28	UF	CS	HEXP	Tetryl	3.7	0.076	X	PARA
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS	HEXP	Tetryl	18	0.076	X	PARA
Cañon del Valle above Highway 501	06/28	UF	CS	HEXP	2-nitrotoluene	1.4	0.069	X	PARA
Canon del Valle above Highway 501	06/28	UF	CS	HEXP	Nitrobenzene	5.6	0.04	X	PARA
Pajarito Canyon above Highway 501	06/28	UF	CS	HEXP	Nitrobenzene	13	0.04	X	PARA
Indio Canyon at Highway 4	06/28	UF	CS	HEXP	Nitrobenzene	4	0.04	X	PARA
Water Canyon below Highway 4	06/28	UF	CS	HEXP	3-Nitrotoluene	2.7	0.031	X	PARA
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS	HEXP	3-Nitrotoluene	3	0.031	X	PARA
Pajarito Canyon above Highway 4	06/28	UF	CS	HEXP	1,3,5-trinitrobenzene	2.6	0.049	X	PARA
Pajarito Canyon at SR-4 Culvert	06/28	UF	CS	HEXP	1,3,5-trinitrobenzene	4.2	0.049	X	PARA
Water Canyon below Highway 4	06/28	UF	CS	HEXP	1,3,5-trinitrobenzene	5.7	0.049	X	PARA
Water Canyon below Highway 4	06/28	UF	CS	HEXP	1,3-Dinitrobenzene	1.9	0.078	X	PARA
Guaje Canyon at SR-502	07/09	UF	CS	HEXP	1,3,5-trinitrobenzene	1.5	0.049	X	PARA
Water Canyon at Highway 4	10/27	UF	CS	HEXP	RDX	0.76	0.0221		GELC
Water Canyon at Highway 4	10/27	UF	CS	HEXP	HMX	0.52	0.0261		GELC
Los Alamos Canyon at Los Alamos	06/03	UF	CS	SVOA	Benzoic Acid	690	40		PARA
Los Alamos Canyon at Los Alamos	06/03	UF	CS	SVOA	Benzoic Acid	250	16		PARA
Pajarito Canyon at TA-18 Culvert	06/28	UF	CS	SVOA	Benzoic Acid	1,900	120		PARA
Pajarito Canyon above Highway 501	06/28	UF	CS	SVOA	Benzoic Acid	1,800	84		PARA
Starmers Gulch at TA-22	06/28	UF	CS	SVOA	Benzoic Acid	1,300	82		PARA
Pajarito Canyon above Highway 4	06/28	UF	CS	SVOA	Benzoic Acid	1,300	95		PARA

Table 5-18. Organic Chemicals Detected in Runoff Samples in 2000 (µg/L) (Cont.)

Station Name	Date	Field Prep[a]	Lab Sample[a]	Suite[b]	Analyte	Result	MDL	Lab Qual[c]	Lab Code[d]
Guaje Canyon at SR-502	07/09	UF	CS	SVOA	Pyridine	16	3		PARA
Los Alamos Canyon near Los Alamos	07/09	UF	CS	SVOA	Bis(2-ethylhexyl)phthalate	1.9	1.1		PARA
Guaje Canyon at SR-502	07/09	UF	CS	SVOA	Benzoic Acid	67	5.2		PARA
Los Alamos Canyon at Los Alamos	09/12	UF	CS	SVOA	Bis(2-ethylhexyl)phthalate	1.4	0.32		GELC
G-4	10/12	UF	CS	SVOA	Bis(2-ethylhexyl)phthalate	5.3	0.32		GELC
G-4	10/12	UF	CS	SVOA	Bis(2-ethylhexyl)phthalate	13.1	0.32		GELC
G-4	10/12	UF	CS	SVOA	2-Methylnaphthalene	3.6	0.15		GELC
Starmer’s Gulch above Highway 501	10/23	UF	CS	SVOA	Benzyl Alcohol	31.6	0.23		GELC
Starmer’s Gulch above Highway 501	10/23	UF	CS	SVOA	Benzoic Acid	111	2.76		GELC
Water Canyon above Highway 501	10/23	UF	CS	SVOA	Benzoic Acid	43.8	2.76		GELC
Cañon del Valle above Highway 501	10/23	UF	CS	SVOA	Benzoic Acid	46.4	2.76		GELC
Twomile Canyon above Highway 501	10/23	UF	CS	SVOA	Benzoic Acid	457	2.76	D	GELC
Pajarito Canyon above Highway 501	09/08	UF	CS	VOA	1,4-Dichlorobenzene	0.18	0.118		GELC
Guaje Canyon at SR-502	09/08	UF	CS	VOA	1,4-Dichlorobenzene	0.22	0.118		GELC
Los Alamos Canyon at Los Alamos	09/12	UF	CS	VOA	1,4-Dichlorobenzene	0.12	0.118		GELC

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[a] Codes: UF–Unfiltered Sample; CS–customer sample; RE–reanalysis; D–analytes analyzed at a secondary dilution.

[b] HEXP–high explosives; SVOA–semivolatile organics; VOA–volatile organics.

[c] Lab qualifier: D–analytes analyzed at secondary dilution; X–probable false positive resulting from matrix interference.

[d] Lab code: PARA–Paragon Analytics, Inc.; GELC–General Engineering Laboratories, Inc.

Table 5-19. Acute and Chronic Biological Toxicity Test Results from the Los Alamos Area in 2000

Station ID	Collector	Date	Sample Type	Acute Tests Results	Chronic Tests Results
E240	LANL	Sept. 8	Runoff	No Effect	No Effect
EGS4	LANL	Sept. 8	Runoff	No Effect	No Effect
LA 12.5	NMED	Sept. 8	Surface Water	No Effect	No Effect
LA Reservoir	NMED	Sept. 8	Surface Water	No Effect	No Effect
PUN 0.01	NMED	Sept. 8	Runoff	No Effect	70% mortality
PU 6.7	NMED	Sept. 8	Runoff	No Effect	100% mortality
PU 2.0	NMED	Sept. 8	Runoff	No Effect	No Effect

Location Key

E240	Pajarito Canyon above SR 501
EGS4	Guaje Canyon above SR 4
LA 12.5	Approximately 1/4–1/2 mile upstream from LA Reservoir
LA Reservoir	Depth composite sample from center of reservoir, near the concrete standpipe
PUN 0.01	Pueblo Canyon, North Tributary (north tributary above land bridge)
PU 6.7	Pueblo Canyon above land bridge
PU 2.0	Pueblo Canyon near Bayo Treatment Plant

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a])

Station Name	Date	Codes[b]	^{3}H (pCi/L)			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (mg/kg, lab)
Reservoirs on Rio Grande (New Mexico)																					
Cochiti Upper	09/15	CS	60	60	207	0.31	0.16	0.54	1.26	0.03	0.03	0.929	0.095	0.036	0.0461	0.0170	0.0524	1.080	0.106	0.052	
Cochiti Upper	09/15	DUP	0	58	206				1.22	0.04	0.04										
Cochiti Middle	09/15	CS	58	59	201	0.19	0.12	0.38	1.34	0.03	0.04	1.150	0.110	0.013	0.0559	0.0176	0.0433	1.280	0.120	0.050	
Cochiti Middle	09/15	CS	0	59	208	0.01	0.12	0.45	1.36	0.03	0.04	1.140	0.113	0.048	0.0642	0.0192	0.0378	1.280	0.123	0.014	
Cochiti Lower	09/15	CS	83	57	192	0.20	0.11	0.37	0.56	0.03	0.06	1.190	0.115	0.053	0.0520	0.0179	0.0530	1.240	0.119	0.036	
Reservoir Rio Chama																					
Abiquiu Lower	10/18	CS	0	58	207	-0.04	0.05	0.17	0.20	0.02	0.03	1.050	0.109	0.054	0.0586	0.0190	0.0159	1.060	0.110	0.016	
Abiquiu Lower	10/18	DUP										1.040	0.105	0.038	0.0592	0.0185	0.0379	1.060	0.106	0.038	
Abiquiu Upper	10/18	CS	60	61	208	0.05	0.05	0.16	0.02	0.01	0.02	0.795	0.085	0.053	0.0421	0.0153	0.0363	0.736	0.080	0.036	
Abiquiu Upper	10/18	DUP				0.05	0.04	0.14	0.03	0.02	0.04										
Abiquiu Middle	10/18	CS	61	62	213	0.20	0.07	0.22	0.29	0.03	0.06	1.030	0.105	0.049	0.1150	0.0265	0.0393	1.260	0.123	0.057	
Regional Stations																					
Rio Chama at Chamita (bank)	07/12	CS	170	910		0.03	0.04	0.15	0.00	0.03		0.313	0.018		0.0158	0.0043		0.308	0.018		
Rio Chama at Chamita (bank)	07/12	CS	110	910		0.00	0.05	0.15	0.04	0.03		0.357	0.019		0.0236	0.0052		0.398	0.020		
Rio Grande at Embudo (bank)	07/12	CS	50	900		-0.08	0.04	0.14	0.06	0.03		0.670	0.030		0.0252	0.0056		0.673	0.030		
Rio Grande at Otowi (bank)	06/27	CS	80	460		0.01	0.09	0.31	0.03	0.03		0.330	0.020		0.0297	0.0061		0.329	0.019		
Rio Grande at Otowi (bank)	06/27	DUP				0.13	0.10	0.34													
Rio Grande at Otowi (bank)	06/27	CS	-20	450		0.11	0.09	0.29	0.03	0.03		0.355	0.020		0.0135	0.0041		0.379	0.020		
Rio Grande at Otowi Upper (bank)	06/27	CS	10	450		0.00	0.09	0.30	0.03	0.02		0.529	0.044		0.0252	0.0107		0.579	0.045		
Rio Grande at Frijoles (bank)	08/22	CS	140	56	184	0.46	0.04		0.32	0.02	0.02	0.895	0.123	0.085	0.0637	0.0290	0.1070	0.941	0.127	0.085	
Rio Grande at Frijoles (bank)	08/22	DUP										1.120	0.147	0.114	0.0678	0.0308	0.1140	0.999	0.136	0.114	
Rio Grande at Cochiti	09/26	CS	515	51	142	0.11	0.09	0.32	1.65	0.05	0.07	1.420	0.134	0.049	0.0554	0.0191	0.0564	1.230	0.120	0.069	
Rio Grande at Bernalillo	07/11	CS	190	920		0.04	0.04	0.14	0.01	0.02		0.778	0.032		0.0357	0.0063		0.802	0.033		
Rio Grande at Bernalillo	07/11	DUP				0.11	0.04	0.14													
Jemez River	07/13	CS	170	920		0.00	0.05	0.15	0.05	0.02		0.886	0.038		0.0356	0.0071		0.753	0.033		
Pajarito Plateau Stations																					
Guaje Canyon:																					
Guaje at SR-502	06/27	CS	0	450		0.55	0.13	0.35	1.61	0.18		1.187	0.055		0.1301	0.0156		1.262	0.057		
Guaje at SR-502	06/27	CS	90	460		0.51	0.12	0.31	1.58	0.18		1.182	0.055		0.1328	0.0151		1.228	0.056		
Bayo Canyon:																					
Bayo at SR-502	06/27	CS	40	450		0.00	0.09	0.30	0.00	0.02		0.463	0.023		0.0178	0.0046		0.490	0.023		
Acid/Pueblo Canyons:																					
Pueblo 1 R	07/25	CS	90	470					3.57	0.40		1.079	0.043		0.0584	0.0078		1.278	0.048		
Pueblo 1 R	07/25	CS				0.80	0.16	0.46													
Acid Weir	07/25	CS	140	470					2.74	0.31		1.118	0.047		0.0480	0.0083		1.328	0.054		
Acid Weir	07/25	CS				1.06	0.18	0.45													
Acid Weir	07/25	DUP				0.77	0.11	0.28													
Pueblo 2	04/24	CS	510	500		-0.09	0.12		0.05	0.03		0.600	0.027		0.0290	0.0056		0.617	0.028		
Hamilton Bend Spring	04/24	CS	270	470		0.16	0.13		0.05	0.03		0.510	0.024		0.0189	0.0048		0.512	0.024		
Pueblo 3	04/24	CS	110	460		0.07	0.13		0.12	0.03		1.145	0.045		0.0463	0.0073		0.950	0.039		
Pueblo at SR-502	06/27	CS	60	460		0.50	0.11	0.29	0.05	0.02		1.192	0.062		0.0587	0.0114		0.952	0.052		
Pueblo at SR-502	06/27	DUP				0.44	0.11	0.30													

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H (pCi/L)			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (mg/kg, lab)	
Pajarito Plateau Stations (Cont.)																						
DP/Los Alamos Canyons:																						
Los Alamos Canyon Reservoir	08/31	CS	51	53	178	0.65	0.12		2.99	0.16	0.05	1.780	0.213	0.148	0.1760	0.0519	0.1020	1.360	0.176	0.037		
Los Alamos Canyon Reservoir	08/31	DUP							2.76	0.16	0.05											
Los Alamos at Bridge	04/04	CS	1,680	600					0.04	0.02											0.22	0.01
Los Alamos at LAO-1	04/04	CS	3,870	760					0.01	0.02											0.72	0.07
Los Alamos at Upper GS	04/24	CS	540	500		0.27	0.13		0.15	0.03		0.808	0.034		0.0479	0.0074		0.777	0.032			
DPS-1	04/04	CS	1,230	570					-0.01	0.17											0.17	0.01
DPS-4	04/04	CS	4,130	770					1.84	0.20											0.45	0.02
Los Alamos at LAO-3	04/24	CS				0.27	0.13															
Los Alamos at LAO-3	04/24	CS	330	480					0.68	0.08		1.104	0.048		0.1013	0.0124		1.090	0.047			
Los Alamos at LAO-4.5	04/04	CS	1,940	620					0.90	0.10											0.25	0.01
Los Alamos at SR-4	06/27	CS	110	460		0.29	0.11	0.32	1.41	0.16		1.168	0.046		0.0483	0.0078		1.192	0.047			
Los Alamos at Totavi	06/27	CS	80	460		0.29	0.11	0.34	0.10	0.03		0.885	0.046		0.0259	0.0078		0.981	0.049			
Los Alamos at Otowi	06/27	CS	20	450		0.41	0.12	0.34	1.02	0.12		1.157	0.050		0.1902	0.0177		1.256	0.053			
Sandia Canyon:																						
Sandia at SR-4	06/27	CS	250	470		0.18	0.09	0.30	-0.04	0.08		0.964	0.039		0.0463	0.0073		0.980	0.039			
Mortandad Canyon:																						
Mortandad near CMR Building	03/28	CS	1,740	610					0.04	0.03											0.52	0.03
Mortandad west of GS-1	03/29	CS	800	530					0.08	0.03											0.66	0.03
Mortandad at GS-1	03/29	CS	23,100	1,600					19.44	2.05											1.06	0.05
Mortandad at MCO-5	03/28	CS	4,100	770					18.02	1.90											0.36	0.00
Mortandad at MCO-5	03/28	CS																			0.15	0.01
Mortandad at MCO-7	03/28	CS	1,000	550					4.86	0.52											0.27	0.03
Mortandad at MCO-9	03/28	CS	-100	450					0.33	0.10											0.46	0.03
Mortandad at MCO-13 (A-5)	06/27	CS				0.43	0.10															
Mortandad at MCO-13 (A-5)	06/27	CS	230	470		0.43	0.11	0.29	0.47	0.06		0.931	0.038		0.0784	0.0097		0.947	0.038			
Mortandad A-6	06/27	CS	400	490		0.19	0.10	0.30	0.52	0.07		0.989	0.042		0.0903	0.0111		1.067	0.044			
Mortandad A-7	06/27	CS	320	480		0.04	0.09	0.28	0.12	0.04		0.567	0.027		0.0221	0.0051		0.611	0.028			
Mortandad at SR-4 (A-9)	06/27	CS	140	460		0.51	0.12	0.32	0.39	0.05		5.384	0.186		0.1080	0.0133		1.199	0.052			
Mortandad at Rio Grande (A-11)	09/25	CS	416	49	141	-0.05	0.09	0.32	0.01	0.01	0.03	0.339	0.051	0.054	0.0470	0.0183	0.0543	0.344	0.051	0.016		
Mortandad at Rio Grande (A-11)	09/25	DUP	423	50	143	0.04	0.07	0.26	0.01	0.02	0.04	0.435	0.062	0.107	-0.0026	0.0077	0.0636	0.545	0.069	0.043		
Cañada del Buey:																						
Cañada del Buey at SR-4	03/28	CS	400	500					0.06	0.03											0.44	0.04
Pajarito Canyon:																						
Two-Mile at SR-501	02/25	CS	270	490					0.36	0.05											1.77	0.07
Pajarito at SR-4	03/28	CS	380	490					0.41	0.05											1.49	0.03
Pajarito at SR-4	03/29	CS	320	490					0.04	0.02											0.16	0.03
Pajarito Retention Pond	10/11	CS	60	60	207	0.90	0.17	0.46	3.93	0.09	0.09	1.620	0.163	0.055	0.1080	0.0301	0.0546	1.920	0.186	0.069		
Pajarito Retention Pond	10/11	DUP										1.710	0.164	0.018	0.0745	0.0233	0.0476	1.610	0.156	0.018		
Pajarito at Rio Grande	09/26	CS	376	47	138	0.61	0.13	0.37	3.13	0.07	0.06	1.540	0.150	0.068	0.0509	0.0212	0.0757	1.260	0.129	0.075		
Potrillo Canyon:																						
Potrillo at SR-4	03/28	CS	380	500					0.25	0.04											1.08	0.03

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H (pCi/L)			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (mg/kg, lab)	
Pajarito Plateau Stations (Cont.)																						
Fence Canyon:																						
Fence at SR-4	03/28	CS	240	480					0.32	0.04											0.68	0.03
Fence at SR-4	03/28	CS	270	490					0.52	0.08											0.90	0.03
Cañon de Valle:																						
Cañon de Valle at SR-501	03/29	CS	300	490					0.22	0.04											0.90	0.02
Water Canyon:																						
Water at SR-501	03/29	CS	0	460					0.05	0.02											1.28	0.04
Water at SR-4	03/28	CS	300	490					0.17	0.06											0.80	0.10
Water at Rio Grande	09/26	CS	422	142	463	0.66	0.09	0.25	4.13	0.09	0.07	1.160	0.116	0.080	0.0404	0.0169	0.0575	1.030	0.105	0.039		
Indio Canyon:																						
Indio at SR-4	03/28	CS	180	480					0.25	0.04											0.49	0.03
Ancho Canyon:																						
Ancho at SR-4	03/28	CS	3,050	700					0.18	0.04											0.30	0.03
Above Ancho Spring	09/26	CS	27,800	328	138	0.16	0.11	0.38	1.02	0.05	0.06	1.290	0.126	0.051	0.1290	0.0293	0.0590	1.570	0.147	0.040		
Ancho at Rio Grande	09/26	CS	-32	40	142	-0.03	0.08	0.31	0.15	0.03	0.05	0.404	0.063	0.100	0.0502	0.0226	0.0851	0.470	0.068	0.052		
Ancho at Rio Grande	09/26	DUP																				
Chaquehui Canyon:																						
Chaquehui at Rio Grande	09/27	CS	951	153	464	0.26	0.10	0.31	0.96	0.05	0.06	1.510	0.148	0.089	0.0697	0.0216	0.0172	1.570	0.153	0.076		
Frijoles Canyon:																						
Frijoles at Monument Headquarters	08/22	CS	-19	51	175	0.06	0.03		0.18	0.02	0.03	0.732	0.112	0.173	0.0311	0.0219	0.1140	0.612	0.099	0.091		
Frijoles at Monument Headquarters	08/22	DUP				0.08	0.03		0.20	0.02	0.02											
Frijoles at Monument Headquarters	08/22	CS	99	54	181	0.00	0.03		0.21	0.02	0.02	0.769	0.114	0.089	0.0605	0.0275	0.0328	0.832	0.120	0.033		
Frijoles at Monument Headquarters	08/22	DUP	-7	55	188																	
Frijoles at Rio Grande	08/22	CS	24	54	182	0.27	0.04		1.53	0.11	0.03	1.690	0.197	0.034	0.0914	0.0366	0.1350	1.350	0.168	0.092		
TA-54 Area G:																						
G-0	04/19	CS	190	480		-0.01	0.12		0.03	0.03		0.748	0.033		0.0344	0.0063		0.795	0.034			
G-0	04/19	CS	310	490		-0.10	0.12		0.06	0.03		0.684	0.031		0.0392	0.0067		0.745	0.032			
G-1	04/19	CS	-90	460		0.05	0.12		0.05	0.03		0.670	0.034		0.0591	0.0096		0.637	0.033			
G-1	04/19	CS	-410	420		0.07	0.12		0.10	0.04		0.665	0.029		0.0332	0.0060		0.647	0.028			
G-2	04/19	CS	-220	440		0.05	0.13		0.05	0.03		0.587	0.027		0.0295	0.0061		0.587	0.027			
G-3	04/19	CS	90	470		0.05	0.13		0.12	0.03		0.798	0.035		0.0584	0.0084		0.840	0.036			
G-4 R-1	04/19	CS	20,100	1,500		0.10	0.13		0.30	0.04		0.829	0.035		0.0434	0.0071		0.872	0.036			
G-4 R-2	04/19	CS	10,400	1,100		0.21	0.13		0.27	0.04		0.854	0.036		0.0404	0.0067		0.821	0.035			
G-5	04/19	CS	1,360	580		0.12	0.13		0.07	0.03		0.452	0.017		0.0142	0.0031		0.446	0.016			
G-7	04/19	CS	-220	440		0.22	0.14		0.49	0.07		0.868	0.041		0.0524	0.0093		0.972	0.045			
G-8	04/19	CS	370	500		0.25	0.14		0.03	0.02		0.719	0.032		0.0292	0.0058		0.743	0.032			
G-9	04/19	CS	20	470		0.00	0.13		0.15	0.04		0.887	0.042		0.0639	0.0100		0.885	0.041			
G-6 R	04/24	CS	1,870	610		0.03	0.12		0.03	0.02		0.692	0.031		0.0140	0.0042		0.685	0.031			

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H (pCi/L)		^{90}Sr		^{137}Cs		^{234}U		^{235,236}U		^{238}U		U (mg/kg, lab)	
Pajarito Plateau Stations (Cont.)																
TA-49 Area AB:																
AB-1	04/25	CS	280	470	0.10	0.12	0.38	0.05	0.392	0.021	0.0240	0.0055	0.463	0.024		
AB-1	04/25	CS	420	490	0.00	0.11	0.32	0.05	0.447	0.023	0.0210	0.0058	0.512	0.025		
AB-2	04/25	CS	450	490	0.14	0.13	0.14	0.02	0.871	0.052	0.0395	0.0101	0.890	0.053		
AB-3	04/05	CS	1,210	560			0.26	0.05							0.90	0.06
AB-4	04/05	CS	990	540			0.22	0.04							1.03	0.05
AB-4A	04/05	CS	1,220	560			0.69	0.08							0.43	0.02
AB-5	04/05	CS	1,090	550			0.74	0.09							1.44	0.08
AB-6	04/05	CS	1,040	550			0.10	0.03							0.46	0.01
AB-7	04/05	CS	1,630	600			0.36	0.05							0.62	0.08
AB-8	04/05	CS	1,080	550			0.06	0.04							0.64	0.03
AB-9	04/05	CS	790	530			0.09	0.03							0.39	0.01
AB-10	04/05	CS	950	540			0.23	0.04							0.52	0.03
AB-11	04/05	CS	610	510			0.20	0.04							0.28	0.02
AB-11	04/05	CS	560	510			0.17	0.03							0.84	0.08
River Background[c]			3,600		1.02		0.56								4.49	
Reservoir Background[c]			500		1.19		0.98								4.58	
Former Background[d]					0.87		0.44								4.40	
SAL[e]			20,000		5.9		4.4								29.0	

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	U (mg/kg, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Reservoirs on Rio Grande (New Mexico)																					
Cochiti Upper	09/15	CS	3.24	0.32	0.9660	1.1450	0.0306	0.1510	0.0367	0.0335	0.0187	0.0075	0.0172	18.3	5.1	2.2	29.9	2.9	3.5		
Cochiti Upper	09/15	DUP			0.0000	1.0000	0.0122	0.0179	0.0090	0.0121				21.1	6.6	7.3	36.5	5.4	9.6		
Cochiti Middle	09/15	CS	3.84	0.36	0.0114	0.0072	0.0210	0.0342	0.0124	0.0264	0.0205	0.0074	0.0070	26.5	8.7	2.3	35.7	3.0	3.5		
Cochiti Middle	09/15	CS	3.84	0.37	0.0097	0.0108	0.0389	0.0485	0.0169	0.0388	0.0441	0.0110	0.0070	24.7	3.4	1.8	36.0	3.0	3.5		
Cochiti Lower	09/15	CS	3.71	0.35	0.0105	0.0055	0.0071	0.0184	0.0074	0.0071	0.0083	0.0048	0.0075	24.0	3.1	2.1	34.6	2.8	3.2		
Reservoir Rio Chama																					
Abiquiu Lower	10/18	CS	3.18	0.33	0.0040	0.0030	0.0099	0.0135	0.0043	0.0037	0.0108	0.0060	0.0185	21.7	5.2	4.4	31.0	4.0	7.4		
Abiquiu Lower	10/18	DUP	3.18	0.32							0.0094	0.0050	0.0146	19.1	4.9	4.4	30.8	3.8	6.4		
Abiquiu Upper	10/18	CS	2.21	0.24	0.0001	0.0023	0.0124	0.0237	0.0072	0.0156	0.0118	0.0061	0.0182	9.3	1.9	1.8	20.1	1.9	2.9		
Abiquiu Upper	10/18	DUP			0.0105	0.0056	0.0163	0.0263	0.0078	0.0163											
Abiquiu Middle	10/18	CS	3.80	0.37	0.0185	0.0050	0.0036	0.0754	0.0107	0.0036	0.0092	0.0055	0.0170	18.7	3.4	2.1	25.9	2.6	3.3		
Regional Stations																					
Rio Chama at Chamita (bank)	07/12	CS	0.92	0.05	0.0004	0.0006		0.0009	0.0006		-0.0001	0.0001		3.3	1.1		2.1	0.9		1.8	0.2
Rio Chama at Chamita (bank)	07/12	CS	1.20	0.06	0.3680	0.0148		0.8714	0.0310		0.0001	0.0001		2.6	1.2		2.7	1.4		1.5	0.2
Rio Grande at Embudo (bank)	07/12	CS	2.01	0.09	0.0044	0.0022		0.0058	0.0023		0.0016	0.0005		3.0	1.7		3.9	2.4		1.9	0.2
Rio Grande at Otowi (bank)	06/27	CS	0.99	0.06	0.0009	0.0006		0.0141	0.0016		0.0023	0.0008		2.2	0.8		1.0	0.5		1.1	0.2
Rio Grande at Otowi (bank)	06/27	DUP																			
Rio Grande at Otowi (bank)	06/27	CS	1.13	0.06	0.0003	0.0003		0.0012	0.0006		0.0005	0.0003		3.5	1.6		2.1	1.2		0.9	0.2
Rio Grande at Otowi Upper (bank)	06/27	CS	1.73	0.14	0.0005	0.0005		0.0034	0.0009		0.0035	0.0011		5.8	1.6		4.4	1.3		4.3	0.4
Rio Grande at Frijoles (bank)	08/22	CS	2.83	0.38	0.0000	0.0053	0.0245	0.0079	0.0047	0.0072	0.0154	0.0054	0.0113	10.8	3.0	1.5	21.1	1.9	2.5		
Rio Grande at Frijoles (bank)	08/22	DUP	3.00	0.41	0.0043	0.0053	0.0198	0.0064	0.0049	0.0157	0.0200	0.0057	0.0042								
Rio Grande at Cochiti	09/26	CS	3.69	0.36	0.0672	0.0153	0.0150	0.1320	0.0249	0.0150	0.0375	0.0081	0.0110	21.3	3.1	1.9	35.0	2.8	2.9		
Rio Grande at Bernalillo	07/11	CS	2.40	0.10	0.0009	0.0006		0.0220	0.0026		0.0025	0.0008		6.1	2.6		4.4	2.5		1.9	0.2
Rio Grande at Bernalillo	07/11	DUP																			
Jemez River	07/13	CS	2.26	0.10	-0.0016	0.0026		0.0136	0.0052		-0.0004	0.0003		10.1	5.1		8.2	5.7		2.2	0.2
Pajarito Plateau Stations																					
Guaje Canyon:																					
Guaje at SR-502	06/27	CS	3.82	0.17	0.0042	0.0015		0.0810	0.0072		0.0220	0.0030		12.3	3.3		10.6	2.9		4.1	0.4
Guaje at SR-502	06/27	CS	3.72	0.17	0.0048	0.0012		0.0875	0.0055		0.0276	0.0039		12.1	3.3		10.3	2.9		5.3	0.5
Bayo Canyon:																					
Bayo at SR-502	06/27	CS	1.47	0.07	-0.0001	0.0002		0.0020	0.0009		-0.0001	0.0002		3.0	1.0		1.8	0.7		3.5	0.3
Acid/Pueblo Canyons:																					
Pueblo 1 R	07/25	CS	3.83	0.14	0.0066	0.0012		0.1342	0.0063		0.0639	0.0049		14.6	3.3		14.6	3.3		6.1	0.6
Pueblo 1 R	07/25	CS																			
Acid Weir	07/25	CS	3.97	0.16	0.0079	0.0016		0.1415	0.0077		0.0454	0.0041		15.7	3.5		15.6	3.5		6.0	0.6
Acid Weir	07/25	CS																			
Acid Weir	07/25	DUP																			
Pueblo 2	04/24	CS	1.85	0.08	0.0137	0.0017		1.8789	0.0571		0.0505	0.0050		3.7	1.1		1.9	0.7		2.6	0.3
Hamilton Bend Spring	04/24	CS	1.53	0.07	0.0021	0.0007		0.6013	0.0210		0.0216	0.0038		2.3	0.8		1.5	0.6		2.0	0.2
Pueblo 3	04/24	CS	2.85	0.12	0.0045	0.0009		0.8885	0.0275		0.0385	0.0044		5.7	1.5		3.0	1.0		3.7	0.4
Pueblo at SR-502	06/27	CS	2.86	0.15	0.0060	0.0011		1.1513	0.0372		0.0396	0.0040		9.8	3.1		5.2	2.0		3.7	0.4
Pueblo at SR-502	06/27	DUP																			

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	U (mg/kg, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Pajarito Plateau Stations (Cont.)																					
DP/Los Alamos Canyons:																					
Los Alamos Canyon Reservoir	08/31	CS	4.13	0.52	0.0017	0.0038	0.0158	0.1060	0.0204	0.0183	0.0312	0.0081	0.0153	25.6	5.7	0.9	39.5	3.3	2.3		
Los Alamos Canyon Reservoir	08/31	DUP																			
Los Alamos at Bridge	04/04	CS			0.0016	0.0007		0.0067	0.0013		0.0037	0.0015		1.9	0.8		1.6	0.8		2.6	0.3
Los Alamos at LAO-1	04/04	CS			0.0023	0.0009		0.3231	0.0129		0.0039	0.0015		3.0	1.0		1.4	0.7		2.4	0.2
Los Alamos at Upper GS	04/24	CS	2.33	0.10	0.0021	0.0007		0.1461	0.0068		0.0108	0.0019		8.4	2.1		4.2	1.2		3.7	0.4
DPS-1	04/04	CS			0.0005	0.0005		0.0053	0.0013		0.0015	0.0010		2.0	0.8		1.4	0.7		2.0	0.2
DPS-4	04/04	CS			0.0301	0.0031		0.1608	0.0083		0.3451	0.0217		4.6	1.3		6.0	1.6		4.9	0.5
Los Alamos at LAO-3	04/24	CS																			
Los Alamos at LAO-3	04/24	CS	3.29	0.14	0.0175	0.0019		0.1178	0.0059		0.1324	0.0095		3.4	1.1		3.3	1.0		3.8	0.4
Los Alamos at LAO-4.5	04/04	CS			0.0219	0.0025		0.1377	0.0072		0.1756	0.0149		2.3	0.8		2.5	0.9		3.4	0.3
Los Alamos at SR-4	06/27	CS	3.57	0.14	0.0234	0.0021		0.2255	0.0090		0.2056	0.0096		5.6	1.9		3.4	1.4		2.8	0.3
Los Alamos at Totavi	06/27	CS	2.93	0.14	0.0014	0.0005		0.0270	0.0023		0.0069	0.0015		12.0	3.5		9.9	3.1		4.5	0.4
Los Alamos at Otowi	06/27	CS	3.83	0.16	0.0069	0.0013		0.1761	0.0079		0.0567	0.0049		11.3	3.4		8.4	2.8		3.8	0.4
Sandia Canyon:																					
Sandia at SR-4	06/27	CS	2.94	0.12	0.0007	0.0005		0.0046	0.0010		0.0019	0.0008		4.0	1.2		2.9	1.0		4.3	0.4
Mortandad Canyon:																					
Mortandad near CMR Building	03/28	CS			0.0263	0.0024		0.0089	0.0013		0.0182	0.0025		4.1	1.2		3.0	1.0		3.4	0.3
Mortandad west of GS-1	03/29	CS			0.0034	0.0009		0.0055	0.0011		0.0102	0.0023		2.8	0.9		1.9	0.8		2.9	0.3
Mortandad at GS-1	03/29	CS			11.7000	0.7500		17.4100	1.1200		43.7000	23.6000		64.0	12.6		28.0	5.8		21.5	2.2
Mortandad at MCO-5	03/28	CS			3.3266	0.0994		7.8130	0.2141		5.8294	0.2375		24.4	5.1		19.3	4.2		19.1	1.9
Mortandad at MCO-5	03/28	CS																			
Mortandad at MCO-7	03/28	CS			0.9933	0.0313		2.6713	0.0746		2.2140	0.0800		12.4	2.9		8.8	2.2		6.4	0.6
Mortandad at MCO-9	03/28	CS			0.0031	0.0009		0.0165	0.0020		0.0011	0.0005		4.7	1.4		3.6	1.2		4.0	0.4
Mortandad at MCO-13 (A-5)	06/27	CS																			
Mortandad at MCO-13 (A-5)	06/27	CS	2.86	0.11	0.0008	0.0005		0.0340	0.0032		0.0071	0.0016		7.4	1.9		5.1	1.4		4.2	0.4
Mortandad A-6	06/27	CS	3.22	0.13	0.0002	0.0007		0.0279	0.0030		0.0109	0.0018		10.1	2.4		6.8	1.8		4.1	0.4
Mortandad A-7	06/27	CS	1.83	0.08	0.0041	0.0013		0.0104	0.0020		0.0009	0.0006		5.3	1.5		3.8	1.2		3.5	0.3
Mortandad at SR-4 (A-9)	06/27	CS	3.62	0.16	0.0011	0.0006		0.0198	0.0023		0.0058	0.0015		10.0	2.4		5.7	1.5		4.9	0.5
Mortandad at Rio Grande (A-11)	09/25	CS	1.05	0.15	0.0121	0.0059	0.0148	0.0040	0.0029	0.0055	0.0073	0.0045	0.0135	5.3	1.2	1.9	24.6	1.9	2.4		
Mortandad at Rio Grande (A-11)	09/25	DUP	1.62	0.21										2.1	0.5	1.2	25.1	1.7	2.3		
Cañada del Buey:																					
Cañada del Buey at SR-4	03/28	CS			0.0043	0.0012		0.0102	0.0018		0.0021	0.0011		4.4	1.3		2.8	1.0		2.9	0.3
Pajarito Canyon:																					
Two-Mile at SR-501	02/25	CS			0.0015	0.0007		0.0123	0.0019		0.0018	0.0006		6.3	1.7		4.5	1.3		3.2	0.3
Pajarito at SR-4	03/28	CS			0.0131	0.0025		0.0429	0.0045		0.0057	0.0012		5.7	1.5		3.9	1.2		3.6	0.4
Pajarito at SR-4	03/29	CS			0.0165	0.0021		0.0423	0.0034		0.0046	0.0016		2.5	0.9		1.9	0.8		2.5	0.2
Pajarito Retention Pond	10/11	CS	5.76	0.55	0.0029	0.0076	0.0309	0.1150	0.0256	0.0345	0.0456	0.0145	0.0280	36.1	13.9	1.7	62.1	9.9	3.4		
Pajarito Retention Pond	10/11	DUP	4.83	0.46	0.0117	0.0144	0.0509	0.1290	0.0277	0.0351	0.0498	0.0145	0.0262								
Pajarito at Rio Grande	09/26	CS	3.77	0.38	0.0104	0.0070	0.0223	0.0952	0.0194	0.0056	0.0844	0.0118	0.0136	17.9	1.9	1.4	38.1	2.6	2.3		
Potrillo Canyon:																					
Potrillo at SR-4	03/28	CS			0.0023	0.0007		0.0137	0.0017		0.0037	0.0009		7.2	1.9		6.1	1.7		3.7	0.4

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	U (mg/kg, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Pajarito Plateau Stations (Cont.)																					
Fence Canyon:																					
Fence at SR-4	03/28	CS			0.0006	0.0003		0.0148	0.0018		0.0055	0.0011		5.2	1.5		3.8	1.2		3.7	0.4
Fence at SR-4	03/28	CS			0.0031	0.0009		0.0206	0.0021		0.0039	0.0013		7.0	1.8		5.8	1.6		3.7	0.4
Cañon de Valle:																					
Cañon de Valle at SR-501	03/29	CS			0.0015	0.0007		0.0130	0.0019		0.0016	0.0006		8.8	2.2		5.2	1.5		2.9	0.3
Water Canyon:																					
Water at SR-501	03/29	CS			0.0012	0.0006		0.0075	0.0014		0.0034	0.0012		4.5	1.3		3.1	1.1		2.9	0.3
Water at SR-4	03/28	CS			-0.0001	0.0001		0.0078	0.0012		0.0026	0.0008		6.7	1.8		4.3	1.3		3.8	0.4
Water at Rio Grande	09/26	CS	3.08	0.31	0.0693	0.0152	0.0054	0.1440	0.0266	0.0146	0.0663	0.0098	0.0033	17.1	3.0	1.3	38.5	2.4	2.3		
Indio Canyon:																					
Indio at SR-4	03/28	CS			0.0069	0.0014		0.0118	0.0018		0.0025	0.0008		4.3	1.3		3.4	1.1		3.2	0.3
Ancho Canyon:																					
Ancho at SR-4	03/28	CS			0.0004	0.0004		0.0090	0.0014		-0.0016	0.0001		5.1	1.4		3.9	1.2		2.9	0.3
Above Ancho Spring	09/26	CS	4.73	0.44	0.0104	0.0054	0.0071	0.0390	0.0115	0.0071	0.0542	0.0091	0.0037	25.7	4.5	1.1	37.5	2.4	2.1		
Ancho at Rio Grande	09/26	CS	1.42	0.20	0.0600	0.0141	0.0058	0.0214	0.0074	0.0058	0.0105	0.0043	0.0047	5.6	1.6	1.1	27.1	2.1	2.1		
Ancho at Rio Grande	09/26	DUP			0.0205	0.0078	0.0173	0.0075	0.0039	0.0051	0.0174	0.0061	0.0128								
Chaquehui Canyon:																					
Chaquehui at Rio Grande	09/27	CS	4.71	0.46	0.0021	0.0048	0.0199	0.0620	0.0147	0.0157	0.0418	0.0088	0.0139	26.4	3.0	1.3	40.1	2.7	2.3		
Frijoles Canyon:																					
Frijoles at Monument Headquarters	08/22	CS	1.84	0.30	0.0024	0.0024	0.0065	0.0193	0.0073	0.0065	0.0078	0.0042	0.0115	5.0	1.1	1.3	29.1	2.6	2.7		
Frijoles at Monument Headquarters	08/22	DUP												3.9	1.2	1.1	27.2	2.4	2.2		
Frijoles at Monument Headquarters	08/22	CS	2.50	0.36	-0.0024	0.0025	0.0179	0.0195	0.0082	0.0179	0.0075	0.0034	0.0040	8.3	1.9	1.6	34.2	3.1	2.5		
Frijoles at Monument Headquarters	08/22	DUP																			
Frijoles at Rio Grande	08/22	CS	4.06	0.50	0.0084	0.0061	0.0195	0.0336	0.0096	0.0057	0.0320	0.0083	0.0157	27.4	6.8	1.5	40.1	4.1	2.6		
TA-54 Area G:																					
G-0	04/19	CS	2.38	0.10	0.0167	0.0017		0.0436	0.0030		0.0151	0.0022		5.2	1.5		2.9	1.0		2.9	0.3
G-0	04/19	CS	2.24	0.10	0.0109	0.0016		0.0644	0.0042		0.0049	0.0013		5.3	1.5		3.2	1.0		3.0	0.3
G-1	04/19	CS	1.92	0.10	0.0044	0.0010		0.0060	0.0012		0.0097	0.0016		5.8	1.6		3.1	1.0		2.7	0.3
G-1	04/19	CS	1.94	0.08	0.0020	0.0006		0.0062	0.0012		0.0002	0.0002		6.1	1.6		3.5	1.1		2.8	0.3
G-2	04/19	CS	1.76	0.08	0.0012	0.0011		0.0114	0.0021		0.0045	0.0011		4.9	1.4		3.2	1.0		2.6	0.3
G-3	04/19	CS	2.53	0.11	-0.0001	0.0001		0.0081	0.0013		0.0010	0.0004		6.0	1.6		4.2	1.3		3.3	0.3
G-4 R-1	04/19	CS	2.61	0.11	0.0075	0.0015		0.0272	0.0028		0.0120	0.0024		7.1	1.8		4.7	1.4		3.5	0.3
G-4 R-2	04/19	CS	2.46	0.10	0.0007	0.0005		0.0598	0.0045		0.0108	0.0018		6.6	1.7		4.3	1.3		4.6	0.5
G-5	04/19	CS	1.33	0.05	0.0106	0.0021		0.0100	0.0020		0.0188	0.0021		6.2	1.7		3.4	1.1		4.1	0.4
G-7	04/19	CS	2.92	0.13	0.3099	0.0128		0.4411	0.0170		0.1084	0.0067		8.8	2.2		5.4	1.5		3.6	0.4
G-8	04/19	CS	2.23	0.10	0.0107	0.0017		0.0344	0.0031		0.0039	0.0011		5.9	1.6		3.7	1.1		3.0	0.3
G-9	04/19	CS	2.66	0.12	0.0339	0.0030		0.0540	0.0041		0.0164	0.0023		5.2	1.5		3.6	1.1		3.4	0.3
G-6 R	04/24	CS	2.05	0.09	0.0125	0.0017		0.2411	0.0102		1.2722	0.0372		7.8	2.4		2.7	1.2		2.3	0.2

Table 5-20. Radiochemical Analysis of Sediments for 2000 (pCi/g[a]) (Cont.)

Station Name	Date	Codes[b]	U (mg/kg, calc)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Pajarito Plateau Stations (Cont.)																
TA-49 Area AB:																
AB-1	04/25	CS	1.39	0.07	0.0015	0.0006	0.0179	0.0021	0.0071	0.0015	9.3	2.7	6.0	2.0	3.6	0.4
AB-1	04/25	CS	1.53	0.08	0.0023	0.0009	0.0118	0.0019	0.0045	0.0013	9.0	2.6	5.2	1.8	3.2	0.3
AB-2	04/25	CS	2.67	0.16	0.0015	0.0006	0.0460	0.0034	0.0128	0.0031	10.2	2.9	5.7	1.9	3.4	0.3
AB-3	04/05	CS			0.0232	0.0027	0.7610	0.0275	0.1896	0.0111	9.3	2.3	5.2	1.4	6.4	0.6
AB-4	04/05	CS			0.0052	0.0040	0.0073	0.0041	0.0189	0.0071	9.2	2.3	5.3	1.5	3.9	0.4
AB-4A	04/05	CS			0.0043	0.0014	0.0247	0.0032	0.0031	0.0009	8.3	2.1	5.9	1.6	3.8	0.4
AB-5	04/05	CS			0.0033	0.0012	0.0332	0.0039	0.0046	0.0016	7.6	1.9	6.4	1.7	4.0	0.4
AB-6	04/05	CS			0.0011	0.0007	0.0047	0.0014	0.0069	0.0030	5.3	1.5	3.8	1.1	3.8	0.4
AB-7	04/05	CS			0.0025	0.0013	0.0158	0.0024	0.0033	0.0018	6.8	1.8	5.1	1.4	3.2	0.3
AB-8	04/05	CS			0.0002	0.0003	0.0079	0.0015	0.0078	0.0035	14.7	3.3	3.1	1.0	3.0	0.3
AB-9	04/05	CS			0.0053	0.0019	0.0076	0.0021	0.0030	0.0046	6.1	1.6	3.9	1.2	2.9	0.3
AB-10	04/05	CS			0.0019	0.0008	0.0151	0.0021	0.0046	0.0014	6.5	1.7	4.7	1.3	2.7	0.3
AB-11	04/05	CS			0.0072	0.0013	0.0287	0.0027	0.0151	0.0023	7.1	1.8	4.9	1.4	3.3	0.3
AB-11	04/05	CS			0.0031	0.0011	0.0119	0.0018	0.0026	0.0010	7.1	1.8	4.3	1.3	3.5	0.3
River Background[c]			4.49		0.0087		0.0130		0.0760		15.7		17.6		8.8	
Reservoir Background[c]			4.58		0.0012		0.0201		0.0100		15.9		9.7		3.6	
Former Background[d]			4.40		0.0060		0.0230									
SAL[e]			29		27		24		22							

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[a] Except where noted. Three columns are listed: the first is the analytical result; the second is the radioactive counting uncertainty (1 standard deviation); and the third is the analytical laboratory measurement-specific minimum detectable activity.

[b] Code: CS–Customer Sample; DUP–Laboratory Duplicate; TOTC–Total Concentration Calculated from Laboratory Data.

[c] Preliminary upper limit for background values (McLin et al., in preparation).

[d] Purtymun et al. (1987a).

[e] Screening Action Level, LANL Environmental Restoration Project, 1998; see text for details.

Table 5-21. Detections of Greater-Than-Background Radionuclides in River and Stream Sediments for 2000[a]

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA[d]	Units	Lab Qual Code[e]	River Background	Result/ Background	SAL	Result/ SAL
Regional Stations												
Rio Chama at Chamita (bank)	07/12	CS	^{238}Pu	0.3680	0.0148		pCi/g		0.0087	42.30		
Rio Chama at Chamita (bank)	07/12	CS	^{239,240}Pu	0.8714	0.0310		pCi/g		0.013	67.03		
Rio Grande at Otowi (bank)	06/27	CS	^{239,240}Pu	0.0141	0.0016		pCi/g		0.013	1.08		
Rio Grande at Frijoles (bank)	08/22	CS	Gross Beta	21.1	1.9	2.5	pCi/g		17.6	1.20		
Rio Grande at Cochiti	09/26	CS	^{137}Cs	1.65	0.05	0.07	pCi/g		0.56	2.95		
Rio Grande at Cochiti	09/26	CS	Gross Alpha	21.3	3.1	1.9	pCi/g		15.7	1.36		
Rio Grande at Cochiti	09/26	CS	Gross Beta	35.0	2.8	2.9	pCi/g		17.6	1.99		
Rio Grande at Cochiti	09/26	CS	^{3}H	515	51	142	pCi/L		3,600	0.14		
Rio Grande at Cochiti	09/26	CS	^{238}Pu	0.0672	0.0153	0.0150	pCi/g	B	0.0087	7.72		
Rio Grande at Cochiti	09/26	CS	^{239,240}Pu	0.1320	0.0249	0.0150	pCi/g	B	0.013	10.15		
Rio Grande at Bernalillo	07/11	CS	^{239,240}Pu	0.0220	0.0026		pCi/g		0.013	1.69		
Pajarito Plateau Stations												
Guaje Canyon:												
Guaje at SR-502	06/27	CS	^{137}Cs	1.61	0.18		pCi/g		0.56	2.87		
Guaje at SR-502	06/27	CS	^{137}Cs	1.58	0.18		pCi/g		0.56	2.82		
Guaje at SR-502	06/27	CS	^{239,240}Pu	0.0810	0.0072		pCi/g		0.013	6.23		
Guaje at SR-502	06/27	CS	^{239,240}Pu	0.0875	0.0055		pCi/g		0.013	6.73		
Acid/Pueblo Canyons:												
Pueblo 1 R	07/25	CS	^{137}Cs	3.57	0.40		pCi/g		0.56	6.37	4.4	0.81
Pueblo 1 R	07/25	CS	^{239,240}Pu	0.1342	0.0063		pCi/g		0.013	10.32		
Acid Weir	07/25	CS	^{137}Cs	2.74	0.31		pCi/g		0.56	4.89		
Acid Weir	07/25	CS	^{239,240}Pu	0.1415	0.0077		pCi/g		0.013	10.88		
Acid Weir	07/25	CS	^{90}Sr	1.06	0.18	0.45	pCi/g		1.02	1.04		
Pueblo 2	04/24	CS	^{238}Pu	0.0137	0.0017		pCi/g		0.0087	1.57		
Pueblo 2	04/24	CS	^{239,240}Pu	1.8789	0.0571		pCi/g		0.013	144.53		
Hamilton Bend Spring	04/24	CS	^{239,240}Pu	0.6013	0.0210		pCi/g		0.013	46.25		
Pueblo 3	04/24	CS	^{239,240}Pu	0.8885	0.0275		pCi/g		0.013	68.35		
Pueblo at SR-502	06/27	CS	^{239,240}Pu	1.1513	0.0372		pCi/g		0.013	88.56		

Table 5-21. Detections of Greater-Than-Background Radionuclides in River and Stream Sediments for 2000[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA[d]	Units	Lab Qual Code[e]	River Background	Result/ Background	SAL	Result/ SAL
Pajarito Plateau Stations (Cont.)												
DP/Los Alamos Canyons:												
Los Alamos Canyon Reservoir	08/31	DUP	^{137}Cs	2.76	0.16	0.05	pCi/g		0.56	4.93		
Los Alamos Canyon Reservoir	08/31	CS	^{137}Cs	2.99	0.16	0.05	pCi/g		0.56	5.34	5.4	0.55
Los Alamos Canyon Reservoir	08/31	CS	Gross Alpha	25.6	5.7	0.9	pCi/g		15.7	1.63		
Los Alamos Canyon Reservoir	08/31	CS	Gross Beta	39.5	3.3	2.3	pCi/g		17.6	2.24		
Los Alamos Canyon Reservoir	08/31	CS	^{239,240}Pu	0.1060	0.0204	0.0183	pCi/g		0.013	8.15		
Los Alamos at LAO-1	04/04	CS	^{3}H	3,870	760		pCi/L		3,600	1.08		
Los Alamos at LAO-1	04/04	CS	^{239,240}Pu	0.3231	0.0129		pCi/g		0.013	24.85		
Los Alamos at Upper GS	04/24	CS	^{239,240}Pu	0.1461	0.0068		pCi/g		0.013	11.24		
DPS-4	04/04	CS	^{241}Am	0.3451	0.0217		pCi/g		0.076	4.54		
DPS-4	04/04	CS	^{137}Cs	1.84	0.20		pCi/g		0.56	3.29		
DPS-4	04/04	CS	^{3}H	4,130	770		pCi/L		3,600	1.15		
DPS-4	04/04	CS	^{238}Pu	0.0301	0.0031		pCi/g		0.0087	3.46		
DPS-4	04/04	CS	^{239,240}Pu	0.1608	0.0083		pCi/g		0.013	12.37		
Los Alamos at LAO-3	04/24	CS	^{241}Am	0.1324	0.0095		pCi/g		0.076	1.74		
Los Alamos at LAO-3	04/24	CS	^{137}Cs	0.68	0.08		pCi/g		0.56	1.22		
Los Alamos at LAO-3	04/24	CS	^{238}Pu	0.0175	0.0019		pCi/g		0.0087	2.01		
Los Alamos at LAO-3	04/24	CS	^{239,240}Pu	0.1178	0.0059		pCi/g		0.013	9.06		
Los Alamos at LAO-4.5	04/04	CS	^{241}Am	0.1756	0.0149		pCi/g		0.076	2.31		
Los Alamos at LAO-4.5	04/04	CS	^{137}Cs	0.90	0.10		pCi/g		0.56	1.61		
Los Alamos at LAO-4.5	04/04	CS	^{3}H	1,940	620		pCi/L		3,600	0.54		
Los Alamos at LAO-4.5	04/04	CS	^{238}Pu	0.0219	0.0025		pCi/g		0.0087	2.52		
Los Alamos at LAO-4.5	04/04	CS	^{239,240}Pu	0.1377	0.0072		pCi/g		0.013	10.59		
Los Alamos at SR-4	06/27	CS	^{241}Am	0.2056	0.0096		pCi/g		0.076	2.71		
Los Alamos at SR-4	06/27	CS	^{137}Cs	1.41	0.16		pCi/g		0.56	2.53		
Los Alamos at SR-4	06/27	CS	^{238}Pu	0.0234	0.0021		pCi/g		0.0087	2.69		
Los Alamos at SR-4	06/27	CS	^{239,240}Pu	0.2255	0.0090		pCi/g		0.013	17.35		
Los Alamos at Totavi	06/27	CS	^{239,240}Pu	0.0270	0.0023		pCi/g		0.013	2.08		
Los Alamos at Otowi	06/27	CS	^{137}Cs	1.02	0.12		pCi/g		0.56	1.82		
Los Alamos at Otowi	06/27	CS	^{239,240}Pu	0.1761	0.0079		pCi/g		0.013	13.55		

Table 5-21. Detections of Greater-Than-Background Radionuclides in River and Stream Sediments for 2000[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA[d]	Units	Lab Qual Code[e]	River Background	Result/ Background	SAL	Result/ SAL
Pajarito Plateau Stations (Cont.)												
Mortandad Canyon:												
Mortandad near CMR Building	03/28	CS	^{238}Pu	0.0263	0.0024		pCi/g		0.0087	3.02		
Mortandad at GS-1	03/29	CS	^{137}Cs	19.44	2.05		pCi/g		0.56	34.71	4.4	4.42
Mortandad at GS-1	03/29	CS	Gross Alpha	64.0	12.6		pCi/g		15.7	4.08		
Mortandad at GS-1	03/29	CS	Gross Beta	28.0	5.8		pCi/g		17.6	1.59		
Mortandad at GS-1	03/29	CS	Gross Gamma	21.5	2.2		pCi/g		8.8	2.44		
Mortandad at GS-1	03/29	CS	^{3}H	23,100	1,600		pCi/L		3,600	6.42	20,000	1.16
Mortandad at GS-1	03/29	CS	^{238}Pu	11.7000	0.7500		pCi/g		0.0087	1,344.83		
Mortandad at GS-1	03/29	CS	^{239,240}Pu	17.4100	1.1200		pCi/g		0.013	1,339.23	24	0.73
Mortandad at MCO-5	03/28	CS	^{241}Am	5.8294	0.2375		pCi/g		0.076	76.70		
Mortandad at MCO-5	03/28	CS	^{137}Cs	18.02	1.90		pCi/g		0.56	32.18	4.4	4.10
Mortandad at MCO-5	03/28	CS	Gross Alpha	24.4	5.1		pCi/g		15.7	1.55		
Mortandad at MCO-5	03/28	CS	Gross Beta	19.3	4.2		pCi/g		17.6	1.10		
Mortandad at MCO-5	03/28	CS	Gross Gamma	19.1	1.9		pCi/g		8.8	2.17		
Mortandad at MCO-5	03/28	CS	^{3}H	4,100	770		pCi/L		3,600	1.14		
Mortandad at MCO-5	03/28	CS	^{238}Pu	3.3266	0.0994		pCi/g		0.0087	382.37		
Mortandad at MCO-5	03/28	CS	^{239,240}Pu	7.8130	0.2141		pCi/g		0.013	601.00		
Mortandad at MCO-7	03/28	CS	^{241}Am	2.2140	0.0800		pCi/g		0.076	29.13		
Mortandad at MCO-7	03/28	CS	^{137}Cs	4.86	0.52		pCi/g		0.56	8.68	4.4	1.10
Mortandad at MCO-7	03/28	CS	^{238}Pu	0.9933	0.0313		pCi/g		0.0087	114.17		
Mortandad at MCO-7	03/28	CS	^{239,240}Pu	2.6713	0.0746		pCi/g		0.013	205.48		
Mortandad at MCO-9	03/28	CS	^{239,240}Pu	0.0165	0.0020		pCi/g		0.013	1.27		
Mortandad at MCO-13 (A-5)	06/27	CS	^{239,240}Pu	0.0340	0.0032		pCi/g		0.013	2.62		
Mortandad A-6	06/27	CS	^{239,240}Pu	0.0279	0.0030		pCi/g		0.013	2.15		
Mortandad at SR-4 (A-9)	06/27	CS	^{239,240}Pu	0.0198	0.0023		pCi/g		0.013	1.52		
Mortandad at Rio Grande (A-11)	09/25	DUP	Gross Beta	25.1	1.7	2.3	pCi/g		17.6	1.43		
Mortandad at Rio Grande (A-11)	09/25	CS	Gross Beta	24.6	1.9	2.4	pCi/g		17.6	1.40		
Mortandad at Rio Grande (A-11)	09/25	DUP	^{3}H	423	50	143	pCi/L		3,600	0.12		
Mortandad at Rio Grande (A-11)	09/25	CS	^{3}H	416	49	141	pCi/L		3,600	0.12		
Pajarito Canyon:												
Pajarito at Rio Grande	09/26	CS	^{241}Am	0.0844	0.0118	0.0136	pCi/g		0.076	1.11		
Pajarito at Rio Grande	09/26	CS	^{137}Cs	3.13	0.07	0.06	pCi/g		0.56	5.59	4.4	0.71
Pajarito at Rio Grande	09/26	CS	Gross Alpha	17.9	1.9	1.4	pCi/g		15.7	1.14		
Pajarito at Rio Grande	09/26	CS	Gross Beta	38.1	2.6	2.3	pCi/g		17.6	2.16		
Pajarito at Rio Grande	09/26	CS	^{3}H	376	47	138	pCi/L		3,600	0.10		
Pajarito at Rio Grande	09/26	CS	^{238}Pu	0.0223	0.0070	0.0223	pCi/g	U	0.0087	2.56		

Table 5-21. Detections of Greater-Than-Background Radionuclides in River and Stream Sediments for 2000[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA[d]	Units	Lab Qual Code[e]	River Background	Result/ Background	SAL	Result/ SAL
Pajarito Plateau Stations (Cont.)												
Pajarito Canyon (Cont):												
Pajarito at Rio Grande	09/26	CS	^{239,240}Pu	0.0952	0.0194	0.0056	pCi/g	B	0.013	7.32		
Pajarito at SR-4	03/28	CS	^{238}Pu	0.0131	0.0025		pCi/g		0.0087	1.51		
Pajarito at SR-4	03/28	CS	^{239,240}Pu	0.0429	0.0045		pCi/g		0.013	3.30		
Pajarito at SR-4	03/29	CS	^{238}Pu	0.0165	0.0021		pCi/g		0.0087	1.90		
Pajarito at SR-4	03/29	CS	^{239,240}Pu	0.0423	0.0034		pCi/g		0.013	3.25		
Potrillo at SR-4	03/28	CS	^{239,240}Pu	0.0137	0.0017		pCi/g		0.013	1.05		
Fence Canyon:												
Fence at SR-4	03/28	CS	^{239,240}Pu	0.0148	0.0018		pCi/g		0.013	1.14		
Fence at SR-4	03/28	CS	^{239,240}Pu	0.0206	0.0021		pCi/g		0.013	1.58		
Cañon de Valle:												
Cañon de Valle at SR-501	03/29	CS	^{239,240}Pu	0.0130	0.0019		pCi/g		0.013	1.00		
Water Canyon:												
Water at Rio Grande	09/26	CS	^{137}Cs	4.13	0.09	0.07	pCi/g		0.56	7.38	4.4	0.94
Water at Rio Grande	09/26	CS	Gross Alpha	17.1	3.0	1.3	pCi/g		15.7	1.09		
Water at Rio Grande	09/26	CS	Gross Beta	38.5	2.4	2.3	pCi/g		17.6	2.19		
Water at Rio Grande	09/26	CS	^{238}Pu	0.0693	0.0152	0.0054	pCi/g	B	0.0087	7.97		
Water at Rio Grande	09/26	CS	^{239,240}Pu	0.1440	0.0266	0.0146	pCi/g	B	0.013	11.08		
Ancho Canyon:												
Ancho at SR-4	03/28	CS	^{3}H	3,050	700		pCi/L		3,600	0.85		
Above Ancho Spring	09/26	CS	^{137}Cs	1.02	0.05	0.06	pCi/g		0.56	1.82		
Above Ancho Spring	09/26	CS	Gross Alpha	25.7	4.5	1.1	pCi/g		15.7	1.64		
Above Ancho Spring	09/26	CS	Gross Beta	37.5	2.4	2.1	pCi/g		17.6	2.13		
Above Ancho Spring	09/26	CS	^{3}H	27,800	328	138	pCi/L		3,600	7.72	20,000	1.39
Above Ancho Spring	09/26	CS	^{239,240}Pu	0.0390	0.0115	0.0071	pCi/g	B	0.013	3.00		
Above Ancho Spring	09/26	TOTC	U	4.73	0.44		mg/kg		4.49	1.05		
Ancho at Rio Grande	09/26	CS	Gross Beta	27.1	2.1	2.1	pCi/g		17.6	1.54		
Ancho at Rio Grande	09/26	CS	^{238}Pu	0.0600	0.0141	0.0058	pCi/g	B	0.0087	6.90		

Table 5-21. Detections of Greater-Than-Background Radionuclides in River and Stream Sediments for 2000[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA[d]	Units	Lab Qual Code[e]	River Background	Result/ Background	SAL	Result/ SAL
Pajarito Plateau Stations (Cont.)												
Chaquehui Canyon:												
Chaquehui at Rio Grande	09/27	CS	^{137}Cs	0.96	0.05	0.06	pCi/g		0.56	1.72		
Chaquehui at Rio Grande	09/27	CS	Gross Alpha	26.4	3.0	1.3	pCi/g		15.7	1.68		
Chaquehui at Rio Grande	09/27	CS	Gross Beta	40.1	2.7	2.3	pCi/g		17.6	2.28		
Chaquehui at Rio Grande	09/27	CS	^{3}H	951	153	464	pCi/L		3,600	0.26		
Chaquehui at Rio Grande	09/27	CS	^{238}Pu	0.0199	0.0048	0.0199	pCi/g	U	0.0087	2.29		
Chaquehui at Rio Grande	09/27	CS	^{239,240}Pu	0.0620	0.0147	0.0157	pCi/g	B	0.013	4.77		
Chaquehui at Rio Grande	09/27	TOTC	U	4.71	0.46		mg/kg		4.49	1.05		
Frijoles Canyon:												
Frijoles at Monument HQ	08/22	DUP	Gross Beta	27.2	2.4	2.2	pCi/g		17.6	1.55		
Frijoles at Monument HQ	08/22	CS	Gross Beta	29.1	2.6	2.7	pCi/g		17.6	1.65		
Frijoles at Monument HQ	08/22	CS	Gross Beta	34.2	3.1	2.5	pCi/g		17.6	1.94		
Frijoles at Rio Grande	08/22	CS	^{137}Cs	1.53	0.11	0.03	pCi/g		0.56	2.73		
Frijoles at Rio Grande	08/22	CS	Gross Alpha	27.4	6.8	1.5	pCi/g		15.7	1.75		
Frijoles at Rio Grande	08/22	CS	Gross Beta	40.1	4.1	2.6	pCi/g		17.6	2.28		
Frijoles at Rio Grande	08/22	CS	^{239,240}Pu	0.0336	0.0096	0.0057	pCi/g		0.013	2.58		
TA-54 Area G:												
G-0	04/19	CS	^{238}Pu	0.0167	0.0017		pCi/g		0.0087	1.92		
G-0	04/19	CS	^{238}Pu	0.0109	0.0016		pCi/g		0.0087	1.25		
G-0	04/19	CS	^{239,240}Pu	0.0436	0.0030		pCi/g		0.013	3.35		
G-0	04/19	CS	^{239,240}Pu	0.0644	0.0042		pCi/g		0.013	4.95		
G-4 R-1	04/19	CS	^{3}H	20,100	1,500		pCi/L		3,600	5.58	20,000	1.01
G-4 R-1	04/19	CS	^{239,240}Pu	0.0272	0.0028		pCi/g		0.013	2.09		
G-4 R-2	04/19	CS	^{3}H	10,400	1,100		pCi/L		3,600	2.89	20,000	0.52
G-4 R-2	04/19	CS	^{239,240}Pu	0.0598	0.0045		pCi/g		0.013	4.60		
G-5	04/19	CS	^{238}Pu	0.0106	0.0021		pCi/g		0.0087	1.22		
G-7	04/19	CS	^{241}Am	0.1084	0.0067		pCi/g		0.076	1.43		
G-7	04/19	CS	^{238}Pu	0.3099	0.0128		pCi/g		0.0087	35.62		
G-7	04/19	CS	^{239,240}Pu	0.4411	0.0170		pCi/g		0.013	33.93		
G-8	04/19	CS	^{238}Pu	0.0107	0.0017		pCi/g		0.0087	1.23		
G-8	04/19	CS	^{239,240}Pu	0.0344	0.0031		pCi/g		0.013	2.65		
G-9	04/19	CS	^{238}Pu	0.0339	0.0030		pCi/g		0.0087	3.90		
G-9	04/19	CS	^{239,240}Pu	0.0540	0.0041		pCi/g		0.013	4.15		

Table 5-21. Detections of Greater-Than-Background Radionuclides in River and Stream Sediments for 2000[a] (Cont.)

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA[d]	Units	Lab Qual Code[e]	River Background	Result/ Background	SAL	Result/ SAL
Pajarito Plateau Stations (Cont.)												
TA-54 Area G: (Cont.)												
G-6 R	04/24	CS	^{241}Am	1.2722	0.0372		pCi/g		0.076	16.74		
G-6 R	04/24	CS	^{3}H	1,870	610		pCi/L		3,600	0.52		
G-6 R	04/24	CS	^{238}Pu	0.0125	0.0017		pCi/g		0.0087	1.44		
G-6 R	04/24	CS	^{239,240}Pu	0.2411	0.0102		pCi/g		0.013	18.55		
TA-49 Area AB:												
AB-1	04/25	CS	^{239,240}Pu	0.0179	0.0021		pCi/g		0.013	1.38		
AB-2	04/25	CS	^{239,240}Pu	0.0460	0.0034		pCi/g		0.013	3.54		
AB-3	04/05	CS	^{241}Am	0.1896	0.0111		pCi/g		0.076	2.49		
AB-3	04/05	CS	^{238}Pu	0.0232	0.0027		pCi/g		0.0087	2.67		
AB-3	04/05	CS	^{239,240}Pu	0.7610	0.0275		pCi/g		0.013	58.54		
AB-4A	04/05	CS	^{137}Cs	0.69	0.08		pCi/g		0.56	1.22		
AB-4A	04/05	CS	^{239,240}Pu	0.0247	0.0032		pCi/g		0.013	1.90		
AB-5	04/05	CS	^{137}Cs	0.74	0.09		pCi/g		0.56	1.31		
AB-5	04/05	CS	^{239,240}Pu	0.0332	0.0039		pCi/g		0.013	2.55		
AB-7	04/05	CS	^{239,240}Pu	0.0158	0.0024		pCi/g		0.013	1.22		
AB-10	04/05	CS	^{239,240}Pu	0.0151	0.0021		pCi/g		0.013	1.16		
AB-11	04/05	CS	^{239,240}Pu	0.0287	0.0027		pCi/g		0.013	2.21		
Pajarito Canyon:												
Pajarito Retention Pond	10/11	CS	^{137}Cs	3.93	0.09	0.09	pCi/g		0.56	7.02	4.4	0.89
Pajarito Retention Pond	10/11	CS	Gross Beta	62.1	9.9	3.4	pCi/g		17.6	3.53		
Pajarito Retention Pond	10/11	DUP	^{238}Pu	0.0509	0.0144	0.0509	pCi/g	U	0.0087	5.85		
Pajarito Retention Pond	10/11	CS	^{238}Pu	0.0309	0.0076	0.0309	pCi/g	U	0.0087	3.55		
Pajarito Retention Pond	10/11	DUP	^{239,240}Pu	0.1290	0.0277	0.0351	pCi/g	B	0.013	9.92		
Pajarito Retention Pond	10/11	CS	^{239,240}Pu	0.1150	0.0256	0.0345	pCi/g	B	0.013	8.85		
Pajarito Retention Pond	10/11	TOTCD	U	4.83	0.46		mg/kg		4.49	1.07		
Pajarito Retention Pond	10/11	TOTC	U		5.76	0.55	mg/kg		4.49	1.28		

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[a] Above background detection defined as ≥ 3× uncertainty and ≥ detection limit and ≥ background. Values indicated by entries in SAL column are greater than half of the SAL. Note that some results in this table were qualified as nondetections by the analytical laboratory. All tritium detections are shown.

[b] Codes: CS–Customer Sample; DUP–Duplicate; TRP–Triplicate; RE–Reanalysis; TOTC–Value Calculated from Other Results; TOTCD–Duplicate Calculated Value.

[c] One standard deviation radioactivity counting uncertainty.

[d] MDA = minimum detectable activity.

[e] Codes: B–analyte found in lab blank; U–analyte not detected.

Table 5-22. Detections of Greater-Than-Background Radionuclides in Reservoir Sediments for 2000[a]

Station Name	Date	Code[b]	Analyte	Result	Uncertainty[c]	MDA	Units	Lab Qual Code[d]	Reservoir Background	Result/ Background
Reservoirs on Rio Grande (New Mexico)										
Cochiti Upper	09/15	CS	^{137}Cs	1.26	0.03	0.03	pCi/g		0.98	1.29
Cochiti Upper	09/15	DUP	^{137}Cs	1.22	0.04	0.04	pCi/g		0.98	1.24
Cochiti Upper	09/15	CS	Gross Alpha	18.3	5.1	2.2	pCi/g		15.9	1.15
Cochiti Upper	09/15	DUP	Gross Alpha	21.1	6.6	7.3	pCi/g		15.9	1.33
Cochiti Upper	09/15	CS	Gross Beta	29.9	2.9	3.5	pCi/g		9.7	3.08
Cochiti Upper	09/15	DUP	Gross Beta	36.5	5.4	9.6	pCi/g		9.7	3.76
Cochiti Upper	09/15	CS	^{238}Pu	0.9660	0.1450	0.0211	pCi/g		0.0012	805.00
Cochiti Upper	09/15	CS	^{239,240}Pu	0.1230	0.0255	0.0078	pCi/g	B	0.02	6.15
Cochiti Middle	09/15	CS	^{241}Am	0.0441	0.0110	0.0070	pCi/g	B	0.01	4.41
Cochiti Middle	09/15	CS	^{137}Cs	1.34	0.03	0.04	pCi/g		0.98	1.37
Cochiti Middle	09/15	CS	^{137}Cs	1.36	0.03	0.04	pCi/g		0.98	1.39
Cochiti Middle	09/15	CS	Gross Alpha	26.5	8.7	2.3	pCi/g		15.9	1.67
Cochiti Middle	09/15	CS	Gross Alpha	24.7	3.4	1.8	pCi/g		15.9	1.55
Cochiti Middle	09/15	CS	Gross Beta	35.7	3.0	3.5	pCi/g		9.7	3.68
Cochiti Middle	09/15	CS	Gross Beta	36.0	3.0	3.5	pCi/g		9.7	3.71
Cochiti Middle	09/15	CS	^{238}Pu	0.0389	0.0108	0.0389	pCi/g	U	0.0012	32.42
Cochiti Lower	09/15	CS	Gross Alpha	24.0	3.1	2.1	pCi/g		15.9	1.51
Cochiti Lower	09/15	CS	Gross Beta	34.6	2.8	3.2	pCi/g		9.7	3.57
Reservoirs on Rio Chama (New Mexico)										
Abiquiu Lower	10/18	CS	Gross Alpha	21.7	5.2	4.4	pCi/g		15.9	1.36
Abiquiu Lower	10/18	DUP	Gross Alpha	19.1	4.9	4.4	pCi/g		15.9	1.20
Abiquiu Lower	10/18	CS	Gross Beta	31.0	4.0	7.4	pCi/g		9.7	3.20
Abiquiu Lower	10/18	DUP	Gross Beta	30.8	3.8	6.4	pCi/g		9.7	3.18
Abiquiu Upper	10/18	CS	Gross Beta	20.1	1.9	2.9	pCi/g		9.7	2.07
Abiquiu Upper	10/18	CS	^{239,240}Pu	0.0237	0.0072	0.0156	pCi/g		0.02	1.19
Abiquiu Upper	10/18	DUP	^{239,240}Pu	0.0263	0.0078	0.0163	pCi/g		0.02	1.32
Abiquiu Middle	10/18	CS	Gross Alpha	18.7	3.4	2.1	pCi/g		15.9	1.18
Abiquiu Middle	10/18	CS	Gross Beta	25.9	2.6	3.3	pCi/g		9.7	2.67
Abiquiu Middle	10/18	CS	^{238}Pu	0.0185	0.0050	0.0036	pCi/g		0.0012	15.42
Abiquiu Middle	10/18	CS	^{239,240}Pu	0.0754	0.0107	0.0036	pCi/g		0.02	3.77

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[a] Above background detection defined as ≥ 3× uncertainty and ≥ detection limit and ≥ background. No values exceeded half of the SAL. Note that some results in this table were qualified as non-detections by the analytical laboratory. All tritium detections are shown.

[b] Codes: CS–Customer Sample; DUP–Duplicate; TRP–Triplicate; RE–Reanalysis; TOTC–Value Calculated from Other Results; TOTCD–Duplicate Calculated Value.

[c] One standard deviation radioactivity counting uncertainty.

[d] Codes: B–analyte found in lab blank; U–analyte not detected.

Table 5-23. Radiochemical Analysis of Sediments for 1999 (pCi/g^{a})

Station Name	Date	Code	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239, 240}$Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations																				
Rio Chama at Chamita	05/04	1	90	600	0.05	0.01	0.90	0.20	0.0028	0.0018	0.0025	0.0014	0.0104	0.0023	3.14	1.47	2.97	1.53	2.4	0.2
Rio Grande at Embudo	05/04	1	140	600	0.13	0.02	1.20	0.20	-0.0010	0.0003	0.0019	0.0029	0.0023	0.0010	3.91	1.80	3.80	1.90	1.2	0.2
Rio Grande at Otowi (bank)	08/03	1	140	610	0.02	0.03	0.86	0.08	0.0007	0.0007	0.0001	0.0009	0.0192	0.0028	1.67	0.69	1.09	0.55	1.9	0.2
Rio Grande at Otowi Upper(bank)	08/03	1	80	610	0.01	0.03	1.70	0.10	0.0029	0.0011	0.0012	0.0008	0.0242	0.0038	3.87	1.52	2.86	1.27	3.0	0.3
Rio Grande at Frijoles (bank)	12/21	1	-290	670	0.06	0.03	1.02	0.05	0.0005	0.0004	0.0042	0.0010	-0.0009	0.0014	2.84	1.24	2.41	1.10	2.1	0.2
Rio Grande at Cochiti Spillway	09/23	1	-40	740	0.12	0.02	1.11	0.07	0.0016	0.0009	0.0046	0.0014	0.0027	0.0009	3.97	1.54	2.33	1.13	2.3	0.2
Rio Grande at Bernalillo	05/04	1	190	600	0.14	0.02	1.30	0.20	0.0100	0.0029	0.0088	0.0028	0.0027	0.0009	3.35	1.87	2.12	1.79	2.3	0.2
Jemez River	08/02	1	130	610	0.05	0.04	0.50	0.04	0.0063	0.0012	0.0030	0.0008	0.0022	0.0008	0.91	0.69	1.00	0.73	2.6	0.3
Reservoirs on Rio Chama (New Mexico)																				
Heron Upper	08/31	1	-190	600	0.38	0.05	1.20	0.20					0.0105	0.0063	3.99	1.20	3.66	1.21	2.6	0.3
Heron Middle	08/31	1	130	630	0.27	0.04	1.20	0.10					0.0042	0.0030	4.00	1.20	2.82	1.04	4.8	0.5
Heron Lower	08/31	1	740	670	0.23	0.04	1.10	0.20					0.1881	0.0851	6.85	1.78	4.23	1.32	5.5	0.5
El Vado Upper	09/02	1					3.10	0.40												
El Vado Upper	08/31	1	600	660	0.19	0.03							0.0074	0.0045	5.32	1.47	3.15	1.11	2.8	0.3
El Vado Middle	08/31	1	190	630	0.18	0.04	1.80	0.10					0.0050	0.0033	6.25	1.66	4.18	1.31	3.3	0.3
El Vado Lower	08/31	1	80	620	0.23	0.03	1.40	0.20					0.0076	0.0046	4.83	1.37	3.43	1.17	3.1	0.3
Abiquiu Upper	08/30	1					2.40	0.30												
Abiquiu Middle	10/12	1	3,090	920	0.40	0.05	2.10	0.50					0.0067	0.0013	12.60	3.71	7.47	2.62	3.2	0.3
Abiquiu Middle	10/12	1D	4,440	980	0.13	0.03							0.0059	0.0020	7.12	2.23	5.75	1.95	2.4	0.2
Abiquiu Lower	10/12	1	3,320	930	0.11	0.03	1.90	0.20					0.0021	0.0008	4.94	1.76	3.42	1.41	1.9	0.2
Abiquiu Lower	10/12	1D	6,500	1,100	0.12	0.03							0.0043	0.0012	6.11	2.02	4.47	1.66	1.8	0.2
Reservoirs on Rio Grande (Colorado)																				
Rio Grande Upper	09/02	1	-150	600	0.67	0.08	3.30	0.30					0.0037	0.0021	11.00	2.58	7.90	2.03	4.5	0.5
Rio Grande Middle	09/02	1	50	620	0.37	0.05	1.70	0.20					0.0186	0.0103	10.40	2.47	6.33	1.73	4.1	0.4
Rio Grande Lower	09/02	1	210	630	0.57	0.08	2.90	0.40					0.0087	0.0041	10.50	2.48	7.33	1.92	4.0	0.4
Rio Grande Lower	09/02	2	-190	600	0.53	0.07	1.70	0.20					0.0094	0.0044	10.10	2.41	6.78	1.82	4.3	0.4
Reservoirs on Rio Grande (New Mexico)																				
Cochiti Upper	10/13	1	-250	730	0.16	0.05	3.90	0.20					0.0048	0.0020	6.67	2.43	5.27	2.11	2.4	0.2
Cochiti Middle	10/13	1	980	800	0.30	0.05	2.90	0.30					0.0092	0.0029	8.88	3.29	8.88	3.31	3.3	0.3
Cochiti Middle	10/13	2	130	750	0.26	0.05	2.30	0.20					0.0226	0.0040	9.07	2.96	6.70	2.44	3.3	0.3
Cochiti Lower	10/13	1	100	750	0.30	0.05	3.70	0.30					0.0170	0.0054	10.80	3.72	10.50	3.68	3.4	0.3
Other Reservoirs (New Mexico)																				
Guaje Reservoir	11/16	1	1,480	700	0.51	0.10	10.90	0.60					0.0620	0.0048	22.30	4.73	14.40	3.26	4.1	0.3
Guaje Reservoir	11/16	1D			0.56	0.07									23.00	4.87	13.30	3.05	3.7	0.4
Pajarito Plateau Stations																				
Guaje Canyon:																				
Guaje at SR-502	12/01	1	-120	690	0.05	0.02	0.29	0.02	0.0043	0.0010	0.0019	0.0007	-0.0006	0.0009	2.60	0.90	2.49	0.87	3.0	0.3
Guaje at SR-502	12/01	2	240	710	0.08	0.04	0.22	0.02	0.0012	0.0008	0.0018	0.0007	0.0045	0.0012	2.52	0.89	1.98	0.75	2.9	0.3

Table 5-23. Radiochemical Analysis of Sediments for 1999 (pCi/g[a]) (Cont.)

Station Name	Date	Code	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations (Cont.)																				
Bayo Canyon:																				
Bayo at SR-502	08/03	1	150	610	0.06	0.01	0.32	0.03	0.0028	0.0010	0.0024	0.0013	0.0082	0.0021	3.02	1.00	1.84	0.74	2.7	0.3
Acid/Pueblo Canyons:																				
Acid Weir	04/27	1	190	630	0.20	0.04	0.58	0.02	0.0290	0.0023	6.6021	0.1717	0.4200	0.0140	16.00	3.54	4.47	1.37	2.2	0.2
Pueblo 1	04/27	1	40	620	0.02	0.02	0.25	0.02	-0.0002	0.0002	0.0049	0.0011	0.0020	0.0007	2.97	0.98	2.86	1.05	2.3	0.2
Pueblo 2	05/24	1	480	630	0.04	0.01	0.20	0.03	0.0005	0.0005	0.9672	0.0313	0.0317	0.0037	2.96	0.99	1.43	0.68	2.5	0.2
Hamilton Bend Spring	05/24	1	290	620	0.04	0.01	0.35	0.04	0.0038	0.0013	0.5096	0.0209	0.0226	0.0038	2.87	0.97	2.19	0.85	3.2	0.3
Pueblo 3	05/24	1	500	640	0.01	0.06	0.18	0.03	0.0038	0.0011	0.2046	0.0092	0.0111	0.0020	1.92	0.75	1.72	0.74	2.9	0.3
Pueblo 3	05/24	2	260	620	0.00	0.09	0.27	0.03	0.0012	0.0006	0.1796	0.0083	0.0120	0.0059	1.40	0.62	1.67	0.73	2.8	0.3
Pueblo at SR-502	08/04	1	-20	600	0.03	0.02	0.59	0.05	0.0031	0.0010	1.0782	0.0336	0.0353	0.0042	5.33	1.85	5.15	1.82	3.4	0.3
DP/Los Alamos Canyons:																				
Los Alamos at Bridge	04/27	1	100	620	0.05	0.03	0.35	0.02	0.0016	0.0007	0.0027	0.0009	0.0021	0.0007	3.78	1.15	2.93	1.07	2.6	0.3
Los Alamos at Bridge	04/27	2	70	620	0.09	0.02	0.77	0.03	0.0010	0.0006	0.0025	0.0007	0.0013	0.0005	4.87	1.38	3.55	1.19	2.3	0.2
Los Alamos at LAO-1	04/23	1	30	590	0.10	0.01	0.90	0.40	0.0141	0.0019	0.1384	0.0065	0.0063	0.0014	4.09	1.23	2.89	1.00	2.3	0.2
DPS-1	04/23	1	1,830	720	0.31	0.04	0.60	0.30	0.0105	0.0018	0.0246	0.0027	0.1087	0.0079	2.49	0.87	2.53	0.90	2.0	0.2
DPS-4	04/27	1	560	660	1.59	0.18	0.33	0.02	0.0277	0.0036	0.0989	0.0071	0.2562	0.0098	3.77	1.15	6.17	1.70	4.6	0.5
Los Alamos at Upper GS	04/23	1	540	630	0.08	0.01	0.40	0.20	0.0006	0.0005	0.2182	0.0087	0.0051	0.0012	2.30	0.84	1.41	0.67	1.9	0.2
Los Alamos at LAO-3	04/23	1	190	600	0.69	0.08	0.60	0.40	0.0022	0.0009	0.3185	0.0131	0.1011	0.0061	2.67	0.93	3.95	1.22	1.5	0.2
Los Alamos at LAO-4.5	04/23	1	-80	580	1.26	0.14	0.50	0.40	0.0233	0.0021	0.1088	0.0052	0.1488	0.0086	2.63	0.92	3.12	1.05	1.4	0.2
Los Alamos at SR-4	08/03	1	240	620	0.05	0.04	0.66	0.03	0.0051	0.0015	0.0344	0.0032	0.0516	0.0052	2.99	1.00	2.99	1.00	3.3	0.3
Los Alamos at Totavi	08/03	1	150	610	0.02	0.03	0.45	0.02	0.0011	0.0010	0.0074	0.0019	0.0005	0.0007	3.78	1.17	2.56	0.90	2.5	0.3
Los Alamos at Otowi	08/03	1	460	640	0.08	0.04	0.48	0.04	0.0016	0.0010	0.0430	0.0040	0.0245	0.0042	5.99	1.62	3.68	1.15	3.0	0.3
Sandia Canyon:																				
Sandia at SR-4	08/03	1	270	620	0.05	0.04	0.11	0.02	0.0023	0.0009	0.0003	0.0005	0.0096	0.0026	2.01	0.78	1.86	0.74	2.5	0.3
Mortandad Canyon:																				
Mortandad near CMR Building	04/29	1	50	610	0.00	0.03	0.27	0.01	0.0324	0.0045	0.0201	0.0036	0.0104	0.0038	4.52	1.32	3.30	1.07	1.9	0.2
Mortandad west of GS-1	04/29	1	530	640	0.24	0.04	1.99	0.03	0.0159	0.0031	0.0409	0.0050	0.0170	0.0043	5.75	1.57	4.78	1.38	2.9	0.3
Mortandad at GS-1	04/29	1	4,870	900	16.50	1.80	0.38	0.01	12.1292	0.3870	10.4218	0.3333	10.0123	0.2505	82.50	16.90	20.70	5.17	16.2	1.6
Mortandad at MCO-5	04/29	1	2,260	750	18.00	2.00	0.23	0.01	3.2056	0.1131	8.0920	0.2771	4.7110	3.1690	23.30	4.93	17.10	0.45	16.5	1.6
Mortandad at MCO-5	04/29	2	3,500	830	21.90	2.40	0.53	0.01	31.2870	1.1610	78.3171	2.8163	10.0212	5.9980	9.22	2.25	7.61	1.94	20.4	2.0
Mortandad at MCO-7	04/29	1	1,080	680	4.21	0.47	0.35	0.02	0.6212	0.0302	1.9244	0.0790	1.9746	0.0835	8.58	2.13	6.77	1.78	4.8	0.5
Mortandad at MCO-9	04/29	1	370	630	0.38	0.05	1.13	0.01	0.0146	0.0030	0.0497	0.0054	0.0109	0.0022	4.94	1.41	4.50	1.32	5.3	0.5
Mortandad at MCO-13 (A-5)	08/05	2	180	620	0.22	0.05	1.30	0.20	0.0044	0.0015	0.0211	0.0025	0.0088	0.0022	7.60	1.93	5.21	1.46	3.1	0.3
Mortandad at MCO-13 (A-5)	08/05	1	230	620	0.34	0.05	0.55	0.07	0.0009	0.0006	0.0164	0.0023	0.0203	0.0057	6.06	1.63	4.86	1.39	3.3	0.3
Mortandad A-6	08/05	1	440	630	0.39	0.07	0.81	0.03	0.0008	0.0006	0.0176	0.0024	0.0240	0.0043	12.10	2.80	7.91	2.00	3.7	0.4
Mortandad A-7	08/05	1	210	620	0.17	0.05	0.69	0.08	0.0030	0.0010	0.0131	0.0020	0.0092	0.0018	4.92	1.40	4.45	1.31	3.1	0.3
Mortandad at SR-4 (A-9)	08/05	2	260	620	0.20	0.05	1.30	0.20	0.0051	0.0015	0.0049	0.0013	0.0352	0.0039	9.54	2.31	7.30	1.88	4.0	0.4
Mortandad at SR-4 (A-9)	08/05	1	140	610	0.15	0.05	1.40	0.30	0.0001	0.0004	0.0064	0.0014	0.0038	0.0014	4.32	1.28	3.74	1.16	3.8	0.4
Mortandad at Rio Grande (A-11)	09/20	1	60	750	0.02	0.02	0.43	0.02	0.0028	0.0012	0.0043	0.0015	0.0014	0.0009	3.04	1.01	3.27	1.06	2.8	0.3

Table 5-23. Radiochemical Analysis of Sediments for 1999 (pCi/g^a) (Cont.)

Station Name	Date	Code	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations (Cont.)																				
Cañada del Buey:																				
Cañada del Buey at SR-4	05/24	1	220	620	0.04	0.01	0.28	0.05	0.0015	0.0008	0.0066	0.0014	-0.0007	0.0006	1.77	0.71	1.50	0.69	2.1	0.2
CDB_01	07/20	1	130	610	0.11	0.02	0.58	0.06	0.0029	0.0009	0.0087	0.0014	0.0052	0.0096	6.00	1.50	4.81	0.90	3.4	0.3
CDB_02	07/20	1	60	610	0.22	0.03	0.98	0.03	0.0013	0.0008	0.0016	0.0008	-0.0046	0.0091	5.90	1.40	4.19	0.82	3.2	0.3
CDB_02	07/20	2	-70	600	0.20	0.02	0.81	0.06	0.0039	0.0013	0.0112	0.0019	-0.0066	0.0088	8.40	1.90	4.14	0.82	3.3	0.3
CDB_02	07/20	3	-40	600	0.19	0.03	0.78	0.05	0.0013	0.0007	0.0100	0.0016	-0.0070	0.0088	5.20	1.40	4.21	0.83	3.1	0.3
TA-54 Area G:																				
G-0	04/14	2	890	690	0.10	0.02	1.10	0.10	0.0124	0.0024	0.1255	0.0087	0.0916	0.0061	6.71	1.76	4.04	1.23	3.7	0.4
G-0	04/14	1D					3.13	0.31												
G-0	04/14	1	880	690	0.15	0.03	1.50	0.10	0.0237	0.0030	0.1072	0.0069	0.0523	0.0046	6.92	1.80	4.38	1.29	3.6	0.4
G-0	04/14	2D					3.11	0.31												
G-1	04/14	1	350	650	0.22	0.06	0.68	0.04	0.0245	0.0030	0.0105	0.0020	0.0022	0.0009	2.01	0.78	1.87	0.76	2.7	0.3
G-2	04/14	1	1,020	700	0.06	0.01	0.94	0.07	0.0019	0.0009	0.0077	0.0016	0.0016	0.0007	3.19	1.03	2.50	0.89	2.5	0.3
G-3	04/14	1	590	670	0.19	0.03	1.46	0.04	0.0030	0.0010	0.0162	0.0022	0.0055	0.0013	6.48	1.72	4.85	1.40	3.3	0.3
G-4																				
G-4 R-1	04/14	1	4,100	880	0.18	0.03	1.35	0.09	0.0066	0.0015	0.0469	0.0043	0.0093	0.0020	3.00	1.00	2.39	0.88	2.9	0.3
G-4 R-2	04/14	1	2,560	790	0.32	0.04	0.34	0.02	0.0041	0.0015	0.0662	0.0052	0.0160	0.0024	6.34	1.69	4.76	1.37	3.6	0.4
G-5	04/14	1	1,210	710	0.08	0.01	1.24	0.07	0.0132	0.0029	0.0570	0.0056	0.0311	0.0034	5.31	1.48	3.89	1.20	3.0	0.3
G-6 R	04/14	1	530	660	0.03	0.01	0.48	0.02	0.0097	0.0024	0.2446	0.0144	0.0526	0.0069	3.38	1.09	2.22	0.84	2.8	0.3
G-7	04/15	2	3,100	800	0.31	0.04	1.17	0.05	0.1624	0.0088	0.2189	0.0108	0.0428	0.0050	6.03	1.62	4.18	1.27	2.7	0.3
G-7	04/15	1	3,010	790	0.30	0.04	0.49	0.02	0.1472	0.0082	0.2612	0.0121	0.0926	0.0073	6.66	1.75	5.99	1.63	3.6	0.4
G-8	04/14	1	300	650	0.10	0.02	0.99	0.05	0.0069	0.0018	0.0101	0.0022	0.0111	0.0024	1.90	0.75	1.66	0.71	3.3	0.3
G-9	04/14	1	400	660	0.11	0.02	4.30	0.20	0.3702	0.0161	0.4851	0.0199	0.0185	0.0028	5.59	1.54	4.64	1.35	2.6	0.3
G3_01	07/20	1	190	620	0.03	0.01	0.90	0.10	0.0045	0.0014	0.0519	0.0047	0.0087	0.0098	2.48	0.71	1.92	0.57	2.7	0.3
G3_01	07/20	3													3.90	1.00	2.88	0.69		
G3_01	07/20	2	260	620	0.07	0.01	0.66	0.04	0.0124	0.0022	0.0357	0.0038	-0.0044	0.0091	3.99	1.00	3.21	0.70	4.0	0.4
G3_02	07/20	2													2.17	0.65	1.79	0.58		
G3_02	07/20	1	1,400	700	0.02	0.01	0.58	0.05	0.0106	0.0022	0.0238	0.0032	0.0083	0.0098	5.20	1.20	2.73	0.69	3.4	0.3
Twisp Dome at Silt Fence	07/29	1	6,800	1,000	0.07	0.02	0.93	0.05	0.0170	0.0027	0.4265	0.0196	0.2229	0.0691	6.98	1.80	3.45	1.17	4.9	0.5
Pajarito Canyon:																				
Two-Mile at SR-501	03/31	1D					0.43	0.03												
Two-Mile at SR-501	03/31	1	390	640	0.13	0.02	1.36	0.14	0.0014	0.0010	0.0050	0.0015	0.0143	0.0080	5.24	1.45	4.13	1.25	2.3	0.2
Pajarito at SR-501	03/31	1	300	640	0.05	0.01	1.00	0.10	0.0010	0.0006	0.0040	0.0011	0.0059	0.0075	2.12	0.80	1.60	0.71	2.2	0.2
Pajarito at SR-501	03/31	1D					0.41	0.02												
Pajarito at SR-4	04/15	1	270	610	0.58	0.06	2.00	0.10	0.4241	0.0183	0.0701	0.0055	0.0108	0.0037	3.28	1.06	2.73	0.97	5.0	0.5
Potrillo Canyon:																				
Potrillo at SR-4	03/31	1	880	680	0.09	0.01	1.62	0.16	0.0003	0.0014	0.0017	0.0011	0.0091	0.0081	3.52	1.11	3.08	1.03	2.6	0.3
Potrillo at SR-4	03/31	1D					1.10	0.20												
Potrillo at SR-4	05/24	1					0.35	0.03												

Table 5-23. Radiochemical Analysis of Sediments for 1999 (pCi/g[a]) (Cont.)

Station Name	Date	Code	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239, 240}$Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations (Cont.)																				
Fence Canyon:																				
Fence at SR-4	04/15	1	570	630	0.52	0.06	0.43	0.03	0.0010	0.0013	0.0273	0.0035	0.0084	0.0018	8.73	2.15	6.35	1.70	5.8	0.6
Cañon de Valle:																				
Cañon de Valle at SR-501	03/31	1D					0.66	0.05												
Cañon de Valle at SR-501	03/31	1	590	650	0.58	0.06	2.19	0.22	0.0021	0.0014	0.0387	0.0045	0.0096	0.0077	6.70	1.76	5.97	1.63	3.6	0.4
Water Canyon:																				
Water at SR-501	03/31	1D					0.48	0.05												
Water at SR-501	03/31	1	150	620	0.08	0.01	1.36	0.14	0.0003	0.0016	0.0061	0.0018	-0.0088	0.0067	2.01	0.80	2.54	0.92	2.4	0.2
Water at SR-4	03/31	1D					1.20	0.30												
Water at SR-4	03/31	1	690	660	0.08	0.01	1.44	0.14	-0.0011	0.0019	-0.0017	0.0015	0.0028	0.0086	4.35	1.28	3.71	1.17	4.2	0.4
Water at Rio Grande																				
Indio Canyon:																				
Indio at SR-4	03/31	1	1,160	690	0.10	0.02	1.30	0.13	0.0021	0.0011	0.0045	0.0016	-0.0037	0.0069	2.67	0.92	2.59	0.93	5.1	0.5
Indio at SR-4	03/31	1D					1.01	0.09												
Ancho Canyon:																				
Ancho at SR-4	03/31	2D					0.80	0.01												
Ancho at SR-4	03/31	1	3,870	860	0.13	0.02	1.71	0.17	-0.0015	0.0019	0.0081	0.0023	0.0073	0.0074	2.59	0.90	2.48	0.90	4.1	0.4
Ancho at SR-4	03/31	2	3,040	810	0.08	0.01	1.65	0.17	0.0003	0.0006	0.0039	0.0013	0.0098	0.0006	2.63	0.90	2.43	0.90	3.3	0.3
Ancho at SR-4	03/31	1D					0.90	0.06												
Above Ancho Spring	09/21	1	150	750	0.30	0.06	0.89	0.05	0.0041	0.0014	0.0113	0.0023	0.0170	0.0024	4.84	1.38	3.68	1.15	3.4	0.3
Ancho at Rio Grande	09/21	1	-60	740	0.29	0.07	0.78	0.03	0.0003	0.0005	0.0092	0.0016	0.0120	0.0019	4.28	1.27	3.74	1.16	3.7	0.4
Chaquehui Canyon:																				
Chaquehui at Rio Grande	09/22	1	110	750	0.69	0.11	1.85	0.08	0.0033	0.0014	0.0272	0.0035	0.0090	0.0023	6.92	1.80	4.64	1.35	3.7	0.4
Chaquehui at Rio Grande	09/22	2	130	750	0.65	0.09	1.52	0.08	0.0026	0.0014	0.0456	0.0052	0.0130	0.0026	7.19	1.85	5.14	1.45	3.9	0.4
Chaquehui at Rio Grande	09/22	1	110	750	0.69	0.11	1.85	0.08	0.0033	0.0014	0.0272	0.0035	0.0090	0.0023	6.92	1.80	4.64	1.35	3.7	0.4
Chaquehui at Rio Grande	09/22	2	130	750	0.65	0.09	1.52	0.08	0.0026	0.0014	0.0456	0.0052	0.0130	0.0026	7.19	1.85	5.14	1.45	3.9	0.4
TA-49, Area AB:																				
AB-1	04/21	1	350	630	0.37	0.05	1.80	0.20	0.0046	0.0016	0.0181	0.0024	0.0152	0.0074	10.50	2.50	6.11	1.65	3.4	0.3
AB-2	04/21	1	590	650	0.17	0.04	1.80	0.20	-0.0008	0.0009	0.0491	0.0063	0.0098	0.0032	8.07	2.02	4.79	1.39	3.3	0.3
AB-3	04/15	1	230	610	0.42	0.05	1.46	0.05	0.0192	0.0028	1.0830	0.0380	0.2536	0.0136	8.45	2.10	6.38	1.71	9.2	0.9
AB-4	04/21	1	160	610	0.17	0.03	1.08	0.06	0.0004	0.0007	0.0082	0.0014	0.0145	0.0075	8.82	2.17	5.45	1.53	3.0	0.3
AB-4A	04/21	1	300	620	0.41	0.06	1.60	0.10	-0.0002	0.0007	0.0172	0.0026	0.0138	0.0075	10.40	2.47	5.89	1.61	3.2	0.3
AB-5	04/21	1	590	650	0.90	0.11	1.45	0.09	0.0018	0.0012	0.0268	0.0026	0.0206	0.0078	7.12	1.84	5.17	1.47	3.4	0.3
AB-6	04/21	1	330	630	0.20	0.04	0.84	0.04	0.0037	0.0016	0.0106	0.0023	0.0030	0.0016	5.01	1.42	3.43	1.11	2.9	0.3
AB-7	04/21	1	470	640	0.53	0.07	4.80	0.20	0.0008	0.0008	0.0103	0.0018	0.0072	0.0072	5.45	1.51	5.36	1.51	3.2	0.3
AB-8	04/21	1	190	620	0.11	0.04	1.77	0.09	0.0007	0.0005	0.0042	0.0010	0.0139	0.0075	6.05	1.63	3.76	1.18	2.8	0.3

Table 5-23. Radiochemical Analysis of Sediments for 1999 (pCi/g[a]) (Cont.)

Station Name	Date	Code	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239, 240}$Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Regional Stations (Cont.)																				
TA-49, Area AB: (Cont.)																				
AB-9	04/21	1	380	630	0.21	0.04	0.92	0.05	0.0007	0.0010	0.0077	0.0013	-0.0005	0.0064	4.07	1.22	3.20	1.07	2.8	0.3
AB-9	04/21	2	420	630	0.27	0.05	0.14	0.01	0.0022	0.0011	0.0194	0.0032	0.0041	0.0016	4.89	1.39	3.56	1.14	2.7	0.3
AB-10	04/21	1	380	630	0.25	0.05	0.38	0.02	0.0037	0.0010	0.0092	0.0014	0.0157	0.0069	4.53	1.32	3.57	1.14	2.7	0.3
AB-11	04/21	1	180	620	0.15	0.04	0.36	0.02	0.0020	0.0012	0.0030	0.0014	0.0019	0.0010	3.76	1.16	3.62	1.15	2.7	0.3
Frijoles Canyon:																				
Frijoles at Monument HQ	12/21	1	40	700	0.09	0.05	0.26	0.01	0.0029	0.0008	0.0046	0.0011	0.0030	0.0010	3.62	1.13	3.38	1.07	2.6	0.3
Frijoles at Rio Grande	12/21	1	-210	680	0.09	0.03	1.10	0.10	0.0012	0.0005	0.0019	0.0007	0.0009	0.0005	3.92	1.19	2.90	0.96	2.6	0.3
White Rock, Cañada del Buey:																				
Site #1 Bonnie View	10/28	2	360	620	0.31	0.06	0.47	0.03	0.0020	0.0011	0.0142	0.0023	0.0039	0.0013	4.98	1.41	3.62	1.19	3.5	0.3
Site #1 Bonnie View	10/28	1	550	640	0.17	0.03	1.08	0.06	0.0039	0.0011	0.0075	0.0014	0.0132	0.0021	3.46	1.10	2.76	1.01	3.5	0.4
Site #1 Bonnie View	10/28	3	730	650	0.01	0.01	0.23	0.02	0.0004	0.0008	0.0041	0.0010	0.0030	0.0009	1.62	0.68	1.48	0.75	2.1	0.2
Site #2 Rover	10/28	3	300	620	0.11	0.03	0.63	0.03	0.0015	0.0006	0.0146	0.0019	0.0020	0.0010	3.76	1.16	2.59	0.98	3.5	0.3
Site #2 Rover	10/28	2	360	620	0.14	0.03	0.99	0.04	0.0009	0.0012	0.0097	0.0027	0.0062	0.0020	3.92	1.19	2.68	1.00	3.1	0.3
Site #2 Rover	10/28	1	440	630	0.05	0.04	0.33	0.02	0.0004	0.0007	0.0037	0.0014	0.0022	0.0009	2.31	0.84	1.46	0.75	2.7	0.3
Site #2 Rover	10/28	4	810	660	0.01	0.03	0.85	0.04	0.0011	0.0006	0.0472	0.0032	0.0132	0.0023	2.01	0.77	1.58	0.77	1.8	0.2
Site #3 Lejano	10/28	3	350	620	0.05	0.04	0.92	0.07	0.0004	0.0004	0.0042	0.0010	0.0065	0.0014	2.33	0.85	1.80	0.82	2.3	0.2
Site #3 Lejano	10/28	2	390	630	0.10	0.02	1.40	0.10	0.0020	0.0007	0.0058	0.0012	0.0013	0.0006	3.92	1.19	2.85	1.03	3.5	0.3
Site #3 Lejano	10/28	1	260	620	0.12	0.03	0.97	0.03	0.0023	0.0008	0.0055	0.0011	0.0018	0.0007	4.65	1.34	3.10	1.08	3.8	0.4
Site #4 Meadow Lane	10/28	5	370	620	-0.01	0.14	0.52	0.03	0.0045	0.0012	0.0084	0.0016	-0.0006	0.0023	2.96	0.99	1.98	0.85	2.7	0.3
Site #4 Meadow Lane	10/28	2	330	620	0.04	0.04	0.48	0.02	0.0016	0.0009	0.0048	0.0010	0.0012	0.0005	3.86	1.18	3.44	1.15	3.7	0.4
Site #4 Meadow Lane	10/28	1	740	650	0.09	0.03	0.64	0.02	0.0012	0.0008	0.0064	0.0013	0.0037	0.0011	3.49	1.10	2.74	1.01	3.9	0.4
Site #4 Meadow Lane	10/28	3	100	610	0.16	0.03	1.00	0.10	0.0031	0.0009	0.0078	0.0014	0.0007	0.0005	3.92	1.19	2.91	1.04	3.1	0.3
Site #5 Overlook Park	10/28	3	350	620	0.16	0.04	0.84	0.06	0.0042	0.0011	0.7472	0.0262	0.0048	0.0017	4.34	1.28	2.52	0.96	3.2	0.3
Site #5 Overlook Park	10/28	5	-240	580	0.07	0.04	0.12	0.02	0.0001	0.0004	0.0042	0.0011	0.0067	0.0018	1.29	0.59	1.52	0.76	2.8	0.3
Site #5 Overlook Park	10/28	4	220	610	0.19	0.04	1.18	0.03	0.0005	0.0005	0.0131	0.0017	0.0044	0.0018	4.01	1.21	3.10	1.08	3.2	0.3
Site #5 Overlook Park	10/28	2	390	630	0.10	0.04	0.71	0.07	0.0054	0.0017	0.0101	0.0021	0.0009	0.0005	3.40	1.08	2.72	1.00	3.8	0.4
Site #5 Overlook Park	10/28	1	230	620	-0.01	0.22	0.38	0.03	0.0007	0.0005	0.0032	0.0011	0.0034	0.0012	2.83	0.96	2.44	0.95	3.1	0.3
Site #5 Overlook Park	10/28	6	-50	590	0.06	0.04	0.68	0.04	0.0029	0.0009	0.0068	0.0012	0.0079	0.0017	2.20	0.82	1.66	0.79	2.4	0.2
Special EPA Sampling																				
Ancho Canyon 1	12/16	1	770	670	0.33	0.04	5.80	0.20	0.0186	0.0019	0.0159	0.0018			12.80	2.93	8.77	2.16	4.9	0.5
Ancho Canyon 2	12/16	1	760	670	0.31	0.05	2.61	0.04	0.0015	0.0005	0.0131	0.0016			6.43	1.70	4.78	1.37	3.5	0.3
Ancho Canyon 3	12/16	1	340	640	0.32	0.05	2.12	0.05	0.0071	0.0013	0.0207	0.0023			8.59	2.12	6.16	1.65	4.0	0.4
Ancho Canyon 4	12/16	1	990	680	0.22	0.03	2.00	0.05	0.0010	0.0005	0.0172	0.0020			7.23	1.86	4.84	1.38	3.1	0.3
Ancho Canyon 5	12/16	1	670	660	0.09	0.03	0.81	0.04	0.0003	0.0004	0.0063	0.0013			4.42	1.29	3.10	1.02	2.9	0.3
Bayo Canyon 1	12/13	1	0	690	0.63	0.08	1.70	0.10	0.0010	0.0006	0.0458	0.0035	0.0193	0.0028	3.07	1.01	3.67	1.12	7.0	0.7
Bayo Canyon 2	12/13	1	40	700	0.27	0.04	1.33	0.06	0.0003	0.0006	0.0177	0.0020	0.0003	0.0003	3.60	1.13	3.90	1.17	7.0	0.7
Bayo Canyon 3	12/13	1	-10	690	0.20	0.03	0.97	0.04	0.0002	0.0005	0.0100	0.0015	0.0037	0.0014	3.27	1.06	2.86	0.94	7.6	0.8
Bayo Canyon 4	12/13	1	350	720	0.27	0.04	1.00	0.10	0.0026	0.0012	0.0158	0.0024	0.0021	0.0008	3.00	1.00	2.76	0.92	8.9	0.9

Table 5-23. Radiochemical Analysis of Sediments for 1999 (pCi/g[a]) (Cont.)

Station Name	Date	Code	^{3}H (pCi/L)		^{137}Cs		U (mg/kg)		^{238}Pu		$^{239, 240}$Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Special EPA Sampling (Cont.)																				
Cañada del Buey 1	12/15	1	300	630	0.07	0.02	0.79	0.02	0.0012	0.0006	0.0037	0.0010			4.87	1.38	3.14	1.05	3.0	0.3
Cañada del Buey 2	12/15	1	290	630	0.13	0.03	0.74	0.03	0.0023	0.0009	0.0047	0.0012			6.13	1.64	3.34	1.10	3.0	0.3
Cañada del Buey 3	12/16	1	-140	680	0.06	0.03	0.54	0.03	0.0060	0.0016	0.0089	0.0020	0.0088	0.0018	4.14	1.24	2.64	0.91	2.7	0.3
Cañada del Buey 4	12/15	1	270	630	0.05	0.02	1.47	0.05	0.0019	0.0006	0.0057	0.0011			4.92	1.39	3.25	1.08	3.9	0.4
Cañada del Buey 4	12/15	2	340	640	0.04	0.02	0.70	0.04	0.0005	0.0003	0.0030	0.0007			4.94	1.40	3.36	1.10	3.7	0.4
Cañada del Buey 5A	12/15	1	130	620	0.05	0.02	0.74	0.07	0.0011	0.0006	0.0046	0.0009			4.83	1.37	3.40	1.11	4.0	0.4
Cañada del Buey 5B	12/16	1	-90	690	0.16	0.04	0.42	0.03	0.0022	0.0009	0.0036	0.0011	0.0025	0.0008	5.99	1.61	3.75	1.15	3.6	0.4
Cañada del Buey 6	12/15	1	300	630	0.08	0.02	0.74	0.07	0.0021	0.0009	0.0159	0.0023			5.63	1.54	3.42	1.11	3.7	0.4
Cañada del Buey 7	12/15	1	300	630	0.11	0.03	0.30	0.02	0.0019	0.0006	0.0072	0.0012			5.43	1.50	3.04	1.03	3.7	0.4
Cañada del Buey 8	12/15	1	150	620	0.09	0.03	0.81	0.06	0.0010	0.0008	0.0044	0.0012			5.27	1.46	3.24	1.07	3.9	0.4
Mortandad Canyon 1	12/14	1	120	700	0.14	0.04	0.77	0.02	0.0005	0.0004	0.0118	0.0016			6.34	1.68	4.52	1.34	4.6	0.5
Mortandad Canyon 2	12/14	1	190	710	0.15	0.03	0.60	0.04	0.0009	0.0005	0.0512	0.0033			4.18	1.24	3.38	1.10	5.4	0.5
Mortandad Canyon 3	12/14	1	60	700	0.00	0.22	0.83	0.05	0.0004	0.0004	0.0086	0.0013			3.03	0.99	2.11	0.83	3.6	0.4
Mortandad Canyon 4	12/14	1	900	750	0.31	0.05	0.38	0.02	0.0007	0.0004	0.0575	0.0041			4.63	1.33	3.65	1.16	3.6	0.4
Mortandad Canyon 5A	12/14	1	100	700	0.08	0.04	0.90	0.10	0.0011	0.0013	0.0152	0.0027			5.44	1.50	2.98	1.02	3.1	0.3
Mortandad Canyon 5B	12/14	1	-60	690	0.05	0.04	0.52	0.03	0.0005	0.0003	0.0021	0.0007			2.54	0.88	1.58	0.71	4.5	0.5
Pajarito Canyon 1	12/16	1	460	650	0.40	0.05	1.24	0.06	0.0046	0.0009	0.0191	0.0018			6.54	1.72	4.30	1.27	5.9	0.6
Pajarito Canyon 2	12/16	1	400	640	0.11	0.03	0.82	0.05	0.0036	0.0009	0.0162	0.0018			5.53	1.52	3.41	1.08	5.1	0.5
Pajarito Canyon 3	12/16	1	160	620	0.37	0.05	1.34	0.06	0.0097	0.0017	0.0119	0.0020			6.22	1.66	5.26	1.47	5.1	0.5
Pajarito Canyon 4	12/16	1	470	650	0.35	0.05	1.05	0.04	0.0011	0.0005	0.0137	0.0017			8.67	2.14	5.54	1.52	5.0	0.5
Sandia Canyon 1	12/13	1	60	700	0.00	0.26	0.65	0.03	0.0013	0.0006	0.0016	0.0006	0.0003	0.0003	3.52	1.11	1.89	0.71	3.5	0.4
Sandia Canyon 2	12/13	1	110	700	0.10	0.04	0.53	0.01	0.0002	0.0003	0.0050	0.0010	0.0013	0.0005	5.58	1.53	3.58	1.10	3.8	0.4
Sandia Canyon 3	12/13	1	3,190	880	0.10	0.04	1.12	0.06	0.0027	0.0009	0.0051	0.0012	0.0014	0.0006	3.22	1.05	2.32	0.82	3.6	0.4
Sandia Canyon 4	12/13	1	80	700	0.05	0.05	1.17	0.07	0.0061	0.0013	0.0095	0.0016	0.0158	0.0022	2.75	0.94	1.91	0.72	4.3	0.4
Sandia Canyon 5	12/13	1	470	720	0.56	0.09	1.64	0.07	0.0014	0.0006	0.0337	0.0027	0.0152	0.0022	3.94	1.20	2.98	0.97	4.6	0.5
Sandia Canyon 6	12/13	1	330	710	0.09	0.03	1.54	0.06	0.0047	0.0015	0.0113	0.0023	0.0743	0.0066	3.30	1.06	2.73	0.91	7.0	0.7
Standardized Comparisons																				
Average Detection Limits			700		0.05		0.25		0.0050[b]		0.0050[b]		0.0050		1.50		1.50		0.8	
Background					0.44[d]		4.4[d]		0.006[c]		0.023[c]		0.09[d]		14.8[d]		12[d]		8.2[d]	
SAL[e]			20,000		4.40		29.00		27.0000		24.0000		22.0000							

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[a] Except where noted. Two columns are listed; the first is the value, the second is the counting uncertainty (1 std. dev.).

[b] Sample sizes for plutonium-238 and -239, -240 analysis: stream channels–100 g; reservoirs–1,000 g. Limits of detection for plutonium-238 and -239, -240 in reservoir samples are 0.0001 pCi/g.

[c] Purtymun et al. (1987a), upper limit for background for sediment samples from 1974–1986.

[d] Preliminary upper limit for background values for channel sediments from 1974–1996.

[e] Screening Action Level, LANL Environmental Restoration Project, 1998.

Table 5-24. Total Recoverable Trace Metals in Sediments for 2000 (mg/kg)

Station Name	Date	Code		Ag	Al		As		B	Ba	Be		Cd	Co	Cr	Cu	Fe
Regional Stations																	
Rio Chama at Chamita (bank)	07/12	CS	<[a]	0.5	2,211		0.5	<	1	49.9	0.3	<	0.2	1.1	2.7	1.4	3,512
Rio Chama at Chamita (bank)	07/12	CS	<	0.8	3,123		0.7	<	1	62.5	0.3	<	0.2	1.6	3.7	2.4	4,463
Rio Grande at Embudo (bank)	07/12	CS		9.1	5,562		2.2	<	1	98.5	0.4	<	0.2	4.9	9.7	8.4	10,798
Rio Grande at Otowi (bank)	06/27	CS	<	0.4	849	<	0.4	<	2	24.0	0.3	<	0.7	1.5	4.2	3.6	4,823
Rio Grande at Otowi (bank)	06/27	CS	<	0.4	1,062		0.5		2	21.5	0.3	<	0.5	1.4	3.9	3.7	4,384
Rio Grande at Otowi Upper (bank)	06/27	CS	<	0.4	5,585		1.0	<	2	104.3	0.6	<	0.2	3.5	8.7	4.8	9,282
Rio Grande at Bernalillo	07/11	CS	<	1.1	7,323		2.5	<	1	141.7	0.4	<	0.2	4.9	7.8	6.4	10,590
Jemez River	07/13	CS	<	0.4	2,544		4.0	<	1	41.8	0.3	<	0.2	1.5	4.0	1.5	4,320
Pajarito Plateau Stations																	
Guaje Canyon:																	
Guaje at SR-502	06/27	CS	<	0.4	4,958		0.9	<	4	100.2	0.6	<	0.2	2.8	4.5	8.8	5,534
Guaje at SR-502	06/27	CS		15.8	4,468		0.7	<	2	89.6	0.5	<	0.2	2.8	4.0	7.0	5,138
Bayo Canyon:																	
Bayo at SR-502	06/27	CS	<	0.4	3,344	<	0.6	<	2	86.9	0.4	<	0.2	3.2	5.1	4.7	6,584
DP/Los Alamos Canyons:																	
Los Alamos at Totavi	06/27	CS	<	0.6	5,207		1.1	<	2	95.2	0.6	<	0.2	3.9	5.9	6.5	7,535
Los Alamos at Otowi	06/27	CS	<	0.4	9,010		1.2		3	123.8	0.8		0.2	3.9	8.2	7.6	9,396
Mortandad Canyon:																	
Mortandad at MCO-5	03/28	CS	<	1.0	1,834		1.1	<	1	18.3	0.2	<	0.2	2.6	2.0	0.6	3,597
Cañon de Valle:																	
Cañon de Valle at SR-501	03/29	CS	<	1.0	6,182		1.0	<	1	80.7	0.5		0.3	2.7	6.6	4.9	7,436
Water Canyon:																	
Water at SR-501	03/29	CS	<	1.0	5,034		1.3	<	1	35.0	0.8	<	0.9	2.2	4.9	5.6	14,458
Frijoles Canyon:																	
Frijoles at Monument Headquarters	08/22	CS	<	101.0	1,770		0.7	<	410	27.8	0.2		0.1	0.7	1.1	1.7	2,150
Frijoles at Monument Headquarters	08/22	DUP	<	101.0	2,020		0.7	<	410	32.0	0.3	<	38.2	0.7	1.4	1.7	2,450
Frijoles at Monument Headquarters	08/22	CS	<	101.0	973		0.4	<	410	14.0	0.1	<	38.2	0.3	0.7	0.7	1,590
Frijoles at Rio Grande	08/22	CS	<	101.0	13,600		4.7		7	347.0	1.6		0.4	8.0	9.5	22.3	12,900

Table 5-24. Total Recoverable Trace Metals in Sediments for 2000 (mg/kg) (Cont.)

Station Name	Date	Code	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe
Pajarito Plateau Stations (Cont.)													
TA-54 Area G:													
G-0	04/19	CS	< 0.4	5,227	0.6	< 1	44.4	0.4	< 0.4	2.1	4.6	3.1	7,729
G-0	04/19	CS	< 0.4	1,596	0.7	< 1	27.6	0.1	< 0.2	1.3	1.7	1.7	2,423
G-1	04/19	CS	< 0.4	385	0.3	< 1	19.7	0.1	< 0.2	0.8	< 0.5	< 0.4	271
G-1	04/19	CS	< 0.4	3,198	0.9	< 1	31.4	0.3	< 0.2	1.9	3.1	1.2	5,766
G-2	04/19	CS	< 0.4	2,504	< 0.9	< 1	25.3	0.3	< 0.2	< 1.5	2.5	1.3	4,085
G-3	04/19	CS	< 0.4	4,830	1.4	< 1	75.0	0.5	< 0.2	2.9	4.0	3.4	6,801
G-4 R-1	04/19	CS	24.3	4,978	1.5	< 1	52.0	0.5	< 0.2	2.6	4.9	3.1	6,390
G-4 R-2	04/19	CS	< 0.4	3,901	1.3	1	45.8	0.5	< 0.2	1.7	3.7	3.3	5,079
G-5	04/19	CS	< 0.4	9,105	2.1	< 1	71.0	0.6	< 0.2	3.3	9.8	5.2	10,004
G-7	04/19	CS	< 0.4	5,998	1.3	< 1	38.5	0.4	< 0.2	2.2	4.4	2.1	7,253
G-8	04/19	CS	14.0	6,950	1.8	< 1	87.0	0.6	< 0.2	5.0	8.6	2.6	11,937
G-9	04/19	CS	< 0.4	3,319	1.1	< 1	43.3	0.4	< 0.2	2.3	2.9	1.7	4,538
G-6 R	04/24	CS	< 0.4	3,329	0.7	< 1	53.7	0.7	0.7	2.3	3.5	7.6	4,809
TA-49 Area AB:													
AB-1	04/25	CS	40.1	5,130	1.4	48	107.1	49.2	47.7	50.5	53.1	55.0	6,158
AB-1	04/25	CS	< 0.4	11,371	1.9	< 1	135.2	1.2	0.5	5.7	8.0	6.3	11,801
AB-2	04/25	CS	1.9	4,879	1.5	< 1	88.4	0.6	< 0.2	3.6	3.6	4.0	6,072
AB-3	04/05	CS	< 1.6	12,231	1.8	< 1	81.8	0.8	< 0.4	3.1	8.1	4.8	8,087
AB-4	04/05	CS	< 1.6	15,102	2.6	< 1	156.8	1.1	< 0.2	4.6	7.6	4.6	9,887
AB-4A	04/05	CS	< 1.6	5,290	1.0	< 1	71.9	0.5	< 0.2	2.1	3.5	3.1	4,580
AB-5	04/05	CS	< 1.6	685	1.6	< 1	5.5	< 0.1	< 0.2	< 0.4	0.6	0.4	869
AB-6	04/05	CS	< 1.6	3,730	1.3	< 1	54.7	0.4	< 0.2	2.9	4.4	2.4	5,592
AB-7	04/05	CS	< 1.6	4,744	1.8	< 1	44.6	0.5	< 0.2	1.9	4.4	2.1	8,461
AB-8	04/05	CS	< 1.6	2,658	1.4	< 1	55.2	0.4	< 0.2	2.7	3.3	2.4	4,335
AB-9	04/05	CS	< 1.6	5,521	0.7	< 1	65.2	0.5	< 0.5	1.8	3.1	2.4	4,517
AB-10	04/05	CS	< 1.6	5,697	1.5	< 1	67.0	0.5	< 0.2	3.0	4.2	4.1	6,291
AB-11	04/05	CS	< 1.6	3,260	0.7	< 1	45.3	0.4	< 0.4	1.5	2.3	2.7	2,962
AB-11	04/05	CS	< 1.6	5,685	1.3	< 1	69.3	0.6	0.3	2.0	3.7	4.1	5,543
SAL[b]			380	78,000	19	5,900	270		38	4,600	30[c]	28,000	

Table 5-24. Total Recoverable Trace Metals in Sediments for 2000 (mg/kg) (Cont.)

Station Name	Date	Code	Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Stations														
Rio Chama at Chamita (bank)	07/12	CS	< 0.010	77	< 1.0	< 2.0	2.8	< 0.04	< 2.0	< 4	23.6		6.0	9.7
Rio Chama at Chamita (bank)	07/12	CS	< 0.010	92	< 1.0	3.2	3.4	< 0.04	2.0	< 4	29.9		8.9	12.5
Rio Grande at Embudo (bank)	07/12	CS	0.016	228	< 1.0	8.8	10.5	< 0.04	< 2.0	< 4	41.0		17.0	69.1
Rio Grande at Otowi (bank)	06/27	CS	< 0.010	56	< 1.0	< 2.0	2.4	< 0.04	0.6	< 4	7.7		12.1	12.3
Rio Grande at Otowi (bank)	06/27	CS	< 0.010	53	< 1.0	< 2.0	3.0	< 0.08	0.6	< 4	7.4		10.1	13.1
Rio Grande at Otowi Upper (bank)	06/27	CS	< 0.010	184	< 1.0	< 2.0	3.0	< 0.08	0.9	< 4	55.2		17.2	23.0
Rio Grande at Bernalillo	07/11	CS	0.011	272	< 1.0	6.5	8.4	< 0.04	< 3.0	< 4	73.2		14.8	28.4
Jemez River	07/13	CS	< 0.010	334	< 1.0	< 4.4	5.2	< 0.04	0.7	< 4	62.5		5.9	13.2
Pajarito Plateau Stations														
Guaje Canyon:														
Guaje at SR-502	06/27	CS	< 0.010	382	< 1.0	2.7	17.0	< 0.08	0.6	< 4	31.2		8.0	43.2
Guaje at SR-502	06/27	CS	< 0.010	325	< 1.0	< 2.0	14.0	< 0.08	0.5	< 4	25.7		7.2	32.8
Bayo Canyon:														
Bayo at SR-502	06/27	CS	< 0.010	236	< 1.0	6.7	4.6	< 0.04	0.4	< 4	19.9		11.5	36.6
DP/Los Alamos Canyons:														
Los Alamos at Totavi	06/27	CS	< 0.010	296	< 1.0	< 7.3	11.0	< 0.08	0.7	< 4	26.0		11.2	34.6
Los Alamos at Otowi	06/27	CS	0.012	395	< 1.0	5.0	12.0	< 0.08	1.1	< 4	37.0		15.4	39.2
Mortandad Canyon:														
Mortandad at MCO-5	03/28	CS	0.012	156	< 1.0	< 2.9	4.9	< 0.04	< 0.2	< 4	3.2		6.4	11.1
Cañon de Valle:														
Cañon de Valle at SR-501	03/29	CS	0.026	498	< 1.0	< 3.5	10.8	< 0.04	0.5	< 4	23.2		9.8	40.1
Water Canyon:														
Water at SR-501	03/29	CS	< 0.010	420	< 3.6	< 5.8	13.4	< 0.04	< 0.5	< 4	5.6		10.9	88.7
Frijoles Canyon:														
Frijoles at Monument Headquarters	08/22	CS	0.005	150	0.2	1.2	5.0	< 0.18	0.2	1	6.9	0.09	2.5	13.2
Frijoles at Monument Headquarters	08/22	DUP	0.008	135	0.2	1.3	4.2	< 89.30	0.3	1	6.6	0.04	2.6	14.1
Frijoles at Monument Headquarters	08/22	CS	< 15.200	107	0.2	0.6	2.1	< 0.23	< 146.0	1	2.9	0.03	1.5	9.3
Frijoles at Rio Grande	08/22	CS	0.031	1,490	0.4	13.5	39.4	< 0.31	1.4	2	101.0	0.26	19.9	72.7

Table 5-24. Total Recoverable Trace Metals in Sediments for 2000 (mg/kg) (Cont.)

Station Name	Date	Code	Hg	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Pajarito Plateau Stations (Cont.)														
TA-54 Area G:														
G-0	04/19	CS	< 0.010	192	< 1.0	4.6	3.0	< 0.08	< 0.1	< 4	14.4		9.6	44.2
G-0	04/19	CS	< 0.010	98	< 1.0	3.3	4.0	< 0.08	0.2	< 4	6.2		2.5	23.4
G-1	04/19	CS	< 0.010	74	< 1.0	< 2.0	4.0	< 0.08	< 0.2	< 4	3.3		1.1	4.0
G-1	04/19	CS	< 0.010	182	< 1.0	< 4.1	6.0	< 0.08	< 0.1	< 4	5.4		6.8	31.6
G-2	04/19	CS	< 0.010	127	< 1.0	2.8	6.0	< 0.08	< 0.3	< 4	5.3		4.4	21.3
G-3	04/19	CS	< 0.010	293	< 1.0	3.7	12.0	< 0.08	< 0.3	< 4	11.8		7.4	62.9
G-4 R-1	04/19	CS	0.018	233	< 1.0	< 3.8	10.0	< 0.08	< 0.3	< 4	9.7		7.0	33.7
G-4 R-2	04/19	CS	0.016	189	< 1.0	< 4.0	9.0	< 0.08	< 0.2	< 4	9.0		5.9	32.6
G-5	04/19	CS	0.016	253	< 1.0	< 5.7	9.0	< 0.08	< 0.3	< 4	16.2		15.2	43.6
G-7	04/19	CS	< 0.010	209	< 1.0	2.7	8.0	< 0.08	< 1.0	< 4	7.5		9.0	35.8
G-8	04/19	CS	< 0.010	324	< 1.0	5.9	9.0	< 0.08	< 0.2	< 4	11.9		21.0	32.1
G-9	04/19	CS	< 0.010	193	< 1.0	3.8	8.0	< 0.08	< 0.1	< 4	6.9		5.4	22.6
G-6 R	04/24	CS	< 0.010	173	< 1.0	< 3.8	6.3	< 0.04	0.4	< 4	17.6		7.5	42.8
TA-49 Area AB:														
AB-1	04/25	CS	0.020	237	49.2	50.2	15.2	< 0.04	0.7	47	63.5		55.4	89.4
AB-1	04/25	CS	0.024	406	< 1.0	5.4	13.3	< 0.04	0.7	< 4	24.6		15.1	472.7
AB-2	04/25	CS	0.023	279	< 1.0	4.4	14.2	< 0.04	0.6	< 4	16.2		6.4	344.4
AB-3	04/05	CS	0.012	177	< 1.0	5.2	8.6	< 0.04	0.3	< 4	15.8		12.5	35.8
AB-4	04/05	CS	0.015	393	< 1.0	5.5	15.0	< 0.04	0.5	< 4	24.5		10.8	25.1
AB-4A	04/05	CS	0.011	153	< 1.0	< 3.3	7.8	< 0.04	< 0.3	< 4	11.8		5.8	15.6
AB-5	04/05	CS	0.016	23	< 1.0	< 2.0	11.1	< 0.04	< 0.2	< 4	1.0		1.1	3.3
AB-6	04/05	CS	< 0.010	210	< 1.0	< 2.0	7.6	< 0.04	< 0.2	< 4	8.5		9.1	15.0
AB-7	04/05	CS	< 0.010	178	< 1.0	2.7	12.0	< 0.04	< 0.3	< 4	8.0		6.8	35.5
AB-8	04/05	CS	0.011	228	< 1.0	< 5.3	10.5	< 0.04	< 0.2	< 4	9.0		4.9	19.2
AB-9	04/05	CS	< 0.010	147	< 1.0	< 2.0	6.2	< 0.04	< 0.4	< 4	10.6		4.1	17.8
AB-10	04/05	CS	< 0.010	218	< 1.0	< 2.0	8.1	< 0.04	< 0.2	< 4	10.5		8.0	18.9
AB-11	04/05	CS	0.014	111	< 1.0	< 2.0	4.6	< 0.04	< 0.2	< 4	8.0		3.2	14.5
AB-11	04/05	CS	< 0.010	164	< 1.0	< 2.0	10.4	< 0.04	< 0.2	< 4	13.0		5.8	18.7
SAL[b]			23	390	380	1,500	400	31	380		46,000	6	540	23,000

[a] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[b] Screening Action Level (Environmental Restoration Project 1997); see text for details.

[c] SAL value for hexavalent chromium is listed; SAL value for trivalent or total chromium is 210 mg/kg.

Table 5-25. Number of Samples Collected for Each Suite of Organic Compounds in Sediments for 2000

		Organic Suite[a]		
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**
AB-1	04/25		2	2
AB-10	04/05		1	1
AB-11	04/05		2	2
AB-2	04/25		1	1
AB-3	04/05		1	1
AB-4	04/05		1	1
AB-4A	04/05		1	1
AB-5	04/05		1	1
AB-6	04/05		1	1
AB-7	04/05		1	1
AB-8	04/05		1	1
AB-9	04/05		1	1
Above Ancho Spring	09/26	1		
Ancho at SR-4	03/28		1	1
Frijoles at Monument Headquarters	08/22		2	2
Pajarito at Rio Grande	09/26	1	1	1
Pajarito at SR-4	03/28	1		
Water at Rio Grande	09/26	1	1	1

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[a] High explosives, polychlorinated biphenyls, semivolatiles, and volatiles.

Table 5-26. Organic Compounds Detected in Sediment Samples in 2000

Station Name	Date	Suite[a]	Analyte	Result	MDL	Units	ER SAL	EPA Residential Soil Screening Level	Results/ Screening Level	Lab Code
Ancho at SR-4	03/28	SVOA	Pyrene	0.44		mg/kg	2,400	2,300	0.00	PARA
Ancho at SR-4	03/28	SVOA	Benzo(g,h,i)perylene	0.11		mg/kg				PARA
Ancho at SR-4	03/28	SVOA	Benzo(b)fluoranthene	0.30		mg/kg	1	0.62	0.48	PARA
Ancho at SR-4	03/28	SVOA	Fluoranthene	0.52		mg/kg	3,200	2,300	0.00	PARA
Ancho at SR-4	03/28	SVOA	Chrysene	0.24		mg/kg	96	62	0.00	PARA
Ancho at SR-4	03/28	SVOA	Benzo(a)pyrene	0.23		mg/kg	0.1	0.62	0.37	PARA
Ancho at SR-4	03/28	SVOA	Benzo(a)anthracene	0.25		mg/kg	1	0.62	0.40	PARA
Ancho at SR-4	03/28	SVOA	Phenanthrene	0.21		mg/kg				PARA
AB-11	04/05	SVOA	Bis(2-ethylhexyl)phthalate	0.25		mg/kg	50	35	0.01	PARA
AB-8	04/05	SVOA	Benzo(g,h,i)perylene	0.18		mg/kg				PARA
AB-1	04/25	SVOA	Benzo(g,h,i)perylene	0.34		mg/kg				PARA
AB-1	04/25	SVOA	Benzo(g,h,i)perylene	0.22		mg/kg				PARA
AB-1	04/25	SVOA	Chrysene	0.14		mg/kg	96	62	0.00	PARA
Pajarito at Rio Grande	09/26	SVOA	Bis(2-ethylhexyl)phthalate	0.29	0.020	mg/kg	50	35	0.01	GELC

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[a] SVOA–semivolatile organics.

Table 5-27. Radiochemical Analysis of Groundwater for 2000 (pCi/L[a])

Station Name	Date	Codes[b]		^{3}H			^{90}Sr			^{137}Cs				^{234}U			^{235,236}U			^{238}U			U (µg/L, lab)
Regional Aquifer Wells																							
Test Wells:																							
Test Well 1	05/02	UF	CS	170	460		0.04	0.03	0.10		-0.43	2.08		1.947	0.096		0.047	0.016		1.097	0.066		
Test Well 2	05/03	UF	CS	60	440		0.03	0.03	0.10		0.32	1.21		0.032	0.016		-0.012	0.004		0.026	0.013		
Test Well 3	05/03	UF	CS	-40	430		0.03	0.03	0.10		0.00	4.49		0.340	0.039		-0.004	0.007		0.180	0.026		
Test Well 3	05/03	UF	CS	20	440		0.04	0.03	0.10		0.00	5.40		0.551	0.045		0.002	0.008		0.210	0.028		
Test Well 4	05/02	UF	CS	20	440		0.01	0.03	0.10		0.15	0.73		0.065	0.018		0.001	0.007		0.022	0.013		
Test Well 8	05/02	UF	CS	60	440		0.04	0.03	0.10		0.00	4.25		0.418	0.047		0.009	0.012		0.229	0.034		
Test Well DT-5A	10/26	UF	CS	-178	55	201	-0.03	0.12	0.44	<	0.00	0.90	3.84	0.159	0.033	0.017	-0.003	0.008	0.066	0.119	0.029	0.045	
Test Well DT-5A	10/26	UF	DUP																				
Test Well DT-5A	10/26	UF	CS	-176	54	198	-0.01	0.12	0.43	<	-0.80	1.07	3.54	0.319	0.051	0.057	0.000	1.000	0.017	0.095	0.027	0.066	
Test Well DT-10	10/27	UF	CS	-180	56	203	-0.02	0.10	0.37	<	0.30	1.11	3.31	0.535	0.073	0.073	0.030	0.016	0.050	0.162	0.036	0.063	
Test Well DT-10	10/27	UF	DUP							<	1.70	1.22	2.89										
Water Supply Wells:																							
O-1	06/21	UF	CS											0.877	0.059		0.016	0.013		0.559	0.045		
O-1	08/14	UF	CS	-60	390						0.00	11.14		0.808	0.057		0.020	0.011		0.419	0.038		
O-1	08/14	UF	CS	-60	390						-0.27	1.71		0.854	0.059		0.016	0.012		0.482	0.041		
O-4	06/21	UF	CS											0.578	0.050		0.011	0.010		0.252	0.029		
O-4	08/14	UF	CS	-60	390						0.00	8.66		0.474	0.043		0.033	0.016		0.264	0.031		
PM-1	02/14	UF	CS				0.01	0.03						1.280	0.125		0.017	0.013		0.600	0.070		
PM-1	06/20	UF	CS											1.309	0.076		0.027	0.014		0.581	0.047		
PM-1	08/14	UF	CS	30	400						0.13	0.84		1.329	0.072		0.035	0.014		0.583	0.044		
PM-1	08/14	UF	CS	30	400						0.00	8.64		0.221	0.032		-0.007	0.010		0.112	0.020		
PM-2	02/14	UF	CS				0.00	0.04						0.174	0.035		-0.002	0.010		0.096	0.025		
PM-2	06/20	UF	CS											0.213	0.029		0.009	0.009		0.105	0.019		
PM-2	08/14	UF	CS	-150	380		-0.07	0.21	0.37		-2.01	4.06		0.169	0.030		0.005	0.008		0.108	0.020		
PM-3	06/21	UF	CS											0.729	0.053		0.002	0.009		0.295	0.031		
PM-3	08/14	UF	CS	30	400		0.09	0.23	0.39		-0.32	2.80		0.663	0.052		0.002	0.007		0.320	0.034		
PM-4	06/21	UF	CS											0.260	0.031		0.012	0.010		0.117	0.020		
PM-4	08/14	UF	CS	-150	380		0.09	0.23	0.39		1.36	1.67		0.239	0.037		0.009	0.007		0.117	0.020		
PM-5	02/14	UF	CS				0.03	0.04						0.350	0.055		0.031	0.015		0.218	0.041		
PM-5	06/20	UF	CS											0.261	0.032		0.013	0.009		0.163	0.024		
PM-5	08/14	UF	CS	30	400		0.06	0.22	0.36		0.00	4.03		0.278	0.032		-0.013	0.010		0.141	0.022		
G-1A	08/14	UF	CS	-150	380		0.02	0.22	0.38		-0.93	6.35		0.263	0.032		0.006	0.009		0.149	0.023		
G-2A	06/20	UF	CS											0.245	0.029		0.033	0.013		0.232	0.028		
G-2A	08/14	UF	CS	-60	390		-0.07	0.22	0.38		-1.47	5.14		0.283	0.032		0.006	0.008		0.198	0.026		
G-3A	06/20	UF	CS											0.554	0.044		0.021	0.011		0.244	0.028		
G-3A	08/14	UF	CS	30	400		-0.09	0.22	0.39		0.00	6.97		0.444	0.046		0.013	0.011		0.321	0.038		
G-4A	06/20	UF	CS											0.460	0.042		-0.001	0.013		0.203	0.027		
G-4A	08/14	UF	CS	30	400		0.06	0.22	0.37		-0.74	4.56		0.586	0.049		0.015	0.010		0.249	0.031		
Regional Aquifer Springs																							
White Rock Canyon Group I:																							
Sandia Spring	09/25	F	CS				0.06	0.09	0.32	<	0.67	1.02	3.64	0.202	0.046	0.104	0.024	0.022	0.112	0.174	0.042	0.095	
Sandia Spring	09/25	F	DUP				0.17	0.09	0.29														
Sandia Spring	09/25	UF	CS	-60	56	192																	
Spring 3A	09/25	F	CS				0.07	0.10	0.35	<	0.00	1.72	3.05	0.729	0.098	0.163	0.019	0.024	0.132	0.402	0.066	0.095	
Spring 3A	09/25	F	DUP							<	1.08	0.72	2.62										
Spring 3A	09/25	UF	CS	-30	57	193																	
Spring 4	09/25	F	CS				0.07	0.09	0.31	<	-0.63	0.91	3.12	0.490	0.057	0.029	0.048	0.017	0.043	0.314	0.042	0.029	
Spring 4	09/25	UF	CS	-61	56	195																	
Spring 4A	09/25	F	CS				-0.09	0.08	0.29		9.09	1.59	2.09	0.601	0.068	0.052	0.013	0.013	0.047	0.290	0.042	0.032	
Spring 4A	09/25	F	DUP											0.504	0.077	0.091	0.034	0.017	0.023	0.322	0.058	0.023	
Spring 4A	09/25	UF	CS	-90	55	192																	
Spring 4A	09/25	UF	DUP	-120	54	191																	
Ancho Spring	09/26	F	CS				0.03	0.09	0.33		3.24	1.64	3.08	0.218	0.051	0.134	-0.009	0.017	0.126	0.062	0.026	0.083	
Ancho Spring	09/26	UF	CS	-90	54	191																	

Table 5-27. Radiochemical Analysis of Groundwater for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{3}H			^{90}Sr			^{137}Cs				^{234}U			^{235,236}U			^{238}U			U (µg/L, lab)
Regional Aquifer Springs (Cont.)																							
White Rock Canyon Group II:																							
Spring 5A	09/26	F	CS				0.24	0.10	0.34		3.92	1.46	3.38	0.922	0.120	0.106	0.015	0.015	0.073	0.488	0.081	0.106	
Spring 5A	09/26	UF	CS	-148	52	189																	
Spring 5B	07/26	F	CS				0.08	0.11	0.37	<	0.26	1.69	4.18	0.474	0.077	0.099	0.010	0.015	0.086	0.231	0.053	0.130	
Spring 5B	07/26	UF	CS	-90	55	192																	
Spring 6	09/26	F	CS				0.26	0.10	0.32	<	0.35	1.00	3.47	0.267	0.058	0.134	0.010	0.010	0.026	0.100	0.033	0.070	
Spring 6	09/26	UF	CS	-152	54	194																	
Spring 6	09/26	F	CS				0.17	0.10	0.33	<	1.10	1.86	2.99	0.234	0.037	0.041	0.013	0.013	0.048	0.088	0.021	0.012	
Spring 6	09/26	UF	CS	-121	54	194																	
Spring 8A	09/26	F	CS				-0.03	0.11	0.37	<	1.43	1.04	4.06	0.058	0.029	0.117	0.000	0.010	0.077	0.046	0.021	0.061	
Spring 8A	09/26	UF	CS	-30	57	193																	
Spring 9A	09/27	F	CS				4.49	0.31	0.48		-0.20	0.73	2.59	0.229	0.047	0.084	-0.012	0.007	0.084	0.035	0.018	0.057	
Spring 9A	09/27	F	DUP				0.02	0.09	0.30		0.51	0.68	2.45										
Spring 9A	09/27	UF	CS	-120	56	192																	
Doe Spring	09/27	F	CS				0.05	0.09	0.31	<	2.57	1.28	3.04	0.085	0.034	0.135	0.000	1.000	0.022	0.028	0.017	0.060	
Doe Spring	09/27	UF	CS	-30	56	192																	
Spring 10	09/27	F	CS				0.09	0.10	0.35	<	0.59	0.98	3.85	0.427	0.072	0.182	0.030	0.024	0.120	0.257	0.050	0.091	
Spring 10	09/27	UF	CS	-60	55	192																	
White Rock Canyon Group III:																							
Spring 1	09/25	F	CS				0.03	0.12	0.42	<	-1.15	1.43	4.78	1.250	0.144	0.147	0.036	0.021	0.082	0.617	0.089	0.106	
Spring 1	09/25	UF	CS	-69	64	220																	
Spring 2	09/25	F	CS				-0.16	0.13	0.46	<	0.74	0.62	2.33	1.040	0.136	0.144	0.044	0.026	0.102	0.499	0.085	0.118	
Spring 2	09/25	UF	CS	-30	57	193																	
White Rock Canyon Group IV:																							
La Mesita Spring	10/19	F	CS				0.07	0.03	0.11		0.20	0.64	2.31	5.860	0.460	0.090	0.147	0.032	0.044	3.730	0.306	0.056	
La Mesita Spring	10/19	F	DUP								-0.33	0.92	3.19										
La Mesita Spring	10/19	UF	CS	-152	54	194																	
Other Springs:																							
Sacred Spring	10/19	F	CS				0.09	0.04	0.12		-0.55	0.89	3.13	3.400	0.284	0.057	0.096	0.026	0.046	2.140	0.193	0.120	
Sacred Spring	10/19	F	DUP				1.99	0.59	1.88														
Sacred Spring	10/19	UF	CS	-90	55	192																	
Sacred Spring	10/19	UF	DUP	-60	56	193																	
Canyon Alluvial Groundwater Systems																							
Acid/Pueblo Canyons:																							
APCO-1	07/26	UF	CS	690	450		0.40	0.06	0.12		-0.39	3.37		0.454	0.050		0.018	0.014		0.273	0.038		
DP/Los Alamos Canyons:																							
LAO-C	08/01	UF	CS	690	450		0.47	0.06			0.00	9.54		0.229	0.029		0.014	0.012		0.170	0.024		
LAO-0.7	08/01	UF	CS				0.37	0.06	0.13					0.559	0.050	0.093	0.032	0.013	0.024	0.483	0.041	0.017	
LAO-2	06/26	UF	CS	90	450		6.90	0.65	0.14		0.57	1.03		0.099	0.022		-0.008	0.010		0.051	0.015		
LAO-3A	06/26	UF	CS	50	440		24.10	2.20	0.17		1.15	1.01		0.136	0.025		-0.002	0.009		0.076	0.017		
LAO-4	08/01	UF	CS	510	440		5.18	0.47			0.32	1.16		0.123	0.024		0.008	0.009		0.055	0.015		

Table 5-27. Radiochemical Analysis of Groundwater for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		^{3}H			^{90}Sr				^{137}Cs			^{234}U			^{235,236}U			^{238}U			U (μg/L, lab)	
Canyon Alluvial Groundwater Systems (Cont.)																								
Mortandad Canyon:																								
MCO-2	07/17	UF	CS	130	450		0.67	0.08			0.00	7.02		0.144	0.033		0.008	0.009		0.157	0.023			
MCO-3	07/17	UF	CS	76,300	3,400		24.30	2.20			7.68	1.84		4.277	0.167		0.103	0.023		1.173	0.069			
MCO-5	07/07	UF	CS	6,686	259		55.00	5.00	0.72	<	-0.10	1.45	2.40	1.330	0.110	0.044	0.058	0.015	0.030	0.305	0.038	0.030	1.22	
MCO-5	07/07	F	CS				57.00	5.50	2.20					1.480	0.120	0.046	0.046	0.014	0.034	0.412	0.047	0.029	1.21	
MCO-6	07/10	UF	CS	8,260	313		60.30	7.00	0.87					1.270	0.120	0.021	0.034	0.009	0.015	0.445	0.048	0.010	1.58	
MCO-6	07/10	F	CS				56.80	6.50	0.76					1.250	0.120	0.016	0.027	0.007	0.009	0.451	0.047	0.013	1.56	
MCO-6	07/10	UF	CS	8,184	294						0.69	2.10	7.89											
MCO-6	07/10	F	CS				54.70	13.00	0.81					1.410	0.135	0.024	0.041	0.010	0.016	0.503	0.055	0.012	1.62	
MCO-7	07/10	UF	CS	10,971	383		2.33	0.44	0.95					0.852	0.085	0.021	0.025	0.007	0.014	0.600	0.060	0.010	2.18	
MCO-7	07/10	F	CS				1.93	0.40	0.88					0.775	0.080	0.022	0.026	0.008	0.016	0.657	0.070	0.012	2.18	
MCO-7.5	07/11	UF	CS	16,137	578		0.16	0.19	0.84					0.516	0.060	0.040	0.028	0.105	0.025	0.556	0.065	0.022	1.69	
MCO-7.5	07/11	F	CS				0.10	0.17	0.75					0.503	0.055	0.016	0.028	0.007	0.010	0.454	0.049	0.014	1.60	
Cañada del Buey:																								
CDBO-6	12/12	UF	CS																					
CDBO-6	12/12	UF	DUP																					
Intermediate Perched Groundwater Systems																								
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:																								
POI-4	07/19	UF	CS	140	450		-0.01	0.04	0.12		-0.90	2.48		1.215	0.069		0.039	0.013		0.769	0.052			
Basalt Spring	07/25	F	CS				0.88	0.09	0.13		-3.50	31.14		0.382	0.042		0.003	0.016		0.274	0.034			
Basalt Spring	07/25	UF	CS	420	430																			
Water Canyon Gallery	08/15	UF	CS	30	400		0.03	0.22	0.38		0.00	6.22		0.140	0.023		0.018	0.011		0.105	0.018			
San Ildefonso Pueblo:																								
LA-5	12/06	UF	CS	-145	55	196	-0.05	0.11	0.40	<	-0.78	0.59	2.00	0.617	0.086	0.096	0.033	0.019	0.075	0.329	0.058	0.074		
Eastside Artesian Well	04/05	UF	CS	-110	450						0.46	0.91											0.05	0.09
Eastside Artesian Well	04/05	UF	CS				0.03	0.03																
Pajarito Well (Pump 1)	11/29	UF	CS	-204	55	203	0.11	0.12	0.39	<	-0.05	0.67	2.37	11.100	1.070	0.213	0.161	0.059	0.165	3.120	0.360	0.165		
Pajarito Well (Pump 1)	11/29	UF	DUP				0.08	0.06	0.20	<	-0.13	0.67	2.37	9.210	0.856	0.108	0.191	0.058	0.137	2.890	0.319	0.158		
Don Juan Playhouse Well	04/05	UF	CS	30	460						0.48	0.91											5.90	0.30
Don Juan Playhouse Well	04/05	UF	CS				0.01	0.04																
Otowi House Well	12/06	UF	CS	-116	55	196	0.13	0.10	0.35	<	-0.05	0.68	2.39	2.240	0.240	0.105	0.057	0.029	0.106	1.250	0.157	0.136		
New Community Well	11/29	UF	CS	-171	54	198	0.04	0.12	0.42	<	1.09	0.95	3.32	13.400	1.150	0.033	0.323	0.069	0.090	9.670	0.854	0.089		
New Community Well	11/29	UF	CS	-147	57	204	0.00	0.12	0.41	<	-0.25	0.64	2.22	13.300	1.120	0.100	0.390	0.073	0.101	8.490	0.738	0.029		
New Community Well	11/29	UF	DUP	-147	57	204																		
Sanchez House Well	04/05	UF	CS	10	460						-0.47	7.24											7.30	0.30
Sanchez House Well	04/05	UF	CS	10	460						0.13	0.83											6.60	0.30
Sanchez House Well	04/05	UF	CS				-0.02	0.03																
Sanchez House Well	04/05	UF	CS				0.00	0.03																
Sanchez House Well	04/05	UF	DUP				0.06	0.03																
Water Quality Standards[c]																								
DOE DCG for Public Dose				2,000,000			1,000				3,000			500			600			600			800	
DOE Drinking Water System DCG				80,000			40				120			20			24			24			30	
EPA Primary Drinking Water Standard				20,000			8																30	
EPA Screening Level																								
NMWQCC Groundwater Limit																							5,000	

Table 5-27. Radiochemical Analysis of Groundwater for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		U (µg/L, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Regional Aquifer Wells																						
Test Wells:																						
Test Well 1	05/02	UF	CS	3.29	0.20	0.025	0.009		0.021	0.009		0.052	0.013		5.2	2.4		3.3	1.7		82.7	49.2
Test Well 2	05/03	UF	CS	0.07	0.04	0.035	0.012		0.015	0.008		0.018	0.007		0.2	0.4		1.4	0.9		108.0	49.3
Test Well 3	05/03	UF	CS	0.54	0.08	0.005	0.007		0.001	0.008		-0.008	0.008		0.2	0.4		1.4	0.9		50.6	48.9
Test Well 3	05/03	UF	CS	0.63	0.08	0.063	0.012		0.056	0.012		0.006	0.003		0.7	0.8		1.0	0.7		80.7	49.1
Test Well 4	05/02	UF	CS	0.07	0.04	0.006	0.004		0.007	0.006		0.005	0.003		0.1	0.2		1.0	0.7		45.1	48.9
Test Well 8	05/02	UF	CS	0.68	0.10	0.020	0.012		0.010	0.008		0.002	0.002		0.4	0.6		2.6	1.4		138.8	49.5
Test Well DT-5A	10/26	UF	CS	0.35	0.09	0.045	0.019	0.047	0.025	0.014	0.037	0.000	1.000	0.028	0.2	0.2	0.6	0.7	0.4	1.3		
Test Well DT-5A	10/26	UF	DUP									0.022	0.012	0.035								
Test Well DT-5A	10/26	UF	CS	0.28	0.47	0.051	0.018	0.037	0.020	0.011	0.029	0.017	0.009	0.025	0.4	0.3	0.7	0.9	0.4	1.4		
Test Well DT-10	10/27	UF	CS	0.50	0.11	0.042	0.016	0.031	-0.004	0.004	0.031	0.023	0.011	0.028	0.4	0.2	0.5	1.0	0.4	1.3		
Test Well DT-10	10/27	UF	DUP																			
Water Supply Wells:																						
O-1	06/21	UF	CS	1.67	0.13																	
O-1	08/14	UF	CS	1.26	0.11							0.046	0.010		1.9	2.2		2.7	2.0		47.0	48.8
O-1	08/14	UF	CS	1.44	0.12	0.001	0.006	0.029	-0.001	0.005	0.026	0.011	0.006		1.4	1.3		3.2	1.7		97.5	49.2
O-4	06/21	UF	CS	0.75	0.09																	
O-4	08/14	UF	CS	0.80	0.09	0.002	0.005	0.023	0.003	0.007	0.032	0.000	0.001		0.9	1.9		0.8	0.8		70.9	49.0
PM-1	02/14	UF	CS	1.79	0.21																	
PM-1	06/20	UF	CS	1.74	0.14																	
PM-1	08/14	UF	CS	1.75	0.13	0.000		0.010	0.001	0.004	0.023	0.026	0.009		2.6	2.5		2.2	1.7		97.5	49.2
PM-1	08/14	UF	CS	0.33	0.06	0.008	0.010	0.041	0.007	0.007	0.028	-0.008	0.010		3.6	1.0		3.7	1.9		46.3	48.8
PM-2	02/14	UF	CS	0.28	0.07																	
PM-2	06/20	UF	CS	0.32	0.06																	
PM-2	08/14	UF	CS	0.32	0.06	0.024	0.009	0.017	0.001	0.005	0.029	0.003	0.002		0.3	1.0		1.8	1.2		66.8	49.0
PM-3	06/21	UF	CS	0.88	0.09																	
PM-3	08/14	UF	CS	0.95	0.10	0.003	0.009	0.042	0.023	0.012	0.034	0.016	0.009		-0.2	0.2		3.3	2.3		113.8	49.3
PM-4	06/21	UF	CS	0.35	0.06																	
PM-4	08/14	UF	CS	0.35	0.06	0.002	0.004	0.022	0.013	0.008	0.022	0.024	0.009		0.5	0.9		1.4	1.0		141.8	49.5
PM-5	02/14	UF	CS	0.66	0.12																	
PM-5	06/20	UF	CS	0.49	0.07																	
PM-5	08/14	UF	CS	0.41	0.07	0.005	0.006	0.026	0.014	0.008	0.019	-0.004	0.005		0.4	0.9		1.5	1.1		83.8	49.1
G-1A	08/14	UF	CS	0.45	0.07	0.005	0.007	0.027	0.006	0.010	0.045	-0.003	0.002		0.6	1.0		1.9	1.2		113.1	49.3
G-2A	06/20	UF	CS	0.71	0.08																	
G-2A	08/14	UF	CS	0.59	0.08	-0.005	0.008	0.046	0.014	0.013	0.049	-0.023	0.043		0.2	1.3		1.9	1.2		110.4	49.3
G-3A	06/20	UF	CS	0.74	0.08																	
G-3A	08/14	UF	CS	0.96	0.11	0.003	0.007	0.032	0.005	0.005	0.020	0.003	0.002		0.3	1.0		1.2	0.9		176.5	49.7
G-4A	06/20	UF	CS	0.60	0.08																	
G-4A	08/14	UF	CS	0.75	0.09	0.021	0.010		-0.002	0.002		0.004	0.003		0.8	1.0		1.8	1.2		127.5	49.4
Regional Aquifer Springs																						
White Rock Canyon Group I:																						
Sandia Spring	09/25	F	CS	0.53	0.12	0.081	0.022	0.012	0.017	0.009	0.012	0.028	0.010	0.023	-0.3	0.4	1.9	4.2	0.9	2.6		
Sandia Spring	09/25	F	DUP												-0.4	0.6	2.4	3.8	1.1	3.3		
Sandia Spring	09/25	UF	CS																			
Spring 3A	09/25	F	CS	1.21	0.20	0.041	0.016	0.034	0.015	0.008	0.010	0.051	0.013	0.008	1.0	0.5	1.4	1.8	0.8	2.5		
Spring 3A	09/25	F	DUP																			
Spring 3A	09/25	UF	CS																			
Spring 4	09/25	F	CS	0.96	0.13	0.026	0.014	0.040	0.011	0.007	0.010	0.030	0.010	0.009	0.6	0.4	1.4	2.8	0.8	2.3		
Spring 4	09/25	UF	CS																			
Spring 4A	09/25	F	CS	0.87	0.12	0.003	0.006	0.024	0.003	0.003	0.009	0.012	0.008	0.027	1.0	0.5	1.5	2.6	0.8	2.6		
Spring 4A	09/25	F	DUP	0.97	0.17	0.003	0.003	0.009	0.009	0.007	0.023	0.051	0.014	0.009								
Spring 4A	09/25	UF	CS																			
Spring 4A	09/25	UF	DUP																			
Ancho Spring	09/26	F	CS	0.18	0.08	0.008	0.008	0.030	-0.004	0.007	0.038	0.030	0.013	0.031	-0.1	0.3	1.4	4.0	0.8	2.2		
Ancho Spring	09/26	UF	CS																			

Table 5-27. Radiochemical Analysis of Groundwater for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		U (µg/L, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Regional Aquifer Springs (Cont.)																						
White Rock Canyon Group II:																						
Spring 5A	09/26	F	CS	1.46	0.24	-0.003	0.006	0.032	0.010	0.009	0.032	0.013	0.009	0.030	1.4	0.7	1.9	3.9	0.9	2.8		
Spring 5A	09/26	UF	CS																			
Spring 5B	07/26	F	CS	0.69	0.16	0.000	0.007	0.034	0.007	0.005	0.010	0.024	0.010	0.025	0.1	0.4	1.6	1.2	0.8	2.8		
Spring 5B	07/26	UF	CS																			
Spring 6	09/26	F	CS	0.30	0.10	0.004	0.004	0.010	-0.004	0.007	0.035	0.020	0.008	0.009	0.3	0.3	1.1	1.5	0.8	2.5		
Spring 6	09/26	UF	CS																			
Spring 6	09/26	F	CS	0.27	0.06	0.025	0.010	0.010	-0.004	0.006	0.033	0.027	0.009	0.008	0.1	0.6	2.1	1.6	0.9	3.0		
Spring 6	09/26	UF	CS																			
Spring 8A	09/26	F	CS	0.14	0.06	0.025	0.010	0.010	0.014	0.007	0.010	0.013	0.007	0.012	-0.3	0.4	1.9	1.4	1.0	3.3		
Spring 8A	09/26	UF	CS																			
Spring 9A	09/27	F	CS	0.10	0.05	0.006	0.011	0.045	0.006	0.006	0.017	0.025	0.012	0.031	0.4	0.4	1.3	2.0	0.8	2.5		
Spring 9A	09/27	F	DUP												-0.3	0.4	1.7	1.7	0.8	2.5		
Spring 9A	09/27	UF	CS																			
Doe Spring	09/27	F	CS	0.08	0.47	0.012	0.012	0.043	0.028	0.014	0.037	0.034	0.013	0.031	-0.1	0.3	1.5	0.9	0.8	2.7		
Doe Spring	09/27	UF	CS																			
Spring 10	09/27	F	CS	0.78	0.15	0.032	0.012	0.010	0.014	0.007	0.010	0.028	0.011	0.011	0.5	0.5	1.8	2.4	0.9	2.9		
Spring 10	09/27	UF	CS																			
White Rock Canyon Group III:																						
Spring 1	09/25	F	CS	1.85	0.26	0.012	0.007	0.011	0.004	0.007	0.029	0.017	0.008	0.009	2.1	0.7	1.9	3.1	1.0	3.1		
Spring 1	09/25	UF	CS																			
Spring 2	09/25	F	CS	1.51	0.25	0.042	0.014	0.010	0.008	0.008	0.028	0.027	0.011	0.025	1.3	0.8	2.3	1.8	0.9	2.8		
Spring 2	09/25	UF	CS																			
White Rock Canyon Group IV:																						
La Mesita Spring	10/19	F	CS	11.17	0.91	0.014	0.007	0.010	0.004	0.008	0.033	0.008	0.006	0.011	8.1	1.6	0.7	4.7	0.5	1.4		
La Mesita Spring	10/19	F	DUP																			
La Mesita Spring	10/19	UF	CS																			
Other Springs:																						
Sacred Spring	10/19	F	CS	6.41	0.57	0.007	0.005	0.009	0.007	0.005	0.009	0.005	0.005	0.013	0.9	0.4	0.9	2.6	0.5	1.5		
Sacred Spring	10/19	F	DUP			0.006	0.005	0.009	0.006	0.005	0.009	0.005	0.009	0.039	0.8	0.3	1.0	2.5	0.5	1.4		
Sacred Spring	10/19	UF	CS																			
Sacred Spring	10/19	UF	DUP																			
Canyon Alluvial Groundwater Systems																						
Acid/Pueblo Canyons:																						
APCO-1	07/26	UF	CS	0.82	0.11	0.004	0.006		0.148	0.024		0.021	0.009		2.0	2.5		16.7	8.5		29.3	51.1
DP/Los Alamos Canyons:																						
LAO-C	08/01	UF	CS	0.51	0.07	0.076	0.014		0.007	0.007		0.051	0.012		0.5	1.3		2.6	1.6		129.4	51.7
LAO-0.7	08/01	UF	CS	1.45	0.12	0.012	0.008	0.025	0.021	0.009	0.022	0.024	0.009	0.026								
LAO-2	06/26	UF	CS	0.15	0.05	0.012	0.008		0.035	0.014		0.011	0.011		3.4	2.5		20.7	6.6		34.9	48.8
LAO-3A	06/26	UF	CS	0.23	0.05	0.006	0.010		0.026	0.014		0.007	0.006		1.8	2.0		55.5	13.5		42.4	48.9
LAO-4	08/01	UF	CS	0.17	0.05	0.014	0.008		0.015	0.009		-0.607	0.536		1.2	1.3		15.2	4.7		118.7	51.7

Table 5-27. Radiochemical Analysis of Groundwater for 2000 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]		U (µg/L, calc)		^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta			Gross Gamma	
Canyon Alluvial Groundwater Systems (Cont.)																						
Mortandad Canyon:																						
MCO-2	07/17	UF	CS	0.47	0.07	0.017	0.009		0.012	0.008		0.007	0.005		2.2	2.1		7.2	4.9		106.6	51.6
MCO-3	07/17	UF	CS	3.54	0.20	1.182	0.106		0.607	0.071		1.534	0.068		21.2	8.6		102.0	25.7		57.9	51.3
MCO-5	07/07	UF	CS	0.93	0.11	0.033	0.012	0.027	0.050	0.014	0.022	0.106	0.026	0.044								
MCO-5	07/07	F	CS	1.25	0.14	0.059	0.016	0.024	0.020	0.009	0.024	0.107	0.025	0.038								
MCO-6	07/10	UF	CS	1.34	0.14	0.020	0.006	0.011	0.014	0.005	0.013	0.077	0.014	0.013								
MCO-6	07/10	F	CS	1.35	0.14	0.014	0.005	0.006	0.004	0.003	0.013	0.080	0.014	0.005								
MCO-6	07/10	UF	CS									-1.150	4.700	16.800								
MCO-6	07/10	F	CS	1.52	0.16	0.029	0.007	0.005	0.017	0.006	0.010	0.083	0.013	0.010								
MCO-7	07/10	UF	CS	1.80	0.18	0.012	0.005	0.012	0.020	0.007	0.013	0.106	0.016	0.004								
MCO-7	07/10	F	CS	1.97	0.21	0.033	0.008	0.004	0.007	0.004	0.011	0.121	0.018	0.012								
MCO-7.5	07/11	UF	CS	1.67	0.20	0.010	0.004	0.005	0.004	0.003	0.010	0.249	0.030	0.013								
MCO-7.5	07/11	F	CS	1.36	0.15	0.010	0.004	0.005	0.004	0.003	0.012	0.218	0.026	0.005								
Cañada del Buey:																						
CDBO-6	12/12	UF	CS												0.6	0.3	1.1					
CDBO-6	12/12	UF	DUP												0.8	0.2	0.6					
Intermediate Perched Groundwater Systems																						
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:																						
POI-4	07/19	UF	CS	2.31	0.16	0.010	0.007		0.020	0.009		0.010	0.007		4.4	3.6		10.0	7.2		44.3	51.2
Basalt Spring	07/25	F	CS	0.82	0.10	0.018	0.009		0.008	0.009		0.032	0.013		1.0	1.9		12.3	7.6		37.2	51.1
Basalt Spring	07/25	UF	CS																			
Water Canyon Gallery	08/15	UF	CS	0.32	0.05	0.018	0.008	0.015	0.007	0.006	0.015	0.017	0.006		0.6	1.0		1.1	0.9		190.8	49.8
San Ildefonso Pueblo:																						
LA-5	12/06	UF	CS	0.99	0.17	0.094	0.022	0.013	0.010	0.007	0.013	0.021	0.013	0.043	0.5	0.4	1.0	1.3	0.5	1.8		
Eastside Artesian Well	04/05	UF	CS			0.013	0.010		0.006	0.006		-0.016	0.189		187.0	39.6		2.1	1.9		84.9	50.5
Eastside Artesian Well	04/05	UF	CS																			
Pajarito Well (Pump 1)	11/29	UF	CS	9.36	1.07	0.049	0.016	0.032	0.002	0.008	0.041	0.031	0.011	0.011	5.0	3.2	1.2	1.9	0.6	1.8		
Pajarito Well (Pump 1)	11/29	UF	DUP	8.69	0.95	0.027	0.010	0.022	-0.003	0.005	0.028	0.029	0.015	0.020								
Don Juan Playhouse Well	04/05	UF	CS			0.036	0.011		0.004	0.007		0.011	0.005		6.1	3.8		6.1	3.5		77.3	50.5
Don Juan Playhouse Well	04/05	UF	CS																			
Otowi House Well	12/06	UF	CS	3.75	0.47	0.305	0.043	0.045	0.016	0.010	0.035	0.010	0.012	0.045	2.0	1.2	1.3	3.2	0.6	1.8		
New Community Well	11/29	UF	CS	28.93	2.54	0.030	0.012	0.014	0.025	0.011	0.014	0.034	0.013	0.013	16.0	6.9	1.8	6.9	0.7	1.8		
New Community Well	11/29	UF	CS	25.45	2.20	0.069	0.020	0.044	0.215	0.034	0.035	0.030	0.013	0.032	4.2	0.9	1.0	2.2	0.6	1.7		
New Community Well	11/29	UF	DUP																			
Sanchez House Well	04/05	UF	CS			0.015	0.008		-0.001	0.006		-0.009	0.014		12.4	6.5		4.5	3.5		133.6	50.9
Sanchez House Well	04/05	UF	CS			0.012	0.007		0.014	0.008		0.007	0.005		5.4	4.4		7.4	4.6		58.5	50.4
Sanchez House Well	04/05	UF	CS																			
Sanchez House Well	04/05	UF	CS																			
Sanchez House Well	04/05	UF	DUP																			
Water Quality Standards[c]																						
DOE DCG for Public Dose				800		40			30			30			30			1,000				
DOE Drinking Water System DCG				30		1.6			1.2			1.2			1.2			40				
EPA Primary Drinking Water Standard				30											15							
EPA Screening Level																		50				
NMWQCC Groundwater Limit				5,000																		

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[a] Except where noted. Three columns are listed: the first is the analytical result, the second is the radioactive counting uncertainty (1 standard deviation), and the third is the analytical laboratory measurement-specific minimum detectable activity.

[b] Codes: UF–unfiltered; F–filtered; CS–customer sample; DUP–laboratory duplicate.

[c] Standards given here for comparison only; see Appendix A.

Table 5-28. Detections of Radionuclides[a] and Comparison to Standards[b] in Groundwater for 2000

Station Name	Date	Code[c]	Analyte	Result	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Result/ Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Regional Aquifer Wells													
Test Wells:													
Test Well 1	05/02	UF CS	^{241}Am	0.052	0.013		pCi/L						
Test Well 3	05/03	UF CS	^{238}Pu	0.063	0.012		pCi/L						
Test Well 3	05/03	UF CS	^{239,240}Pu	0.056	0.012		pCi/L						
Water Supply Wells:													
O-1	06/21	UF DUP	^{90}Sr	0.19	0.05	0.15	pCi/L						
O-1	07/07	UF CS	^{3}H	38.0	1.3		pCi/L						
O-1	08/14	UF CS	^{241}Am	0.046	0.010		pCi/L						
O-1	10/16	UF CS	^{3}H	31.9	1.0		pCi/L						
O-1	10/16	UF CS	^{3}H	35.4	1.3		pCi/L						
O-1	11/15	UF CS	^{3}H	23.8	0.8		pCi/L						
O-1	12/12	UF CS	^{3}H	22.0	0.8		pCi/L						
O-1	12/12	UF CS	^{3}H	23.9	0.8		pCi/L						
G-3A	06/20	UF CS	^{90}Sr	0.17	0.04	0.13	pCi/L						
Regional Aquifer Springs													
White Rock Canyon Group I:													
Sandia Spring	09/25	F CS	^{238}Pu	0.081	0.022	0.012	pCi/L						
Spring 3A	09/25	F CS	^{241}Am	0.051	0.013	0.008	pCi/L						
Spring 4A	09/25	F DUP	^{241}Am	0.051	0.014	0.009	pCi/L						
Spring 4A	09/25	F CS	^{241}Am	0.027	0.008	0.027	pCi/L	U					
Spring 4A	09/25	F CS	^{137}Cs	9.090	1.590	2.090	pCi/L						
Spring 4A	09/25	F CS	^{238}Pu	0.024	0.006	0.024	pCi/L	U					
Ancho Spring	09/26	F CS	^{238}Pu	0.030	0.008	0.030	pCi/L	U					
Ancho Spring	09/26	F CS	^{239,240}Pu	0.038	0.007	0.038	pCi/L	U					
White Rock Canyon Group II:													
Spring 5A	09/26	F CS	^{241}Am	0.030	0.009	0.030	pCi/L	U					
Spring 5A	09/26	F CS	^{238}Pu	0.032	0.006	0.032	pCi/L	U					
Spring 5A	09/26	F CS	^{239,240}Pu	0.032	0.009	0.032	pCi/L	U					
Spring 5B	07/26	F CS	^{238}Pu	0.034	0.007	0.034	pCi/L	U					
Spring 6	09/26	F CS	^{239,240}Pu	0.035	0.007	0.035	pCi/L	U					
Spring 6	09/26	F CS	^{239,240}Pu	0.033	0.006	0.033	pCi/L	U					
Spring 9A	09/27	F CS	^{90}Sr	4.49	0.31	0.48	pCi/L		0.56	8	EPA PRIM DW STD		
Doe Spring	09/27	F CS	^{238}Pu	0.043	0.012	0.043	pCi/L	U					

Table 5-28. Detections of Radionuclides[a] and Comparison to Standards[b] in Groundwater for 2000 (Cont.)

Station Name	Date		Code[c]	Analyte	Result	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Result/ Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Regional Aquifer Springs (Cont.)														
White Rock Canyon Group III:														
Spring 1	09/25	F	CS	^{239,240}Pu	0.029	0.007	0.029	pCi/L	U					
Spring 2	09/25	F	CS	^{238}Pu	0.042	0.014	0.010	pCi/L						
Spring 2	09/25	F	CS	^{239,240}Pu	0.028	0.008	0.028	pCi/L	U					
White Rock Canyon Group IV:														
La Mesita Spring	10/19	F	CS	Gross Alpha	8.1	1.6	0.7	pCi/L		0.54	15	EPA PRIM DW STD		
La Mesita Spring	10/19	F	TOTC	U	11.2	0.9		µg/L						
Other Springs:														
Sacred Spring	10/19	F	DUP	^{90}Sr	1.99	0.59	1.88	pCi/L						
Sacred Spring	10/19	F	TOTC	U	6.4	0.6		µg/L						
Canyon Alluvial Groundwater Systems														
Acid/Pueblo Canyons:														
APCO-1	07/26	UF	CS	^{239,240}Pu	0.148	0.024		pCi/L						
APCO-1	07/26	UF	CS	^{90}Sr	0.40	0.06	0.12	pCi/L						
DP/Los Alamos Canyons:														
LAO-C	08/01	UF	CS	^{241}Am	0.051	0.012		pCi/L						
LAO-C	08/01	UF	CS	^{238}Pu	0.076	0.014		pCi/L						
LAO-C	08/01	UF	CS	^{90}Sr	0.47	0.06		pCi/L						
LAO-0.7	08/01	UF	CS	^{90}Sr	0.37	0.06	0.13	pCi/L						
LAO-2	06/26	UF	CS	Gross Beta	20.7	6.6		pCi/L						
LAO-2	06/26	UF	CS	^{90}Sr	6.90	0.65	0.14	pCi/L		0.86	8	EPA PRIM DW STD		
LAO-3A	06/26	UF	CS	Gross Beta	55.5	13.5		pCi/L		1.11	50	EPA SEC DW LVL		
LAO-3A	06/26	UF	CS	^{90}Sr	24.10	2.20	0.17	pCi/L		3.01	8	EPA SEC DW LVL		
LAO-4	08/01	UF	CS	^{90}Sr	5.18	0.47		pCi/L		0.65	8	EPA PRIM DW STD		
Mortandad Canyon:														
MCO-2	07/17	UF	CS	^{90}Sr	0.67	0.08		pCi/L						
MCO-3	07/17	UF	CS	^{241}Am	1.534	0.068		pCi/L		1.28	1.2	DOE DW DCG		
MCO-3	07/17	UF	CS	^{137}Cs	7.680	1.840		pCi/L						
MCO-3	07/17	UF	CS	Gross Beta	102.0	25.7		pCi/L		2.04	50	EPA SEC DW LVL		
MCO-3	07/17	UF	CS	^{3}H	76,300	3,400		pCi/L		3.82	20,000	EPA SEC DW LVL		

Table 5-28. Detections of Radionuclides[a] and Comparison to Standards[b] in Groundwater for 2000 (Cont.)

Station Name	Date		Code[c]	Analyte	Result	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Result/ Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Canyon Alluvial Groundwater Systems (Cont.)														
Mortandad Canyon (Cont):														
MCO-3	07/17	UF	CS	^{238}Pu	1.182	0.106		pCi/L		0.74	1.6	EPA PRIM DW STD		
MCO-3	07/17	UF	CS	^{239,240}Pu	0.607	0.071		pCi/L		0.51	1.2	EPA PRIM DW STD		
MCO-3	07/17	UF	CS	^{90}Sr	24.30	2.20		pCi/L		3.04	8	EPA SEC DW LVL		
MCO-5	07/07	F	CS	^{241}Am	0.107	0.025	0.038	pCi/L						
MCO-5	07/07	F	CS	^{238}Pu	0.059	0.016	0.024	pCi/L						
MCO-5	07/07	F	CS	^{90}Sr	57.00	5.50	2.20	pCi/L		7.13	8	EPA SEC DW LVL		
MCO-5	07/07	UF	CS	^{241}Am	0.106	0.026	0.044	pCi/L						
MCO-5	07/07	UF	CS	^{3}H	6,686	259		pCi/L						
MCO-5	07/07	UF	CS	^{239,240}Pu	0.050	0.014	0.022	pCi/L						
MCO-5	07/07	UF	CS	^{90}Sr	55.00	5.00	0.72	pCi/L		6.88	8	EPA SEC DW LVL		
MCO-6	07/10	F	CS	^{241}Am	0.080	0.014	0.005	pCi/L						
MCO-6	07/10	F	CS	^{241}Am	0.083	0.013	0.010	pCi/L						
MCO-6	07/10	F	CS	^{238}Pu	0.029	0.007	0.005	pCi/L						
MCO-6	07/10	F	CS	^{90}Sr	56.80	6.50	0.76	pCi/L		7.10	8	EPA SEC DW LVL		
MCO-6	07/10	F	CS	^{90}Sr	54.70	13.00	0.81	pCi/L		6.84	8	EPA SEC DW LVL		
MCO-6	07/10	UF	CS	^{241}Am	0.077	0.014	0.013	pCi/L						
MCO-6	07/10	UF	CS	^{3}H	8,260	313		pCi/L						
MCO-6	07/10	UF	CS	^{3}H	8,184	294		pCi/L						
MCO-6	07/10	UF	CS	^{238}Pu	0.020	0.006	0.011	pCi/L						
MCO-6	07/10	UF	CS	^{90}Sr	60.30	7.00	0.87	pCi/L		7.54	8	EPA SEC DW LVL		
MCO-7	07/10	F	CS	^{241}Am	0.121	0.018	0.012	pCi/L						
MCO-7	07/10	F	CS	^{238}Pu	0.033	0.008	0.004	pCi/L						
MCO-7	07/10	F	CS	^{90}Sr	1.93	0.40	0.88	pCi/L						
MCO-7	07/10	UF	CS	^{241}Am	0.106	0.016	0.004	pCi/L						
MCO-7	07/10	UF	CS	^{3}H	10,971	383		pCi/L		0.55	20,000	EPA PRIM DW STD		
MCO-7	07/10	UF	CS	^{239,240}Pu	0.020	0.007	0.013	pCi/L						
MCO-7	07/10	UF	CS	^{90}Sr	2.33	0.44	0.95	pCi/L						
MCO-7.5	07/11	F	CS	^{241}Am	0.218	0.026	0.005	pCi/L						
MCO-7.5	07/11	UF	CS	^{241}Am	0.249	0.030	0.013	pCi/L						
MCO-7.5	07/11	UF	CS	^{3}H	16,137	578		pCi/L		0.81	20,000	EPA PRIM DW STD		

Table 5-28. Detections of Radionuclides[a] and Comparison to Standards[b] in Groundwater for 2000 (Cont.)

Station Name	Date	Code[c]	Analyte	Result	Uncertainty[d]	MDA[e]	Units	Lab Qual Code[f]	Result/ Minimum Standard	Minimum Standard	Minimum Standard Type	DOE DCG	Result/ DOE DCG
Intermediate Perched Groundwater Systems													
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:													
Basalt Spring	07/25	F CS	^{90}Sr	0.88	0.09	0.13	pCi/L						
San Ildefonso Pueblo:													
LA-5	12/06	UF CS	^{238}Pu	0.094	0.022	0.013	pCi/L						
Eastside Artesian Well	04/05	UF CS	Gross Alpha	187.0	39.6		pCi/L		12.47	15	EPA PRIM DW STD	30	6.23
Pajarito Well (Pump 1)	11/29	UF CS	^{238}Pu	0.049	0.016	0.032	pCi/L						
Pajarito Well (Pump 1)	11/29	UF TOTC	U	9.4	1.1		µg/L						
Pajarito Well (Pump 1)	11/29	UF TOTCD	U	8.7	0.9		µg/L						
Don Juan Playhouse Well	04/05	UF CS	^{238}Pu	0.036	0.011		pCi/L						
Don Juan Playhouse Well	04/05	UF CS	U	5.9	0.3		µg/L						
Otowi House Well	12/06	UF CS	^{238}Pu	0.305	0.043	0.045	pCi/L						
New Community Well	11/29	UF CS	^{238}Pu	0.069	0.020	0.044	pCi/L						
New Community Well	11/29	UF CS	^{239,240}Pu	0.215	0.034	0.035	pCi/L						
New Community Well	11/29	UF TOTC	U	28.9	2.5		µg/L		0.96	30	EPA SEC DW LVL		
New Community Well	11/29	UF TOTC	U	25.5	2.2		µg/L		0.85	30	EPA SEC DW LVL		
Sanchez House Well	04/05	UF CS	U	7.3	0.3		µg/L						
Sanchez House Well	04/05	UF CS	U	6.6	0.3		µg/L						

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[a] Detection defined as value ≥ 3× uncertainty and ≥ detection limit, except values shown for uranium ≥5 µg/L, for gross alpha ≥5 pCi/L, and for gross beta ≥20 pCi/L. Note that some results in this table were qualified as nondetections by the analytical laboratory.

[b] Values indicated by entries in right-hand columns are greater than half the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.

[c] Codes: UF–unfiltered, F–filtered, CS–customer sample; DUP–duplicate; TRP–triplicate; RE–reanalysis; TOTC–value calculated from other results; TOTCD–duplicate calculated value.

[d] One standard deviation radioactivity counting uncertainty.

[e] MDA = minimum detectable activity.

[f] Codes: B–analyte found in lab blank; U–analyte not detected.

Table 5-29. Special Regional Aquifer Sampling for Strontium-90 During 2000[a]

Station Name	Date	Codes[b]		Result	Uncertainty	MDA	Detect?[c]
Test Well 1	05/02	UF	CS	0.04	0.03	0.10	
Test Well 1	05/02	UF	DUP	0.04	0.03	0.09	
Test Well 1	09/12	UF	CS	0.01	0.13	0.46	
Test Well 1	09/12	UF	DUP	–0.06	0.09	0.32	
Test Well 1	12/13	UF	CS	–0.03	0.07	0.24	
Test Well 2	05/03	UF	CS	0.03	0.03	0.10	
Test Well 2	09/12	UF	CS	–0.22	0.14	0.50	
Test Well 2	12/13	UF	CS	0.01	0.07	0.24	
Test Well 3	05/03	UF	CS	0.03	0.03	0.10	
Test Well 3	05/03	UF	CS	0.04	0.03	0.10	
Test Well 3	09/27	UF	CS	0.10	0.12	0.42	
Test Well 3	12/18	UF	CS	0.07	0.08	0.26	
Test Well 3	12/18	UF	DUP	–0.04	0.05	0.20	
Test Well 4	05/02	UF	CS	0.01	0.03	0.10	
Test Well 4	09/12	UF	CS	0.06	0.14	0.48	
Test Well 4	12/18	UF	CS	–0.10	0.08	0.30	
Test Well 8	05/02	UF	CS	0.04	0.03	0.10	
Test Well 8	09/13	UF	CS	0.00	0.11	0.38	
Test Well 8	12/11	UF	CS	0.06	0.07	0.24	
Test Well DT-5A	10/26	UF	CS	–0.03	0.12	0.44	
Test Well DT-5A	10/26	UF	CS	–0.01	0.12	0.43	
Test Well DT-5A	12/19	UF	CS	–0.08	0.10	0.36	
Test Well DT-10	10/27	UF	CS	–0.02	0.10	0.37	
Test Well DT-10	12/19	UF	CS	0.09	0.08	0.27	
O-1	06/21	UF	CS	0.07	0.05	0.16	
O-1	06/21	UF	DUP	0.19	0.05	0.15	Detect
O-1	06/21	UF	RE	0.02	0.03	0.11	
O-1	08/03	UF	CS	0.03	0.43	0.74	
O-1	08/03	UF	DUP	–0.04	0.32	0.57	
O-1	08/03	UF	CS	0.07	0.04	0.13	
O-1	08/03	UF	CS	0.23	0.14	0.23	
O-1	08/03	UF	CS	–0.10	0.39	0.68	
O-1	08/03	UF	CS	–0.09	0.05	0.17	
O-1	08/14	UF	CS	–0.03	0.15	0.25	
O-1	08/14	UF	CS	–0.01	0.05		
O-1	08/14	UF	CS	0.01	0.05		
O-1	08/14	UF	DUP	0.00	0.05		
O-1	11/15	UF	CS	–0.09	0.07	0.24	
O-4	06/21	UF	CS	0.07	0.05	0.16	
O-4	06/21	UF	DUP	0.14	0.05	0.15	
O-4	08/14	UF	CS	0.05	0.11	0.19	
O-4	08/14	UF	CS	0.05	0.04		
O-4	11/15	UF	CS	–0.09	0.08	0.29	
PM-1	02/14	UF	CS	0.01	0.03		
PM-1	06/20	UF	CS	0.04	0.05	0.15	
PM-1	08/14	UF	CS	–0.02	0.12	0.20	
PM-1	08/14	UF	CS	–0.04	0.05		

Table 5-29. Special Regional Aquifer Sampling for Strontium-90 During 2000[a] (Cont.)

Station Name	Date	Codes[b]		Result	Uncertainty	MDA	Detect?[c]
PM-1	11/15	UF	CS	–0.07	0.05	0.17	
PM-2	02/14	UF	CS	0.00	0.04		
PM-2	06/20	UF	CS	0.13	0.05	0.16	
PM-2	08/14	UF	CS	–0.07	0.21	0.37	
PM-2	08/14	UF	CS	0.11	0.15	0.24	
PM-2	08/14	UF	CS	0.03	0.05		
PM-2	11/15	UF	CS	–0.05	0.06	0.20	
PM-3	06/21	UF	CS	0.10	0.04	0.13	
PM-3	06/21	UF	RE	0.01	0.04	0.12	
PM-3	08/14	UF	CS	0.09	0.23	0.39	
PM-3	08/14	UF	CS	-0.12	0.13	0.22	
PM-3	08/14	UF	CS	0.05	0.05		
PM-3	11/15	UF	CS	-0.02	0.04	0.15	
PM-4	06/21	UF	CS	0.09	0.04	0.13	
PM-4	06/21	UF	RE	0.05	0.03	0.10	
PM-4	08/03	UF	CS	-0.11	0.05	0.16	
PM-4	08/03	UF	CS	0.22	0.40	0.68	
PM-4	08/14	UF	CS	0.09	0.23	0.39	
PM-4	08/14	UF	CS	–0.17	0.16	0.28	
PM-4	08/14	UF	CS	–0.02	0.04		
PM-4	11/15	UF	CS	–0.03	0.06	0.21	
PM-5	02/14	UF	CS	0.03	0.04		
PM-5	06/20	UF	CS	0.06	0.04	0.13	
PM-5	08/14	UF	CS	0.06	0.22	0.36	
PM-5	08/14	UF	CS	–1.22	0.14	0.21	
PM-5	08/14	UF	CS	–0.02	0.05		
PM-5	08/14	UF	DUP	0.10	0.06		
PM-5	11/15	UF	CS	0.04	0.06	0.20	
G-1A	03/07	UF	CS	0.02	0.04	0.13	
G-1A	08/14	UF	CS	0.02	0.22	0.38	
G-1A	08/14	UF	CS	–0.02	0.15	0.26	
G-1A	08/14	UF	CS	0.03	0.04		
G-1A	11/15	UF	CS	0.14	0.07	0.23	
G-1A	11/15	UF	DUP	0.03	0.05	0.16	
G-2A	03/07	UF	CS	0.03	0.04	0.13	
G-2A	03/07	UF	DUP	0.03	0.04	0.13	
G-2A	06/20	UF	CS	0.05	0.04	0.13	
G-2A	08/14	UF	CS	–0.07	0.22	0.38	
G-2A	08/14	UF	CS	0.05	0.17	0.28	
G-2A	08/14	UF	CS	–0.04	0.04		
G-2A	11/15	UF	CS	0.00	0.07	0.24	
G-3A	03/06	UF	CS	0.01	0.04	0.12	
G-3A	06/20	UF	CS	0.17	0.04	0.13	Detect
G-3A	06/20	UF	RE	–0.01	0.03	0.10	
G-3A	08/03	UF	CS	0.07	0.33	0.56	
G-3A	08/03	UF	DUP	0.04	0.20	0.34	
G-3A	08/03	UF	CS	0.01	0.04	0.14	

Table 5-29. Special Regional Aquifer Sampling for Strontium-90 During 2000[a] (Cont.)

Station Name	Date	Codes[b]		Result	Uncertainty	MDA	Detect?[c]
G-3A	08/14	UF	CS	–0.09	0.22	0.39	
G-3A	08/14	UF	CS	–0.04	0.15	0.26	
G-3A	08/14	UF	CS	0.02	0.04		
G-3A	11/15	UF	CS	–0.09	0.05	0.19	
G-4A	03/06	UF	CS	0.01	0.04	0.13	
G-4A	06/20	UF	CS	0.00	0.04	0.13	
G-4A	08/14	UF	CS	0.03	0.12	0.21	
G-4A	08/14	UF	DUP	–0.06	0.16	0.27	
G-4A	08/14	UF	CS	0.06	0.22	0.37	
G-4A	08/15	UF	CS	–0.05	0.04		
G-4A	11/15	UF	CS	–0.01	0.05	0.19	
G-4A	11/15	UF	CS	–0.07	0.07	0.24	
Water Quality Standards[d]							
DOE DCG for Public Dose				1,000			
DOE Drinking Water System DCG				40			
EPA Primary Drinking Water Standard				8			

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[a] Three columns are listed: the first is the analytical result, the second is the radioactive counting uncertainty (1 standard deviation), and the third is the analytical laboratory measurement-specific minimum detectable activity.

[b] Codes: UF–Unfiltered; F–Filtered; CS–Customer Sample; DUP–Laboratory Duplicate; RE–Reanalysis of Sample.

[c] Detection defined as value ≥ 3× uncertainty and ≥ detection limit.

[d] Standards given here for comparison only; see Appendix A.

Table 5-30. Special Water Supply Sampling for Tritium during 2000 (pCi/L)[a]

Sample Date	PM-1	PM-2	PM-3	PM-4	PM-5	O-1	O-4	G-1A	G-2A	G-3A	G-4A	G-5A
02/14	0.51 ± 0.29	–0.06 ± 0.29	OS[b]	OS	0.19 ± 0.29	OS	OS					
03/07								0.06 ± 0.29	0.00 ± 0.29	–0.29 ± 0.29	0.13 ± 0.29	OS
06/21			0.096 ± 0.32	–0.22 ± 0.29		38.00 ± 1.3	0.96 ± 0.29					OS
10/16						31.93 ± 0.96						
10/16						35.44 ± 1.28						
11/15						23.82 ± 0.80						
12/12						21.97 ± 0.77						
12/12						23.95 ± 0.80						

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[a] Analyses done by University of Miami. Results ± one standard deviation counting uncertainity.

[b] OS = means that the well was out-of-service on that date.

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a])

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N
Regional Aquifer Wells															
Test Wells:															
Test Well 1	05/02	F	CS												
Test Well 1	05/02	UF	CS	46	49.6	9.8	4.2	16.9	36.7	23.7	<[f] 5	115	0.33	0.03	5.31
Test Well 1	07/07	UF	CS												
Test Well 1	07/07	UF	CS												
Test Well 2	05/03	F	CS												
Test Well 2	05/03	UF	CS	26	8.5	2.4	1.8	15.9	2.0	1.7	< 5	64	0.47	0.03	0.22
Test Well 3	05/03	F	CS												
Test Well 3	05/03	UF	CS	82	16.7	5.1	2.0	11.0	3.0	2.9	< 5	80	0.35	0.03	0.73
Test Well 3	05/03	F	CS												
Test Well 3	05/03	UF	CS	83	17.2	5.2	2.5	11.2	2.9	2.9	< 5	84	0.35	0.03	0.74
Test Well 4	05/02	F	CS												
Test Well 4	05/02	UF	CS	19	10.9	5.8	2.5	9.4	1.8	1.3	< 5	77	0.88	0.03	0.11
Test Well 8	05/02	F	CS												
Test Well 8	05/02	UF	CS	71	11.5	3.9	2.1	9.8	1.8	1.9	< 5	64	0.88	0.03	0.35
Test Well DT-5A	10/26	F	CS												
Test Well DT-5A	10/26	F	DUP												
Test Well DT-5A	10/26	F	TRP												
Test Well DT-5A	10/26	UF	CS	67	8.7	2.5	1.6	10.7	1.7	1.5	< 1	53	0.24	0.02	0.31
Test Well DT-5A	10/26	UF	DUP	68	8.7	2.5	1.6	10.9							
Test Well DT-5A	10/26	F	CS												
Test Well DT-5A	10/26	F	DUP												
Test Well DT-5A	10/26	UF	CS	67	8.7	2.5	1.6	10.8	1.6	1.4	< 1	50	0.24	< 0.02	0.30
Test Well DT-10	10/27	F	CS												
Test Well DT-10	10/27	F	DUP												
Test Well DT-10	10/27	UF	CS	64	11.7	3.6	1.3	10.8	1.6	1.3	< 1	66	0.26	< 0.02	0.23
Test Well DT-10	10/27	UF	DUP												
Water Supply Wells:															
O-1	08/14	F	CS												
O-1	08/14	UF	CS	75	20.3	3.1	3.3	21.4	6.3	6.8	< 5	98	0.36	0.06	1.48
O-1	08/14	F	CS												
O-1	08/14	UF	CS	76	20.5	3.1	3.1	21.2	6.3	6.8	< 5	88	0.36	0.06	1.48
O-4	08/14	F	CS												
O-4	08/14	UF	CS	95	22.2	8.2	2.8	18.5	7.5	5.4	< 5	109	0.28	0.06	0.43
PM-1	08/14	F	CS												
PM-1	08/14	UF	CS	83	27.1	6.6	3.3	18.7	6.1	5.1	< 5	115	0.26	0.06	0.52
PM-1	08/14	F	CS												
PM-1	08/14	UF	CS	75	20.5	3.1	3.4	21.2	6.3	6.8	< 5	86	0.35	0.06	1.48
PM-2	08/14	F	CS												

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N
Regional Aquifer Wells (Cont.)															
Water Supply Wells: (Cont.)															
PM-2	08/14	UF	CS	80	9.5	2.9	1.6	10.2	1.7	1.5	< 5	53	0.16	0.06	0.37
PM-3	08/14	F	CS												
PM-3	08/14	UF	CS	86	24.9	8.1	3.3	17.8	6.8	5.1	< 5	120	0.26	0.06	0.50
PM-4	08/14	F	CS												
PM-4	08/14	UF	CS	85	11.9	4.1	2.3	12.4	2.3	2.4	< 5	68	0.23	0.06	0.37
PM-5	08/14	F	CS												
PM-5	08/14	UF	CS	89	10.6	3.9	1.8	12.8	2.1	2.1	< 5	66	0.21	0.06	0.35
G-1A	08/14	F	CS												
G-1A	08/14	UF	CS	74	10.8	0.5	2.5	28.1	3.4	4.3	< 5	88	0.50	0.06	0.50
G-2A	08/14	F	CS												
G-2A	08/14	UF	CS	65	13.1	1.1	1.8	21.5	2.2	3.3	< 5	76	0.27	0.06	0.47
G-3A	08/14	F	CS												
G-3A	08/14	UF	CS	52	15.8	2.5	1.3	14.1	2.4	3.2	< 5	72	0.26	0.06	0.59
G-4A	08/14	F	CS												
G-4A	08/14	UF	CS	57	16.9	3.3	1.6	12.4	2.4	3.1	< 5	73	0.20	0.06	0.54
Regional Aquifer Springs															
White Rock Canyon Group I:															
Sandia Spring	09/25	F	CS	52	50.3	4.5	4.4	19.7	5.6	2.6	2	165	0.60	< 0.02	0.11
Sandia Spring	09/25	F	DUP												
Sandia Spring	09/25	UF	CS												
Sandia Spring	09/25	UF	DUP												
Sandia Spring	09/25	UF	TRP												
Spring 3	09/25	UF	CS												
Spring 3A	09/25	F	CS	53	21.8	1.8	2.9	16.1	3.4	4.3	< 1	76	0.44	< 0.02	1.00
Spring 3A	09/25	F	DUP												
Spring 3A	09/25	UF	CS												
Spring 4	09/25	F	CS	55	22.9	4.3	2.6	14.2	6.2	9.3	< 1	77	0.49	< 0.02	1.34
Spring 4	09/25	F	DUP												
Spring 4	09/25	UF	CS												
Spring 4	09/25	UF	DUP												
Spring 4A	09/25	F	CS	73	20.4	4.5	2.1	12.9	4.6	5.3	< 1	79	0.45	< 0.02	0.93
Spring 4A	09/25	F	DUP												
Spring 4A	09/25	UF	CS												
Ancho Spring	09/26	F	CS	81	13.0	3.0	1.9	11.1	1.9	2.2	< 1	57	0.36	< 0.02	0.37
Ancho Spring	09/26	F	DUP								< 1	58			
Ancho Spring	09/26	UF	CS												
Ancho Spring	09/26	UF	DUP												

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N
Regional Aquifer Springs (Cont.)															
White Rock Canyon Group II:															
Spring 5A	09/26	F	CS	58	26.4	2.4	2.9	22.2	4.1	6.8	< 1	109	0.39	< 0.02	0.26
Spring 5A	09/26	F	DUP												
Spring 5A	09/26	UF	CS												
Spring 5A	09/26	UF	DUP												
Spring 5B	07/26	F	CS	66	17.6	4.0	2.1	13.2	3.1	3.8	< 1	71	0.49	< 0.02	1.05
Spring 5B	07/26	F	DUP												
Spring 5B	07/26	F	TRP												
Spring 5B	07/26	UF	CS												
Spring 5B	07/26	UF	DUP												
Spring 6	09/26	F	CS	78	12.5	3.5	1.9	11.2	2.1	2.3	< 1	60	0.36	< 0.02	0.39
Spring 6	09/26	F	DUP												
Spring 6	09/26	UF	CS												
Spring 6	09/26	UF	DUP												
Spring 6	09/26	F	CS	77	12.5	3.5	1.9	11.1	2.1	2.2	< 1	60	0.36	< 0.02	0.39
Spring 6	09/26	F	DUP												
Spring 6	09/26	F	TRP												
Spring 6	09/26	UF	CS												
Spring 6	09/26	UF	DUP												
Spring 8A	09/26	F	CS	87	14.8	3.3	1.9	13.2	2.1	2.3	< 1	75	0.45	< 0.02	0.14
Spring 8A	09/26	F	DUP												
Spring 8A	09/26	UF	CS												
Spring 8A	09/26	UF	DUP												
Spring 9A	09/27	F	CS	73	11.6	3.2	1.4	11.4	2.0	1.9	< 1	55	0.48	0.02	0.32
Spring 9A	09/27	F	DUP	74	11.8	3.3	1.5	11.1	2.0	2.0				0.02	
Spring 9A	09/27	F	TRP												
Spring 9A	09/27	UF	CS												
Spring 9A	09/27	UF	DUP												
Spring 9A	09/27	UF	TRP												
Doe Spring	09/27	F	CS	78	12.3	3.3	1.5	12.5	1.8	1.8	< 1	63	0.50	< 0.02	0.05
Doe Spring	09/27	F	DUP												
Doe Spring	09/27	UF	CS												
Doe Spring	09/27	UF	DUP												
Spring 10	09/27	F	CS	74	23.6	3.5	1.9	13.0	2.2	2.0	< 1	89	0.53	0.04	0.34
Spring 10	09/27	F	DUP												
Spring 10	09/27	UF	CS												
Spring 10	09/27	UF	DUP												
Spring 10	09/27	UF	TRP												

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N
Regional Aquifer Springs (Cont.)															
White Rock Canyon Group III:															
Spring 1	09/25	F	CS	35	16.8	1.0	2.1	28.5	3.0	6.5	< 1	97	0.52	0.08	0.37
Spring 1	09/25	F	DUP		16.9	1.0	2.2	28.8	3.0	6.5	< 1	95	0.51		
Spring 1	09/25	UF	CS												
Spring 1	09/25	UF	DUP												
Spring 2	09/25	F	CS	34	15.1	0.7	1.6	36.4	2.6	5.2	2	108	0.60	< 0.02	0.05
Spring 2	09/25	F	DUP												
Spring 2	09/25	UF	CS												
White Rock Canyon Group IV:															
La Mesita Spring	10/19	F	CS	28	36.2	1.0	2.7	29.3	6.8	13.4	2	125	0.25	0.06	2.16
La Mesita Spring	10/19	F	DUP												
La Mesita Spring	10/19	UF	CS												
La Mesita Spring	10/19	UF	DUP												
Other Springs:															
Sacred Spring	10/19	F	CS	44	37.7	1.6	2.6	22.2	2.9	7.8	2	126	0.47	0.03	0.16
Sacred Spring	10/19	F	DUP	43	37.0	1.6	2.5	21.7	2.8	7.7	2	129			
Sacred Spring	10/19	F	TRP												
Sacred Spring	10/19	UF	CS												
Sacred Spring	10/19	UF	DUP												
Canyon Alluvial Groundwater Systems															
Acid/Pueblo Canyons:															
APCO-1	07/26	F	CS	69	38.7	8.2	13.7	60.4	40.3	17.1	< 5	196	0.63	5.98	0.57
APCO-1	07/26	UF	CS												
DP/Los Alamos Canyons:															
LAO-C	08/01	F	CS	36					85.5	7.9	< 5	107	0.14	0.06	0.02
LAO-C	08/01	UF	CS		33.7	7.3	4.6	48.2							
LAO-0.7	08/01	UF	CS												
LAO-2	06/26	F	CS	58	17.0	4.5	4.6	29.0	25.2	12.9	< 5	78	0.62	0.19	1.23
LAO-2	06/26	UF	CS												
LAO-3A	06/26	F	CS	59	16.4	3.8	5.2	29.3	18.5	13.9	< 5	80	0.77	0.21	1.17
LAO-3A	06/26	UF	CS												
LAO-3A	06/26	UF	CS												
LAO-4	08/01	F	CS	52					18.5	19.6	< 5	106	0.50	0.07	0.10
LAO-4	08/01	UF	CS		20.5	5.3	5.2	29.3							

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N
Canyon Alluvial Groundwater Systems (Cont.)															
Mortandad Canyon:															
MCO-2	07/17	F	CS	83	28.7	6.8	3.9	36.1	4.6	1.3	< 5	175	0.88	0.43	0.03
MCO-2	07/17	UF	CS												
MCO-3	07/17	F	CS	48	31.7	1.6	7.3	92.1	5.9	18.7	< 5	182	0.81	0.21	3.32
MCO-3	07/17	UF	CS												
MCO-5	07/07	UF	CS		41.0	3.5	16.0	55.0						0.10	5.70
MCO-5	07/07	F	CS		42.0	3.5	16.0	53.0	13.0	76.0		150	0.93	0.10	6.10
MCO-6	07/10	UF	CS		18.3	1.7	8.1	29.3						< 0.10	6.60
MCO-6	07/10	F	CS		44.9	4.2	17.7	59.1	13.0	80.0	< 10	140	1.20	< 0.10	6.60
MCO-6	07/10	UF	CS												
MCO-6	07/10	F	CS		47.5	4.3	17.4	58.3	13.0	83.0	< 10	140	1.20	< 0.10	6.70
MCO-7	07/10	UF	CS		15.6	3.5	9.6	38.3						0.27	9.50
MCO-7	07/10	F	CS		33.8	7.4	19.2	73.0	15.0	77.0	< 10	150	1.40	0.23	9.70
MCO-7.5	07/11	UF	CS		29.2	7.2	7.8	83.9						< 10.00	18.00
MCO-7.5	07/11	F	CS		30.4	7.2	7.8	84.9	19.0	29.0	< 10	170	1.40	< 10.00	18.00
Cañada del Buey:															
CDBO-6	12/12	F	CS												0.10
CDBO-6	12/12	F	DUP												
CDBO-6	12/12	UF	CS						17.9	7.9			0.19		
CDBO-6	12/12	UF	DUP												
Intermediate Perched Groundwater Systems															
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:															
POI-4	07/19	F	CS												
POI-4	07/19	UF	CS	57	43.1	10.5	7.4	39.4	42.3	23.0	< 5	160	0.32	1.24	3.12
Basalt Spring	07/25	F	CS	62	30.7	7.6	8.3	53.1	32.4	38.0	< 5	133	0.36	2.84	16.20
Basalt Spring	07/25	UF	CS												
Perched Groundwater System in Volcanics:															
Water Canyon Gallery	08/15	F	CS												
Water Canyon Gallery	08/15	UF	CS	47	8.1	3.7	1.7	5.8	1.0	1.8	< 5	45	0.03	0.06	0.33

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		SiO_2	Ca	Mg	K	Na	Cl	SO_4	CO_3 Alkalinity	Total Alkalinity	F	PO_4-P	NO_3+ NO_2-N
San Ildefonso Pueblo:															
LA-5	12/06	UF	CS												
LA-5	12/06	UF	DUP												
LA-5	12/06	UF	CS												
Eastside Artesian Well	04/05	F	CS												
Eastside Artesian Well	04/05	UF	CS	6	2.7	0.1	0.7	88.1	3.3	19.2	18	190	0.73	0.03	2.00
Pajarito Well (Pump 1)	11/29	F	CS												
Pajarito Well (Pump 1)	11/29	F	DUP												
Pajarito Well (Pump 1)	11/29	UF	CS	31	40.3	4.0	3.8	285.0	145.0	48.1	2	442	1.19	< 0.02	0.44
Pajarito Well (Pump 1)	11/29	UF	DUP	33	43.7	4.3	4.0	286.0	142.0	48.1	2	449	1.15	< 0.02	
Don Juan Playhouse Well	04/05	F	CS												
Don Juan Playhouse Well	04/05	UF	CS	26	6.2	0.3	1.2	65.5	3.0	16.3	11	144	0.52	0.03	1.00
Otowi House Well	12/06	UF	CS												
New Community Well	11/29	F	CS												
New Community Well	11/29	F	DUP												
New Community Well	11/29	UF	CS	25	17.6	1.0	1.0	82.9	8.7	36.6	4	176	0.15	< 0.02	0.01
New Community Well	11/29	F	CS												
New Community Well	11/29	F	DUP												
New Community Well	11/29	F	TRP												
New Community Well	11/29	UF	CS	25	19.1	1.1	1.0	82.6	8.8	36.7	4	178	0.14	< 0.02	0.43
Sanchez House Well	04/05	F	CS												
Sanchez House Well	04/05	UF	CS	40	21.9	1.3	1.5	78.0	33.1	30.7	< 5	158	1.05	0.03	0.07
Sanchez House Well	04/05	F	CS												
Sanchez House Well	04/05	UF	CS	40	21.2	1.3	1.3	77.6	33.1	30.7	< 5	165	1.07	0.03	0.97
Water Quality Standards[g]															
EPA Primary Drinking Water Standard										500			4		10
EPA Secondary Drinking Water Standard									250	250					
EPA Health Advisory								20							
NMWQCC Groundwater Limit									250	600			2		10

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	ClO_4 (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Regional Aquifer Wells											
Test Wells:											
Test Well 1	05/02	F CS				230					
Test Well 1	05/02	UF CS	< 4.00		0.0300		1.00	164.4	7.9	7.3	409
Test Well 1	07/07	UF CS	< 1.00								
Test Well 1	07/07	UF CS	2.80								
Test Well 2	05/03	F CS				48					
Test Well 2	05/03	UF CS	< 4.00		0.0100		4.00	31.1	7.7	7.9	119
Test Well 3	05/03	F CS				168					
Test Well 3	05/03	UF CS	< 4.00		0.0100		1.00	62.8	7.4	7.7	160
Test Well 3	05/03	F CS				156					
Test Well 3	05/03	UF CS	< 4.00		0.0100		1.00	64.5		7.6	162
Test Well 4	05/02	F CS				134					
Test Well 4	05/02	UF CS	< 4.00		0.0100		1.00	51.2	8.0	7.7	127
Test Well 8	05/02	F CS				144					
Test Well 8	05/02	UF CS	< 4.00		0.0100		1.00	44.7	7.9	7.6	129
Test Well DT-5A	10/26	F CS				128					
Test Well DT-5A	10/26	F DUP				129					
Test Well DT-5A	10/26	F TRP				131					
Test Well DT-5A	10/26	UF CS	< 1.04	< 0.0028	< 0.0028		< 1.17	32.0			104
Test Well DT-5A	10/26	UF DUP		< 0.0028	< 0.0028		< 1.17				103
Test Well DT-5A	10/26	F CS				129					
Test Well DT-5A	10/26	F DUP				128					
Test Well DT-5A	10/26	UF CS	< 1.04	< 0.0028	< 0.0028		< 0.78	32.0	7.1		105
Test Well DT-10	10/27	F CS				133					
Test Well DT-10	10/27	F DUP				136					
Test Well DT-10	10/27	UF CS	< 1.04	< 0.0028	< 0.0028		< 0.78	43.9	8.4		119
Test Well DT-10	10/27	UF DUP					0.89				
Water Supply Wells:											
O-1	08/14	F CS				154					
O-1	08/14	UF CS	2.40		0.0300		1.00	63.4	6.9	7.8	203
O-1	08/14	F CS				144					
O-1	08/14	UF CS			0.0300		1.00	64.0		7.9	206
O-4	08/14	F CS				150					
O-4	08/14	UF CS			0.0300		1.00	89.4	7.9	7.6	236
PM-1	08/14	F CS				198					
PM-1	08/14	UF CS			0.0300		1.00	94.7		7.9	227
PM-1	08/14	F CS				170					
PM-1	08/14	UF CS			0.0300		1.00	63.9	7.5	8.3	205
PM-2	08/14	F CS				112					

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	ClO$_4$ (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as CaCO$_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Regional Aquifer Wells (Cont.)											
Water Supply Wells: (Cont.)											
PM-2	08/14	UF CS			0.0300		1.00	35.7	6.9	8.2	107
PM-3	08/14	F CS				200					
PM-3	08/14	UF CS			0.0300		1.00	95.5	6.9	8.1	234
PM-4	08/14	F CS				90					
PM-4	08/14	UF CS			0.0300		1.00	46.6	6.9	8.1	133
PM-5	08/14	F CS				136					
PM-5	08/14	UF CS			0.0600		1.00	42.4	7.2	8.1	129
G-1A	08/14	F CS				162					
G-1A	08/14	UF CS			0.0300		1.00	29.0	7.2	8.4	165
G-2A	08/14	F CS				106					
G-2A	08/14	UF CS			0.0300		1.00	37.1	6.8	8.4	150
G-3A	08/14	F CS				98					
G-3A	08/14	UF CS			0.0300		1.00	49.9	6.9	8.4	150
G-4A	08/14	F CS				110					
G-4A	08/14	UF CS			0.0300		1.00	55.7	6.8	8.4	90
Regional Aquifer Springs											
White Rock Canyon Group I:											
Sandia Spring	09/25	F CS				259		144.0			260
Sandia Spring	09/25	F DUP				529					
Sandia Spring	09/25	UF CS	< 1.04	< 0.0028	< 0.0028		87.10		7.3		
Sandia Spring	09/25	UF DUP					95.00				
Sandia Spring	09/25	UF TRP					92.90				
Spring 3	09/25	UF CS	< 1.04						7.7		
Spring 3A	09/25	F CS				146		61.5			140
Spring 3A	09/25	F DUP				149					
Spring 3A	09/25	UF CS	< 1.04	< 0.0028	< 0.0028		< 1.40		7.6		
Spring 4	09/25	F CS				181		79.6			161
Spring 4	09/25	F DUP				237					
Spring 4	09/25	UF CS	8.49	< 0.0028	< 0.0028		28.80		7.1		
Spring 4	09/25	UF DUP					38.80				
Spring 4A	09/25	F CS				171		69.2			138
Spring 4A	09/25	F DUP				180					
Spring 4A	09/25	UF CS	< 1.04	< 0.0028	< 0.0028		< 1.40		8.0		
Ancho Spring	09/26	F CS				148		44.7			101
Ancho Spring	09/26	F DUP				155					
Ancho Spring	09/26	UF CS	< 1.04	< 0.0028	< 0.0028		10.00		7.2		
Ancho Spring	09/26	UF DUP					12.00				

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		ClO_4 (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Regional Aquifer Springs (Cont.)												
White Rock Canyon Group II:												
Spring 5A	09/26	F	CS				184		77.9			187
Spring 5A	09/26	F	DUP				199					
Spring 5A	09/26	UF	CS	< 1.04	< 0.0028	< 0.0028		22.40		7.6		
Spring 5A	09/26	UF	DUP		< 0.0028	< 0.0028		24.40				
Spring 5B	07/26	F	CS				151		60.7			127
Spring 5B	07/26	F	DUP				172					
Spring 5B	07/26	F	TRP				154					
Spring 5B	07/26	UF	CS	< 1.04	< 0.0028	< 0.0028		11.60		8.3		
Spring 5B	07/26	UF	DUP					14.80				
Spring 6	09/26	F	CS				126		46.7			102
Spring 6	09/26	F	DUP				156					
Spring 6	09/26	UF	CS	< 1.04	< 0.0028	< 0.0028		2.80		7.5		
Spring 6	09/26	UF	DUP					5.60				
Spring 6	09/26	F	CS				142		46.7			105
Spring 6	09/26	F	DUP				168					
Spring 6	09/26	F	TRP				151					
Spring 6	09/26	UF	CS	< 1.04	< 0.0028	< 0.0028		10.40		7.5		
Spring 6	09/26	UF	DUP					8.80				
Spring 8A	09/26	F	CS				187		53.2			113
Spring 8A	09/26	F	DUP				188					
Spring 8A	09/26	UF	CS	< 1.04	< 0.0028	< 0.0028		< 1.40				
Spring 8A	09/26	UF	DUP					2.00				
Spring 9A	09/27	F	CS				127		37.9			102
Spring 9A	09/27	F	DUP				130					
Spring 9A	09/27	F	TRP				130					
Spring 9A	09/27	UF	CS	< 1.04	< 0.0028	< 0.0028		8.00		7.2		
Spring 9A	09/27	UF	DUP		< 0.0028	< 0.0028		9.60				
Spring 9A	09/27	UF	TRP					9.60				
Doe Spring	09/27	F	CS				124		45.4			101
Doe Spring	09/27	F	DUP				148					
Doe Spring	09/27	UF	CS	< 1.04	< 0.0028	< 0.0028		4.62		8.0		
Doe Spring	09/27	UF	DUP					5.00				
Spring 10	09/27	F	CS				183		75.0			144
Spring 10	09/27	F	DUP				175					143
Spring 10	09/27	UF	CS	< 1.04	< 0.0028	< 0.0028		1,350.00		7.7		
Spring 10	09/27	UF	DUP					1,590.00				
Spring 10	09/27	UF	TRP					1,370.00				

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		ClO_4 (μg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (μS/cm)
Regional Aquifer Springs (Cont.)												
White Rock Canyon Group III:												
Spring 1	09/25	F	CS				152		46.1			159
Spring 1	09/25	F	DUP				162					156
Spring 1	09/25	UF	CS	< 1.04	< 0.0028	< 0.0028		8.75		7.9		
Spring 1	09/25	UF	DUP		< 0.0028	< 0.0028						
Spring 2	09/25	F	CS				151		40.8			172
Spring 2	09/25	F	DUP				158					
Spring 2	09/25	UF	CS	< 1.04	< 0.0028	< 0.0028		< 1.40		8.5		
White Rock Canyon Group IV:												
La Mesita Spring	10/19	F	CS				201		94.3			291
La Mesita Spring	10/19	F	DUP				202					291
La Mesita Spring	10/19	UF	CS	< 1.04	< 0.0028	< 0.0028		366.00		7.7		
La Mesita Spring	10/19	UF	DUP					400.00				
Other Springs:												
Sacred Spring	10/19	F	CS				196		101.0			269
Sacred Spring	10/19	F	DUP				199					
Sacred Spring	10/19	F	TRP				198					
Sacred Spring	10/19	UF	CS	< 1.04	< 0.0028	< 0.0028		39.00		7.6		
Sacred Spring	10/19	UF	DUP					62.00				
Canyon Alluvial Groundwater Systems												
Acid/Pueblo Canyons:												
APCO-1	07/26	F	CS				416		130.6		7.3	507
APCO-1	07/26	UF	CS	< 1.00		0.0100		1.00		7.8		
DP/Los Alamos Canyons:												
LAO-C	08/01	F	CS				308				7.7	473
LAO-C	08/01	UF	CS	< 1.00		0.0600		1.00		7.2		
LAO-0.7	08/01	UF	CS	< 1.00		0.0100		6.00		6.9		
LAO-2	06/26	F	CS				220		61.0		7.0	230
LAO-2	06/26	UF	CS	< 4.00		0.0100		2.00		7.0		
LAO-3A	06/26	F	CS				246		56.5		7.2	222
LAO-3A	06/26	UF	CS	< 4.00		0.0100		1.00				
LAO-3A	06/26	UF	CS	< 4.00						6.9		
LAO-4	08/01	F	CS				208				7.1	279
LAO-4	08/01	UF	CS	< 1.00		0.0500		1.00		7.5		

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]		ClO_4 (µg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (µS/cm)
Canyon Alluvial Groundwater Systems (Cont.)												
Mortandad Canyon:												
MCO-2	07/17	F	CS				338		99.6		6.8	324
MCO-2	07/17	UF	CS	< 1.00		0.0100		6.00		6.8		
MCO-3	07/17	F	CS	120.00			416		85.9		7.5	526
MCO-3	07/17	UF	CS			0.0100		1.00		7.4		
MCO-5	07/07	UF	CS	252.00		< 0.0100				7.2		290
MCO-5	07/07	F	CS				360					290
MCO-6	07/10	UF	CS	268.00		0.0024				7.2		340
MCO-6	07/10	F	CS				390					340
MCO-6	07/10	UF	CS			0.0019				7.2		340
MCO-6	07/10	F	CS									340
MCO-7	07/10	UF	CS	282.00		0.0016				8.1		360
MCO-7	07/10	F	CS				440					360
MCO-7.5	07/11	UF	CS	252.00		0.0014						
MCO-7.5	07/11	F	CS				420					
Cañada del Buey:												
CDBO-6	12/12	F	CS				169					
CDBO-6	12/12	F	DUP				173					
CDBO-6	12/12	UF	CS			< 0.0028						
CDBO-6	12/12	UF	DUP			< 0.0028						
Intermediate Perched Groundwater Systems												
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:												
POI-4	07/19	F	CS				338					
POI-4	07/19	UF	CS	< 1.00		0.0100		1.00	151.0	8.2	7.9	432
Basalt Spring	07/25	F	CS				418		108.2		7.3	459
Basalt Spring	07/25	UF	CS	< 1.00		0.0100		1.00		6.7		
Perched Groundwater System in Volcanics:												
Water Canyon Gallery	08/15	F	CS				60					
Water Canyon Gallery	08/15	UF	CS	< 1.04		0.0300		1.00	35.5	7.0	8.4	152

Table 5-31. Chemical Quality of Groundwater in 2000 (mg/L[a]) (Cont.)

Station Name	Date	Code[b]	ClO_4 (μg/L)	CN (amen)	CN (Total)	TDS[c]	TSS[d]	Hardness as $CaCO_3$	Field pH[e]	Lab pH[e]	Conductance (μS/cm)
San Ildefonso Pueblo:											
LA-5	12/06	UF CS							8.4		
LA-5	12/06	UF DUP					< 1.08				
LA-5	12/06	UF CS							8.6		
Eastside Artesian Well	04/05	F CS				296					
Eastside Artesian Well	04/05	UF CS	< 4.00		0.0200		1.00	7.2	9.0	8.7	356
Pajarito Well (Pump 1)	11/29	F CS				821					
Pajarito Well (Pump 1)	11/29	F DUP				838					
Pajarito Well (Pump 1)	11/29	UF CS	2.46	< 0.0028	< 0.0028		< 1.40	117.0	7.7		1,220
Pajarito Well (Pump 1)	11/29	UF DUP		< 0.0028	< 0.0028		< 1.40				1,210
Don Juan Playhouse Well	04/05	F CS				56					
Don Juan Playhouse Well	04/05	UF CS	< 4.00		0.0200		1.00	16.8	8.7	8.9	262
Otowi House Well	12/06	UF CS							7.2		
New Community Well	11/29	F CS				289					
New Community Well	11/29	F DUP				291					
New Community Well	11/29	UF CS	1.69	< 0.0028	< 0.0028		< 0.87	48.1	8.6		416
New Community Well	11/29	F CS				288					
New Community Well	11/29	F DUP				292					
New Community Well	11/29	F TRP				297					
New Community Well	11/29	UF CS	< 1.04	< 0.0028	< 0.0028		< 0.87	52.2	8.6		399
Sanchez House Well	04/05	F CS				362					
Sanchez House Well	04/05	UF CS	< 4.00		0.0200		1.00	60.2		7.8	383
Sanchez House Well	04/05	F CS				284					
Sanchez House Well	04/05	UF CS	< 4.00		0.0300		1.00	58.2	7.9	8.5	393
Water Quality Standards[g]											
EPA Primary Drinking Water Standard					0.2						
EPA Secondary Drinking Water Standard						500			6.8-8.5	6.8-8.5	
EPA Health Advisory											
NMWQCC Groundwater Limit					0.2	1,000			6-9	6-9	

[a] Except where noted.

[b] Codes: UF–Unfiltered; F–Filtered; CS–Customer Sample; DUP–Laboratory Duplicate; TRP–Laboratory Triplicate.

[c] Total dissolved solids.

[d] Total suspended solids.

[e] Standard units.

[f] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[g] Standards given here for comparison only; see Appendix A.

Table 5-32. Trace Metals in Groundwater for 2000 (µg/L)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Aquifer Wells															
Test Wells:															
Test Well 1	05/02	UF	CS	<[b] 6.0	< 40.0	< 3.0	90.0	81.0	< 1.00	< 3.0	8.0	< 5.0	< 4.0	402.0	< 0.10
Test Well 2	05/03	UF	CS	< 7.0	394.0	< 2.0	27.0	28.0	3.00	< 3.0	9.0	< 5.0	7.0	2,566.0	< 0.10
Test Well 3	05/03	UF	CS	< 6.0	< 40.0	< 2.0	36.0	24.0	< 1.00	< 3.0	13.0	< 5.0	< 4.0	190.0	< 0.10
Test Well 3	05/03	UF	CS	< 6.0	< 40.0	< 2.0	41.0	23.0	< 1.00	< 3.0	8.0	< 5.0	< 4.0	62.0	< 0.10
Test Well 4	05/02	UF	CS	< 6.0	< 40.0	< 2.0	14.0	58.0	< 1.00	< 3.0	< 6.0	< 5.0	12.0	1,431.0	< 0.10
Test Well 8	05/02	UF	CS	< 6.0	< 40.0	< 2.0	< 12.0	6.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	< 40.0	< 0.10
Test Well DT-5A	10/26	UF	CS	< 0.5	11.7	< 2.6	14.9	22.8	< 0.47	< 0.6	< 0.6	1.6	< 1.8	64.1	< 0.06
Test Well DT-5A	10/26	UF	DUP	< 0.5	61.2	< 2.6	13.7	22.5	< 0.47	< 0.6	0.7	1.4	< 1.8	118.0	
Test Well DT-5A	10/26	UF	CS	< 0.5	20.5	< 2.6	20.0	22.5	< 0.47	< 0.6	5.0	1.3	< 1.8	65.5	< 0.06
Test Well DT-10	10/27	UF	CS	< 0.5	49.5	< 2.6	19.1	7.0	< 0.47	< 0.6	0.8	3.7	< 1.8	145.0	< 0.06
Regional Aquifer Springs															
White Rock Canyon Group I:															
Spring 3A	09/25	F	CS	< 0.5	18.6	< 2.6	13.3	32.5	< 0.47	< 0.6	4.1	3.6	< 1.8	< 19.9	< 0.06
Spring 4	09/25	F	CS	< 0.5	< 23.4	< 2.6	9.7	40.8	< 0.47	< 0.6	< 0.6	3.0	< 1.8	< 19.9	< 0.06
Ancho Spring	09/26	F	CS	< 0.5	9.7	< 2.6	< 4.7	28.1	< 0.47	< 0.6	1.2	3.4	< 1.8	< 19.9	< 0.06
White Rock Canyon Group II:															
Spring 5A	09/26	F	CS	< 0.5	18.5	< 2.6	30.1	46.9	< 0.47	< 0.6	< 0.6	2.1	< 1.8	23.1	< 0.06
Spring 5B	07/26	F	CS	< 0.5	9.1	< 2.6	14.3	33.2	< 0.47	< 0.6	3.0	4.8	< 1.8	< 19.9	< 0.06
Spring 5B	07/26	F	DUP												
Spring 6	09/26	F	CS	< 0.5	15.4	< 2.6	6.3	25.3	< 0.47	< 0.6	7.0	3.4	< 1.8	< 19.9	< 0.06
Spring 6	09/26	F	DUP												
Spring 6	09/26	F	CS	< 0.5	12.0	< 2.6	5.1	25.3	< 0.47	< 0.6	5.4	3.7	< 1.8	< 19.9	< 0.06
Spring 6	09/26	F	DUP												< 0.06
Spring 8A	09/26	F	CS	< 0.5	8.7	< 2.6	< 4.7	33.7	< 0.47	< 0.6	1.2	< 1.1	< 1.8	34.1	< 0.06
Spring 9A	09/27	F	CS	< 0.5	< 23.4	< 2.6	< 4.7	10.1	< 0.47	< 0.6	4.2	2.7	< 1.8	< 19.9	< 0.06
Spring 9A	09/27	F	DUP	< 0.5	< 23.4	< 2.6	< 4.7	10.2	< 0.47	< 0.6	4.4	2.5	< 1.8	< 19.9	
Doe Spring	09/27	F	CS	< 0.5	< 23.4	< 2.6	< 4.7	16.2	< 0.47	< 0.6	1.1	< 1.1	< 1.8	< 19.9	< 0.06
Spring 10	09/27	F	CS	< 0.5	19.9	2.7	4.0	61.7	< 0.47	< 0.6	1.8	< 1.1	< 1.8	130.0	< 0.06
White Rock Canyon Group III:															
Spring 1	09/25	F	DUP	< 0.5	27.8	4.0	41.4	27.3	< 0.47	< 0.6	6.4	4.8	< 1.8	< 19.9	

Table 5-32. Trace Metals in Groundwater for 2000 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Canyon Alluvial Groundwater Systems															
Acid/Pueblo Canyons:															
APCO-1	07/26	UF	CS	< 6.0	< 438.0	9.0	329.0	68.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	731.0	< 0.10
APCO-1	07/26	F	CS	< 6.0	< 438.0	10.0	339.0	63.0	< 1.00	< 3.0	< 9.0	< 5.0	< 4.0	773.0	
DP/Los Alamos Canyons:															
LAO-C	08/01	UF	CS	< 6.0	75.0	< 2.0	22.0	127.0	< 1.00	< 3.0	< 6.0	< 5.0	47.0	54.0	< 0.10
LAO-2	06/26	UF	CS	< 6.0	917.0	< 2.0	< 75.0	42.0	2.00	< 3.0	11.0	9.0	< 4.0	462.0	< 0.00
LAO-2	06/26	F	CS	< 6.0	646.0	< 2.0	< 75.0	53.0	4.00	< 3.0	19.0	12.0	< 4.0	302.0	
LAO-3A	06/26	UF	CS	< 6.0	985.0	2.0	< 75.0	43.0	2.00	< 3.0	8.0	13.0	< 4.0	439.0	< 0.00
LAO-3A	06/26	F	CS	< 6.0	841.0	< 2.0	< 75.0	46.0	8.00	< 4.0	13.0	12.0	< 4.0	307.0	
LAO-4	08/01	UF	CS	< 6.0	208.0	< 2.0	36.0	60.0	< 1.00	< 3.0	< 6.0	< 5.0	33.0	137.0	< 0.10
Mortandad Canyon:															
MCO-2	07/17	UF	CS	8.0	129.0	15.0	36.0	155.0	< 1.00	< 3.0	< 6.0	17.0	< 4.0	16,041.0	< 0.10
MCO-2	07/17	F	CS	9.0	111.0	17.0	38.0	155.0	2.00	< 3.0	< 6.0	13.0	< 4.0	15,328.0	
MCO-3	07/17	UF	CS	< 9.0	263.0	< 4.0	91.0	26.0	< 1.00	< 3.0	< 6.0	< 7.0	< 4.0	167.0	0.10
MCO-3	07/17	F	CS	< 7.0	153.0	< 2.0	90.0	25.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	62.0	
MCO-5	07/07	UF	CS	< 0.4	75.0	< 3.4	110.0	110.0	0.04	0.3	< 0.3	1.5	< 0.3	86.0	< 0.01
MCO-5	07/07	F	CS	< 0.4	29.0	< 3.4	110.0	110.0	< 0.01	0.3	< 0.3	1.7	0.3	52.0	< 0.01
MCO-6	07/10	UF	CS	0.0	33.1	1.5	56.8	51.3	0.05	0.3	0.7	3.9	4.9	10.7	< 0.03
MCO-6	07/10	F	CS	0.0	43.7	0.8	123.0	109.0	0.04	0.3	0.3	1.8	2.9	< 7.9	< 0.03
MCO-6	07/10	F	CS	< 0.0	77.6	0.8	137.0	109.0	0.04	0.3	0.3	1.8	2.9	< 7.9	< 0.03
MCO-7	07/10	UF	CS	0.1	66.9	1.4	41.9	116.0	0.05	0.5	0.4	1.9	4.3	48.8	< 0.03
MCO-7	07/10	F	CS	0.0	< 31.5	1.3	83.1	224.0	0.04	0.4	0.3	1.9	3.2	15.3	< 0.03
MCO-7.5	07/11	UF	CS	0.0	880.0	0.9	79.0	172.0	0.16	0.3	0.5	2.8	2.4	761.0	< 0.03
MCO-7.5	07/11	F	CS	< 0.0	81.5	0.8	84.0	165.0	0.03	0.3	0.3	2.2	0.9	12.6	< 0.03
Cañada del Buey:															
CDBO-6	12/12	UF	CS	< 0.5		< 2.6		86.5		< 0.6		< 1.1	< 1.8	432.0	< 0.06
CDBO-6	12/12	UF	DUP	< 0.5		< 2.6		88.0		< 0.6		< 1.1	< 1.8	435.0	< 0.06
Intermediate Perched Groundwater Systems															
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:															
POI-4	07/19	UF	CS	< 6.0	< 270.0	3.0	211.0	89.0	< 1.00	< 3.0	< 6.0	< 5.0	< 4.0	57.0	< 0.02
Basalt Spring	07/25	F	CS	< 6.0	< 438.0	5.0	280.0	90.0	< 1.00	< 3.0	8.0	< 5.0	< 4.0	< 208.0	
Basalt Spring	07/25	UF	CS												< 0.10

Table 5-32. Trace Metals in Groundwater for 2000 (µg/L) (Cont.)

Station Name	Date	Codes[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
San Ildefonso Pueblo:														
Eastside Artesian Well	04/05	UF CS	< 22.0	< 100.0	< 2.0	89.0	< 3.0	< 2.00	< 3.0	< 6.0	< 5.0	< 25.0	148.0	< 0.10
Pajarito Well (Pump 1)	11/29	UF CS	< 0.5	< 23.4	9.8	1,160.0	75.8	< 0.47	< 0.6	< 0.6	4.8	5.6	114.0	< 0.06
Pajarito Well (Pump 1)	11/29	UF DUP	< 0.5	< 23.4	12.5	1,230.0	80.2	< 0.47	< 0.6	< 0.6	5.1	5.9	123.0	< 0.06
Don Juan Playhouse Well	04/05	UF CS	< 22.0	< 100.0	4.0	43.0	< 3.0	< 2.00	< 3.0	10.0	< 11.0	< 25.0	< 30.0	< 0.10
New Community Well	11/29	UF CS	< 0.5	< 23.4	3.1	47.9	15.6	< 0.47	< 0.6	< 0.6	1.0	2.5	< 19.9	< 0.06
New Community Well	11/29	UF CS	< 0.5	< 23.4	< 2.6	39.1	17.6	< 0.47	< 0.6	< 0.6	1.5	2.5	4.3	< 0.06
Sanchez House Well	04/05	UF CS	44.0	< 100.0	14.0	158.0	64.0	< 2.00	< 3.0	< 6.0	< 5.0	< 25.0	< 30.0	< 0.10
Sanchez House Well	04/05	UF CS	< 22.0	< 100.0	13.0	162.0	62.0	< 2.00	< 3.0	< 6.0	< 5.0	< 25.0	< 30.0	< 0.10
Water Quality Standards[c]														
EPA Primary Drinking Water Standard					50		2,000	4	5		100			2
EPA Secondary Drinking Water Standard				50-200									300	
EPA Action Level												1,300		
EPA Health Advisory														
NMWQCC Livestock Watering Standard				5,000	200	5,000			50	1,000	1,000	500		10
NMWQCC Groundwater Limit			50	5,000	100	750	1,000		10	50	50	1,000	1,000	2
NMWQCC Wildlife Habitat Standard														0.77

Table 5-32. Trace Metals in Groundwater for 2000 (µg/L) (Cont.)

Station Name	Date	Codes[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Aquifer Wells														
Test Wells:														
Test Well 1	05/02	UF	CS	29.0	< 10.0	< 20.0	42.00	4.20	< 3.0	< 60.0	273.0		< 7.0	746.0
Test Well 2	05/03	UF	CS	199.0	< 10.0	< 20.0	40.00	3.00	3.0	< 60.0	39.0		< 7.0	499.0
Test Well 3	05/03	UF	CS	13.0	< 10.0	< 20.0	< 2.00	3.00	3.0	< 60.0	73.0		< 7.0	57.0
Test Well 3	05/03	UF	CS	11.0	< 10.0	< 20.0	< 2.00	< 3.00	3.0	< 60.0	74.0		< 7.0	58.0
Test Well 4	05/02	UF	CS	33.0	< 10.0	< 20.0	40.00	3.00	3.0	< 60.0	52.0		< 7.0	621.0
Test Well 8	05/02	UF	CS	< 4.0	< 10.0	< 20.0	7.00	< 3.00	< 3.0	< 60.0	50.0		< 7.0	397.0
Test Well DT-5A	10/26	UF	CS	9.5	2.0	1.7	< 1.83	0.18	< 2.4	< 2.0	44.0	0.27	8.0	259.0
Test Well DT-5A	10/26	UF	DUP	10.3	< 1.1	1.6	< 1.83	< 0.11	< 2.4	< 2.0	44.6	0.08	8.3	287.0
Test Well DT-5A	10/26	UF	CS	9.9	1.5	2.2	< 1.83	< 0.11	< 2.4	< 2.0	44.6	0.02	8.1	260.0
Test Well DT-10	10/27	UF	CS	6.1	2.0	1.8	< 1.83	0.18	< 2.4	< 2.0	47.9	0.02	4.4	75.2
Regional Aquifer Springs														
White Rock Canyon Group I:														
Spring 3A	09/25	F	CS	< 1.2	1.6	< 3.1	< 1.83	< 0.11	< 2.4	< 2.0	239.0	0.28	13.4	2.5
Spring 4	09/25	F	CS	< 1.2	< 1.1	< 3.1	< 1.83	< 0.11	4.1	< 2.0	137.0	0.02	8.8	1.7
Ancho Spring	09/26	F	CS	2.7	< 1.1	1.6	< 1.83	< 0.11	< 2.4	< 2.0	63.9	0.02	6.8	2.3
White Rock Canyon Group II:														
Spring 5A	09/26	F	CS	53.6	2.0	< 3.1	< 1.83	< 0.11	< 2.4	< 2.0	175.0	0.02	10.4	1.2
Spring 5B	07/26	F	CS	0.5	1.9	< 3.1	< 1.83	< 0.11	< 2.4	< 2.0	100.0	0.53	9.0	2.0
Spring 5B	07/26	F	DUP					< 0.11				0.13		
Spring 6	09/26	F	CS	< 1.2	< 1.1	1.5	< 1.83	< 0.11	3.7	< 2.0	63.9	0.02	7.2	1.9
Spring 6	09/26	F	DUP						< 2.4					
Spring 6	09/26	F	CS	0.5	< 1.1	1.8	< 1.83	< 0.11	< 2.4	< 2.0	63.6	0.02	7.3	2.2
Spring 6	09/26	F	DUP											
Spring 8A	09/26	F	CS	62.2	1.4	< 3.1	< 1.83	0.78	< 2.4	< 2.0	70.7	0.02	9.2	2.1
Spring 9A	09/27	F	CS	< 1.2	1.6	1.3	< 1.83	< 0.68	< 2.4	< 2.0	52.9	0.35	8.1	< 3.9
Spring 9A	09/27	F	DUP	< 1.2	< 1.1	< 3.1	< 1.83	< 0.11	< 2.4	< 2.0	53.8	< 0.01	8.0	< 3.9
Doe Spring	09/27	F	CS	14.7	1.7	< 3.1	< 1.83	< 0.11	2.5	< 2.0	60.0	0.02	5.8	1.8
Spring 10	09/27	F	CS	358.0	< 1.1	1.5	< 1.83	< 0.11	6.1	< 2.0	130.0	0.02	9.1	1.9
White Rock Canyon Group III:														
Spring 1	09/25	F	DUP	< 1.2	3.2	1.7	< 1.83			< 2.0	215.0		16.2	1.5

Table 5-32. Trace Metals in Groundwater for 2000 (µg/L) (Cont.)

Station Name	Date	Codes[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Canyon Alluvial Groundwater Systems														
Acid/Pueblo Canyons:														
APCO-1	07/26	UF	CS	739.0	< 10.0	< 62.0	< 5.00	< 3.00	< 3.0	< 60.0	171.0		8.0	32.0
APCO-1	07/26	F	CS	842.0	< 10.0	< 20.0	< 2.00	3.00		< 60.0	169.0		7.0	23.0
DP/Los Alamos Canyons:														
LAO-C	08/01	UF	CS	1,904.0	< 16.0	< 20.0	< 2.00	< 3.00	< 3.0	< 60.0	213.0		< 7.0	12.0
LAO-2	06/26	UF	CS	7.0	950.0	< 20.0	< 2.00	< 3.00	3.0	66.0	110.0		< 7.0	15.0
LAO-2	06/26	F	CS	13.0	949.0	< 20.0	6.00	< 3.00		73.0	118.0		< 7.0	21.0
LAO-3A	06/26	UF	CS	13.0	1,720.0	< 20.0	< 5.00	< 3.00	< 3.0	< 60.0	103.0		< 7.0	21.0
LAO-3A	06/26	F	CS	7.0	1,702.0	< 20.0	< 2.00	3.00		62.0	107.0		< 7.0	14.0
LAO-4	08/01	UF	CS	5.0	404.0	< 20.0	< 5.00	< 3.00	< 3.0	< 60.0	133.0		< 7.0	< 10.0
Mortandad Canyon:														
MCO-2	07/17	UF	CS	2,375.0	355.0	< 20.0	< 2.00	< 3.00	3.0	< 60.0	154.0		< 7.0	< 10.0
MCO-2	07/17	F	CS	2,266.0	401.0	< 20.0	< 2.00	< 3.00		< 60.0	153.0		< 7.0	< 10.0
MCO-3	07/17	UF	CS	< 6.0	68.0	< 20.0	< 2.00	3.00	< 3.0	< 60.0	59.0		< 7.0	< 10.0
MCO-3	07/17	F	CS	< 1.0	71.0	< 20.0	< 2.00	3.00		< 60.0	60.0		< 7.0	< 10.0
MCO-5	07/07	UF	CS	1.4		8.9	0.12	< 0.68	< 2.6			0.14	< 0.3	3.6
MCO-5	07/07	F	CS	0.6		9.2	0.03	< 0.68	< 2.6			0.14	< 0.3	4.4
MCO-6	07/10	UF	CS	2.2		22.8	0.29	< 0.68	2.8			0.74	1.9	13.8
MCO-6	07/10	F	CS	0.5		12.5	0.21	< 0.68	1.4			1.02	1.1	19.5
MCO-6	07/10	F	CS	0.5		11.4	0.20	0.75	1.4			0.17	1.0	21.2
MCO-7	07/10	UF	CS	3.1		10.0	0.32	< 0.68	1.0			0.42	2.6	18.8
MCO-7	07/10	F	CS	1.2		10.6	0.08	< 0.68	1.1			0.31	2.6	20.2
MCO-7.5	07/11	UF	CS	23.0		8.6	0.99	< 0.68	1.3			0.13	3.2	20.0
MCO-7.5	07/11	F	CS	0.5		8.0	0.11	< 0.68	1.2			0.11	1.8	19.6
Cañada del Buey:														
CDBO-6	12/12	UF	CS	6.0			< 1.83		3.0					3.8
CDBO-6	12/12	UF	DUP	5.9			< 1.83		< 2.4					4.2
Intermediate Perched Groundwater Systems														
Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt:														
POI-4	07/19	UF	CS	< 2.0	< 10.0	< 20.0	< 2.00	< 3.00	< 3.0	< 60.0	209.0		< 7.0	< 10.0
Basalt Spring	07/25	F	CS	3.0	< 10.0	< 53.0	< 5.00	< 3.00		< 60.0	160.0		7.0	< 10.0
Basalt Spring	07/25	UF	CS						3.0					

Table 5-32. Trace Metals in Groundwater for 2000 (µg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
San Ildefonso Pueblo:													
Eastside Artesian Well	04/05	UF CS	9.0	< 14.0	< 20.0	< 2.00	< 3.00	< 3.0	< 60.0	40.0		< 7.0	< 10.0
Pajarito Well (Pump 1)	11/29	UF CS	1.4	15.3	< 3.1	< 1.83	0.20	< 2.4	2.5	930.0	0.02	18.2	2.7
Pajarito Well (Pump 1)	11/29	UF DUP	1.3	14.4	< 3.1	< 1.83	0.20	< 2.4	< 2.0	1,010.0	< 0.01	19.6	3.0
Don Juan Playhouse Well	04/05	UF CS	< 3.0	< 10.0	< 20.0	< 2.00	< 3.00	< 3.0	< 60.0	88.0		14.0	< 10.0
New Community Well	11/29	UF CS	0.7	< 1.1	< 3.1	< 1.83	0.17	4.0	< 2.0	210.0	0.02	6.0	0.8
New Community Well	11/29	UF CS	3.2	< 1.1	< 3.1	< 1.83	0.17	3.6	< 2.0	226.0	0.02	5.6	2.6
Sanchez House Well	04/05	UF CS	< 3.0	< 10.0	< 20.0	< 2.00	3.00	< 3.0	< 75.0	219.0		16.0	< 10.0
Sanchez House Well	04/05	UF CS	< 3.0	10.0	< 20.0	< 2.00	< 3.00	< 3.0	< 60.0	213.0		18.0	< 10.0
Water Quality Standards[c]													
EPA Primary Drinking Water Standard					100		6	50			2		
EPA Secondary Drinking Water Standard			50										5,000
EPA Action Level						15							
EPA Health Advisory										25,000-90,000		80-110	
NMWQCC Livestock Watering Standard						100		50				100	25,000
NMWQCC Groundwater Limit			200	1,000	200	50		50					10,000
NMWQCC Wildlife Habitat Standard								5					

[a] Codes: UF–unfiltered; F–filtered; CS–customer sample; DUP–laboratory duplicate.

[b] Less than symbol (<) means measurement was below the specified limit of detection of the analytical method.

[c] Standards given here for comparison only; see Appendix A. Note that New Mexico Livestock Watering and Groundwater limits are based on dissolved concentrations, whereas many of these analyses are of unfiltered samples; thus, concentrations may include suspended sediment quantities.

Table 5-33. Special Water Supply Well Sampling for Perchlorate in 2000 (μg/L)

Station Name	Date	Codes[a]		Result	MDL[b]	Lab Qual Code[c]
O-1	06/21	UF	CS	3.50		
O-1	06/29	UF	CS	<4.00		U
O-1	07/06	UF	CS	3.50	1.00	J
O-1	07/06	UF	CS	2.00	1.00	J
O-1	08/03	UF	CS	<4.16	4.16	U
O-1	08/03	UF	CS	2.00	1.00	J
O-1	08/03	UF	CS	1.20	1.04	J
O-1	08/03	UF	DUP	1.58	1.04	J
O-1	08/03	UF	CS	2.30	1.00	J
O-1	08/14	UF	CS	2.40	1.00	J
O-1	08/14	UF	CS	<1.00	1.00	U
O-1	08/14	UF	CS	<4.16	4.16	U
O-1	09/12	UF	CS	1.90	1.00	J
O-1	09/12	UF	CS	2.40	1.00	J
O-1	10/10	UF	CS	<1.00	1.00	U
O-1	11/14	UF	CS	5.00	1.00	
O-1	12/12	UF	CS	<1.00	1.00	U
O-1	12/12	UF	CS	1.50	1.00	J
O-4	06/21	UF	CS	<4.00		U
O-4	11/15	UF	CS	<1.00	1.00	U
PM-1	02/14	UF	CS	<4.00		U
PM-1	11/15	UF	CS	<1.00	1.00	U
PM-1	11/15	UF	CS	<1.00	1.00	U
PM-2	02/15	UF	CS	<4.00		U
PM-2	11/15	UF	CS	<1.00	1.00	U
PM-3	06/21	UF	CS	<4.00		U
PM-3	06/29	UF	CS	<4.00		U
PM-3	06/29	UF	CS	<4.00		U
PM-3	11/15	UF	CS	<1.00	1.00	U
PM-4	06/21	UF	CS	<4.00		U
PM-4	06/29	UF	CS	<4.00		U
PM-4	08/03	UF	CS	<1.00	1.00	U
PM-4	08/03	UF	CS	<4.16	4.16	U
PM-4	11/15	UF	CS	<1.00	1.00	U
PM-5	02/15	UF	CS	<4.00		U
PM-5	11/15	UF	CS	<1.00	1.00	U
G-1A	03/07	UF	CS	<4.00		U
G-1A	11/15	UF	CS	<1.00	1.00	U
G-2A	03/07	UF	CS	<4.00		U
G-2A	11/15	UF	CS	<1.00	1.00	U
G-3A	03/06	UF	CS	<4.00		U
G-3A	08/03	UF	CS	<1.00	1.00	U
G-3A	08/03	UF	CS	<4.16	4.16	U
G-3A	11/15	UF	CS	<1.00	1.00	U
G-4A	03/06	UF	CS	<4.00		U
G-4A	11/15	UF	CS	<1.00	1.00	U

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[a] Codes: UF–unfiltered; F–filtered; CS–customer sample; DUP–laboratory duplicate.

[b] MDL = method detection limit.

[c] Laboratory Qualifiers: U–not detected; J–result estimated because it is below the analytical laboratory’s reporting limit.

Table 5-34. Mortandad Canyon Alluvial Groundwater Perchlorate in 2000 (µg/L)

Station Name	Date	Codes[a]	Symbol	Result	MDL[b]	Lab Qual Code[c]
MCO-2	07/17	UF	CS	<1.00	1.00	U
MCO-3	02/24	F	CS	66.00		
MCO-3	04/17	F	CS	33.00		
MCO-3	06/23	F	CS	66.00		
MCO-3	07/17	UF	CS	120.00	1.00	
MCO-3	08/15	F	CS	170.00	1.00	
MCO-3	10/30	UF	CS	280.00	1.00	
MCO-5	07/07	UF	CS	252.00		
MCO-6	02/24	F	CS	210.00		
MCO-6	04/17	F	CS	400.00		
MCO-6	06/23	F	CS	240.00		
MCO-6	07/10	UF	CS	268.00		
MCO-6	08/15	F	CS	180.00	1.00	
MCO-6	10/30	UF	CS	170.00	1.00	
MCO-7	02/24	F	CS	190.00		
MCO-7	02/24	UF	CS	190.00		
MCO-7	04/17	F	CS	180.00		
MCO-7	06/23	F	CS	220.00		
MCO-7	07/10	UF	CS	282.00		
MCO-7	08/15	F	CS	240.00	1.00	
MCO-7	10/30	UF	CS	69.00	1.00	
MCO-7.5	07/11	UF	CS	252.00		

[a] Codes: UF–Unfiltered; F–Filtered; CS–Customer Sample; DUP–Laboratory Duplicate.

[b] MDL = method detection limit.

[c] Laboratory Qualifiers: U–not detected; J–result estimated because it is below the analytical laboratory's reporting limit.

Table 5-35. Number of Samples Collected for Each Suite of Organic Compounds in Groundwater for 2000

		Organic Suite[a]			
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**	**Volatile**
Ancho Spring	09/26	1			
Basalt Spring	07/25		1	1	1
CDBO-6	12/12			1	1
DI Blank	02/15	1			
DI Blank	06/21	1			
DI Blank	06/26	1	1	1	1
DI Blank	08/01		1	1	1
DI Blank	09/26	1	1	1	1
Doe Spring	09/27	1	1	1	1
G-1A	11/15	1			
G-2A	06/20	1			
G-3A	06/20	1			
G-4A	06/20	1			
LAO-0.7	08/01				1
LAO-2	06/26		1	1	1
LAO-3A	06/26		1	1	1
LAO-4	08/01		1	1	1
LAO-C	08/01		1	1	1
MCO-2	07/17		1	1	1
MCO-5	07/07		1	1	
MCO-6	07/10		2		
MCO-7	07/10		1		
MCO-7.5	07/11		1		
O-1	06/21	1			
O-4	06/21	1			
Organics Trip Blank	05/02				1
Organics Trip Blank	05/03				1
Organics Trip Blank	06/26				1
Organics Trip Blank	06/27				1
Organics Trip Blank	07/17				1
Organics Trip Blank	07/19				1
Organics Trip Blank	07/25				1
Organics Trip Blank	07/27				1
Organics Trip Blank	08/01				1
Organics Trip Blank	09/25				1
Organics Trip Blank	09/26				1
Organics Trip Blank	10/26				1
PM-1	06/20	1			
PM-2	02/14	1			
PM-2	06/20	1			
PM-2	11/15	1			
PM-3	06/21	1			
PM-4	06/21	1			
PM-4	11/15	1			
PM-5	02/14	1			
PM-5	06/20	1			

Table 5-35. Number of Samples Collected for Each Suite of Organic Compounds in Groundwater for 2000 (Cont.)

		Organic Suite[a]			
Station Name	**Date**	**HE**	**PCB**	**Semivolatile**	**Volatile**
PM-5	11/15	1			
POI-4	07/19	1	1	1	1
Spring 10	09/27	1	1	1	1
Spring 3	09/25		1	1	1
Spring 3A	09/25		1	1	1
Spring 4	09/25	1	2	1	2
Spring 4A	09/25	1			
Spring 5A	09/26	1	1	1	1
Spring 5B	07/26	1	1	1	1
Spring 6	09/26	1	1	1	1
Spring 6	09/26	1	1		1
Spring 8A	09/26	1	1	1	1
Spring 9A	09/27	1	1	1	1
Test Well 1	05/02	1	1	1	1
Test Well 2	05/03	1			
Test Well 3	05/03	1	1	1	1
Test Well 3	05/03	1	1	1	1
Test Well 4	05/02	1	1	1	1
Test Well 8	05/02	1			
Test Well DT-10	10/27	1	1	1	1
Test Well DT-5A	10/26	1	1	1	1
Test Well DT-5A	10/26	1	1	1	1

[a] High explosives, polychlorinated biphenyls, semivolatiles, and volatiles.

Table 5-36. Organic Compounds Detected in Groundwater Samples in 2000

Detect[a]	Station Name	Date	Code[b]	Suite[c]	Analyte	Result	MDL[d]	Units
Detect	Test Well 4	05/02	UF	PEST/PCB	Aroclor-1260	0.53		µg/L
Detect	Test Well 4	05/02	UF	SVOA	Benzoic Acid	9.00		µg/L
	Organics Trip Blank	05/02	UF	VOA	Chloroform	5.10		µg/L
	Organics Trip Blank	05/02	UF	VOA	Chloroethane	2.50		µg/L
	Organics Trip Blank	05/02	UF	VOA	Bromodichloromethane	1.10		µg/L
	Organics Trip Blank	05/03	UF	VOA	Chloroform	4.50		µg/L
	Organics Trip Blank	05/03	UF	VOA	Chloroethane	2.40		µg/L
	Organics Trip Blank	05/03	UF	VOA	Bromodichloromethane	1.10		µg/L
	Organics Trip Blank	07/19	UF	VOA	Chloromethane	0.84		µg/L
	Organics Trip Blank	07/27	UF	VOA	Chloroform	6.60	0.198	µg/L
	Organics Trip Blank	07/27	UF	VOA	Bromodichloromethane	1.70	0.024	µg/L
Detect	LAO-0.7	08/01	UF	VOA	Methyl-2-pentanone[4-]	6.90		µg/L
	Organics Trip Blank	08/01	UF	VOA	Acetone	14.00		µg/L
	LAO-0.7	08/01	UF	VOA	Acetone	23.00		µg/L
	LAO-C	08/01	UF	VOA	Acetone	20.00		µg/L
	DI Blank	08/01	UF	VOA	Acetone	15.00		µg/L
	LAO-4	08/01	UF	VOA	Chloromethane	1.80		µg/L
	Organics Trip Blank	08/01	UF	VOA	Chloroethane	4.20		µg/L
	LAO-0.7	08/01	UF	VOA	Methylene chloride	1.70		µg/L
	LAO-4	08/01	UF	VOA	Methylene chloride	1.30		µg/L
	DI Blank	08/01	UF	VOA	Methylene chloride	13.00		µg/L
	Organics Trip Blank	08/01	UF	VOA	Methylene chloride	2.60		µg/L
	LAO-C	08/01	UF	VOA	Methylene chloride	2.20		µg/L
Detect	LAO-0.7	08/01	UF	VOA	Butanone[2-]	13.00		µg/L
	Organics Trip Blank	09/25	UF	VOA	Chloroform	7.10	0.198	µg/L
	Organics Trip Blank	09/25	UF	VOA	Bromodichloromethane	1.80	0.024	µg/L
	DI Blank	09/26	UF	SVOA	Bis(2-ethylhexyl)phthalate	1.70	0.320	µg/L
	Organics Trip Blank	09/26	UF	VOA	Chloroform	6.60	0.198	µg/L
	Organics Trip Blank	09/26	UF	VOA	Bromodichloromethane	1.60	0.024	µg/L
	Spring 9A	09/27	F	SVOA	Bis(2-ethylhexyl)phthalate	1.30	0.320	µg/L

Table 5-36. Organic Compounds Detected in Groundwater Samples in 2000 (Cont.)

Detect[a]	Station Name	Date	Code[b]	Suite[c]	Analyte	Result	MDL[d]	Units
Detect	Spring 10	09/27	F	VOA	Toluene	1.50	0.262	µg/L
	Organics Trip Blank	10/26	UF	VOA	Toluene	1.00	0.262	µg/L
	Organics Trip Blank	10/26	UF	VOA	Chloroform	7.20	0.198	µg/L
	Organics Trip Blank	10/26	UF	VOA	Bromodichloromethane	1.80	0.024	µg/L

[a] Indicates compound was not detected in associated blank. Results are sorted by analyte and date to show association of field blanks with samples.

[b] UF–unfiltered; F–filtered.

[c] PEST/PCB–pesticides and polychlorinated biphenyls; SVOA–semivolatile organics; VOA–volatile organics.

[d] MDL = method detection limit.

Table 5-37. Quality Assurance Sample Results for Radiochemical Analysis of Water Samples by Paragon in 2000[a,b] (pCi/L)

	Date	Code	^{90}Sr		
DI Blank	02/15	CS	0.000	0.018	
DI Blank	06/21	CS	0.083	0.021	0.140
DI Blank	06/26	CS	0.048	0.021	0.140
DI Blank	07/26	CS	0.039	0.018	0.120
DI Blank	08/01	CS	0.070	0.023	
Average of Blank Values			0.048	0.020	
Standard Deviation of Blank Values			0.032		
Spiked Sample	04/26	CS	4.020	0.185	
Spiked Sample	05/03	CS	4.290	0.198	0.093
Spiked Sample	03/03	CS	3.980	0.185	0.130
Average of Results			4.097	0.189	
Standard Deviation of Results			0.169		
Spiked Concentration			4.000		
Average Result/Spiked Value			1.024		

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[a] Three colums are listed: the first is the value; the second is the radioactive counting uncertainties (1 std. dev.); the third is the minimum detectable activity. Radioactivity counting uncertainties may be less than analytical method uncertainties.

[b] See Appendix B for an explanation of negative numbers.

Table 5-38. Quality Assurance Sample Results for Radiochemical Analysis by GEL of Water Samples in 2000[a,b] (pCi/L)

	Date	F/UF	Code	^{3}H			^{90}Sr			^{137}Cs			^{234}U			^{235,236}U			^{238}U		
DI Blank	08/03	UF	CS				–0.015	0.369	0.651												
DI Blank	09/26	UF	CS	–63	71.4	242	–0.089	0.099	0.353	0.301	0.672	2.360	–0.0145	0.0160	0.0724	–0.0048	0.0108	0.0520	0.0048	0.0084	0.0355
DI Blank	09/26	UF	DUP	–180	58	201															
DI Blank	09/27	UF	CS				0.036	0.105	0.368												
DI Blank	11/15	UF	CS				–0.047	0.060	0.209												
DI Blank	12/19	UF	CS				–0.019	0.117	0.411												
Average of Blank Values				–121			–0.027														
Standard Deviation of Blank Values				83			0.046														
Spiked Sample	09/26	UF	CS	[c]	48.9	168	[c]	0.133	0.456	0.269	0.615	2.250	0.0131	0.0146	0.0526	0.0176	0.0108	0.0323	0.0175	0.0139	0.0472
Spiked Sample	10/27	UF	CS	9,950	207	201	4.500	0.286	0.509	<0.433	0.843	2.990	–0.0031	0.0080	0.0651	0.0121	0.0114	0.0563	–0.0001	0.0074	0.0562
Spiked Sample	10/27	UF	DUP										0.0218	0.0170	0.0821	–0.0096	0.0122	0.0943	–0.0001	0.0077	0.0582
Spiked Sample	12/06	UF	CS	9,700	203	198	5.590	0.388	0.537	<–0.143	0.639	2.240	0.0264	0.0209	0.1030	–0.0124	0.0072	0.0924	0.0003	0.0103	0.0795
Spiked Sample	12/06	UF	DUP	9,710	202	197															
Spiked Sample	12/13	UF	CS				5.370	0.211	0.256												
Average of Spiked Value				9,787			5.153														
Standard Deviation of Spiked Values				142			0.576														
Spiked Concentration				10,000			5														
Ratio of Result/Spiked Value				0.98			1.03														

Table 5-38. Quality Assurance Sample Results for Radiochemical Analysis by GEL of Water Samples in 2000[a,b] (pCi/L) (Cont.)

	Date	F/UF	Code	^{238}Pu			^{239,240}Pu			^{241}Am			Gross Alpha			Gross Beta		
DI Blank	08/03	UF	CS															
DI Blank	09/26	UF	CS	–0.0043	0.0044	0.0318	0.0000	1.0100	0.0117	0.0270	0.0109	0.0279	0.081	0.282	1.180	–0.452	0.682	2.490
DI Blank	09/26	UF	DUP															
DI Blank	09/27	UF	CS															
DI Blank	11/15	UF	CS															
DI Blank	12/19	UF	CS															
Average of Blank Values																		
Standard Deviation of Blank Values																		
Spiked Sample	09/26	UF	CS	0.1060	0.0407	0.0360	0.1200	0.0474	0.0978	0.1150	0.0217	0.0257	0.693	0.456	1.400	10.600	1.050	2.360
Spiked Sample	10/27	UF	CS	0.0880	0.0287	0.0697	0.1160	0.0319	0.0666	0.1170	0.0224	0.0269	0.314	0.211	0.641	8.530	0.633	1.360
Spiked Sample	10/27	UF	DUP	0.1880	0.0368	0.0247	0.1040	0.0247	0.0312									
Spiked Sample	12/06	UF	CS	0.1640	0.0268	0.0275	0.0932	0.0207	0.0346	0.1320	0.0315	0.0498	0.016	0.254	0.747	9.860	0.774	1.750
Spiked Sample	12/06	UF	DUP															
Spiked Sample	12/13	UF	CS															
Average of Spiked Value				0.1365			0.1083			0.1213								
Standard Deviation of Spiked Values				0.0472			0.0121											
Spiked Concentration				0.1000			0.1000			0.1000								
Ratio of Result/Spiked Value				1.37			1.08			1.21								

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[a] Three colums are listed: the first is the value; the second is the radioactive counting uncertainties (1 std. dev.); the third is the minimum detectable activity. Radioactivity counting uncertainties may be less than analytical method uncertainties.

[b] See Appendix B for an explanation of negative numbers.

[c] Explanation in text.

Table 5-39. Quality Assurance Sample Results for Radiochemical Analysis of Water Samples by CST in 2000[a,b] (pCi/L[c])

	Date	Code[c]	^{3}H		^{137}Cs		^{234}U		^{235,236}U		^{238}U		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
DI Blank	02/15	CS					0.002	0.014	0.011	0.012	–0.002	0.009												
DI Blank	06/26	CS	–70	430	–0.91	10.28	0.022	0.026	0.002	0.015	0.035	0.021	0.009	0.008	0.005	0.005	–0.011	0.020	0.8	1.2	1.4	1.1	38.3	48.8
DI Blank	07/26	CS	600	440	–1.08	8.58	0.009	0.009	–0.007	0.005	0.021	0.010	–0.003	0.003	0.017	0.008	0.010	0.008	–0.2	0.2	0.1	0.2	435.5	53.8
DI Blank	08/01	CS	420	430	–0.53	1.75	0.008	0.015	0.008	0.008	0.018	0.010	0.025	0.009	0.005	0.006	0.020	0.008	0.0	0.0	–0.4	0.7	335.4	53.2
Analytical Detection Limit			700		4.00								0.040		0.040		0.040		3.0		3.0		120.0	
Average of Blank Values			317	433	–0.84	6.87	0.013	0.017	0.001	0.009	0.025	0.014	0.010	0.007	0.009	0.006	0.006	0.012	0.2	0.5	0.4	0.7	269.7	51.9
Standard Deviation of Blank Values			347		0.28		0.008		0.008		0.009		0.014		0.007		0.016		0.5		0.9		206.6	
Spiked Sample	04/05	CS			–0.61	5.51							0.101	0.018	0.113	0.018	0.095	0.020	1.1	1.3	10.5	3.6	56.4	50.3
Spiked Sample	05/03	CS	8,290	990	–0.69	2.10	–0.001	0.014	–0.009	0.005	0.004	0.007	0.144	0.027	0.190	0.030	0.056	0.018	0.0	0.0	7.8	2.9	52.0	48.9
Spiked Sample	07/18	CS			–0.65	4.50	–0.014	0.014	0.006	0.010	0.001	0.009	0.117	0.020	0.116	0.020	0.096	0.019	0.3	0.6	9.7	3.7	45.1	51.2
Spiked Sample	08/16	CS	8,770	1,000	–0.43	1.87	–0.018	0.039	–0.006	0.013	0.000	0.008	0.081	0.018	0.108	0.022	0.118	0.024	0.6	1.2	9.3	3.4	196.5	49.9
Average of Spiked Value			8,530	995									0.111	0.021	0.132	0.023	0.091	0.020						
Standard Deviation of Spiked Values			339										0.026		0.039		0.026							
Spiked Concentration			10,000										0.100		0.100		0.100							
Ratio of Result/Spiked Value			0.85										1.11		1.32		0.91							

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[a] Two colums are listed: the first is the value; the second is the radioactive counting uncertainties (1 std. dev.). Radioactivity counting uncertainties may be less than analytical method uncertainties.

[b] See Appendix B for an explanation of negative numbers.

[c] CS: Customer Sample.

Table 5-40. Quality Assurance Sample Results for Metals Analysis by GEL of Water Samples in 2000 (μg/L)

Station Name	Date	F/UF	Code		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
DI Blank	09/26	UF	CS	GELC	<1	24	<3	8.0	<1	<0.5	<0.6	1.5	1	<2	<20	<0.1
Spiked Sample	09/26	UF	CS	GELC	26	21	<3	<5	507	<0.5	<0.6	<0.6	<1	<2	<20	[a]
Spiked Sample	10/27	UF	CS	GELC	24	<23	<3	3	490	<0.5	<0.6	<0.6	<1	<2	6	4.3
Spiked Sample	12/06	UF	CS	GELC	24	<23	<3	<5	486	<0.5	<0.6	<0.6	<1	<2	15	5.5
Average of Spiked Value					25				494							4.9
Standard Deviation of Spiked Values					1.1				11.2							0.9
Spiked Concentration					25				500							5.0
Ratio of Result/Spiked Value					0.99				0.99							0.98

Table 5-40. Quality Assurance Sample Results for Metals Analysis by GEL of Water Samples in 2000 (μg/L) (Cont.)

Station Name	Date	F/UF	Code		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
DI Blank	09/26	UF	CS	GELC	<1.2	<1	<3	<2	<0.7	<2	<2	<0.5	0.43	<1	<4
Spiked Sample	09/26	UF	CS	GELC	<1.2	<1	<3	9	<0.7		<2	<0.5	0.11	<1	<4
Spiked Sample	10/27	UF	CS	GELC	0.8	<1	<3	8	<0.1	<2	<2	<0.5	0.02	<1	<1
Spiked Sample	12/06	UF	CS	GELC	<1.2	<1	<3	7	0.2	<2	<2	<0.5	0.02	<1	<1
Average of Spiked Value								8							
Standard Deviation of Spiked Values								1.0							
Spiked Concentration								8							
Ratio of Result/Spiked Value								1.07							

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[a] See explaination in text.

Table 5-41. Quality Assurance Sample Results for Metals Analysis by CST of Water Samples in 2000 (µg/L)

	Date	F/UF	Code		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
DI Blank	06/26	UF	CS	CST	<6	170	<2	<75	28	2	<3	8	10	5	<50	
DI Blank	06/26	UF	CS	CST	<6	<580	<2	<75	2	2	<3	<6	<5	<4	<50	
DI Blank	07/26	UF	CS	CST	9	<270	<2	10	<2	<1	<3	<6	<5	<4	<30	
DI Blank	07/26	UF	CS	CST												<0.1
DI Blank	08/01	UF	CS	CST	<6	51	<3	<18	<2	<1	<3	<6	<5	37	42	<0.1
Spiked Sample	04/05	UF	CS	CST	<22	<100	<2	<39	513	<2	<3	<6	<5	<25	<30	2.3
Spiked Sample	05/03	UF	CS	CST	26	<40	<3	<9	506	<1	<3	<6	<5	<4	<40	1.8*
Spiked Sample	07/18	UF	CS	CST	32	<40	<2	<9	464	<1	<3	<6	<5	<4	<30	4.5
Spiked Sample	08/16	UF	CS	CST	17	<40	<2	<9	461	<1	<3	<6	<5	4	<30	4.8
Spiked Sample	08/16	UF	CS	CST												
Average of Spiked Value					25				486							3.0
Standard Deviation of Spiked Values					8				27							2.0
Spiked Concentration					25				500							5.0
Ratio of Result/Spiked Value					1.00				0.97							0.67*

Table 5-41. Quality Assurance Sample Results for Metals Analysis by CST of Water Samples in 2000 (µg/L) (Cont.)

	Date	F/UF	Code		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Ti	V	Zn
DI Blank	06/26	UF	CS	CST	<1	40	<20	<5	<3		60	53		14	14
DI Blank	06/26	UF	CS	CST	<1	<43	<20	<2	<3	3	<60	<2		<12	42
DI Blank	07/26	UF	CS	CST	3	<10	<20	<2	<3		<60	<1		<7	<10
DI Blank	07/26	UF	CS	CST						<4					
DI Blank	08/01	UF	CS	CST	<2	<10	<20	<5	<3	<3	<60	<1		<7	<10
Spiked Sample	04/05	UF	CS	CST	<3	<10	<20	7	<3	<3	<60	<2		<7	<10
Spiked Sample	05/03	UF	CS	CST	<4	<10	<20	8	<3	<3	<60	<1		<7	<10
Spiked Sample	07/18	UF	CS	CST	<5	<10	<20	<2	<3	<3	<60	<1		<7	<10
Spiked Sample	08/16	UF	CS	CST	<1	<10	<20	7	<3		<60	<1		<7	<10
Spiked Sample	08/16	UF	CS	CST						3					
Average of Spiked Value								7							
Standard Deviation of Spiked Values								1							
Spiked Concentration								8							
Ratio of Result/Spiked Value								0.98							

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*Explanation in text.

Table 5-42. QAP 51 September 1999, Paragon Analytics, Inc.

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	159	27	124	4.8	1.28	A
^{241}Am	2.46	0.72	1.44	0.19	1.71	A
^{212}Bi	158	31	140	14	1.13	
^{214}Bi	87	15	69.5	1.8	1.25	A
Bq U	424	35	401	8.7	1.06	A
^{137}Cs	271	45	204	5	1.33	A
^{40}K	1,000	170	780	27	1.28	A
^{212}Pb	173	29	127	4.8	1.36	A
^{214}Pb	99	17	72	0.42	1.38	A
^{239}Pu	3.5	0.76	3.2	0.5	1.09	A
^{90}Sr	13.5	3.9	13	0.47	1.04	A
^{234}Th	318	79	198	5.6	1.61	A
^{234}U	207	25	190	5.2	1.09	A
^{238}U	209	25	202	7.2	1.04	A
Water						
^{241}Am	0.98	0.13	0.85	0.1	1.15	A
Bq U	0.86	0.11	0.76	0.04	1.13	A
^{60}Co	50.8	8.4	52.4	2.2	0.97	A
^{137}Cs	80	14	76	3.4	1.05	A
^{55}Fe	39.1	8.3	53	2	0.74	
^{3}H	78	11	80.7	3.7	0.97	A
^{63}Ni	113	16.1	114	10	0.99	A
^{238}Pu	0.83	0.12	0.79	0.08	1.05	A
^{239}Pu	0.93	0.13	0.87	0.1	1.07	A
^{90}Sr	1.71	0.31	1.72	0.1	0.99	W
^{234}U	0.469	0.083	0.37	0.02	1.27	A
^{238}U	0.377	0.071	0.36	0.02	1.05	A

[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-43. QAP 52 June 2000, Paragon Analytics, Inc.

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	113.000	23.000	97.600	4.200	1.158	A
^{241}Am	3.810	0.800	3.360	0.510	1.134	A
^{212}Bi	92.000	55.000	106.000	7.000	0.868	A
^{214}Bi	91.000	19.000	86.700	3.800	1.050	A
Bq U	246.000	22.000	229.000	23.000	1.074	A
^{137}Cs	408.000	68.000	339.000	9.300	1.204	A
^{40}K	887.000	158.000	811.000	29.000	1.094	A
^{212}Pb	117.000	20.000	97.300	4.600	1.202	A
^{214}Pb	106.000	21.000	86.500	6.800	1.225	A
^{238}Pu	18.700	2.800	18.600	0.500	1.005	A
^{239}Pu	7.200	1.300	7.000	0.340	1.029	A
^{90}Sr	22.600	4.700	20.200	0.200	1.119	A
^{234}U	116.000	15.000	111.000	11.000	1.045	A
^{238}U	121.000	16.000	114.000	12.000	1.061	A
µg/g U	9.900	1.300	9.150	0.910	1.082	A
Water						
^{241}Am	1.930	0.260	1.950	0.180	0.990	A
Bq U	1.110	0.130	0.995	0.087	1.116	A
^{60}Co	49.200	8.300	48.900	1.800	1.006	A
^{137}Cs	105.000	17.000	103.000	4.000	1.019	A
^{3}H	91.000	14.000	79.400	2.500	1.146	A
^{63}Ni	153.000	38.000	112.000	11.000	1.366	A
^{238}Pu	0.950	0.140	0.944	0.040	1.006	A
^{239}Pu	0.880	0.130	0.918	0.030	0.959	A
^{90}Sr	2.900	0.520	3.390	0.120	0.855	W
^{234}U	0.560	0.093	0.482	0.040	1.162	A
^{238}U	0.519	0.088	0.492	0.040	1.055	A
µg/L U	0.040	0.005	0.040	0.003	1.010	

[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-44. QAP 53 December 2000, Paragon Analytics, Inc.

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	88.000	14.700	80.200	3.600	1.097	A
^{241}Am	11.000	21.000	8.270	0.700	1.330	A
^{212}Bi	67.600	29.200	80.500	6.600	0.840	A
^{214}Bi	71.100	18.200	83.300	4.200	0.854	W
Bq U	309.000	27.000	327.000	11.000	0.945	A
^{137}Cs	1,163.000	147.000	1,020.000	51.000	1.140	A
^{40}K	808.000	113.000	713.000	38.000	1.133	A
^{212}Pb	87.400	14.300	79.300	4.300	1.102	A
^{214}Pb	84.700	13.700	86.300	4.300	0.981	A
^{238}Pu	19.200	2.800	19.100	0.200	1.005	A
^{239}Pu	18.200	2.900	16.800	0.300	1.083	A
^{90}Sr	50.900	9.700	50.400	2.000	1.010	A
^{234}Th	211.000	84.000	148.000	10.000	1.426	A
µg/g U	10.800	1.500	13.200	0.500	0.818	A
^{234}U	148.000	19.000	157.000	10.000	0.943	A
^{238}U	152.000	19.000	163.000	10.000	0.933	A
Water						
^{241}Am	1.250	0.170	1.190	0.045	1.050	A
Bq U	0.920	0.100	0.916	0.031	1.004	A
^{60}Co	72.000	9.000	73.700	2.900	0.977	A
^{137}Cs	65.600	9.100	67.000	3.500	0.979	A
^{3}H	99.000	17.000	91.300	0.300	1.084	A
^{238}Pu	0.740	0.100	0.786	0.011	0.941	A
^{239}Pu	0.590	0.080	0.591	0.021	0.998	A
^{90}Sr	4.610	0.850	4.530	0.120	1.018	A
µg/L U	0.020	0.004	0.030	0.001	0.658	N
^{234}U	0.480	0.070	0.481	0.023	0.998	A
^{238}U	0.350	0.060	0.368	0.012	0.951	A

[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-45. QAP 51 September 1999, General Engineering Labs

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	131	20.4	124	4.8	1.06	A
^{241}Am	1.69	0.311	1.44	0.19	1.17	A
^{212}Bi	82.9	14.2	140	14	0.59	A
^{214}Bi	88.5	11.3	69.5	1.8	1.27	W
^{137}Cs	217	24.2	204	5	1.06	A
^{40}K	914	97.3	780	27	1.17	A
^{212}Pb	142	16.1	127	4.8	1.12	A
^{214}Pb	102	12.6	72	0.42	1.42	W
^{239}Pu	2.75	0.419	3.2	0.5	0.86	W
^{90}Sr	9.8	1.07	13	0.47	0.75	W
^{234}Th	188	45	198	5.6	0.95	A
^{234}U	183	23.5	190	5.2	0.96	A
^{238}U	197	25.1	202	7.2	0.98	A
µg/g U	15.1	0.16	16.3	0.3	0.93	A
Water						
^{241}Am	0.984	0.139	0.85	0.1	1.16	A
^{60}Co	54.8	5.91	52.4	2.2	1.05	A
^{137}Cs	77.6	8.24	76	3.4	1.02	A
^{55}Fe	45.8	10.6	53	2	0.86	A
Gross Alpha	1,790	43.9	1,580	20	1.13	A
Gross Beta	969	24.7	740	40	1.31	A
^{3}H	84.2	9.3	80.7	3.7	1.04	A
^{63}Ni	115	2.65	114	10	1.01	A
^{238}Pu	0.857	0.144	0.79	0.08	1.09	A
^{239}Pu	0.934	0.155	0.87	0.1	1.07	A
^{90}Sr	1.77	0.066	1.72	0.1	1.03	A
^{234}U	0.386	0.063	0.37	0.02	1.04	A
^{238}U	0.39	0.063	0.36	0.02	1.08	A
µg/L U	0.032	0.001	0.03	0.01	1.07	A

[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-46. QAP 52 June 2000, General Engineering Laboratories

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	108.000	16.600	97.600	4.200	1.107	A
^{241}Am	3.530	0.507	3.360	0.510	1.051	A
^{212}Bi	63.300	17.900	106.000	7.000	0.597	A
^{214}Bi	94.800	14.000	86.700	3.800	1.093	A
^{137}Cs	349.000	38.200	339.000	9.300	1.029	A
^{40}K	850.000	94.500	811.000	29.000	1.048	A
^{212}Pb	110.000	12.900	97.300	4.600	1.131	A
^{214}Pb	106.000	12.800	86.500	6.800	1.225	A
^{239}Pu	5.000	1.470	7.000	0.340	0.714	W
^{90}Sr	14.300	1.320	20.200	0.200	0.708	W
^{234}Th	114.000	33.300	130.000	5.000	0.877	A
^{234}U	110.000	13.100	111.000	11.000	0.991	A
^{238}U	113.000	13.400	114.000	12.000	0.991	A
µg/g U	8.160	0.200	9.150	0.910	0.892	
Water						
^{241}Am	2.530	0.305	1.950	0.180	1.297	W
^{60}Co	51.400	5.320	48.900	1.800	1.051	A
^{137}Cs	104.000	10.900	103.000	4.000	1.010	A
^{55}Fe	31.600	1.730	33.100	0.700	0.955	A
Gross Alpha	1,752.000	42.700	1,700.000	170.000	1.031	A
Gross Beta	932.000	24.500	690.000	70.000	1.351	W
^{3}H	81.100	6.080	79.400	2.500	1.021	A
^{63}Ni	134.000	4.640	112.000	11.000	1.196	A
^{238}Pu	1.340	0.239	0.944	0.040	1.419	N
^{239}Pu	1.260	0.225	0.918	0.030	1.373	W
^{90}Sr	3.130	0.260	3.390	0.120	0.923	A
^{234}U	0.470	0.057	0.482	0.040	0.975	A
^{238}U	0.490	0.059	0.492	0.040	0.996	A
µg/L U	0.044	0.001	0.040	0.003	1.103	

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[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-47. QAP 53 December 2000, General Engineering Labs

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	80.300	13.700	80.200	3.600	1.001	A
^{241}Am	9.550	4.330	8.270	0.700	1.155	A
^{212}Bi	52.900	13.800	80.500	6.600	0.657	A
^{214}Bi	74.200	11.400	83.300	4.200	0.891	A
^{137}Cs	1,120.000	153.000	1,020.000	51.000	1.098	A
^{40}K	858.000	86.200	713.000	38.000	1.203	A
^{212}Pb	88.100	10.200	79.300	4.300	1.111	A
^{214}Pb	87.900	11.500	86.300	4.300	1.019	A
^{239}Pu	17.400	2.070	16.800	0.300	1.036	A
^{90}Sr	41.100	1.910	50.400	2.000	0.815	A
^{234}Th	113.000	41.500	148.000	10.000	0.764	W
µg/g U	8.930	0.330	13.200	0.500	0.677	A
^{234}U	132.000	13.600	157.000	10.000	0.841	W
^{238}U	134.000	13.700	163.000	10.000	0.822	W
Water						
^{241}Am	1.330	0.130	1.190	0.045	1.118	A
^{60}Co	76.200	5.380	73.700	2.900	1.034	A
^{137}Cs	68.100	5.000	67.000	3.500	1.016	A
Gross Alpha	964.000	33.900	1,070.000	100.000	0.901	A
Gross Beta	1,020.000	25.200	950.000	90.000	1.074	A
^{3}H	105.000	9.210	91.300	0.300	1.150	A
^{238}Pu	0.760	0.090	0.786	0.011	0.967	A
^{239}Pu	0.590	0.070	0.591	0.021	0.998	A
^{90}Sr	3.600	0.190	4.530	0.120	0.795	W
µg/L U	0.020	0.001	0.030	0.001	0.658	N
^{234}U	0.390	0.040	0.481	0.023	0.811	W
^{238}U	0.320	0.040	0.368	0.012	0.870	W

[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-48. QAP 51 September 1999, Chemical Sciences and Technology Division, Los Alamos National Laboratory

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Soil						
^{228}Ac	151	17	124	4.8	1.22	A
^{228}Ac	174	19	124	4.8	1.40	W
^{228}Ac	144	16	124	4.8	1.16	A
^{241}Am	3.13	0.37	1.44	0.19	2.17	W
^{241}Am	1.88	0.37	1.44	0.19	1.31	A
^{241}Am	2.26	0.37	1.44	0.19	1.57	W
^{212}Bi	119	15	140	14	0.85	A
^{212}Bi	107	14	140	14	0.76	A
^{212}Bi	107	13	140	14	0.76	A
^{214}Bi	99	11	69.5	1.8	1.42	N
^{214}Bi	117	13	69.5	1.8	1.68	N
^{214}Bi	92	10	69.5	1.8	1.32	W
^{137}Cs	268	28	204	5	1.31	W
^{137}Cs	262	28	204	5	1.28	W
^{137}Cs	236	25	204	5	1.16	A
^{212}Pb	138	15	127	4.8	1.09	A
^{212}Pb	156	17	127	4.8	1.23	W
^{212}Pb	147	16	127	4.8	1.16	A
^{214}Pb	85	9	72	0.42	1.18	A
^{214}Pb	93	10	72	0.42	1.29	W
^{214}Pb	87	10	72	0.42	1.21	A
^{239}Pu	13.41	0.61	3.2	0.5	4.19	N
^{239}Pu	9.59	0.49	3.2	0.5	3.00	N
^{234}Th	338	39	198	5.6	1.71	W
^{234}Th	562	70	198	5.6	2.84	N
^{234}Th	423	48	198	5.6	2.14	N
µg/g U	16.01	1.6	16.3	0.3	0.98	A
µg/g U	16.46	1.65	16.3	0.3	1.01	A
µg/g U	15.72	1.57	16.3	0.3	0.96	A
Water						
^{241}Am	0.856	0.024	0.85	0.1	1.01	A
^{241}Am	0.845	0.024	0.85	0.1	0.99	A
^{241}Am	0.903	0.026	0.85	0.1	1.06	A
^{60}Co	59.1	6.3	52.4	2.2	1.13	A
^{60}Co	57.6	6.2	52.4	2.2	1.10	A
^{60}Co	58	6.2	52.4	2.2	1.11	A
^{137}Cs	87.6	9.3	76	3.4	1.15	A
^{137}Cs	85.9	9.1	76	3.4	1.13	A
^{137}Cs	90.7	9.6	76	3.4	1.19	W
Gross Alpha	1,713	353	1,580	20	1.08	A
Gross Alpha	1,676	346	1,580	20	1.06	A
Gross Alpha	1,772	364	1,580	20	1.12	A
Gross Beta	1,021	223	740	40	1.38	W
Gross Beta	1,006	221	740	40	1.36	W
Gross Beta	1043	227	740	40	1.41	W

Table 5-48. QAP 51 September 1999, Chemical Sciences and Technology Division, Los Alamos National Laboratory (Cont.)

Radionuclide	Reported Value	Reported Error	EML[a] Value	EML[a] Error	Reported/ EML[a]	Evaluation[b]
Water (Cont.)						
^{3}H	80	27.4	80.7	3.7	0.99	A
^{3}H	76.6	27.4	80.7	3.7	0.95	A
^{3}H	68.1	26.6	80.7	3.7	0.84	A
^{238}Pu	0.788	0.022	0.79	0.08	1.00	A
^{238}Pu	0.766	0.019	0.79	0.08	0.97	A
^{238}Pu	0.794	0.02	0.79	0.08	1.01	A
^{239}Pu	0.866	0.024	0.87	0.1	1.00	A
^{239}Pu	0.83	0.02	0.87	0.1	0.95	A
^{239}Pu	0.845	0.021	0.87	0.1	0.97	A
^{90}Sr	1.78	0.21	1.72	0.1	1.04	A
^{90}Sr	1.65	0.18	1.72	0.1	0.96	A
^{90}Sr	1.95	0.22	1.72	0.1	1.13	A

[a] Environmental Measurements Laboratory.

[b] A = Acceptable
W = Acceptable with Warning
N = Not Acceptable

pCi/g or mL = Bq × 0.027

Table 5-49. MAPEP 99 W7 June 2000, Paragon Analytics, Inc.

Analyte	Reported Value	Reported Error	MAPEP Value	Reported/ MAPEP	Units	Evaluation[a]
As	0.21		0.203	1.03	(mg/L)	A
Ba	51.1		50.8	1.01	(mg/L)	A
Be	0.507		0.508	1.00	(mg/L)	A
Cd	0.3		0.305	0.98	(mg/L)	A
Se	0.194		0.203	0.96	(mg/L)	A
Ag	1.22				(mg/L)	
Tl	0.511		0.508	1.01	(mg/L)	A
U-Total	NR		0.036			
^{238}U	NR		0.036			
V	0.72		0.711	1.01	(mg/L)	A
Zn	4.92		5.08	0.97	(mg/L)	A
^{241}Am	0.655	0.04	0.635	1.03	(Bq/L)	A
^{134}Cs	72.8	6.65	82.9	0.88	(Bq/L)	A
^{137}Cs	68.6	5.72	72.7	0.94	(Bq/L)	A
^{57}Co	93.2	7.71	96.8	0.96	(Bq/L)	A
^{60}Co	267	22	270	0.99	(Bq/L)	A
^{55}Fe	NR		97			
^{54}Mn	392	32.4	395	0.99	(Bq/L)	A
^{63}Ni	174	21.8	157	1.11	(Bq/L)	A
^{238}Pu	0.33	0.02	0.32	1.03	(Bq/L)	A
^{239,240}Pu	0.01	0			(Bq/L)	
^{90}Sr	7.23	0.65	8.19	0.88	(Bq/L)	A
^{234,233}U	0.449	0.03	0.428	1.05	(Bq/L)	A
^{235}U	0.0304	0			(Bq/L)	
^{238}U	0.449	0.03	0.444	1.01	(Bq/L)	A
^{65}Zn	231	19.4	220	1.05	(Bq/L)	A

[a] Flags:
A = Result acceptable Bias ≤20%
W = Result acceptable with warning 20% < Bias ≤30%
N = Result not acceptable Bias > 30%
L = Uncertainty potentially too low (for infomation purposes only)
H = Uncertainty potentially too high (for information purposes only)
QL = Detection Limit
RW = Report Warning
NR = Not Reported

Table 5-50. MAPEP 99 W7 June 2000, General Engineering Laboratories Inc.

Analyte	Reported Value	Reported Error	MAPEP Value	Reported/ MAPEP	Units	Evaluation[a]
As	0.208	0.04	0.203	1.02	(mg/L)	A
Ba	50.5	10.1	50.8	0.99	(mg/L)	A
Be	0.52	0.1	0.508	1.02	(mg/L)	A
Cd	0.314	0.06	0.305	1.03	(mg/L)	A
Se	0.202	0.04	0.203	1.00	(mg/L)	A
Ag	1.08	0.21			(mg/L)	
Tl	0.538	0.1	0.508	1.06	(mg/L)	A
U-Total	NR		0.036			
^{238}U	NR		0.036			
V	0.753	0.15	0.711	1.06	(mg/L)	A
Zn	5.17	1.03	5.08	1.02	(mg/L)	A
^{241}Am	0.725	0.13	0.635	1.14	(Bq/L)	A
^{134}Cs	NR		82.9			
^{137}Cs	67	7.84	72.7	0.92	(Bq/L)	A
^{57}Co	89.9	11.1	96.8	0.93	(Bq/L)	A
^{60}Co	271	31.1	270	1.00	(Bq/L)	A
^{55}Fe	73.5	8.84	97	0.76	(Bq/L)	W
^{54}Mn	388	49.9	395	0.98	(Bq/L)	A
^{63}Ni	131	8.4	157	0.83	(Bq/L)	A
^{238}Pu	0.36	0.06	0.32	1.13	(Bq/L)	A
^{239,240}Pu	0.00345	0			(Bq/L)	
^{90}Sr	5.84	0.37	8.19	0.71	(Bq/L)	W
^{234,233}U	0.477	0.06	0.428	1.11	(Bq/L)	A
^{238}U	0.481	0.06	0.444	1.08	(Bq/L)	A
^{65}Zn	234	27.6	220	1.06	(Bq/L)	A

[a] Flags:
A = Result acceptable Bias ≤2%
W = Result acceptable with warning 20% < Bias ≤30%
N = Result not acceptable Bias > 30%
L = Uncertainty potentially too low (for infomation purposes only)
H = Uncertainty potentially too high (for information purposes only)
QL = Detection Limit
RW = Report Warning
NR = Not Reported

Table 5-51. MAPEP 99 W7 June 2000, Chemical Sciences and Technology Division, Los Alamos National Laboratory

Analyte	Reported Value	Reported Error	MAPEP Value	Reported/ MAPEP	Units	Evaluation[a]
Sb	0.0003	0			(mg/L)	
As	0.238	0.02	0.203	1.17	(mg/L)	A
Ba	45	4.5	50.8	0.89	(mg/L)	A
Be	0.46	0.04	0.508	0.91	(mg/L)	A
Cd	0.26	0.02	0.305	0.85	(mg/L)	A
Cr	0.002	0			(mg/L)	A
Cu	0	0			(mg/L)	W
Pb	0.001	0			(mg/L)	A
Ni	0	0.01			(mg/L)	W
Se	0.209	0.01	0.203	1.03	(mg/L)	A
Ag	0.03	0			(mg/L)	
Th	0.477	0.01	0.508	0.94	(mg/L)	A
U-Total	NR		0.036			
^{238}U	NR		0.036			
V	0.63	0.06	0.711	0.89	(mg/L)	A
Zn	4.4	0.44	5.08	0.87	(mg/L)	A
^{241}Am	0.64	0.02	0.635	1.01	(Bq/L)	A
^{134}Cs	NR		82.9			
^{137}Cs	73	8	72.7	1.00	(Bq/L)	A
^{57}Co	96	11	96.8	0.99	(Bq/L)	A
^{60}Co	269	30	270	1.00	(Bq/L)	A
^{55}Fe	NR		97			
^{54}Mn	403	45	395	1.02	(Bq/L)	A
^{63}Ni	NR		157			
^{238}Pu	0.32	0.02	0.32	1.00	(Bq/L)	A
^{239,240}Pu	0.01	0.01			(Bq/L)	
^{90}Sr	3.21	0.54	8.19	0.39	(Bq/L)	N
^{234,233}U	7.77	0.77	0.428	18.15	(Bq/L)	N
^{238}U	8.23	0.78	0.444	18.54	(Bq/L)	N
^{65}Zn	230	26	220	1.05	(Bq/L)	A

[a] Flags:
A = Result acceptable Bias ≤20%
W = Result acceptable with warning 20% < Bias ≤30%
N = Result not acceptable Bias > 30%
L = Uncertainty potentially too low (for infomation purposes only)
H = Uncertainty potentially too high (for information purposes only)
QL = Detection Limit
RW = Report Warning
NR = Not Reported

Table 5-52. MAPEP 00 S7 December 2000, Paragon Analytics, Inc.

Analyte	Reported Value	Reported Error	MAPEP Value	Reported/ MAPEP	Units	Evaluation[a]
As	8.16				mg/kg	A
Ba	459		425.3	1.08	mg/kg	A
Be	89.3		84.9	1.05	mg/kg	A
Cd	13.2		14.27	0.93	mg/kg	A
Cr	22.5		27.1	0.83	mg/kg	A
Pb	67.8		61.3	1.11	mg/kg	A
Ni	44.1		44.3	1.00	mg/kg	A
Se	9.29		7.46	1.25	mg/kg	W
U-Total	NR		7.53			
^{238}U	NR		7.48			
V	129		122.6	1.05	mg/kg	A
Zn	69.4		80.3	0.86	mg/kg	A
^{241}Am	59	7.66	61.1	0.97	Bq/kg	A
^{134}Cs	937	118	1,047	0.89	Bq/kg	A
^{137}Cs	976	123	930	1.05	Bq/kg	A
^{57}Co	959	121	949	1.01	Bq/kg	A
^{60}Co	1,160	146	1,180	0.98	Bq/kg	A
^{54}Mn	1,130	143	1,023	1.10	Bq/kg	A
^{63}Ni	975	126	960	1.02	Bq/kg	A
^{238}Pu	0.5063	0.239			Bq/kg	A
^{239,240}Pu	69.9	8.72	74.4	0.94	Bq/kg	A
^{40}K	739	102	652	1.13	Bq/kg	A
^{90}Sr	319.4	58	304	1.05	Bq/kg	A
^{234,233}U	88.7	11.2	90	0.99	Bq/kg	A
^{235}U	7.65	1.33			Bq/kg	
^{238}U	89.3.	11.2	93		Bq/kg	A
^{65}Zn	1,680	218	1,540	1.09	Bq/kg	A
Phenol	727		589	1.23	µg/kg	A
1,3-dichlorobenzene	382		333	1.15	µg/kg	A
Nitrobenzene	611		546	1.12	µg/kg	A
2-Nitrophenol	NR		104			
Naphthalene	583		517	1.13	µg/kg	A
2,6-Dichlorophenol	NR		230		µg/kg	
2,4 Dinitrotoluene	747		708	1.06	µg/kg	A
2,4 Dinitrophenol	546		629	0.87	µg/kg	A
Diethylphthalate	1,040		1,038	1.00	µg/kg	A
Anthracene	NR		155			
Pyrene	545		444	1.23	µg/kg	A
Benzo(a)anthracene	660		594	1.11	µg/kg	A
Bis(2-ethylhexyl)phthalat	5,130		5,420	0.95	µg/kg	A

[a] Flags:
A = Result acceptable Bias ≤20%
W = Result acceptable with warning 20% < Bias ≤30%
N = Result not acceptable Bias ≤30%
L = Uncertainty potentially too low (for information purposes only)
H = Uncertainty potentially too high (for information purposes only)
QL = Detection Limit
RW = Report Warning
NR = Not Reported

Table 5-53. MAPEP 00 S7 December 2000, General Engineering Laboratories

Analyte	Reported Value	Reported Error	MAPEP Value	Reported/ MAPEP	Units	Evaluation[a]
As	6.84	1.37			mg/kg	A
Ba	435	87	425.3	1.02	mg/kg	A
Be	81.7	16.3	84.9	0.96	mg/kg	A
Cd	12	2.4	14.27	0.84	mg/kg	A
Cr	24.1	4.82	27.1	0.89	mg/kg	A
Pb	60	12	61.3	0.98	mg/kg	A
Ni	41.9	8.38	44.3	0.95	mg/kg	A
Se	6.83	1.37	7.46	0.92	mg/kg	A
Tl	0.379	0.076			mg/kg	A
U-Total	NR		7.53			
^{238}U	NR		7.48			
V	126	25.2	122.6	1.03	mg/kg	A
Zn	69.1	13.8	80.3	0.86	mg/kg	A
^{241}Am	64.1	15.7	61.1	1.05	Bq/kg	A
^{134}Cs	901	117	1,047	0.86	Bq/kg	A
^{137}Cs	1,020	160	930	1.10	Bq/kg	A
^{57}Co	1,040	126	949	1.10	Bq/kg	A
^{60}Co	1,330	130	1,180	1.13	Bq/kg	A
^{55}Fe	652	30.8			Bq/kg	N
^{54}Mn	1,210	197	1,023	1.18	Bq/kg	A
^{63}Ni	668	63.5	960	0.70	Bq/kg	N
^{238}Pu	–0.546	25.8			Bq/kg	A
^{239,240}Pu	62.3	14.8	74.4	0.84	Bq/kg	A
^{40}K	844	106	652	1.29	Bq/kg	W
^{90}Sr	146	5.39	304	0.48	Bq/kg	N
^{234,233}U	77.7	20.1	90	0.86	Bq/kg	A
^{238}U	96.4	23.1	93	1.04	Bq/kg	A
^{65}Zn	1,990	232	1,540	1.29	Bq/kg	W
Phenol	677		589	1.15	µg/kg	A
1,3-Dichlorobenzene	385		333	1.16	µg/kg	A
Nitrobenzene	498		546	0.91	µg/kg	A
2-Nitrophenol	NR		104			
Naphthalene	471		517	0.91	µg/kg	A
2,6-Dinitrotoluene	1,300		1,572	0.83	µg/kg	A
2,4-Dinitrotoluene	614		708	0.87	µg/kg	A
2,4Dinitrophenol	793		629	1.26	µg/kg	A
4-Nitrophenol	NR		56.4			
Diethylphthalate	930		1,038	0.90	µg/kg	A
Anthracene	146		155	0.94	µg/kg	A
Pyrene	382		444	0.86	µg/kg	A
Benso(a)anthracene	460		594	0.77	µg/kg	A
Bis(2-ethylhexyl)phthalat	NR		5,420			

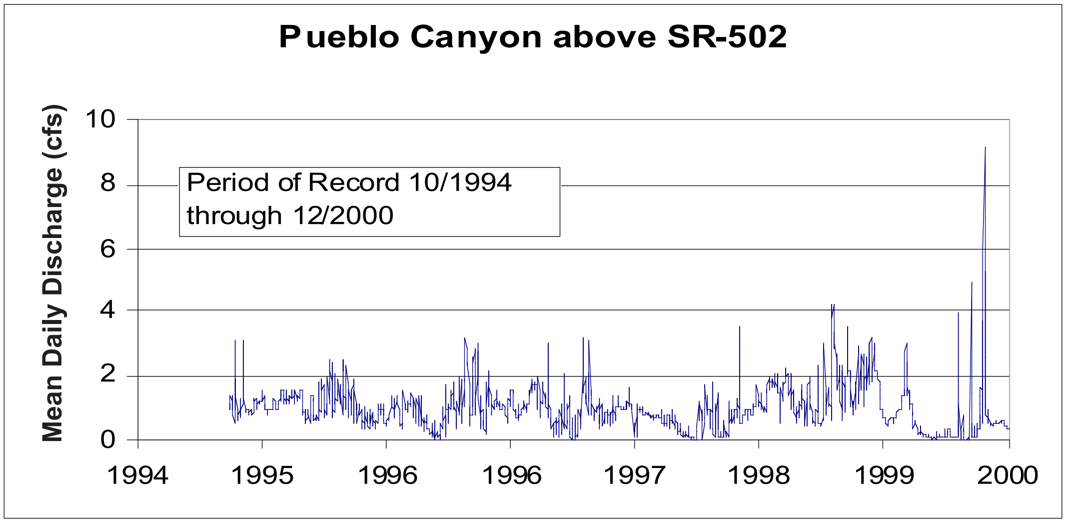
[a] Flags:
A = Result acceptable Bias ≤20%
W = Result acceptable with warning 20% < Bias ≤30%
N = Result not acceptable Bias ≤30%
L = Uncertainty potentially too low (for information purposes only)
H = Uncertainty potentially too high (for information purposes only)
QL = Detection Limit
RW = Report Warning
NR = Not Reported

Table 5-54. MAPEP 00 S7 November 2000, Chemical Sciences and Technology Division, Los Alamos National Laboratory

Analyte	Reported Value	Reported Error	MAPEP Value	Reported/ MAPEP	Units	Evaluation[a]
As	5.57	0.50			mg/kg	A
Ba	383.3	38.30	425.3	.90	mg/kg	A
Be	76.33	7.63	84.9	.90	mg/kg	A
Cd	12.33	1.23	14.27	.86	mg/kg	A
Cr	25.67	2.57	27.1	.95	mg/kg	A
Pb	65.67	2.00	61.3	1.07	mg/kg	A
Ni	37.33	4.22	44.3	.84	mg/kg	A
Se	6.07	0.53	7.46	.81	mg/kg	A
Tl	0.2	0.01			mg/kg	A
^{Total}U	NR		7.53			
^{238}U	NR		7.48			
V	106.7	10.70	122.6	.87	mg/kg	A
Zn	78.67	7.87	80.3	.98	mg/kg	A
^{241}Am	NR		61.1			
^{134}Cs	824	92.00	1,047	.79	Bq/kg	W
^{137}Cs	790	88.00	930	.83	Bq/kg	A
^{57}Co	782	87.00	949	.82	Bq/kg	A
^{60}Co	1,009	112.00	1,180	.85	Bq/kg	A
^{54}Mn	900	100.00	1,023	.88	Bq/kg	A
^{63}Ni	NR		960			
^{238}Pu	0.36	0.06			Bq/kg	N
^{239,240}Pu	50.7	1.50	74.4	.68	Bq/kg	N
^{40}K	547	66.00	652	.84	Bq/kg	A
^{90}Sr	NR		304			
^{234,233}U	66.2	2.80	90	.74	Bq/kg	W
^{238}U	69.2	2.90	93	.74	Bq/kg	W
^{65}Zn	1,387	155.00	1,540	.90	Bq/kg	A

[a] Flags:
A = Result acceptable Bias ≤20%
W = Result acceptable with warning 20% < Bias ≤30%
N = Result not acceptable Bias >30%
L = Uncertainty potentially too low (for information purposes only)
H = Uncertainty potentially too high (for information purposes only)
QL = Detection Limit
RW = Report Warning
NR = Not Reported

L. Figures



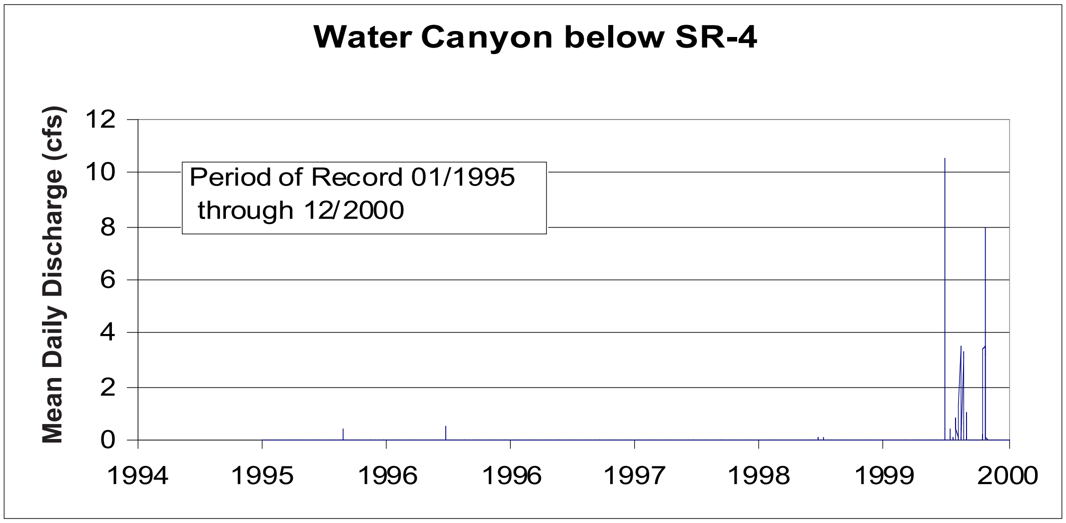


Figure 5-1. Daily average flows (cfs) at gaging stations in lower Pueblo Canyon at State Road 502 (top) and lower Water Canyon below State Road 4 (bottom). Base flow in lower Pueblo Canyon is supported by sanitary effluent discharges from Los Alamos County Bayo wastewater treatment plant. Post-fire runoff yields from summer storms substantially increased in both canyons.

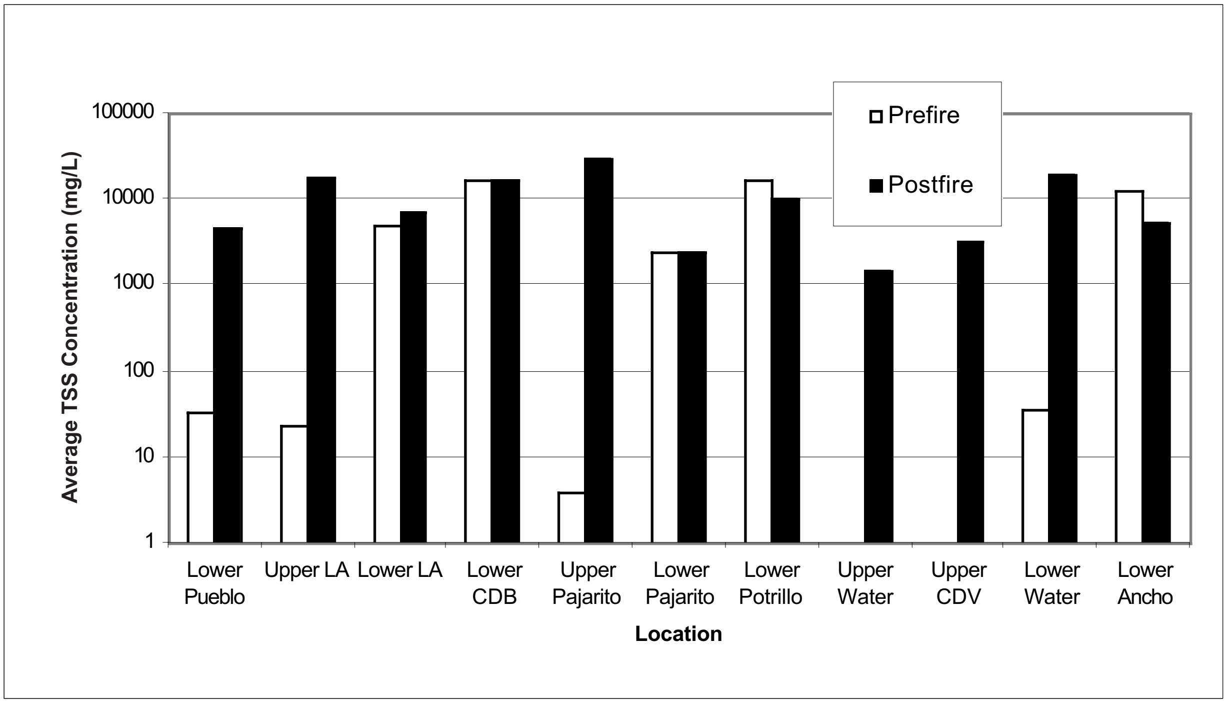


Figure 5-2. Average (volume-weighted) suspended sediment loads in summer runoff before and after the Cerro Grande fire. Note logarithmic scale of chart.

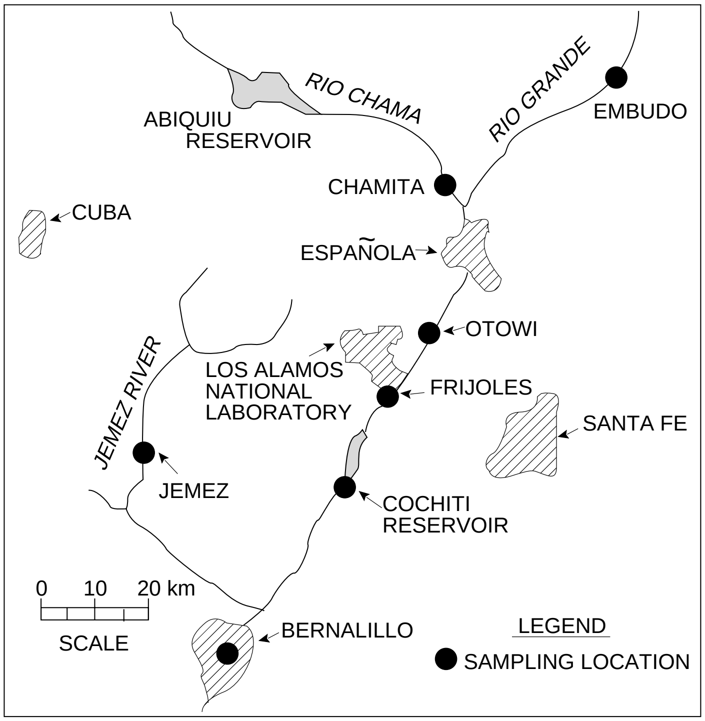


Figure 5-3. Regional surface water and sediment sampling locations.

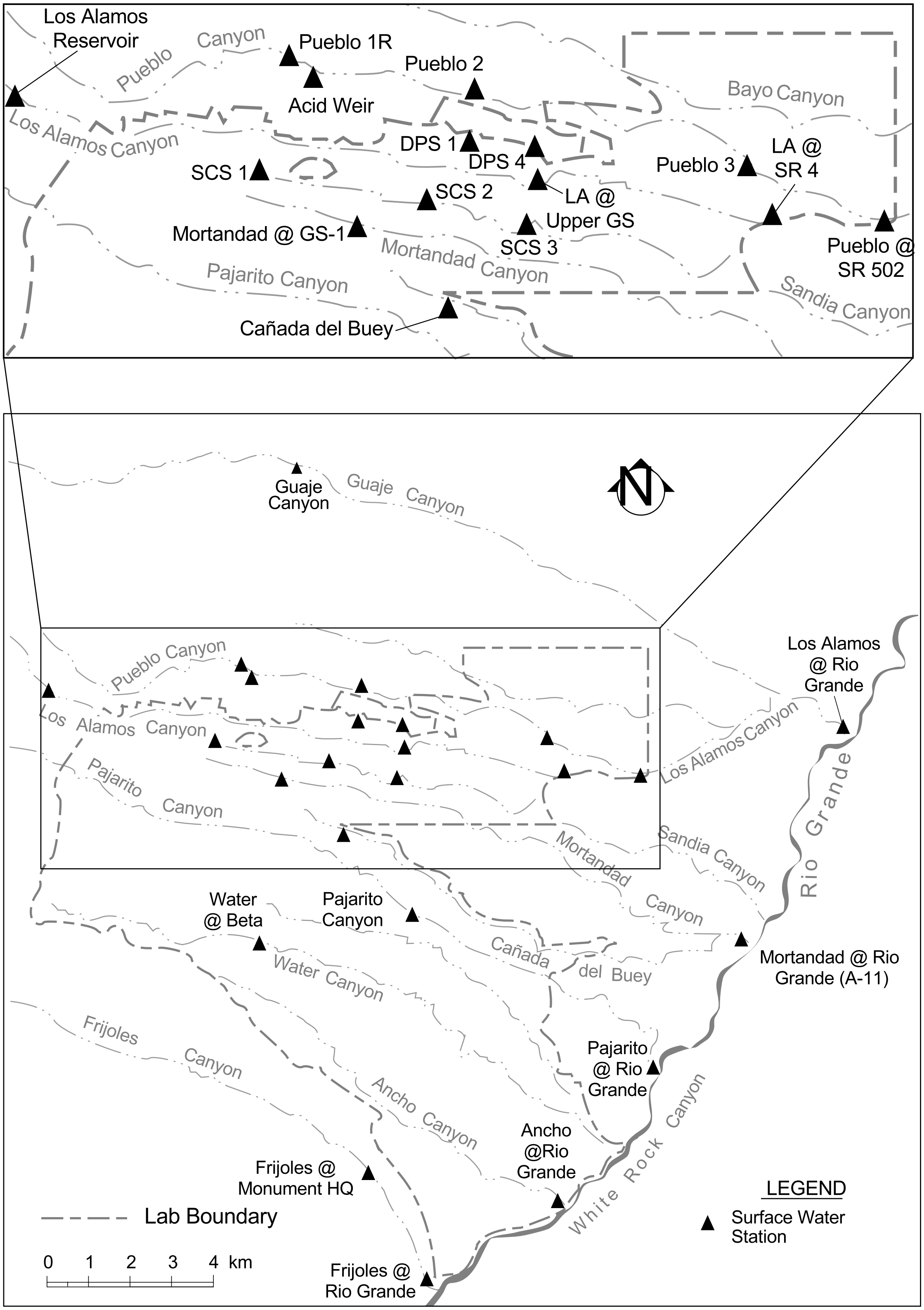


Figure 5-4. Surface water sampling locations in the vicinity of Los Alamos National Laboratory.

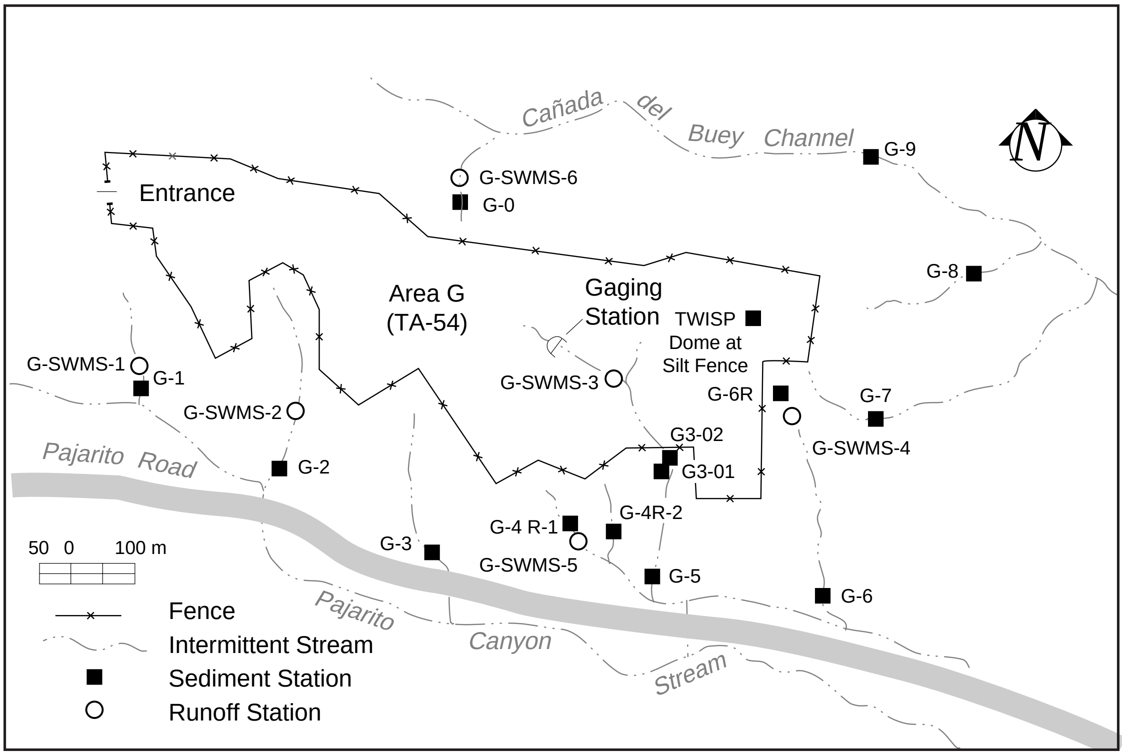


Figure 5-5. Sediment and runoff sampling stations at TA-54, Area G.

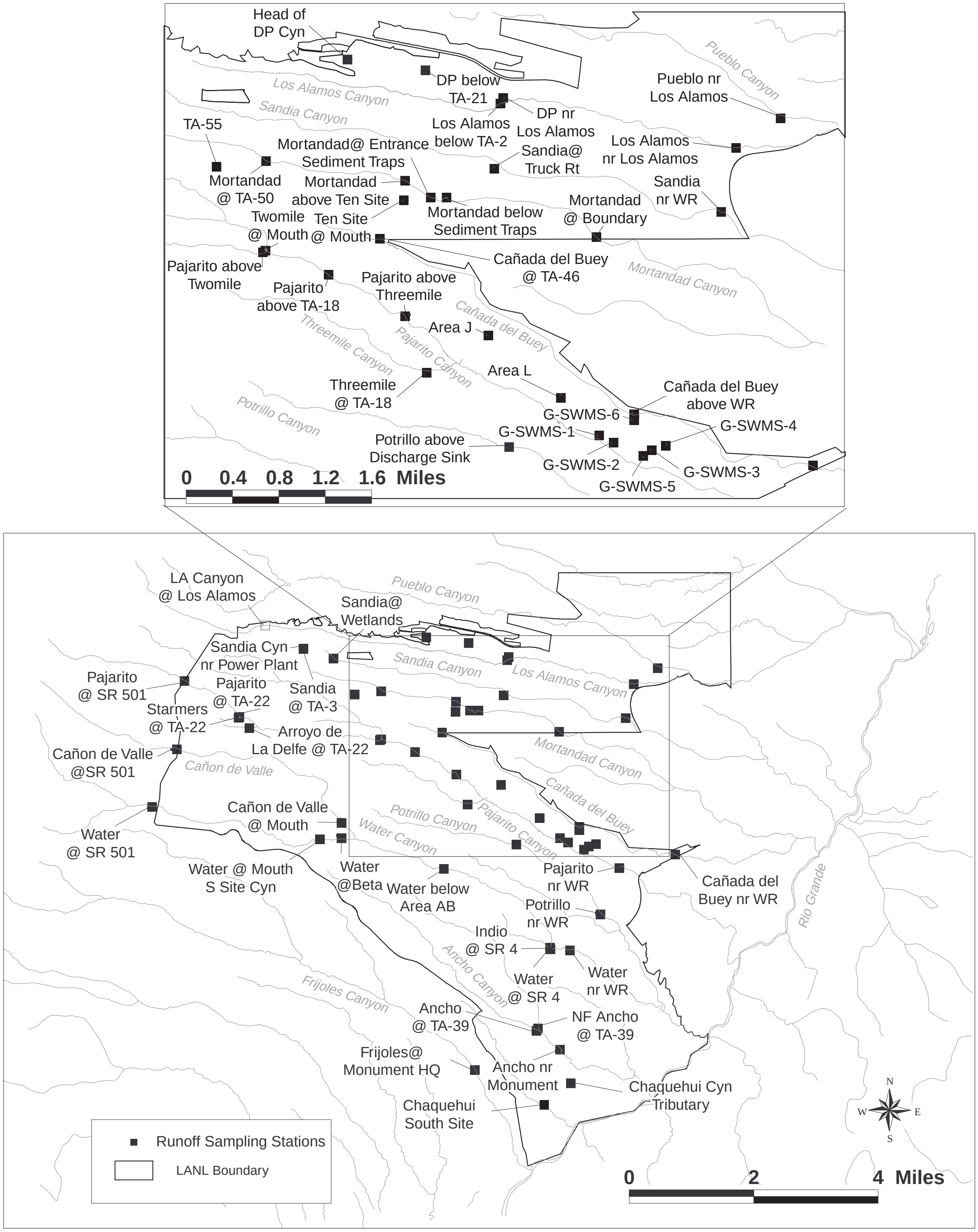


Figure 5-6. Runoff sampling stations in the vicinity of Los Alamos National Laboratory.

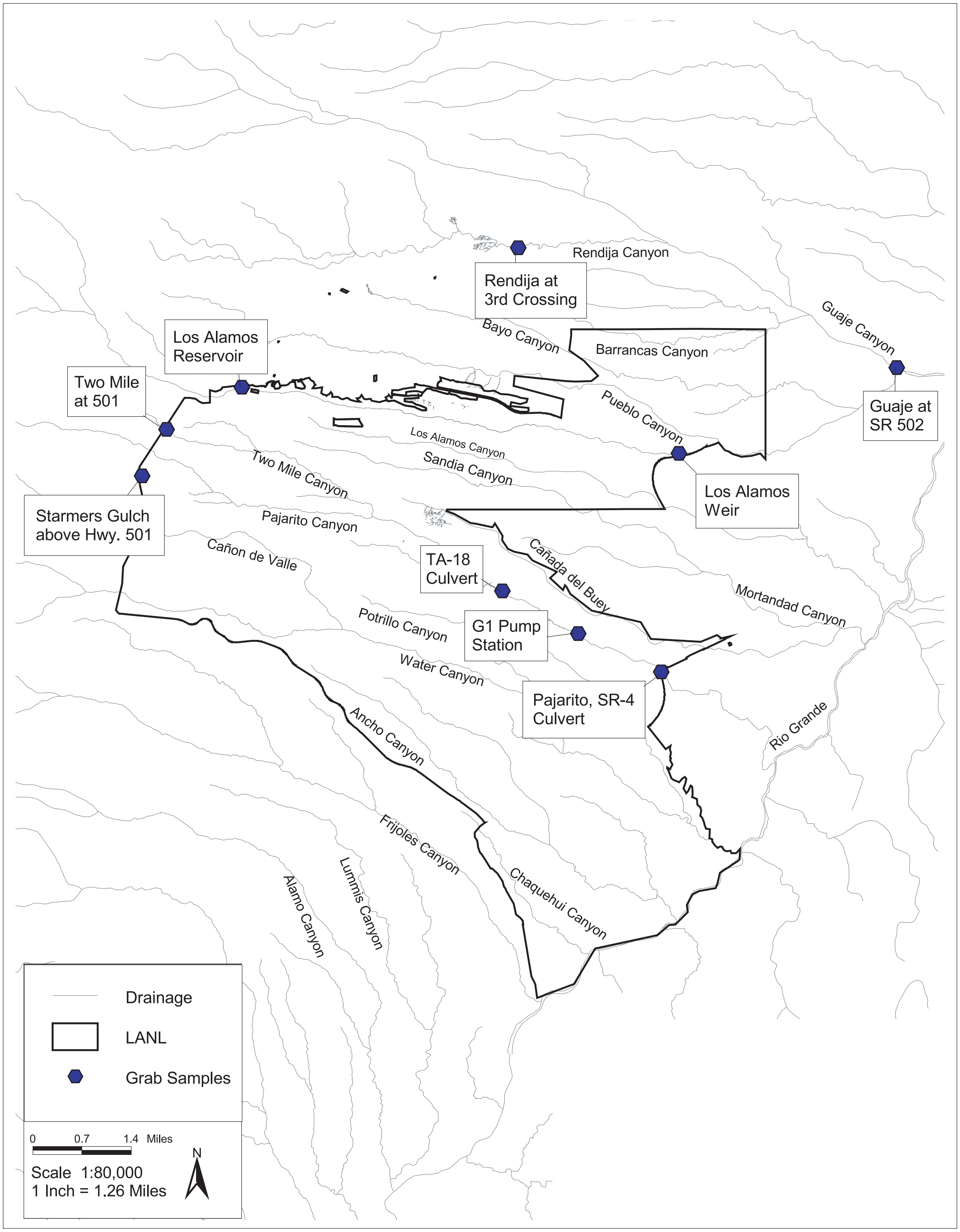


Figure 5-7. Locations of runoff grab samples collected during 2000 at LANL.

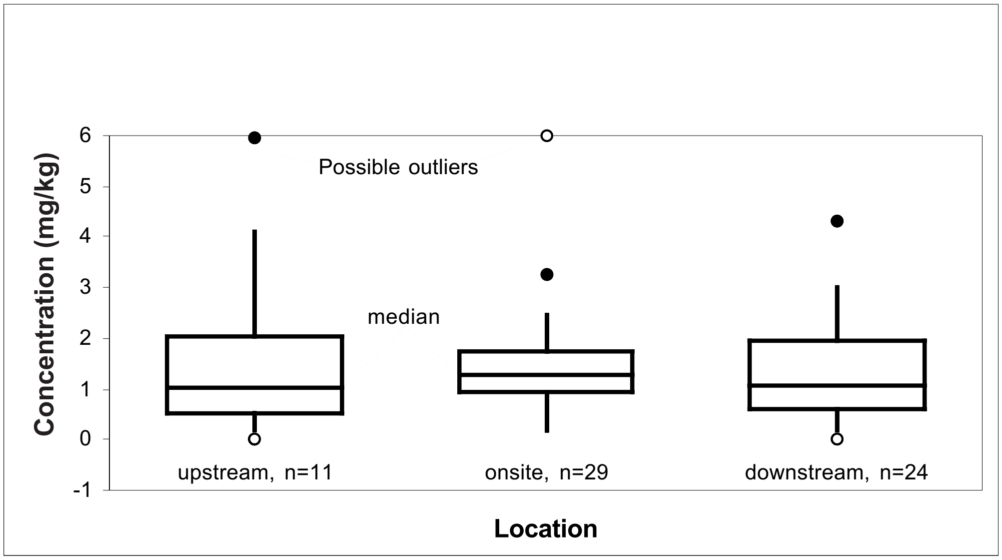


Figure 5-8. Box plot of uranium concentrations in suspended sediment in 2000 runoff. The box plots summarize the distribution of concentrations in upstream, on-site, and downstream stations. The line in the middle of the box identifies the median concentration. The upper and lower ends of the box contain the middle 50% or so of the data. The lines above and below the box indicate the 10th and 90th percentiles.

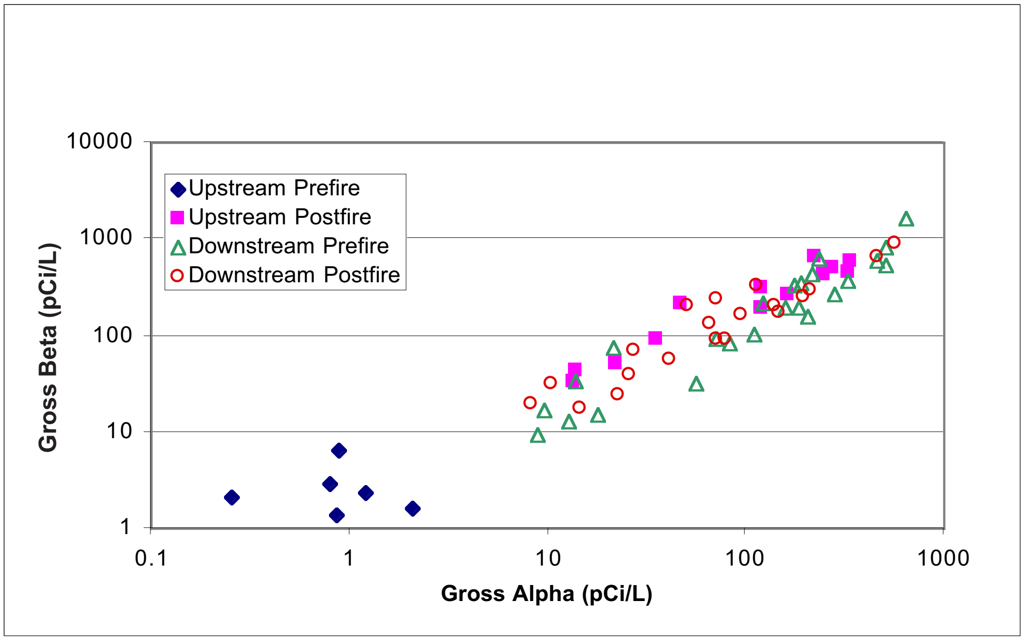


Figure 5- 9. Gross alpha and gross beta in unfiltered runoff pre-fire and post-fire. Note logarithmic scales of chart axes. Along the upstream boundary of the Laboratory, the concentrations of alpha and beta activity in runoff increased by 10-fold or more after the fire. The increase is largely related to the increased sediment load in the upstream samples after the fire. The sediment contains naturally occurring radioactivity from uranium, thorium, and potassium elements.

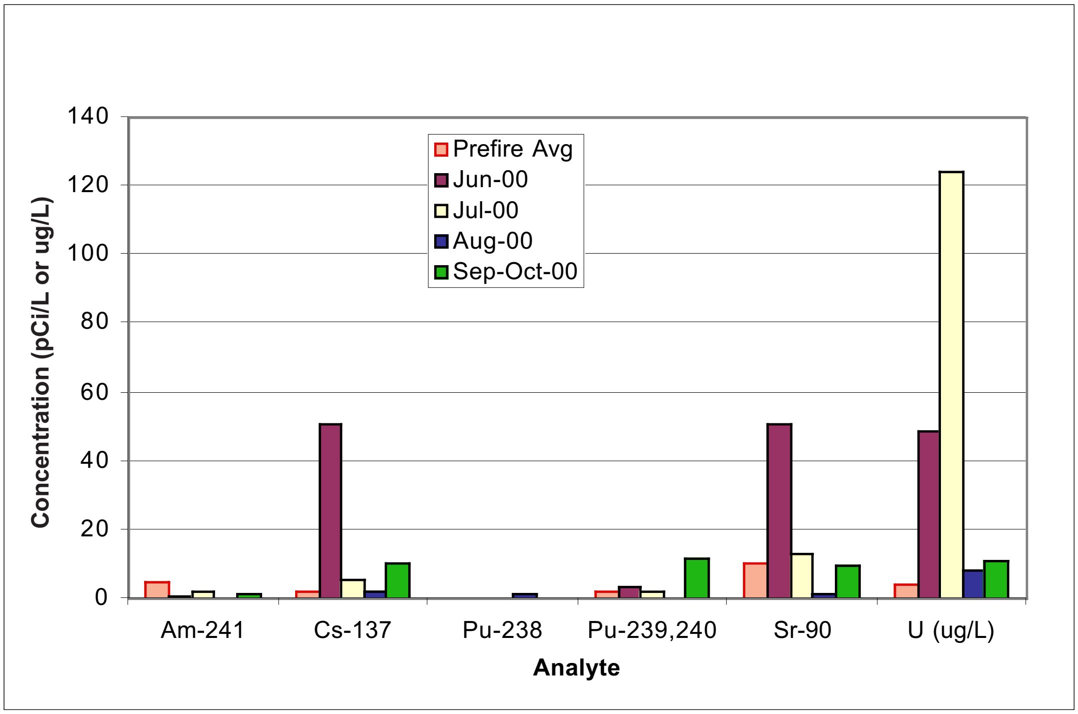


Figure 5-10. Monthly average (flow-weighted) radionuclide concentrations in unfiltered runoff at LANL downstream stations.

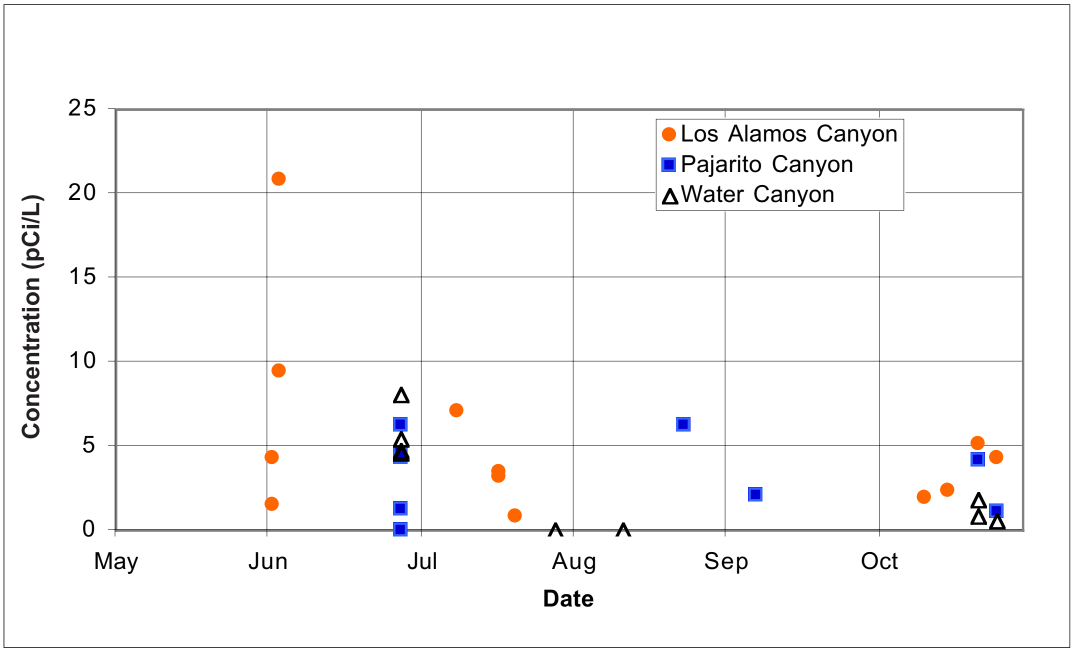
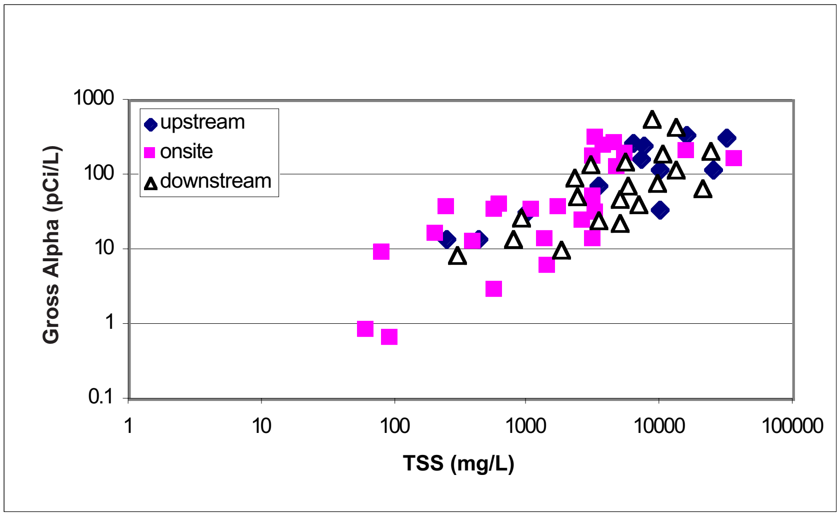


Figure 5-11. Cesium-137 concentrations in suspended sediment in runoff. Data from various stations in Los Alamos, Pajarito, and Water Canyons.



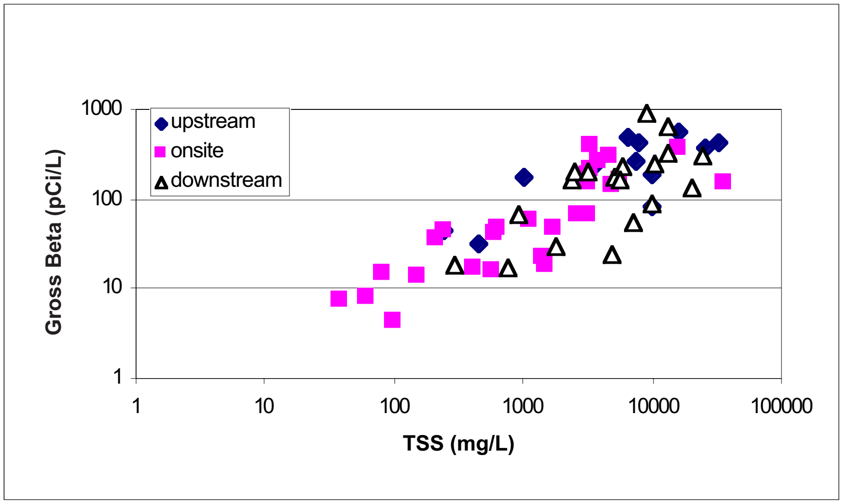


Figure 5-12. Comparison of gross alpha (top) and gross beta (bottom) activities to the total suspended solids (TSS) concentrations in unfiltered 2000 runoff samples. Note that axes use logarithmic scales.

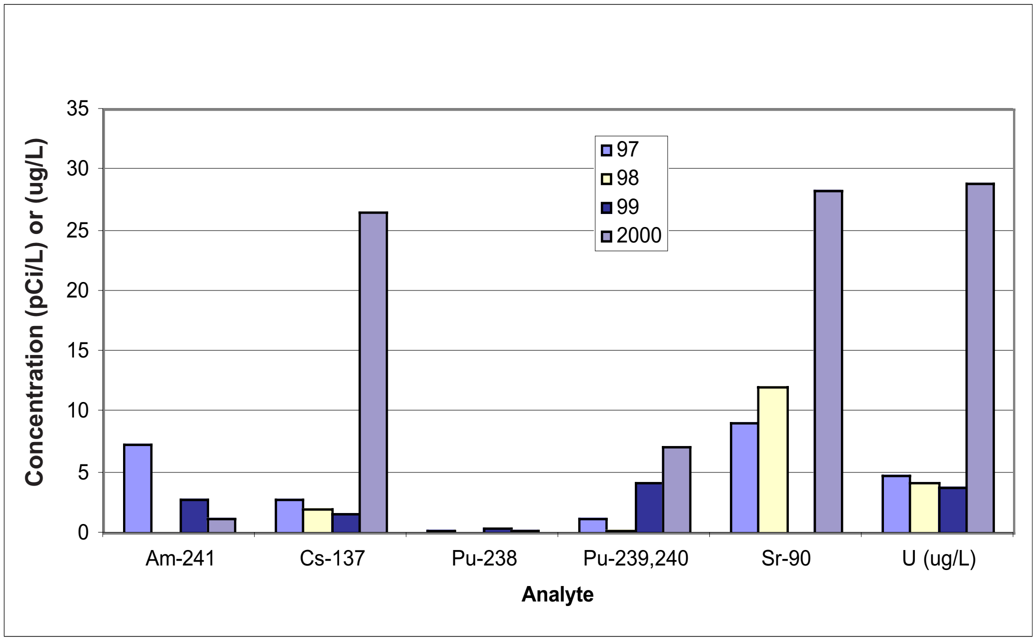


Figure 5-13. Yearly average (flow-weighted) radionuclide concentrations in unfiltered runoff leaving LANL The concentrations of cesium-137, strontium-90, uranium, and possibly plutonium-239, -240 significantly increased in 2000 from prior years.

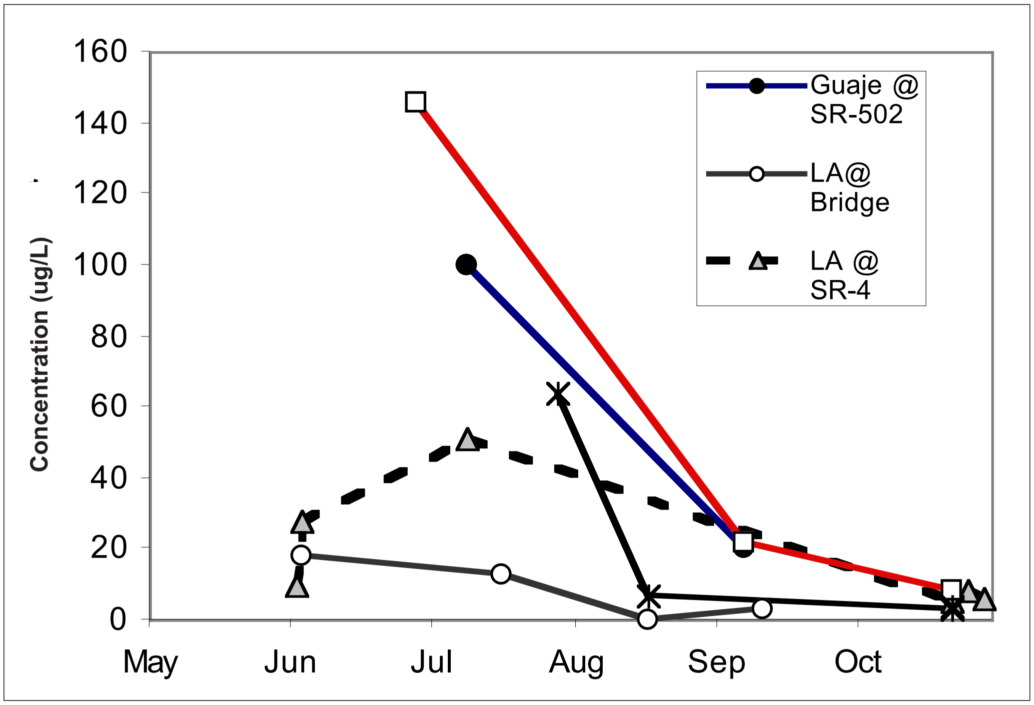
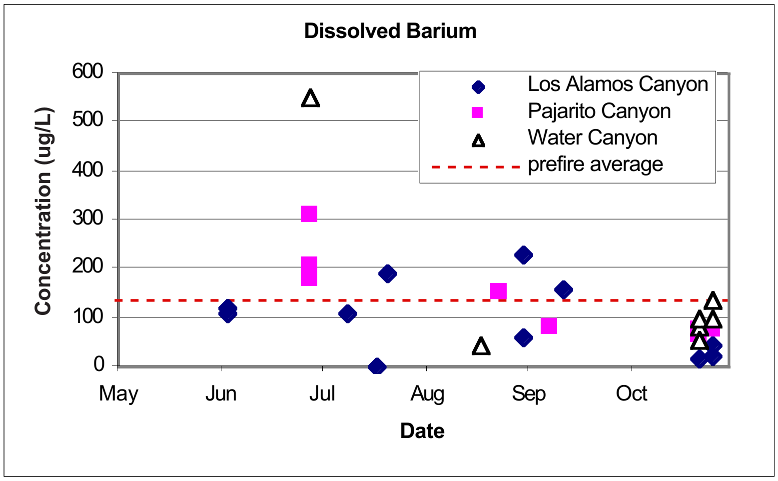
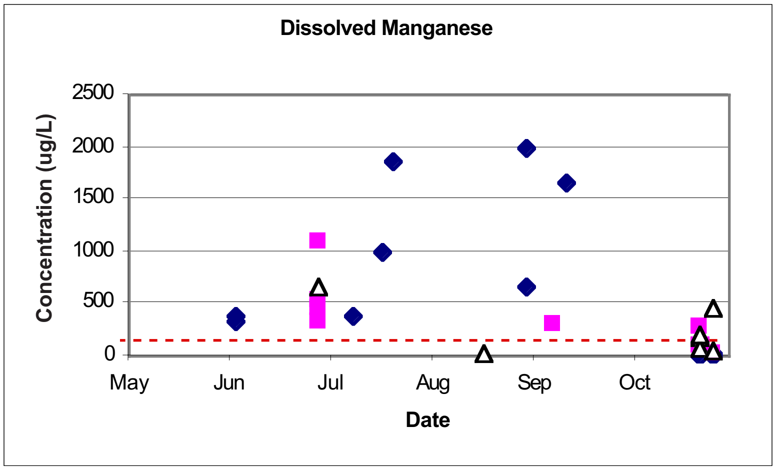


Figure 5-14. Total cyanide levels in runoff during 2000.





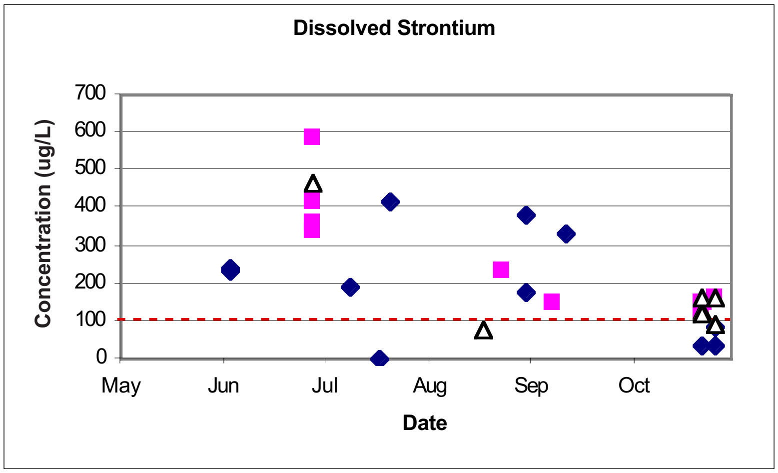
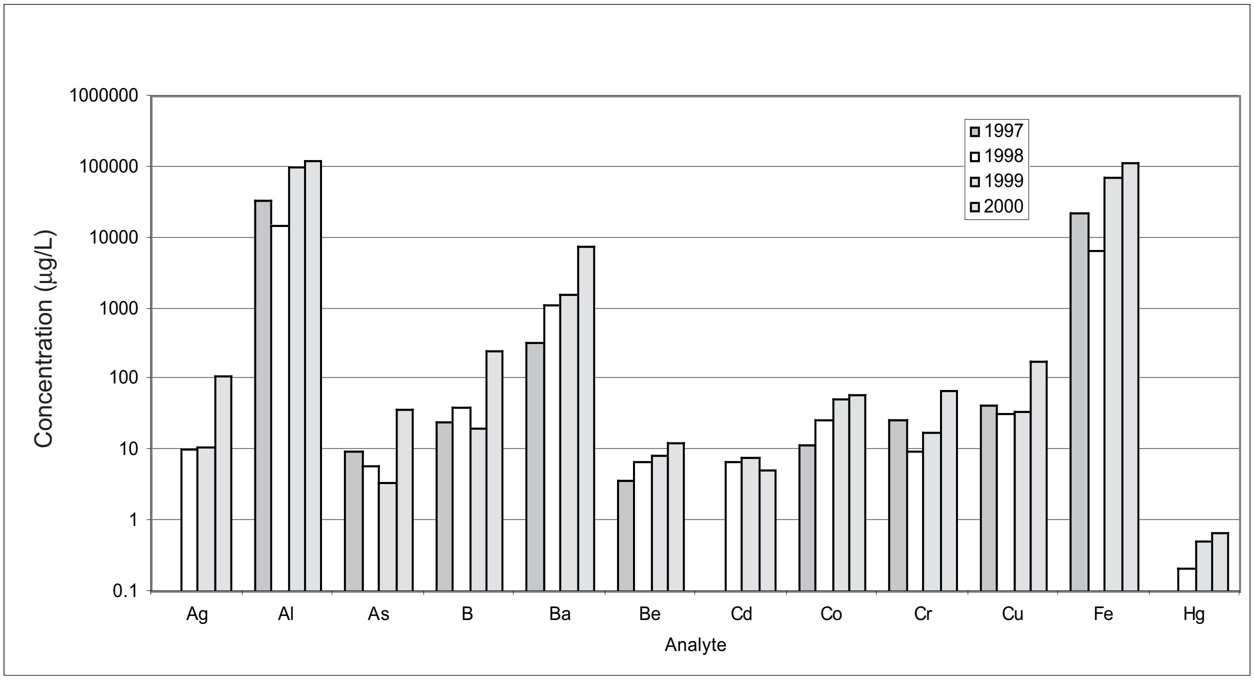


Figure 5-15. Dissolved metals concentrations in runoff for various stations in Los Alamos, Pajarito, and Water Canyons.



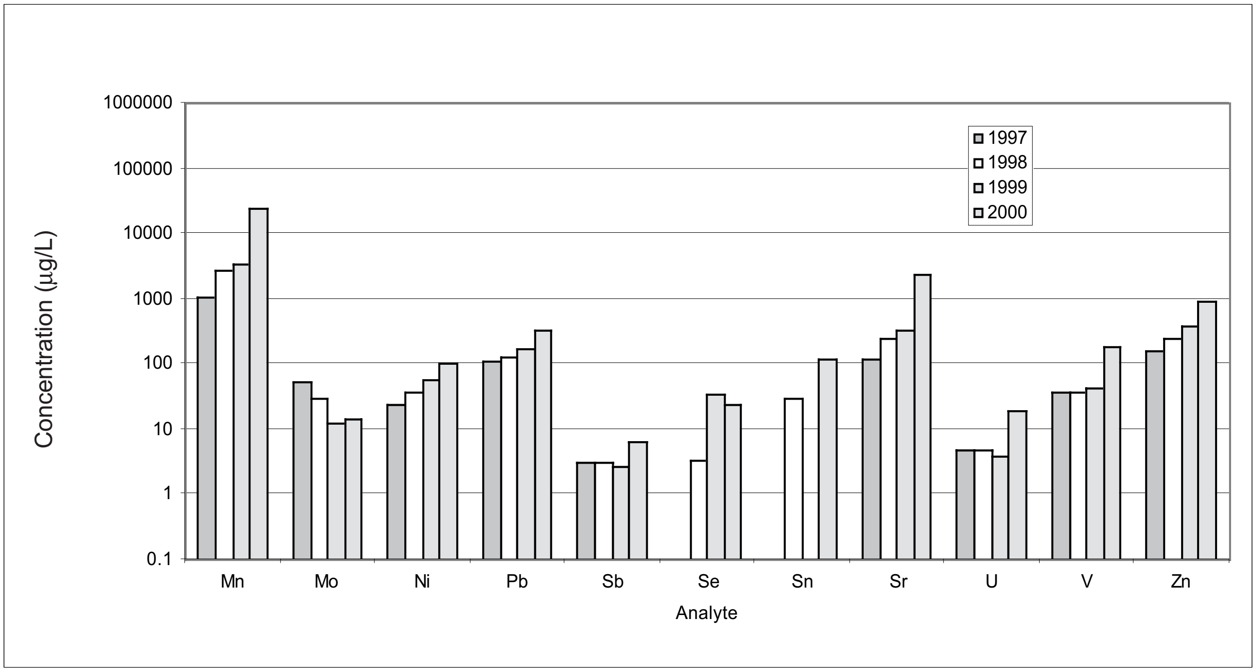


Figure 5-16. Log of yearly average (flow-weighted) metals concentrations in unfiltered runoff leaving LANL.

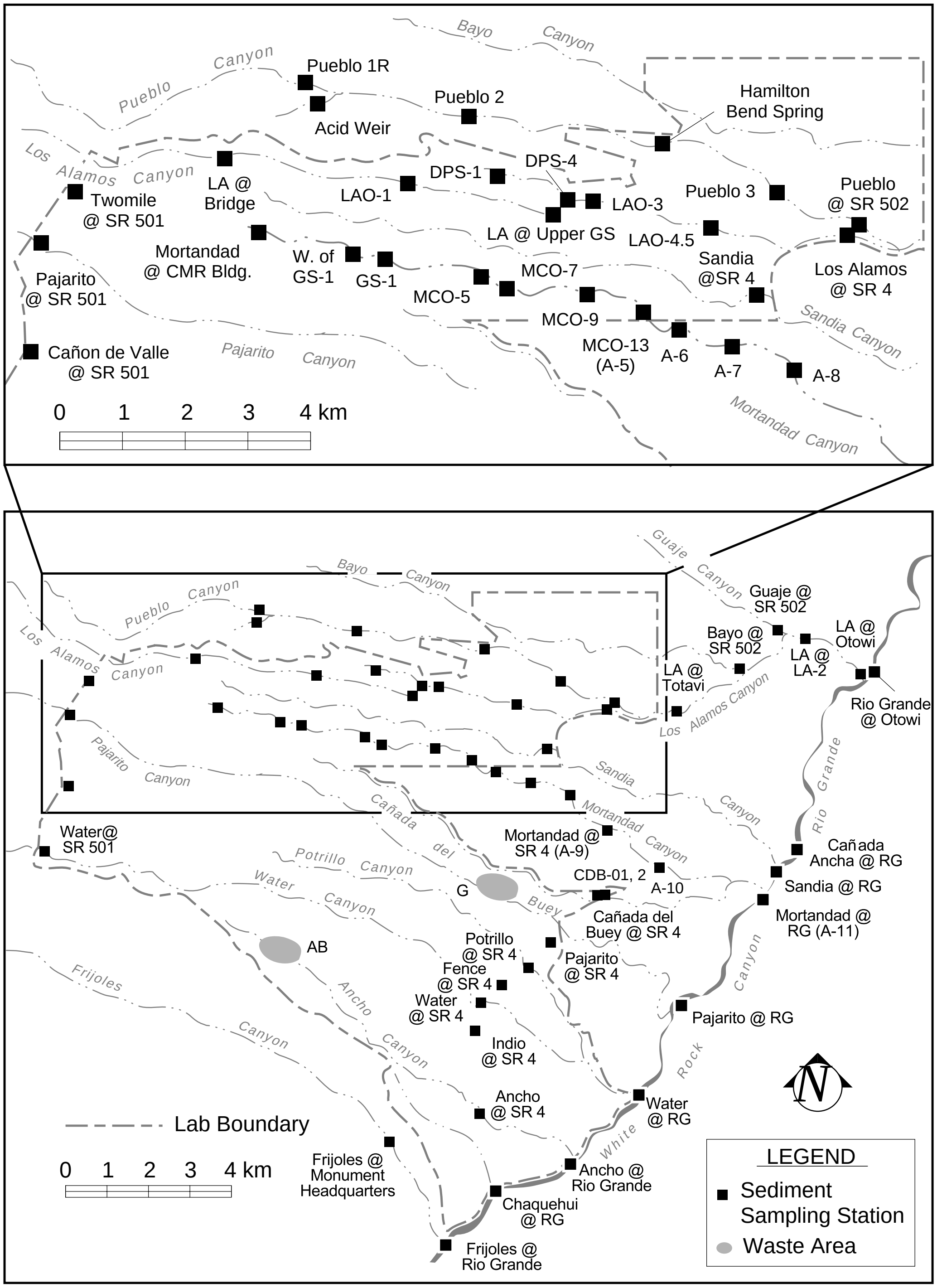


Figure 5-17. Sediment sampling stations on the Pajarito Plateau near Los Alamos National Laboratory. Solid waste management areas with multiple sampling locations are shown in Figure 5-5.

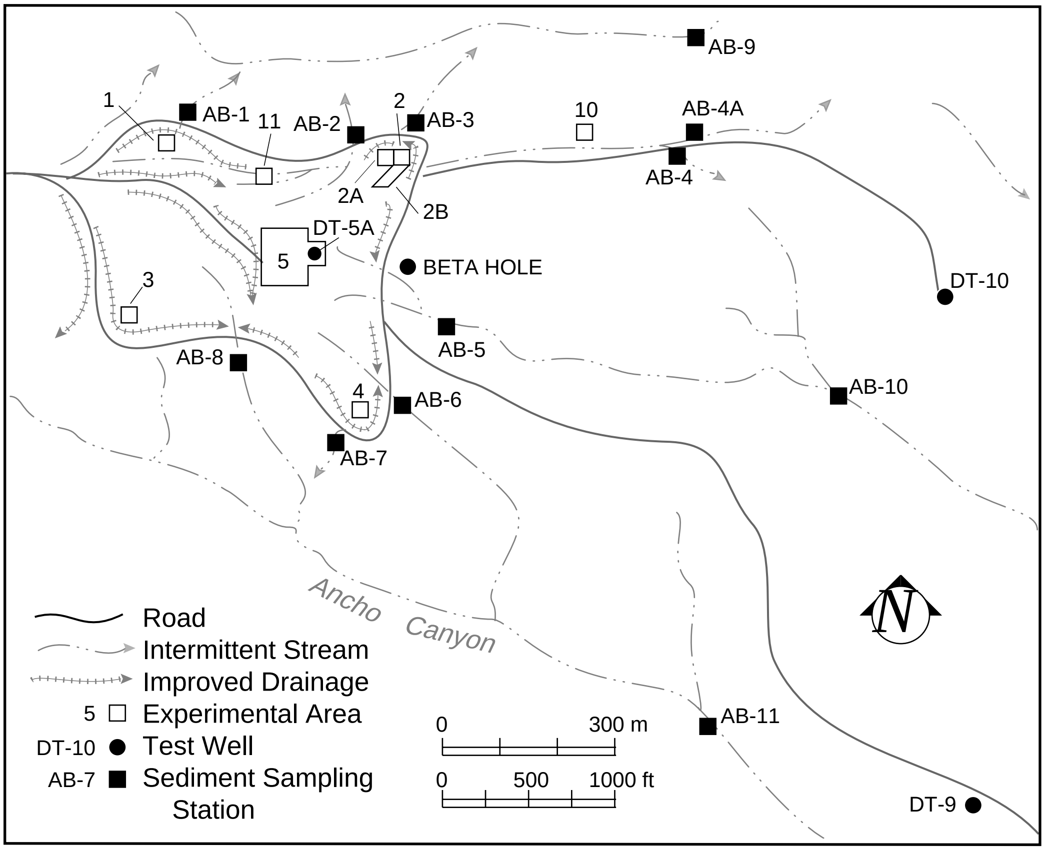
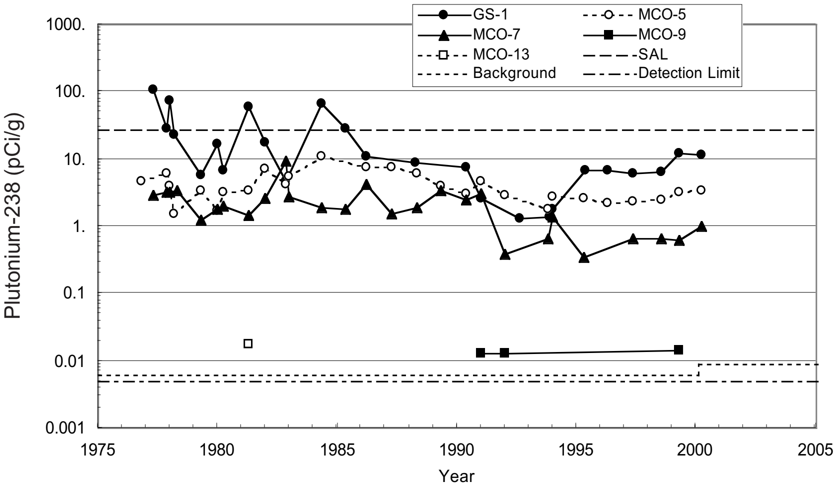
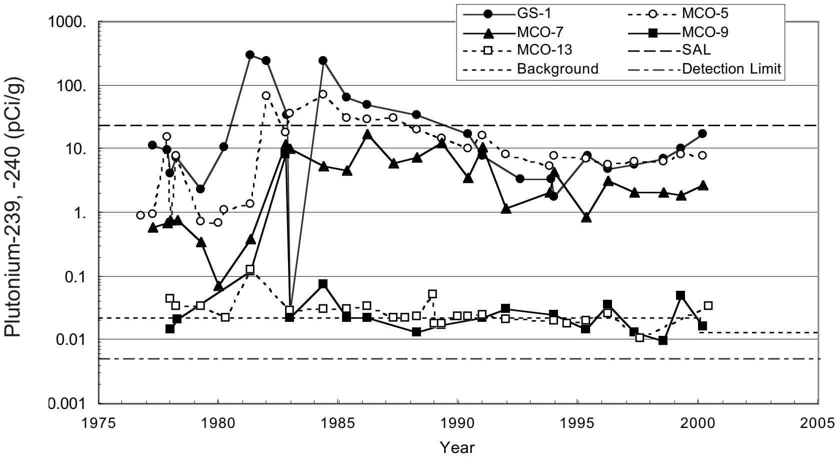


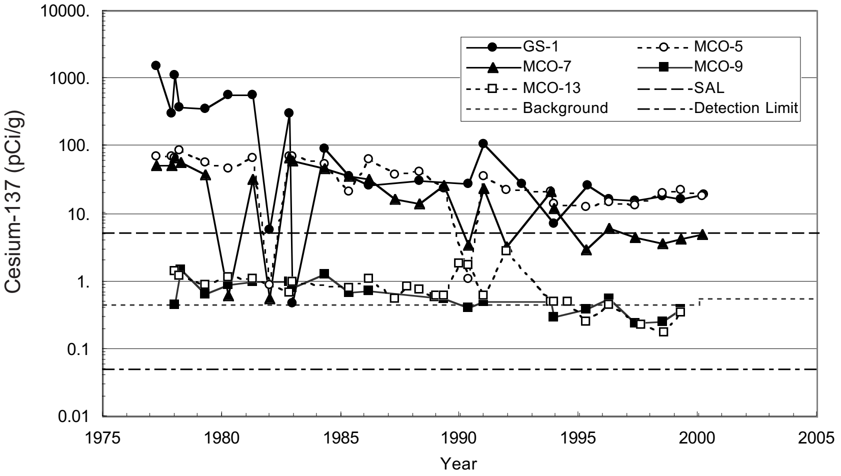
Figure 5-18. Sediment sampling stations at Technical Area 49, Area AB.



a. Plutonium-238 on Laboratory lands in Mortandad Canyon.



b. Plutonium-239, -240 on Laboratory lands in Mortandad Canyon.



c. Cesium-137 on Laboratory lands in Mortandad Canyon.

Figure 5-19. Sediment radioactivity histories for stations located on Laboratory lands in Mortandad Canyon. Only detections are shown, although data are available for most years.

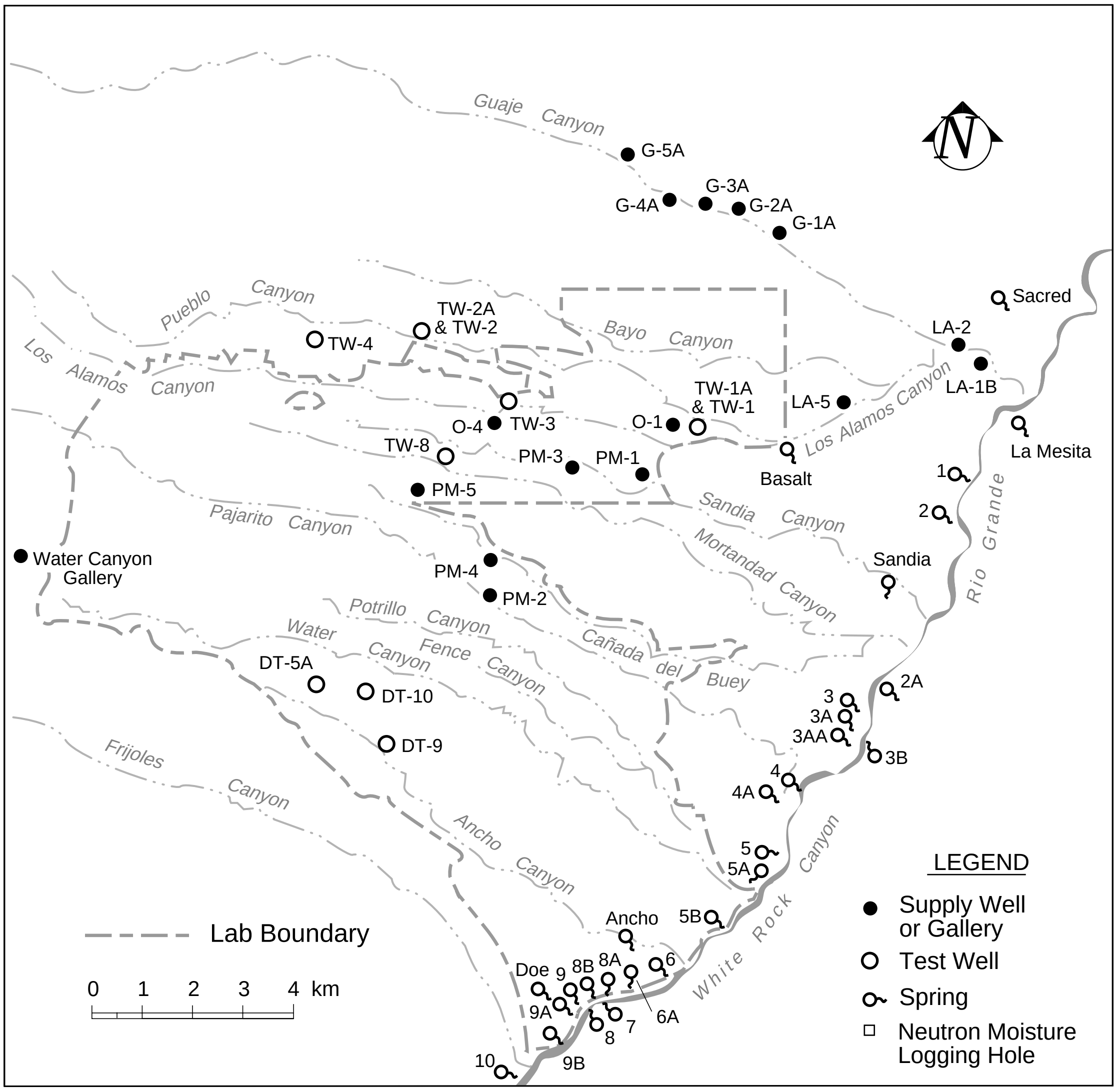


Figure 5-20. Springs and deep and intermediate wells used for groundwater sampling.

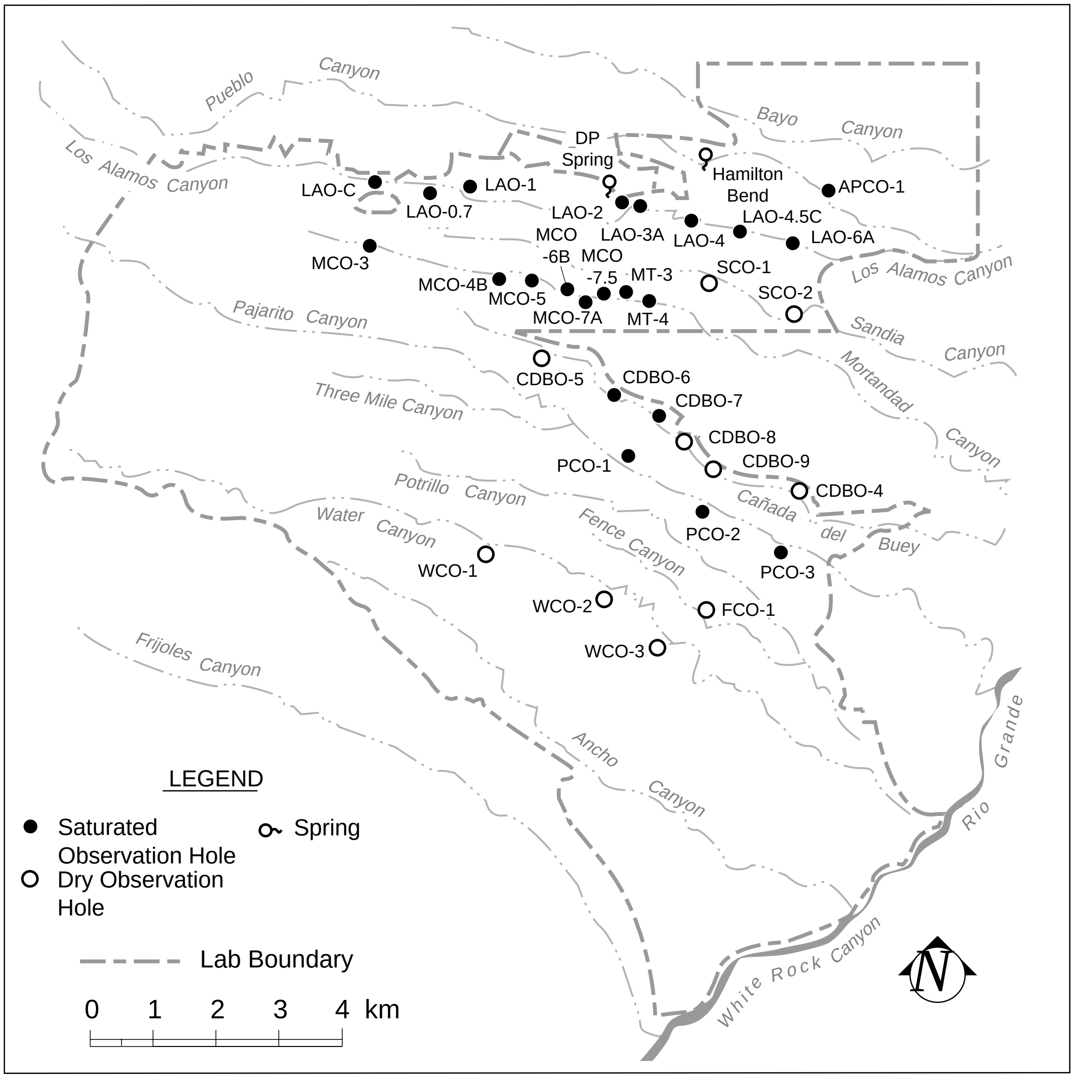
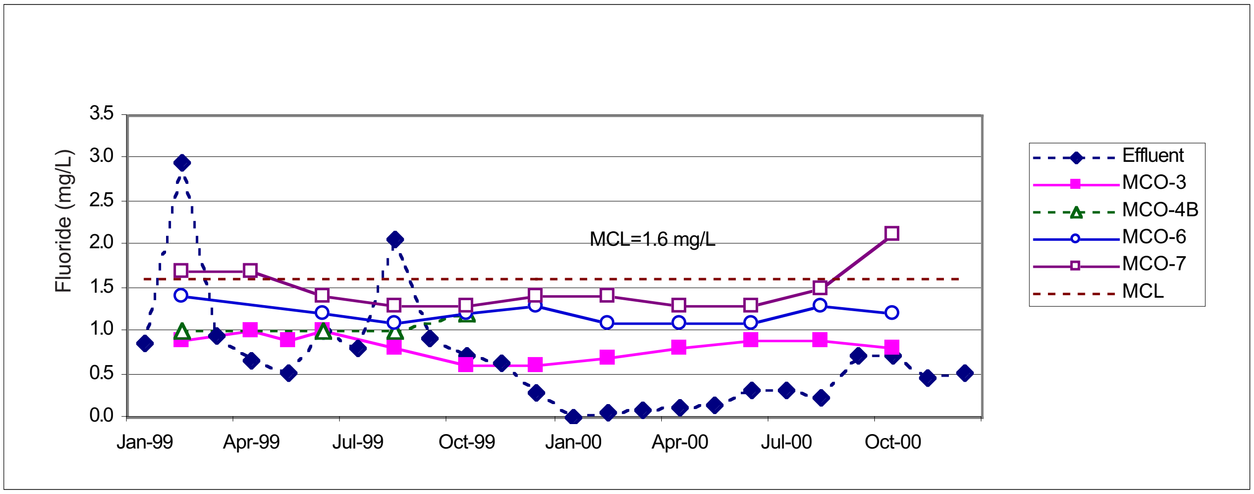
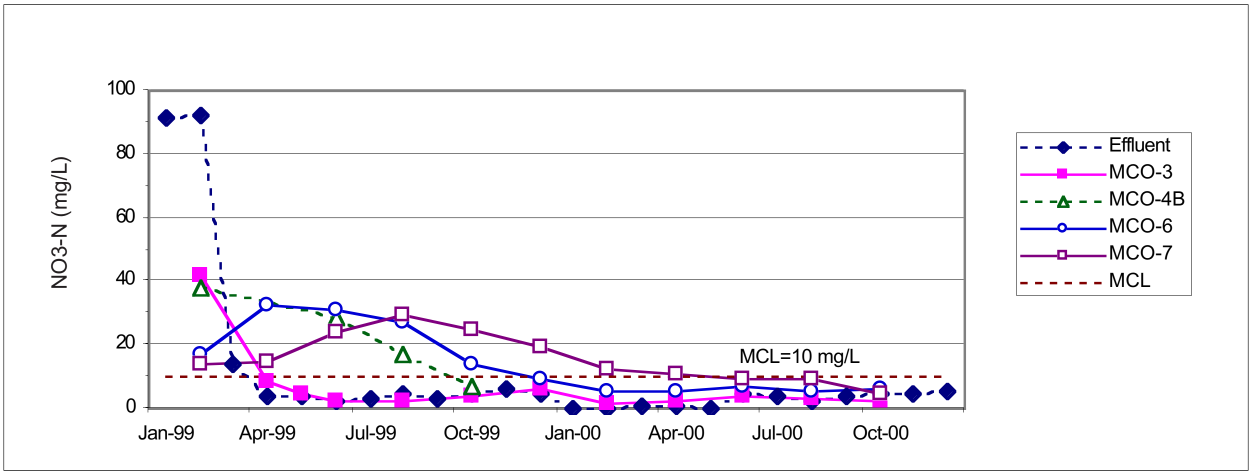


Figure 5-21. Observation wells and springs used for alluvial groundwater sampling.

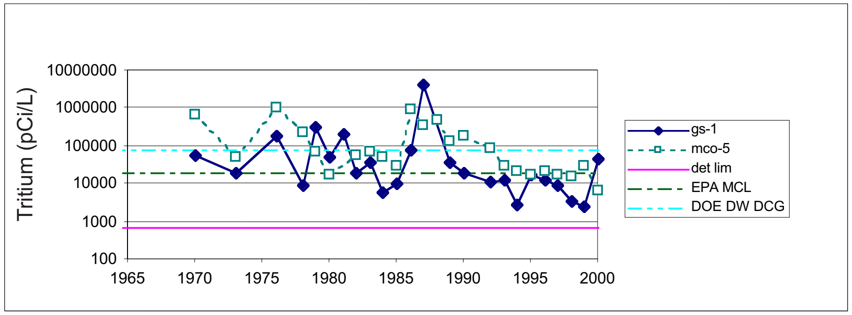


a. Fluoride

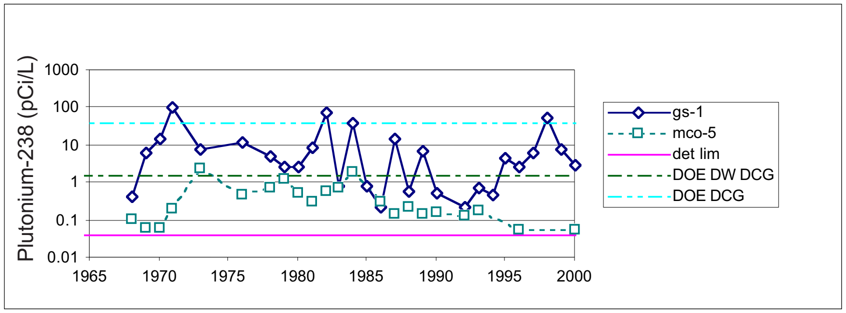


b. Nitrate

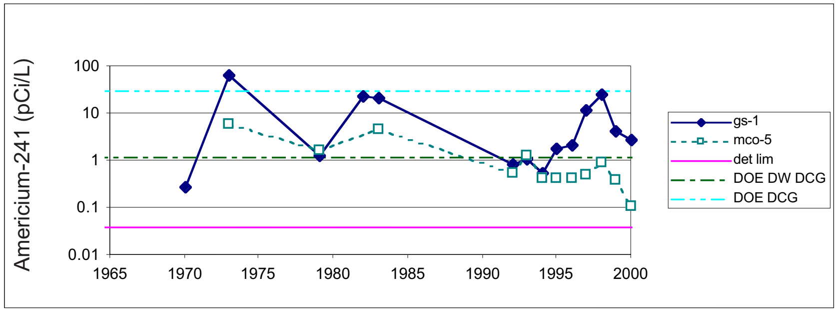
Figure 5-22. Fluoride and nitrate in Mortandad Canyon alluvial groundwater in 1999 and 2000.



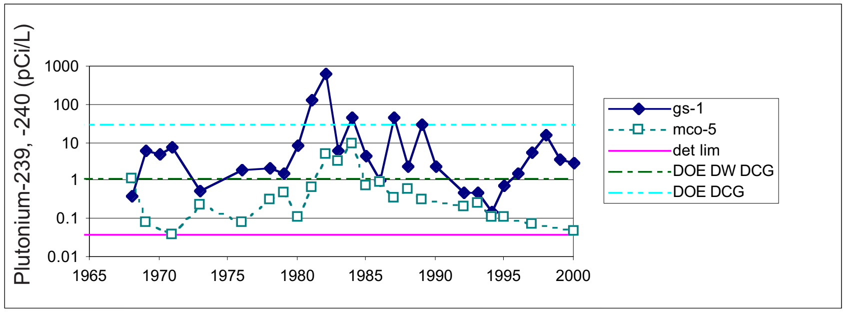
a. Mortandad Canyon tritium



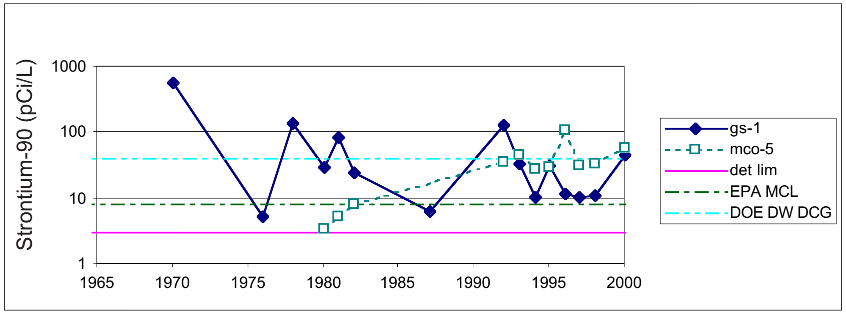
b. Mortandad Canyon plutonium-238



c. Mortandad Canyon americium-241



d. Mortandad Canyon plutonium-239, -240



e. Mortandad Canyon strontium-90

Figure 5-23. Annual average radioactivity in surface water and groundwater from Mortandad Canyon.

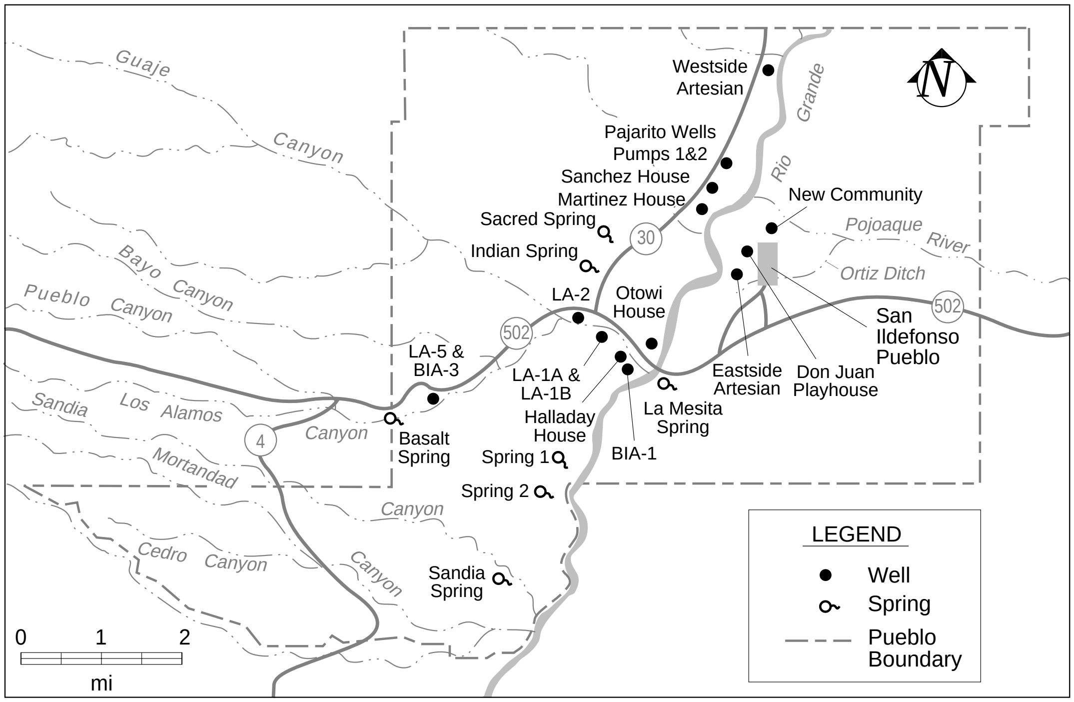


Figure 5-24. Springs and groundwater stations on or adjacent to San Ildefonso Pueblo land.

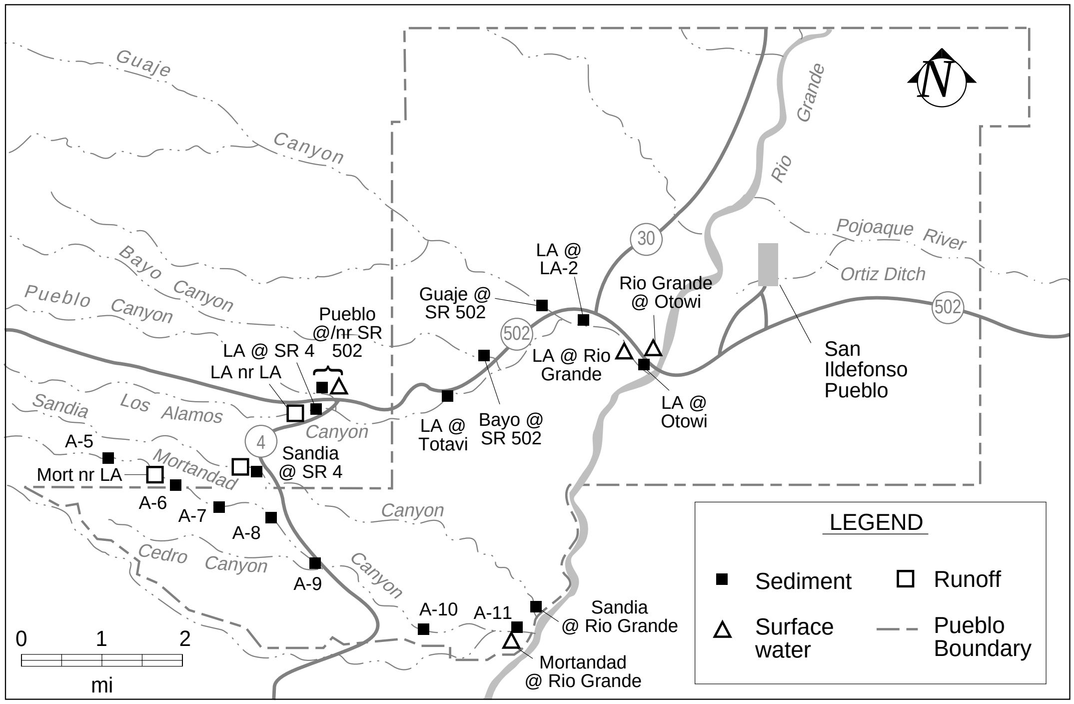


Figure 5-25. Sediment and surface water stations on or adjacent to San Ildefonso Pueblo land.

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6. Soil, Foodstuffs, and Associated Biota

6. Soil, Foodstuffs, and Associated Biota

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Abstract

Soil samples were collected from 12 on-site and 10 perimeter areas around Los Alamos National Laboratory (LANL or the Laboratory). We analyzed the samples for radiological, trace element, and organic constituents and compared the results with soils collected from regional background locations in northern New Mexico. These samples, which were collected after the Cerro Grande fire—a catastrophic wildfire that burned nearly 50,000 acres, including 7,500 at LANL—were compared with samples collected in 1999. In addition, we collected soil samples at selected (garden) farming locations downwind of the Cerro Grande fire, analyzed them for radiological and nonradiological constituents, and compared them with soil samples collected upwind of the fire to determine if smoke and fallout ash impacted soil farming resources. All radionuclide concentrations (activity) in soils were low, and most were nondetectable or within upper-level regional background concentrations. Similarly, most trace elements, with the exception of beryllium and lead, in soils from on-site and perimeter areas were within regional background concentrations; most organic constituents, with the exception of 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin (OCDD) at pg/g 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 ($\alpha = 0.05$) similar to soils collected before the fire in 1999, and the OCDD was not related to the fire.

We collected foodstuffs samples (produce, milk, fish, elk, deer, herbal teas, honey, and wild prickly pear fruit) from Laboratory or surrounding perimeter areas, including several Native American pueblo communities, to determine the potential impact of releases from LANL operations on the human food chain. The concentrations of radionuclides and trace elements in foodstuffs collected from the Laboratory and perimeter locations were low, and most were nondetectable or within upper-level regional background concentrations and, for the most part, were statistically ($\alpha = 0.05$) indistinguishable from foodstuffs collected before the Cerro Grande fire in 1999. Produce and fish, in particular, because of the concern for airborne contaminants from smoke and fallout ash and contaminants in storm water runoff (e.g., cyanide was elevated possibly because of use in fire retardants and natural combustion of vegetation during the fire), respectively, were not significantly affected.

Biota samples—whole body burdens of polychlorinated biphenyls (PCBs) and organochlorine pesticides in carp and carp sucker—collected from Cochiti and Abiquiu reservoirs showed that, although PCB and dichlorodiphenylethane (DDE) concentrations in Cochiti fish were statistically ($\alpha = 0.05$) higher than in upstream Abiquiu fish, levels are within regional and national levels and are within limits suggested for the protection of both piscivores and the fish themselves. Additionally, even though PCB and DDE levels decreased from June to July following the Cerro Grande fire, the effect of time was statistically nonsignificant, and comparisons with regional and local data indicate that our measurements may still provide a baseline.

Other environmental surveillance program activities conducted in 2000 included assessing radionuclide and trace elements in soil, vegetation, bees, raccoons, elk, and deer within and around Technical Area (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, examining the effects of depleted uranium on amphibians, assessing potential risks from exposure to natural uranium in well water, conducting development surveys of fire effects and rehabilitation treatments after the Cerro Grande fire, and estimating soil erosion in forest areas burned during the Cerro Grande fire.

6. Soil, Foodstuffs, and Associated Biota

A. Soil Monitoring

1. Introduction

A soil sampling and analysis program provides the most direct means of determining the concentration (activity), inventory, and distribution of radionuclides and radioactivity around nuclear facilities (DOE 1991). Department of Energy (DOE) Orders 5400.1 and 5400.5 mandate this program. Soil provides an integrating medium that can account for contaminants released to the atmosphere, either directly in gaseous effluents (such as air stack emissions) or indirectly from resuspension of on-site contamination (such as firing sites and waste disposal areas) or through liquid effluents released to a stream that is subsequently used for irrigation (Purtymun et al., 1987). The knowledge gained from a soil radiological sampling program is critical for providing information about potential pathways (such as soil ingestion, food crops, resuspension into the air, and contamination of groundwater) that may result in a radiation dose to a person (Fresquez et al., 1998a).

The soil surveillance program at Los Alamos National Laboratory (LANL or the Laboratory) consists of an institutional program that monitors soil contaminants within and around LANL and a facility program that monitors soil contaminants directly around the perimeter of major facilities at LANL. The two main facilities where soil monitoring takes place are the Laboratory's principal low-level radioactive waste disposal site (Area G) at Technical Area (TA) 54 and the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility at TA-15.

The main objectives of these programs include evaluating (1) radionuclide and nonradionuclide (trace element and organic) concentrations in soils collected from potentially impacted areas (institution- and facility-wide); (2) trends over time (that is, whether radionuclides and nonradionuclides are increasing or decreasing over time); and (3) committed effective dose equivalent (CEDE) to surrounding area residents. The Ecology Group's (ESH-20's) Contaminant Monitoring Team compares on-site and perimeter areas with regional background areas; background areas are located at such a distance away from the Laboratory that their radionuclide and nonradionuclide contents are mostly due to naturally occurring elements or to worldwide fallout. See Chapter 3 for potential radiation doses to individuals from exposure to soils.

This year, a catastrophic wildfire burned across the Los Alamos area. The fire was fully contained by June 6. Because the fire burned over 7,500 acres of LANL lands and some areas are known to contain radionuclides and chemicals in soils and plants above background concentrations (Fresquez et al., 1998a; Gonzales et al., 2000a), some of these materials may have been suspended in smoke and ash and transported by wind-principally downwind of the fire. The predominant wind direction during the fire was to the northeast of LANL. Therefore, in addition to the samples collected as part of the routine soil (institutional and facility) monitoring program at LANL during 2000, we also collected soil samples at selected (garden) farming locations in northern New Mexico downwind of the Cerro Grande fire and compared them with soil samples collected upwind of the fire to determine the impact of smoke and fallout ash from the Cerro Grande fire on soil farming resources.

2. Institutional Monitoring

a. Monitoring Network. We collect soil surface samples (0- to 2-in. depth) from relatively level, open, and undisturbed areas at regional background locations (four sites), LANL's perimeter (10 sites), and at LANL (12 sites) (see Figure 6-1). Areas sampled at LANL are not from solid waste management units (SWMUs). Instead, the majority of on-site soil-sampling stations are located on mesa tops close to and downwind from major facilities or operations at LANL in an effort to assess radionuclides and nonradionuclides in soils that may have been contaminated as a result of air stack emissions and fugitive dust (the resuspension of dust from SWMUs and active firing sites).

The 10 perimeter stations are located within 4 km (2.5 mi.) of the Laboratory. These stations reflect the soil conditions of the inhabited areas to the north (Los Alamos town site area—four stations) and east (White Rock area and San Ildefonso Pueblo lands—four stations) of the Laboratory. The other two stations, one located on Forest Service land to the west and the other located on Park Service land (Bandelier) to the southwest, provide additional coverage. We compare soil samples from all these areas with soils collected from regional background locations in northern New Mexico surrounding the Laboratory where radionuclides, radioactivity, and trace elements are from natural or worldwide fallout events; these areas are located around Embudo to the north, Cochiti to the south, and Jemez to the southwest. All are more than 32 km (20 mi.) from the Laboratory and are beyond the range of potential influence from normal Laboratory operations (DOE 1991). (Note: This year, because of the Cerro Grande fire, we collected an additional background sample upwind of LANL near the start of the Cerro Grande fire on Bandelier property.)

To determine the potential impact of the Cerro Grande fire on soil farming resources, we collected six soil surface samples from farm gardens north, northeast, south, and southeast of the Cerro Grande fire (and LANL) on June 19–21, 2000. Four of the farms were predominantly downwind of the Cerro Grande fire (Ojo Sarco, Española, Embudo, and Abiquiu), whereas the other two were southeast (Pecos) and south (Cochiti) of the fire and not within the predominant wind direction. The latter areas were used as control (background) sites.

b. Sampling Procedures, Data Management, and Quality Assurance. Collection of samples for chemical analyses follows a set procedure to ensure proper collection, processing, submittal, and posting of analytical results. Stations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting. The ESH-20 operating procedure (OP) entitled “Soil Sampling for the Soil Monitoring Program,” LANL-ESH-20-SF-OP-007, R0, 1997, contains all quality assurance/quality control (QA/QC) protocols, chemical analyses, data handling, validation, and tabulation information. An internal laboratory at LANL—the Inorganic Trace Analysis Group (CST-9)—analyzed most radionuclides and trace elements (light, heavy, and nonmetal), with the exception of strontium-90. Paragon Analytics of Fort Collins, CO, analyzed strontium-90 and all organic constituents. Both laboratories met all QA/QC requirements for analyzing the radionuclide and nonradionuclides of interest.

c. Radiochemical Analytical Results (On-Site, Perimeter, and Regional Background Soils). Table 6-1 shows data from soils collected in 2000. All radionuclide concentrations (activity) and radioactivity in soils collected from on-site and perimeter stations were low (e.g., in the pCi range), and most were nondetectable (i.e., the analytical result was lower than three times the counting uncertainty = 99% confidence level) (Corely et al., 1981) or within regional statistical reference levels (RSRLs). The RSRL (Purtymun et al., 1987) is the upper-level background concentration (mean plus two standard deviations = 95% confidence level) from data collected from regional background areas from 1995 through 1999 for worldwide fallout and natural sources of tritium; strontium-90; cesium-137; americium-241; plutonium-238; plutonium-239, -240; total uranium; and gross alpha, beta, and gamma radioactivity.

As a group (and using detectable and nondetectable values), the average concentrations of tritium and total uranium (and uranium isotopes) and gross gamma activity in soils collected from on-site or perimeter areas were significantly higher (95% confidence level) than concentrations in soils from regional background locations. Although the mean concentrations of these radionuclides were statistically higher than regional background, the differences in concentrations between the sites were very small. Also, mean concentrations of all radionuclides were far below LANL screening action levels (SALs) used to discern risk to humans. LANL SALs, developed by the Environmental Restoration (ER) Project at the Laboratory, identify the contaminants of concern on the basis of a 15-mrem/yr protective dose limit (ER 2001).

The slightly higher tritium activity in soils from on-site and perimeter areas as compared with regional background locations is probably due to Laboratory operations. We have observed higher amounts of tritium in soil samples collected from perimeter and especially from on-site areas when compared with regional background areas in past surveys, even though concentrations of tritium are still generally decreasing over time as average levels of tritium in 2000 are lower than in 1996 (Fresquez et al., 1998a). The higher levels of uranium detected in soil samples collected from on-site and perimeter areas, on the other hand, may be a result of either geologic or soil differences between the areas. Soils in the Los Alamos area, for example, are derived from Bandelier (volcanic) tuff and have higher-than-average natural uranium concentrations, ranging from 3 to 11 µg of uranium per gram of soil (Crowe et al., 1978). Uranium concentrations in soils collected from on-site and perimeter areas have generally been higher than in regional background soils (Fresquez and Gonzales 2000); the concentrations on LANL and perimeter lands, however, are not changing and are similar to past results (Fresquez et al., 1998a).

Table 6-2 shows the results of radionuclide concentrations in soils collected in 2000 after the fire and results of soils collected in 1999 before the fire. Because only one regional background site, Embudo, was predominantly downwind of the fire (Fresquez and Gonzales 2000), it was the only regional background station compared with pre-fire soil conditions. With the exception of the regional background station, we made statistical comparisons within LANL and perimeter sites and years (1999 versus 2000) using a nonparametric Wilcoxon Rank Sum test at the 0.05 probability level (Gilbert 1987). All mean radionuclide and radioactivity concentrations in soils collected from LANL and perimeter areas collected after the Cerro Grande fire were statistically similar to soils collected before the fire in 1999. Individual soil stations in LANL TAs most affected by the fire—TA-06, TA-15, and TA-16—contained radionuclides and radioactivity similar to concentrations in soils collected in 1999. Similarly, soils collected from the perimeter of LANL lands directly within the predominant path of the smoke plume (airport area, North Mesa area, Sportsman's Club area, and Tsankawi area) contained radionuclides and radioactivity similar to concentrations in soils collected in 1999. For a more detailed discussion of these data comparisons, see the report by Fresquez et al. (2000).

d. Radiochemical Analytical Results (Farm Soils). Table 6-3 presents the results of radionuclide concentrations in soils collected at selected (organic) farming communities downwind of the Cerro Grande fire. All of the radionuclides in soils collected from tilled gardens directly downwind of the Cerro Grande fire were either nondetectable, within activity levels in soils collected from farms not directly impacted by the fire (Cochiti and Pecos), or within the RSRL measured in regional soils (Cochiti, Jemez, Embudo) collected as part of the institutional surveillance program (Table 6-1). Only one radioactivity (screening) measurement out of 18 exceeded regional background concentrations. That measurement, gross gamma activity (5.5 [±0.6] pCi/g dry) from one soil/farm sample, was just above the regional background concentration of 4.1 pCi/g dry; that level, however, was still within the range of 8.5 pCi/g dry measured from regional background soils in past years (1995 through 1999). (Note: Gross gamma is a screening measurement, and it is the summation of all gammas recorded by an instrument.) Cesium-137, a gamma emitter, for this latter soil sample measured only 0.42 pCi/g dry and was within regional background concentrations, and a scan of the gamma spectroscopy output showed no other detectable man-made gamma emitters. Therefore, the slightly higher levels of gross gamma activity in this one soil sample compared with other regional background sites were probably due to naturally occurring gamma emitters. Results of the current survey are consistent with results of radionuclides and radioactivity in soils collected as part of the institutional soil surveillance program at LANL directly after the Cerro Grande fire (Table 6-1) and to the New Mexico Environmental Department results (Yanicak 2001a). For a more detailed discussion of these data, see Fresquez et al. (2001a).

e. Nonradiochemical Analytical Results (On-site, Perimeter, and Regional Background Soils). We analyzed soils for 22 light (barium, beryllium, titanium), heavy (silver, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, antimony, selenium, tin, thallium, vanadium, zinc), and nonmetal (arsenic, boron, selenium, cyanide) trace elements (occur at <1000 µg/g in soil) and three light (aluminum) and heavy (iron, manganese) abundant elements (occur at >1000 µg/g in soil). Table 6-4 contains the results of the 2000 soil-sampling survey. In general, nine out of the 25 elements measured in surface soils collected from regional background, perimeter, and on-site stations were below the limits of detection (LOD). Of those elements that were above the LOD in soils collected from perimeter and on-site areas, most were within RSRLs. The RSRLs were derived from regional background data averaged over eight years (1992–1999).

As a group, beryllium and lead concentrations in soils collected from perimeter and on-site areas were significantly higher ($\alpha = 0.05$) than lead and beryllium in soils from regional background locations. These results are similar to those reported in past surveys (Fresquez 1999; Fresquez and Gonzales 2000). All individual site and average lead and beryllium concentrations in soils from both on-site and perimeter areas were far below the SALs of 400 µg/g and

150 µg/g, respectively (EPA 2000). Like uranium, natural beryllium concentrations in the Los Alamos area are at higher-than-average levels. Ferenbaugh et al. (1990) and Longmire et al. (1995), for example, report that the range of naturally occurring beryllium in soils in the Los Alamos area is from 1.0 to 4.4 µg/g.

See Table 6-5 for the results of a comparison of trace elements before and after the fire. In addition, see Table 6-6 for many organic substances—volatile (VOC), semivolatile (SVOC), organochlorine pesticides (PEST), polychlorinated biphenyls (PCBs), high explosives (HE), and dioxin and dioxin-like compounds-assessed in soils from LANL, perimeter, and regional background locations after the fire. All mean trace elements in soils collected from perimeter and LANL areas after the Cerro Grande fire were statistically ($\alpha = 0.05$) similar to soils collected before the fire in 1999. Although the regional background site could not be statistically compared between years, all of the elements in soils collected after the fire were equal to concentrations in soils collected before the fire in 1999 and were well within the long-term background statistical range (Fresquez and Gonzales 2000). Also, cyanide, a compound ion of high concern because increased levels had been reported in storm water runoff after the fire (Gallaher 2000), appears to be similar at all three sites and is within background concentrations (1.0 µg/g) from other regional areas (Eisler 2000). Individual soil stations in LANL TAs most affected by the fire (TA-06, TA-15, and TA-16) and from the perimeter of LANL lands directly within the predominant path of the smoke plume (airport area, North Mesa area, Sportsman's Club area, and Tsankawi area) contained trace elements similar to concentrations in soils collected in 1999. For a more detailed discussion of these data comparisons, see Fresquez et al. (2000).

We did not detect organic compounds—VOC, SVOC, PEST, PCB, and HE—above reporting limits in any of the soils collected within or around LANL (Table 6-6). Nor did we detect dioxin (2,3,7,8-tetrachlorodibenzodioxin [TCDD]) in any of the soil samples analyzed. Of the other less toxic dioxin-like compounds analyzed, we detected 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin (OCDD) and, to a lesser extent, 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD) above reporting limits in most of the soil samples analyzed. These compounds, the least toxic of the six dioxin-like compounds analyzed, are by-products of natural (forest fires) and man-made (residential wood burning, municipal and industrial waste, etc.) sources. (Note: Recent studies show that dioxin emissions from forest fires could represent resuspended material from aerial deposits rather than originally formed material.) And, the highest amounts detected in the soil collected near the airport (3.7 parts per trillion [pg/g] of HpCDD, which is equal to 0 pg/g toxicity equivalents [TEQ], plus 29.1 pg/g of OCDD, which is equal to 0.029 pg/g TEQ, equals 0.029 pg/g total TEQ) were very far below the Agency for Toxic Substances and Disease Registry's soil screening level of 50 pg/g TEQs (ATSDR 1997). Because we detected OCDD upwind as well as downwind of the Cerro Grande fire (and LANL) (concentrations ranged from 9.9 to 22.4 pg/g) (Fresquez et al., 2001a), the OCDD was probably not related to the fire. (Note: The average soil concentration of dioxins in North America is 8.0 ± 6.0 pg/g TEQ, and uptake from water into food crops is insignificant because of the hydrophobic nature of these compounds [EPA 1994].) For a more detailed discussion concerning these data comparisons, see Fresquez et al. (2000).

f. Nonradiochemical Analytical Results (Farm Soils). Tables 6-7 and 6-8 show the results of trace elements and organic constituents in soils collected from selected (organic) farming communities downwind and upwind of the Cerro Grande fire. Four out of the 14 trace elements in all farm soils were below the LOD (Table 6-7). Of the 10 elements that were above the LOD in soils collected from farms predominantly downwind of the Cerro Grande fire, all, with the exception of slightly higher cadmium and selenium concentrations at one farm location, were within the concentrations detected in soils collected from farming areas not predominantly downwind of the fire (Cochiti and Pecos) and, for the most part, they were within trace element concentrations in soils collected as part of the environmental surveillance program (ESP) from regional areas (Table 6-4) and were within the lower range of elements normally encountered in soils within the continental United States (Bowen 1979).

We did not detect any PCBs, HEs, or polyaromatic hydrocarbons (PAHs) above reporting limits in any of the farm soil samples collected upwind or downwind of the Cerro Grande fire (Table 6-8). In addition, dioxin was not detected in any of the six farm soil samples. Of the other less toxic dioxin-like compounds analyzed, we detected only one, OCDD, and we detected it in all of the soils collected, including the two soil samples collected upwind of the fire. The highest amount of OCDD we detected in soils from the local farms (22.4 pg/g, which is equal to 0.022 pg/g

TEQ) was very far below the Agency for Toxic Substances and Disease Registry's soil screening level of 50 pg/g TEQs.

Of the 21 PEST compounds analyzed, we detected only trace amounts (in the parts per billion [ng/g] range) of 4,4-dichlorodiphenylethyene (4,4-DDE), a dichlorodiphenyltrichloroethane (DDT) breakdown product, above reporting limits in two out of the six farm soils; one out of the two farm soils included a sample collected from a farm upwind of the Cerro Grande fire (and LANL). (Note: DDT was banned in 1972, and although its derivatives remain in soil for many years, it is not readily taken up by most crop plants.) Because we detected no pesticides, including DDT-related compounds, in any of the soils (Table 6-6), surface ash plus soil, or ash (bark) (Gonzales and Fresquez 2000) collected within LANL lands after the fire, the source of 4,4-DDE in soils from these two farms was probably related to drift from the large-scale spraying operations the US Forest Service conducted on the Santa Fe National Forest in the 1960s (Brown et al., 1986). Small quantities of 4,4-DDE, for example, were detected in soils before the fire (Podolsky 2000) and in surface ash plus soil in samples collected after the fire (Gonzales and Fresquez 2000) on US Forest Service lands to the west (upwind and upslope) of LANL. In addition, 4,4-DDE was detected in fish collected in the Rio Grande upstream of LANL before the fire (Gonzales et al., 1999). For a more detailed discussion concerning the results of the soil samples collected from the farming areas, see Fresquez et al. (2001a).

g. Long-Term Trends. We performed a Mann-Kendal test for trend analysis on radionuclides and radioactivity in soils collected from on-site and perimeter stations from 1974 through 1996 (Fresquez et al., 1996a; Fresquez et al., 1998a). Although radionuclide and radioactivity levels were significantly higher in on-site (9 out of 10) and perimeter (4 out of 10, including plutonium-239, -240) soils when compared with regional background levels, most radionuclides, with the exception of plutonium-238 in soils from perimeter areas, exhibited significantly decreasing concentrations over time. The statistically significant (but very small) increase of plutonium-238 in perimeter soils over this interval may be related to the resuspension and redistribution of global fallout. Plutonium-238 and plutonium-239, -240 in soils from regional background areas also exhibited statistically increasing trends; however, the plutonium levels in regional background soils were still well within worldwide fallout concentrations.

The decreasing concentrations of the other isotopes in soils collected from on-site and perimeter areas over time may be a result of (1) cessation of aboveground nuclear weapons testing in the early 1960s, (2) weathering (water and wind erosion and leaching), (3) radioactive decay (half-life), and (4) reductions in operations or better engineering controls at LANL. Tritium, which has a half-life of about 12 years, exhibited the greatest decrease in activity over the 20-plus-year period of this study at all three areas: regional background, perimeter, and on-site. Indeed, by 1996, the majority of radionuclide and radioactivity values in soils collected from both perimeter and on-site areas were statistically similar to values detected in regional background locations. (Note: This trend analysis is the most current to date; however, concentrations of all radionuclides in soils collected from on-site and perimeter areas during the 2000 year, including tritium and uranium, were lower or similar to concentrations in 1996.)

Recently, these (long-term) data (1974 through 1999), particularly cesium-137 and plutonium-239, -240, were employed to determine the extent of LANL-added plutonium to the perimeter area environment. The ratio of cesium-137 to plutonium-239, -240 concentrations from worldwide fallout is about 33 (Hodge et al., 1996). Results (using median numbers) from data summarized over the 26-year-period show cesium-137/plutonium-239, -240 ratios ranging from 2 to 27 in on-site soils and from 5 to 37 in perimeter soils; regional background soils averaged 33, which compares well with cesium-137/plutonium-239, -240 ratios from other "background" areas. Maps of the ratios tend to show possible LANL-derived plutonium in a north to northeasterly direction generally concurrent with the major wind direction in the area. These interpretations are preliminary, and a more detailed study is currently underway that will, we hope, show the extent of LANL-derived plutonium with distance from the Laboratory.

3. Facility Monitoring

a. Area G. In 2000, we collected soil samples within and around the perimeter of Area G at TA-54-the Laboratory's primary low-level radioactive disposal facility (Figure 6-2). Collection of soil samples for chemical analyses follows a set procedure to ensure proper collection, processing, submittal, and posting of analytical results. Stations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled "Sampling and Sample Processing for the Waste-Site Monitoring Program," LANL-ESH-20-SF-OP/HCP-011, 1999. Laboratory group CST-9 analyzed the soil samples for tritium; plutonium-238 and plutonium-239, -240; strontium-90; americium-241; cesium-137; and uranium, and all QA/QC requirements were met. Results are available in Table 6-9.

All of the radionuclide concentrations in soils collected within and around Area G were less than LANL screening action levels. Most of the values for soils were within the upper-level background concentrations except for tritium; plutonium-238 and plutonium-239, -240; and americium-241. The concentrations of plutonium-238 and plutonium-239,-240 in soils were largest in samples collected on the northern and eastern sides of Area G and were consistent with previous years (Nyhan et al., 2000).

b. DARHT. We completed a baseline report that lists the concentrations of radionuclides and trace elements in soils and sediments (and vegetation, small mammals, birds, and bees) around the DARHT facility during the construction phase (1996 through 1999) in 2000 (Nyhan et al., 2001a). The Mitigation Action Plan for the DARHT facility at LANL mandated establishing baseline concentrations for potential environmental contaminants before the start-up of the operational phase. These concentrations of radionuclides and trace elements now represent preoperational baseline statistical reference levels (BSRLs), which are calculated from the mean DARHT facility sample concentration plus two standard deviations.

In 2000, we collected soil and sediment samples during the operational phase within and around the DARHT facility (Figure 6-3). Collection, processing, and analysis of soil and sediment samples follow the protocols described in Section A.3.a. Tables 6-10 and 6-11 contain the results of radionuclides and trace elements. Results show that most radionuclides and trace elements in soil and sediment samples were below BSRLs (Fresquez et al., 2001b). Exceptions were concentrations of uranium; cesium-137; plutonium-238 and plutonium-239, -240; and americium-241 found in the soil and sediment samples collected at the east sample location, although a few other samples had slightly higher plutonium-238 and plutonium-239, -240 and lead concentrations than the BSRLs.

B. Foodstuffs Monitoring

1. Introduction

A wide variety of wild and domestic edible plant, fruit, and animal products are grown or harvested in the area surrounding the Laboratory. Ingestion of foodstuffs constitutes a critical pathway by which radionuclides can be transferred to humans (Whicker and Schultz 1982). For this reason, we collect samples of a wide host of foodstuffs (e.g., milk, eggs, produce [wild and domestic fruits, vegetables, and grains], fish, honey, herbal teas, mushrooms, piñon, domestic animals, and large and small game animals) on a systematic basis from Laboratory property and from the surrounding communities. DOE Orders 5400.1 and 5400.5 mandate this Foodstuffs Monitoring program.

The three main objectives of the program are to determine (1) radioactive and nonradioactive (light, heavy, and nonmetal trace elements) constituents in foodstuffs from on-site LANL, perimeter, and regional background areas; (2) trends; and (3) dose. Chapter 3 presents potential radiation doses to individuals from the ingestion of foodstuffs.

2. Produce

a. Monitoring Network. We collect fruits, vegetables, and grains each year from on-site, perimeter, and regional background locations (Figure 6-4). We also collect samples of produce from Cochiti and San Ildefonso Pueblos, which are located in the general vicinity of LANL. We compare produce from areas within and around the perimeter of LANL with produce collected from regional background gardens in northern New Mexico; these gardens are located in the Española, Santa Fe, and Jemez Pueblo areas. The regional sampling locations are far enough from the Laboratory that they are unaffected by Laboratory airborne emissions.

b. Sampling Procedures, Data Management, and Quality Assurance. We collect produce samples from local gardens within and around the perimeter of the Laboratory in the summer and fall of each year. (Note: All produce samples were collected after the Cerro Grande fire between the dates of June 22 and August 23, 2000.) All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, R0, 1997. During past years, Laboratory group CST-9 has analyzed produce for radionuclides and nonradionuclides.

This year, Paragon Analytics of Fort Collins, CO, analyzed produce samples. All QA/QC requirements for analyzing the radionuclides of interest were met.

c. Radiochemical Analytical Results. See Table 6-12 for concentrations of radionuclides in produce collected from on-site, perimeter, and regional background locations during the 2000 growing season. All radionuclide concentrations in fruits, vegetables, and grains collected from on-site, perimeter, and regional background areas were low, and most were nondetectable or within RSRLs.

As a group (and using detectable and nondetectable values), most radionuclides were not significantly higher ($\alpha = 0.05$) than produce collected from regional background locations. The only radionuclide in produce that was statistically higher between sites was tritium; concentrations of tritium were significantly higher in produce from Los Alamos, San Ildefonso/El Rancho, and on-site areas compared with regional background; however, the differences between the sites were small.

Last year (1999), concentrations of plutonium-238 were significantly ($\alpha = 0.05$) higher in produce from all of the perimeter areas compared with regional background. The source of the higher concentrations of plutonium-238 in produce from all of the perimeter areas was not completely known as all of the other radionuclides in produce from the perimeter areas collected last year were similar to background concentrations. This year (2000), concentrations of plutonium-238 in perimeter areas were similar to concentrations of plutonium-238 in produce collected from regional background areas, and the concentrations from all areas, including perimeter, were consistent with years before 1999.

See Table 6-13 for mean concentrations of radionuclides in produce collected from regional background, perimeter, and on-site areas before (1999) and after the fire (2000). In general, most radionuclides in produce at most sites collected after the Cerro Grande fire were statistically ($\alpha = 0.05$) similar to produce collected before the fire in 1999. Some radionuclides like cesium-137 and strontium-90 in produce collected at some sites, however, were higher in concentrations in 1999 than in 2000, and some radionuclides like tritium; plutonium-239, -240; and americium-241 in produce samples collected at some sites in 2000 were higher in concentrations than in 1999. Laboratory group CST-9 analyzed produce samples in 1999, whereas Paragon Analytics of Fort Collins, CO, analyzed produce samples collected in 2000. The differences in radionuclide concentrations—with the exception of tritium, which is probably related to the Laboratory—in produce collected in 1999 and 2000, therefore, are probably related more to differing analytical laboratory biases than to the effects of the Cerro Grande fire for the following reasons: (1) produce collected in 1999 had significantly higher concentrations of some radionuclides than produce collected in 2000, (2) produce collected upwind of the Cerro Grande fire (Cochiti/Peña Blanca/Sile) contained higher concentrations of plutonium-239, -240 and americium-241 than produce collected downwind of the fire (Los Alamos town site) [Note: The predominant wind direction during the Cerro Grande fire was to the northeast.], (3) americium and especially plutonium are not readily taken up by plants (Whicker and Schultz 1982), and (4) plutonium and americium in soils collected after the Cerro Grande fire in 2000 showed no significant increases compared with 1999 (Table 6-2). Additionally, most radionuclides, including americium and plutonium in produce collected from pueblo gardens, are similar to radionuclides in produce collected from these areas in years before 1999 (Fresquez et al., 1995).

d. Nonradiochemical Analytical Results. The trace elements silver, arsenic, beryllium, cadmium, chromium (for the most part), mercury, and thallium in produce from on-site, perimeter, and regional background locations were below the LOD (Table 6-14). These findings are not unexpected because metal uptake in plants is restricted in alkaline semiarid soil as a result of the formation of insoluble carbonate and phosphate complexes (Fresquez et al., 1991). In those cases where produce samples contained trace elements above the LOD (for barium, nickel, lead, selenium, and zinc), very few individual samples exceeded RSRLs. As a group, the levels of barium, nickel, lead, and zinc in produce from on-site and perimeter areas were not significantly higher ($\alpha = 0.05$) than in produce collected from regional background areas. Conversely, selenium concentrations in all perimeter and on-site stations were significantly higher than regional background concentrations. Although the concentrations of selenium in produce collected from perimeter and on-site stations were higher than regional background, the differences between the sites were low (e.g., a maximum difference of less than one µg/g). It should also be noted at this point that beryllium and lead, which were significantly higher in soils collected in perimeter and on-site areas, were not significantly higher in produce collected from perimeter or on-site areas compared with regional background.

Table 6-15 shows trace elements in produce collected before (1999) and after (2000) the Cerro Grande fire. With the exception of selenium, which was significantly higher in produce collected from all stations in 2000, none of the other concentrations of trace elements in produce collected after the Cerro Grande fire were significantly different from trace element concentrations in produce collected before the fire. It is hard to say that selenium in produce increased in concentration because of the Cerro Grande fire because (1) selenium in produce collected upwind of the fire (Cochiti/Peña Blanca) also showed statistical differences between the two years, (2) no other trace elements were elevated after the fire, and (3) selenium in soil samples collected from these same sites in 2000 was not significantly higher than selenium concentrations in soils collected in 1999 (Table 6-3). Instead, the statistically higher concentrations of selenium in produce collected in 2000 from most sites as compared with produce collected in 1999 may be a result of analytical laboratory bias.

3. Milk

a. Monitoring Network. We collected goat milk from Los Alamos and White Rock/Pajarito Acres and compared it with goat milk collected from a background dairy located near Albuquerque, NM. Albuquerque is located approximately 80 miles upwind of LANL. The samples were collected after the Cerro Grande fire.

b. Sampling Procedures, Data Management, and Quality Assurance. The farmer collected the milk and delivered it to our team. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Milk and Tea Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-005, R0, 1997. Laboratory group CST-9 analyzed the milk for radionuclides, and all QA/QC requirements were met.

c. Radiochemical Analytical Results. Table 6-16 presents the results of the radiochemical analysis performed on goat milk collected from the perimeter areas and Albuquerque in 2000. All radionuclide concentrations, including iodine-131, in goat milk from the perimeter areas were nondetectable or within upper-level background concentrations. Moreover, most radionuclides are lower than or similar to radionuclides in goat milk collected before the Cerro Grande fire in 1999 (Fresquez 1999; Fresquez and Gonzales 2000), and tritium and strontium-90 levels, in particular, are similar to tritium and strontium-90 levels in milk from other states around the country (Black et al., 1995).

4. Fish

a. Monitoring Network. We collect fish annually upstream and downstream of the Laboratory—mainly because 19 canyons cut through Laboratory property, and some flow resulting from excessive storm events may eventually reach the Rio Grande (Figure 6-4). This year, because of the Cerro Grande fire, we collected fish on three occasions—June, July, and August of 2000. Cochiti Reservoir, a 10,690-acre flood and sediment control project, is located on the Rio Grande approximately five miles downstream from the Laboratory. We compared radionuclides and nonradionuclides in fish collected from Cochiti Reservoir with fish collected from a background reservoir. The background reservoir, Abiquiu, is located on the Rio Chama, upstream from the confluence of the Rio Grande and intermittent streams that cross Laboratory lands (Fresquez et al., 1994).

The samples include two types of fish: game (predators) and nongame (bottom-feeders). This year, game fish include northern pike (*Esox lucius*), largemouth bass (*Micropterus salmoides salmoides*), smallmouth bass (*Micropterus dolomieui*), white crappie (*Pomoxis annularis*), and walleye (*Stizostedion vitreum*). Nongame fish include the white sucker (*Catostomus commersoni*), channel catfish (*Ictalurus punctatus*), carp (*Cyprinus carpio*), and carp sucker (*Carpiodes carpio carpio*). (Note: bottom-feeding fish are better indicators of environmental contamination than the predator game fish because they forage on the bottom where contaminants [e.g., radionuclides] readily bind to sediments [Whicker and Schultz 1982]).

b. Sampling Procedures, Data Management, and Quality Assurance. We collected fish by gill nets and transported them under ice to the laboratory for preparation. At the laboratory, fish were gutted, had their heads and tails removed, and were washed. We submitted muscle (plus associated bone) tissue for radiochemical analysis as an ash sample and submitted muscle (filet) in a wet frozen state for trace element analysis. All QA/QC protocols, chemical analyses, data handling, validation and tabulation can be found in the ESH-20 OP entitled, “Fish Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-002, R0, 1997. Laboratory group CST-9 analyzed the fish samples, and all QA/QC requirements were met.

c. Radiochemical Analytical Results. Table 6-17 presents concentrations of radionuclides in game and nongame fish collected upstream and downstream of the Laboratory in June, July, and August of 2000 (after the fire). In general, all radionuclide concentrations in game and nongame fish collected from Cochiti Reservoir were low, and most were nondetectable or within upper-level background concentrations. These results were similar to radionuclide contents in crappie, trout, and salmon from comparable (background) reservoirs and lakes in Colorado (Whicker et al., 1972; Nelson and Whicker 1969) and New Mexico (Fresquez et al., 1996b; Fresquez et al., 1998c) and, more recently, in fish collected along the length of the Rio Grande from Colorado to Texas (Booher et al., 1998). Also, they compare well with fish collected in the Rio Grande below LANL in 1998 (Fresquez et al., 1999b).

As a group, both game and nongame fish collected downstream of LANL at Cochiti reservoir were not significantly higher ($\alpha = 0.05$) in most radionuclide concentrations (using detectable and nondetectable values) than were fish collected upstream of LANL at Abiquiu Reservoir. Strontium-90, cesium-137, and total uranium concentrations in game fish collected from Cochiti reservoir were significantly higher than fish collected from Abiquiu on the last sampling date (August). Only americium-241 concentrations in bottom-feeding fish from Cochiti on the last sampling date were significantly higher than background. The differences in these radionuclides in fish from Cochiti as compared with fish from Abiquiu, however, were low.

As expected, the nongame fish from both downstream and upstream reservoirs from LANL contained significantly higher average uranium contents (10 ng per dry gram) than the predators (4 ng per dry gram). The higher concentration of uranium in bottom-feeding fish compared with predator fish is attributed to the ingestion of sediments on the bottom of the lake (Gallegos et al., 1971). Radionuclides readily bind to sediments (Whicker and Schultz 1982).

Table 6-18 contains a comparison of radionuclide concentrations in fish collected before (1999) and after (2000) the Cerro Grande fire. Most mean radionuclide concentrations in fish collected after the Cerro Grande fire were statistically similar ($\alpha = 0.05$) to radionuclide concentrations in fish collected before the fire in 1999. In fact, fish collected in 1999 were higher in most mean radionuclide concentrations, particularly total uranium; plutonium-238 and plutonium-239, -240; and americium-241, than in fish collected after the fire.

d. Long-Term (Radionuclide) Trends. Fresquez et al. (1994) conducted a summary and trend analysis of radionuclides in game and nongame fish collected from reservoirs upstream (Abiquiu, Heron, and El Vado Reservoirs) and downstream (Cochiti Reservoir) of LANL from 1981 to 1993. In general, the average levels of strontium-90, cesium-137, plutonium-238, and plutonium-239, -240 in game and nongame fish collected from Cochiti Reservoir were not significantly different ($\alpha = 0.05$) from concentrations in fish collected from reservoirs upstream of the Laboratory. Total uranium was the only radionuclide that we found to be significantly higher in both game and nongame fish from Cochiti Reservoir when compared with fish from Abiquiu, Heron, and El Vado Reservoirs. Uranium concentrations in fish collected from Cochiti Reservoir, however, significantly decreased from 1981 to 1993, and fish samples collected from Cochiti Reservoir in 1993 showed no evidence of depleted uranium (DU) (Fresquez and Armstrong 1996). (Note: This trend analysis is the most current to date; however, concentrations of all radionuclides in fish collected downstream of LANL during the 2000 year were lower or similar to concentrations in 1993.)

e. Nonradiological Analytical Results. Total recoverable trace elements in the muscle (filet) of bottom-feeding fish collected upstream and downstream of LANL at three different sampling times after the Cerro Grande fire are available in Table 6-19. In general, many of the trace elements in fish collected upstream and downstream of LANL were below the LOD. Of those elements that were above the LOD, most, including mercury and cyanide, in fish collected from Cochiti reservoir were within RSRLs. All of the mean trace element concentrations in these fish on all three sampling dates were statistically similar ($\alpha = 0.05$) to fish collected upstream of LANL.

The results of the trace element analysis in fish samples from Cochiti and Abiquiu Reservoirs in past years showed that mercury was the only element to be detected above the LOD, and, this year as in past years, the concentrations of mercury in fish from Cochiti Reservoir were within the RSRL of 0.48 μg mercury per gram (wet weight basis) (Fresquez et al., 1999d). These data also compare well with bottom-feeding fish (split) samples the New Mexico Environment Department (NMED) collected from Cochiti in July; we show 0.20 μg mercury per gram in filet samples, and they show 0.30 μg mercury per gram in whole-gutted samples (wet weight basis) (Yanicak 2001b). Also, it should be noted at this point that total cyanide, a compound ion that was detected in elevated concentrations in storm water runoff as a result of the Cerro Grande fire (Gallaher 2000), was not significantly higher ($\alpha = 0.05$) in fish downstream of LANL compared with fish upstream of LANL.

See Table 6-20 for a comparison of bottom-feeding fish collected before (1999) and after (2000) the Cerro Grande fire. Most trace elements, including mercury, in bottom-feeding fish collected from Cochiti reservoir after the Cerro Grande fire were similar to fish collected from Cochiti reservoir before the fire. Only silver, barium, and cadmium concentrations in bottom-feeding fish collected from Cochiti reservoir in 2000 were significantly higher ($\alpha = 0.05$) than in fish collected in 1999. These same elements, for the most part, however, were significantly higher in fish collected from Abiquiu reservoir after the Cerro Grande fire than before the fire, and these elements were not statistically different in fish collected from Cochiti as compared with Abiquiu (Table 6-19). Therefore, the increase in these three elements in fish collected from Cochiti reservoir was probably not related to the fire.

f. Long-Term (Nonradiological) Trends. From 1991 to 1999, we conducted a summary and trend analysis of major trace elements, with special reference to mercury, in game and nongame fish collected from Abiquiu, Heron, and El Vado Reservoirs upstream of LANL (hereafter referred to collectively as Abiquiu) and Cochiti Reservoir downstream of LANL (Fresquez et al., 1999d). With the exception of mercury, most trace elements in fish collected from Abiquiu and Cochiti over a nine-year period were below the LOD. Mean mercury concentrations in all years in fish from Abiquiu, upstream of LANL, were generally higher than mercury concentrations in fish from Cochiti, and the statistical analysis of the mean of means showed that mercury in fish from Abiquiu was significantly higher ($\alpha = 0.10$) than mercury in fish collected from Cochiti. The highest individual mercury concentrations [1.0 μg/g wet weight] were detected in a single catfish each from Abiquiu and Cochiti in 1994, and the only carnivorous fish collected, brown trout from Abiquiu and white crappie from Cochiti in 1991, contained 0.30 and 0.36 μg/g of mercury (wet weight basis), respectively.

Mean concentrations of mercury in fish from both Abiquiu and Cochiti were within mercury concentrations typical of fish from nonpolluted fresh water systems (Abernathy and Cumbie 1977) and below the US Food and Drug Administration's ingestion limit of 1μg mercury/g wet weight (Torres 1998). Concentrations of mercury in catfish from this study were very similar to mercury levels in catfish recently collected from Conchas Lake, which averaged 0.25 μg/g wet weight, and Santa Rosa Lake, which ranged from 0.22 to 0.33 μg/g wet weight (Bousek 1996; Torres 1998). These authors concluded that the health risks that mercury in fish from Conchas and Santa Rosa Lakes poses to the average sport fisherman were negligible.

Overall, mean mercury concentrations in fish collected from both reservoirs show significantly decreasing trends over time; Abiquiu ($p = 0.045$) was significant at the 0.05 probability level, and Cochiti ($p = 0.066$) was significant at the 0.10 probability level. It is not completely known why concentrations of mercury are decreasing in fish collected from Abiquiu and Cochiti, but the reduction of emissions in coal-burning power plants or the reduction of carbon sources within the reservoirs may be part of the reason. Since the early 1980s, for example, coal-burning power plants in the northwest corner of New Mexico have been required to install venturi scrubbers and baghouses to capture particulates and reduce air emissions (Martinez 1999). Additionally, because the conversion of mercury to methyl mercury is primarily a biological process, it has been demonstrated that mercury concentrations in fish tissue rise significantly in impoundments that form behind new dams and then gradually decline to an equilibrium level as the carbon provided by flooded vegetation is depleted (NMED 1999). (Note: This trend analysis is the most current to date; however, concentrations of most trace elements, including mercury, in fish collected downstream of LANL during the 2000 year were similar to concentrations in 1999.)

5. Game Animals (Elk and Deer)

a. Monitoring Network. Mule deer (*Odocoileus hemionus*) and Rocky Mountain elk (*Cervus elaphus*) are common inhabitants of LANL lands. Resident populations of deer number from 50 to 100; elk number from 100 to 200 and increase to as many as 2,000 animals during the winter months (Fresquez et al., 1999c), reflecting large mammal migration to lower elevations. We collect samples of elk and deer as roadkills; therefore, the availability of samples is beyond our control, but usually the collection of one or two animals per year from Laboratory areas is possible. When an animal is collected, the muscle and bone are processed and analyzed for a host of radionuclides—the muscle because it is the major organ that humans consume and the bone because it may also be consumed, albeit indirectly, and many radionuclides like strontium and plutonium are deposited there. We then compare these data with meat and bone samples from elk and deer collected from regional background locations.

b. Sampling Procedures, Data Management, and Quality Assurance. We collected samples of elk and deer meat and bone tissue (1000 g each) from fresh roadkills around and within the Laboratory. The New Mexico Department of Game and Fish collected background samples. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Game Animal Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-003, R0, 1997. Laboratory group CST-9 analyzed the samples. We collected the samples reported here in 1999. (Note: These data were received late, so we could not report the results in the 1999 ESR; they are reported here, however, for completeness.)

c. Radiochemical Analytical Results. All radionuclide concentrations in meat and bone tissue of a bull elk collected from LANL lands within TA-16, a TA where environmental testing of high explosives occurs, were nondetectable or below upper-level background concentrations (Table 6-21) and were within concentrations from past years (Fresquez et al., 1998b).

Most radionuclide concentrations in meat and bone tissue of a deer collected from LANL lands at TA-49, a TA where high explosives and radioactive experiments occurred in past years, were nondetectable or within RSRLs (Table 6-22) and were within concentrations from past years (Fresquez et al., 1998b). Strontium-90 was the only radionuclide in bone of the deer collected from LANL lands that was higher than regional background concentrations. The differences in concentrations between the deer collected from the two areas, however, were low.

d. Long-Term Trends. A 1998 report summarized radionuclide concentrations (tritium, strontium-90; cesium-137; plutonium-238 and plutonium-239, -240; americium-241; and uranium) determined in meat and bone tissue of deer and elk collected from LANL lands from 1991 through 1998 (Fresquez et al., 1998b). Also, we estimated the CEDE to people who ingest meat and bone from deer and elk collected from LANL lands. Most radionuclide concentrations in meat and bone from individual deer and elk collected from LANL lands were at less than detectable quantities or within upper-level background concentrations. As a group, most radionuclides in meat and bone of deer and elk from LANL lands were not significantly higher ($\alpha = 0.10$; at the 90% confidence level) than in similar tissues from deer and elk collected from regional background locations (using detectable and nondetectable values). Also, elk that had been tracked for two years with radio collars and spent an average time of 50% on LANL lands were not significantly different in most radionuclide levels from roadkill elk that have been collected on LANL lands as part of the ESP. All CEDEs were far below the International Commission on Radiological Protection guideline of 100 mrem/yr. (Note: This trend analysis is the most current to date; however, concentrations of all radionuclides in elk and deer collected from LANL lands during 1999 were lower or similar to concentrations in 1998.)

6. Honey

a. Monitoring Network. We sampled honey bee (*Apis mellifera ligustica*) hives located within perimeter areas—Los Alamos town site and White Rock/ Pajarito Acres. We compared honey from those hives with honey collected from regional background hives located in Jemez and Española, New Mexico. These samples were collected after the Cerro Grande fire.

b. Sampling Procedures, Data Management, and Quality Assurance. We collected honey directly from the producer in their bottles. All QA/QC protocols, chemical analyses, data handling, validation and tabulation can be found in the ESH-20 OP entitled, “Honey Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-004, RO, 1997. Laboratory group CST-9 analyzed the samples, and all QA/QC requirements were met.

c. Radiochemical Analytical Results. See Table 6-23 for the analytical results of the honey collected during 1999 and 2000. The honey sample collected in 1999 from the Los Alamos town site hive was lost in analysis during the tritium distillation process (Fresquez and Gonzales 2000). Consequently, we obtained another sample from the same hive and time period for a reanalysis of selected radionuclides and are reporting the results here. These results showed that all radionuclides analyzed were nondetectable or within upper-level background concentrations and were in concentrations similar to past years (Fresquez et al., 1997a; Fresquez et al., 1997b).

For the year 2000 samples, which we collected after the Cerro Grande fire, results show that all radionuclides in honey collected from the perimeter and regional background hives were at nondetectable levels or within upper-level background concentrations and were in concentrations similar to past years (Fresquez et al., 1997a; Fresquez et al., 1997b; Fresquez and Gonzales 2000).

d. Long-Term Trends. Several recent long-term data evaluations have examined radionuclide concentrations, particularly tritium, in bees and honey within the LANL environs. The first study evaluated a host of radionuclides (tritium; cobalt-57; cobalt-60; europium-152; potassium-40; beryllium-7; sodium-22; manganese-54; rubidium-83; cesium-137; plutonium-238 and plutonium-239, -240; strontium-90; americium-241; and total uranium) in honey collected from hives located around the perimeter of LANL (Los Alamos and White Rock/Pajarito Acres) over a 17-year period (Fresquez et al., 1997a). All radionuclides, with the exception of tritium, in honey collected from perimeter hives around LANL were not significantly different (a = 0.05) from background. Overall, the maximum total net positive CEDE—based on the average concentration plus two standard deviations of all the radionuclides measured over the years after the subtraction of background—from consuming 11 lb. of honey (maximum consumption rate) collected from Los Alamos and White Rock/Pajarito Acres was 0.031 mrem/yr and 0.006 mrem/yr, respectively. The highest CEDE was <0.04% of the International Commission on Radiological Protection permissible dose limit of 100 mrem/yr from all pathways. (Note: This trend analysis is the most current to date; however, concentrations of all radionuclides in honey collected from perimeter locations during the 2000 year were lower or similar to concentrations in 1997.)

The second study examined tritium concentrations in bees and honey collected from within and around LANL over an 18-year period (Fresquez et al., 1997b). Based on the long-term average, bees from nine out of 11 hives and honey from six out of 11 hives on LANL lands contained tritium that was significantly higher ($\alpha = 0.05$) than regional background. The bees with the highest average concentration of tritium (435 pCi/mL) collected over the years were from LANL's low-level radioactive waste disposal site (Area G) at TA-54. Similarly, the honey with the highest average concentration of tritium (709 pCi/mL) came from a hive located near three tritium-contaminated storage ponds at LANL TA-53. The average concentrations of tritium in bees and honey from background hives were 1.0 pCi/mL and 1.5 pCi/mL, respectively. Although the concentrations of tritium in bees and honey from most LANL and perimeter (White Rock/Pajarito Acres) areas were significantly higher than regional background, most areas, with the exception of TA-53 and TA-54, generally exhibited decreasing tritium concentrations over time. (Note: This trend analysis is the most current to date; however, concentrations of tritium in honey collected from perimeter and LANL lands in 2000 were lower or similar to concentrations in 1997.)

7. Special Foodstuffs Monitoring Studies

a. Prickly Pear. We collected prickly pear (fruit) (*Opuntia phaecantha*) from LANL and three perimeter areas in 1999: Los Alamos town site on the north, White Rock/Pajarito Acres on the southeast, and Pueblo of San Ildefonso lands on the east. (Note: These data were received late, so we could not report the results in the 1999 ESR; they are reported here, however, for completeness.) We also collected fruit from prickly pear in the Española/Santa Fe/Jemez area as a background comparison. The regional sampling locations were far enough from the Laboratory that they were mostly unaffected by Laboratory airborne emissions. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, R0, 1997. Laboratory group CST-9 analyzed the samples, and all QA/QC requirements were met.

Tables 6-24 and 6-25 present the radionuclide and trace element results of the prickly pear collected during 1999. All radionuclides, with the exception of strontium-90, in prickly pear fruit collected from perimeter areas were in nondetectable quantities or within RSRLs. Although strontium-90 in prickly pear fruit collected from two of the perimeter areas—San Ildefonso and Los Alamos town site—was higher than regional background, the differences between the two general sites were low. Uranium concentrations tended to also be higher in prickly pear fruit collected from the perimeter areas as compared with regional background; however, the concentrations of uranium in the perimeter areas were similar to produce samples collected from past years.

Of the 12 trace elements in prickly pear fruit collected from the perimeter areas, only four (barium, copper, nickel, and lead) were above the LOD (Table 6-25). And, of these four elements, only barium and possibly copper appeared to be in higher concentrations than regional background concentrations. It is not known exactly why barium concentrations in prickly pear fruit from the perimeter area were relatively higher than in regional background fruit, as the concentrations of barium in soils from perimeter locations in past years were not significantly higher than regional background soils (Fresquez 1999). Although this may be due to other agronomic factors, we will repeat the study this coming season and reappraise the results with special reference to barium.

b. Herbal Teas. We collected two types of herbal teas—Saint John’s Wort (*Hypericum perforatum*) and Elderberry (*Sambucus canadensis*)—from the La Puebla area just north east of Española at the request of the producer who had concerns about the effect of large amounts of smoke and fallout ash from the Cerro Grande fire on these products. In past years, we have collected Navajo Tea, another popular local tea, and the herbal teas we collected this year were processed in the same manner. In general, we added tap water to a defined quantity of the vegetative (unwashed) portion of each tea variety and brought the mixture to a boil. After the tea was cooled, it was filtered and poured into a suitable container and submitted to chemistry as a liquid. All QA/QC protocols, chemical analyses, and data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Milk and Tea Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-005, R0, 1997. Laboratory group CST-9 analyzed the samples, and all QA/QC requirements were met.

Table 6-26 contains the results of radionuclides in Saint John’s Wort and Elderberry tea collected from regional background areas after the Cerro Grande fire. All of the radionuclides analyzed were nondetectable and, with the exception of tritium, were within radionuclide concentrations in Navajo Tea collected from regional background areas in past years (Fresquez and Gonzales 2000). Reported values for tritium were larger in the 2000 samples than for previous samples of Navajo Tea, but the measurement uncertainties were too large for these values to be considered detectable.

C. Biota Monitoring

1. Introduction

In addition to monitoring human foodstuffs for contaminants, DOE Orders 5400.1 and 5400.5 mandate the monitoring of nonfoodstuffs biota for the protection of ecosystems (DOE 1991). Although monitoring of biota mostly in the form of facility-specific or site-specific studies began in the 1970s with the ESP, in 1994 the DOE requested additional emphasis on nonfoodstuffs biota. Nonfoodstuffs biota, such as small mammals, amphibians, birds, and vegetation, are monitored within and around LANL on a systematic or special study basis for radiological and nonradiological constituents. We also monitor or study some human foodstuffs that serve as an important link in ecological foodchains, such as fish consumed by bald eagles. We are currently emphasizing organic chemical analysis because research has determined that the highest risk to nonhuman biota at the Laboratory is generally not from radionuclides but rather from organic compounds such as pesticides and PCBs (Gonzales 2000).

Last year, we reported on vegetation that was systematically collected at the 25 traditional soil sampling stations within and around LANL (Fresquez and Gonzales 2000). Vegetation is one of the media that we will periodically sample as part of the routine surveillance program because it is the foundation of ecosystems as it provides a usable form of energy and nutrients that are transferred through food chains. Because of this function in the food chain, vegetation can serve as an important pathway of contaminants to biological systems. Fish and small mammals are also on the routine surveillance list. As reported below, we sampled fish in the year 2000 at Cochiti Reservoir, which is down-channel of LANL, and analyzed them for organic contaminants. We have sampled small mammals in special monitoring studies but never on a

Laboratory-wide, routine basis. This section will also summarize an ecological risk assessment that was conducted at LANL in the year 2000. Ecological risk assessment is becoming an important tool at LANL and other DOE sites because it helps risk managers identify locations where field studies are needed. Site-specific special monitoring studies, also discussed in this chapter, are important in establishing site-specific coefficients of contaminant transfer between different feeding levels so that accurate dose estimates can be made (Whicker and Schultz 1982; Calabrese and Baldwin 1993; EPA 1998).

The two main historical objectives of the biota program are to determine (1) on-site and perimeter contaminant concentrations in biota and compare them with off-site regional background concentrations and (2) trends over time. With the issuance of the interim standard on evaluating radiation doses to aquatic and terrestrial biota that resulted from anthropogenic sources at DOE sites as reported in Chapter 3 (DOE 2000), a new and third objective is providing data for use in evaluating compliance with specified limits on radiation dose to plants and animals. The standard will be implemented incrementally over time.

2. Institutional Surveillance of Fish

a. Monitoring Network. As discussed in Section 6.B.4, we sample and analyze fish from bodies of water that are adjacent to or potentially influenced by LANL as part of the routine surveillance program. In calendar year 2000, we sampled Cochiti and Abiquiu (background site) reservoirs. We analyzed carp and carp sucker whole-body samples for PCBs and organochlorine pesticides.

b. Sampling Procedures, Data Management, and Quality Assurance. The sampling procedure, data management, and quality assurance were generally the same as described in Section 6.B.4.b. Whole-body (head, tail, skin, viscera, bone, and muscle) fresh weight (FW) samples were homogenized and analyzed using a modified Environmental Protection Agency Method 1668—high-resolution gas chromatography and high-resolution mass spectrometry (HRGC/HRMS). The organochlorine pesticides were hexachlorobenzene; alpha, beta, and gamma hexachlorohexane; heptachlor, aldrin, oxychlordane, trans-chlordane, cis-chlordane, dichlorodiphenyltrichloroethane (DDT); dichlorodiphenyldichloroethane (DDD); dichlorodiphenylethane (DDE); trans-nonachlor, cis-nonachlor, mirex, alpha-endosulfan (I); dieldrin, endrin, beta-endosulfan (II); endosulfan sulfate; methoxychlor; delta HCH; and heptachlor epoxide. Theoretically, PCBs have 209 different possible congeners, but only about 130 have ever been detected, and the majority of the toxicity exhibited by PCBs is from the group of 13 coplanar PCBs that behave like dioxins (“dioxin-like PCBs”). We analyzed the fish for the 13 dioxin-like PCBs: PCB No. 77 (3,3',4,4'-TeCB), 81 (3,4,4',5-TeCB), 105 (2,3,3',4,4'-PeCB), 114 (2,3,4,4',5-PeCB), 118 (2,3',4,4',5-PeCB), 123 (2',3,4,4',5-PeCB), 126 (3,3',4,4',5-PeCB), 156 (2,3,3',4,4',5-HxCB), 167 (2,3',4,4',5,5'-HxCB), 169 (3,3',4,4',5,5'-HxCB), 170 (2,2',3,3',4,4',5-HpCB), 180 (2,2',3,4,4',5,5'-HpCB), and 189 (2,3,3',4,4',5,5'-HpCB).

Detection limits ranged from 0.01–10 pg/g (parts per trillion [ppt]) for the PCB congeners and 0.01-0.5 ng/g (parts per billion [ppb]) for the pesticides. Measured levels were generally two to four orders of magnitude above the detection limits. Axys, Inc., documented the specifics of the analytical method in a statement of qualification (1999).

To assess the toxicity of PCBs, we computed one other parameter—TEQ values—as follows. Some structurally related aromatic hydrocarbons, such as the 13 dioxin-like PCBs and dioxins, invoke a number of common toxic responses. The relative toxicity or potency of the 13 dioxin-like PCBs in comparison with the toxicity of tetrachlorodibenzodioxin (TCDD) is known. On this basis, the World Health Organization has developed TCDD equivalency factors (TEFs) for the 13 congeners and a method by which their toxicity can be assessed. To evaluate the dioxin-like toxicity PCBs cause, the concentration of each congener in biological tissue is multiplied by the TEF, and the 13 resulting values are summed, resulting in a TEQ. The TEQ can then be used in a number of ways such as comparing it with a screening value or other benchmarks for TCDD.

c. Analytical Results (PCBs and TEQs). Table 6-27 shows the congener analytical results, TEQs, and totals. With very low detection limits (ppt), we detected PCBs in all 18 samples (13 Cochiti and 5 Abiquiu). Total dioxin-like PCBs ranged from 5.9E-04 to 1.6E-03 parts per million (ppm)-FW in Abiquiu reservoir and from 1.5E-03 to 2.8E-02 ppm-FW in Cochiti. Mean total PCB levels in Cochiti were 1.5E-02 (June), 4.2E-03 (July), and 5.2E-03 (August) ppm-FW. The national mean concentration of total PCBs in whole fish in 1984 was 0.39 ppm (EPA 1999). The mean total PCB concentration for Abiquiu was 1.1E-03 ppm-FW. The five Abiquiu values were fairly tightly grouped as shown by a standard deviation of 32% of the mean. July values at Cochiti were also fairly tightly (56%) grouped, and June and August samples exhibited high variation.

To determine whether data from both species of fish could be combined within each location to statistically compare Cochiti to Abiquiu, we statistically analyzed species effect using the Cochiti data. Species differences were nonsignificant (P = 0.12, $t_{0.05,4,7} = 2.8$). The effect of time for the Cochiti samples was also nonsignificant (P = 0.15, $F_{0.05,2,10} = 2.3$). The mean PCB concentration at Cochiti (7.1E-03 ppm) was about seven times higher than the Abiquiu reference site mean concentration (1.1E-03 ppm), and these differences were statistically significant (P = 0.02; $t_{0.05,13,5} = 2.7$). PCB distribution is known to be worldwide (Stoker and Seager 1976; EPA 1999), and sources into the Rio Grande up-river from LANL are possible. The contribution of PCBs into Cochiti Reservoir from LANL operations cannot be discerned from data only on these reservoirs. Long-term sampling of the Rio Grande, such as done in 1997 (Gonzales et al., 1999), is also needed to discern the LANL contribution.

The mean total PCB concentration at Cochiti was about four times higher than the mean plus two standard deviations for Abiquiu. Although the PCB concentrations at Cochiti generally showed a slight decreasing trend over the three-month time period (Figure 6-5), the variation within each sampling time is too great to imply any Cerro Grande fire-related short-term trend on a statistical basis for the three months sampled.

The net (Cochiti minus Abiquiu) mean total PCB concentration was 6.0 µg/kg (0.006 ppm), and the net maximum total PCB concentration was 26.0 µg/kg (0.026 ppm). Eisler and Belisle (1996) recommend a whole-body total PCB concentration of <400 µg/kg FW for the protection of fish. Niimi (1996) cites concentrations of >50 ppm as necessary to affect reproduction or growth and concludes that concentrations in the high ppb to low ppm can cause cellular or biochemical changes but also notes that the ecotoxicological significance of these changes is largely unknown. Barron et al. (1995) cites a dietary no-observable-adverse-effects-concentration (NOAEC) of 0.5 ppm in the American kestrel.

TEQs ranged from 1.5E-07 to 6.3E-06 ppm. The net (Abiquiu minus Cochiti) mean total TEQ was 2.5E-06 ppm, and the net maximum total TEQ was 3.7E-06 ppm. Giesy and Kurunthachalam (1998) cite a NOAEC of 3.0E-07 ppm for the protection of mink. Mink are known to be extremely sensitive to PCBs.

The PCB concentrations measured in this study are not suitable for comparison with human risk screening values because they include contribution by tissue (e.g., bone) and media (e.g., sediment in the stomach) not normally consumed by humans.

d. Analytical Results (Pesticides). Table 6-28 shows the analytical results for the pesticides. With very low detection limits (<ppb), we detected DDT, DDD, and DDE in all 18 samples (13 Cochiti and 5 Abiquiu). DDT concentrations ranged from 3.4E-04 to 2.6E-03 ppm-FW in Abiquiu fish and from 8.9E-04 to 4.2E-03 ppm-FW in Cochiti fish. The mean DDT concentration in Cochiti fish was 2.8E-03 ppm compared with the mean DDT concentration in Abiquiu fish of 1.3E-03 ppm. The mean DDE concentration in Cochiti fish was 5.5E-02 ppm-FW compared with the mean DDE concentration in Abiquiu fish of 2.0 E-02 ppm-FW. Both concentrations are below a 1990 national geometric mean concentration of 1.9E-01 ppm-FW (Schmitt et al., 1990) and are within the range (0.02–0.08 ppm) in whole-body concentration measured by Carter (1997) in the common carp in the Rio Grande at three locations below Cochiti Reservoir in 1992–1993. In our study, the mean whole-body DDE concentration in the common carp, 0.085 ppm (n = 5), compares with the mean muscle (fillet) concentration of 0.096 ppm (n = 8) that we measured in common carp sampled from the Rio Grande in 1997 (Gonzales et al., 1999).

As with PCBs, to determine whether data from both species of fish could be combined within each location to statistically compare Cochiti fish to Abiquiu fish, we statistically analyzed species effect for DDT and DDE using the Cochiti data. Species differences were nonsignificant (DDT: P = 0.62, $t_{0.05,4,7} = -0.5$; DDE: P = 0.09, $t_{0.05,4,7} = 2.1$). The mean DDT and DDE concentrations at Cochiti were significantly (DDT: P = 0.029, $t_{0.05,13,5} = 2.7$; DDE: P = 0.01, $t_{0.05,13,5} = 2.9$) higher than the respective mean DDT and DDE concentrations at Abiquiu. Cochiti Reservoir is the first reservoir on the Rio Grande from its origin in Colorado. The distribution of DDT and its metabolites are known to be worldwide (Stoker and Seager 1976), and sources into the Rio Grande up-river from LANL are known to exist because they have been detected (Carter 1997). The contribution, if any, of DDT and its metabolites into Cochiti Reservoir from LANL operations cannot be discerned from data only on these reservoirs. Long-term sampling of the Rio Grande, such as the sampling that we did in 1997 (Gonzales et al., 1999), is also needed to discern the LANL contribution. DDT and DDE have been detected in fish at up-river locations in New Mexico and Colorado (Carter 1997) and more locally at locations just above and below LANL at higher concentrations than at LANL confluence's with the Rio Grande (Gonzales et al., 1999). A previous study identified an aerial application of a high concentration of DDT in 1963 (Gonzales et al., 1999); however, isolated use of DDT in the Rito de los Frijoles watershed is also documented (Allen 1989). Localized use of DDT was common in the 1960s and early 1970s. The net (Abiquiu minus Cochiti) mean DDE concentration was 0.035 µg/g (ppm), and the net maximum DDE concentration was 0.11 µg/g (ppm). The effects of DDT and its metabolites on eggshell thinning, one of the most sensitive endpoints, are well documented. Studies indicate that a piscivore's diet averaging 1.0 ppm DDE or more can cause eggshell thinning.

The pesticide concentrations measured in this study are not suitable for comparison with human risk screening values because they include contribution by tissue (e.g., bone) and media (e.g., sediment in the stomach) not normally consumed by humans.

3. Facility Monitoring

a. Area G.

Vegetation. We did not collect vegetation samples at Area G in 2000. The last vegetation samples were collected in 1999 and are reported here for completeness. In general, we collected unwashed overstory and understory vegetation samples at 12 locations within and around Area G (Figure 6-2). Collection of vegetation samples for chemical analyses follows a set procedure to ensure proper collection, processing, submittal, and posting of analytical results. Stations and samples have unique identifiers to provide chain-of-custody control from the time of collection through analysis and reporting. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled "Sampling and Sample Processing for the Waste-Site Monitoring Program," LANL-ESH-20-SF-OP/HCP-011, 1999. Laboratory group CST-9 analyzed the vegetation samples for tritium; plutonium-238 and plutonium-239, -240; strontium-90; americium-241; cesium-137; and uranium, and all QA/QC requirements were met.

Results showed that most of the radionuclide concentrations in the unwashed vegetation samples collected in 1999 were below upper-level background concentrations, except for tritium (data not given but can be found in Nyhan et al., 2000). Tritium concentrations in vegetation from most sites were greater than background concentrations of about 2 pCi/mL.

Bees. We did not collect honey bee samples in 2000 at Area G. The last bee samples were collected at Area G in 1999 and are reported here for completeness. In general, two colonies were established on the south end of Area G near the tritium shafts. We brought these colonies into the study site from a background area. In addition, a control (regional background) site with one colony was established 10 km (6 mi.) south of Jemez Springs, NM. In the early fall 1999, we collected bee tissue samples from all of the colonies. Each of the three separate 100-g samples (one from each colony) consisted of approximately 1,000 bees. We used a small, rechargeable vacuum to collect the bee samples. Bees were vacuumed off frames that were removed from the hive, transferred to a plastic resealable bag, weighed, and double bagged into plastic resealable bags. We kept all samples in a cooler and froze them upon returning to the laboratory. After collecting each sample, we thoroughly cleaned the vacuum collection area to avoid cross-contamination of samples. All samples were analyzed for tritium; strontium-90; cesium-137; americium-241; plutonium-238; plutonium-239, -240; and total uranium; see Fresquez et al. (1997a) for a description of the methods. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Managing Bee Colonies," LANL-ESH-20-BIO-OP-024, RO, 1997. Laboratory group CST-9 analyzed the bee samples, and all QA/QC requirements were met.

In general, most radionuclides, with the exception of tritium, strontium-90, and total uranium, were within RSRLs (data not given but can be found in Haarmann and Fresquez 2000). The RSRL is the upper-level background concentration derived from the combined 1997, 1998, and 1999 control data (Haarmann and Fresquez 1998, 1999). Similar to our results from 1997 and 1998, the largest concentration difference between Area G and the RSRL was in the tritium levels. Tritium levels in the Area G bees, for example, were at 146.9 and 122.0 pCi/mL; the control colony contained –0.10 pCi/mL, with a RSRL of 5.5 pCi/mL. Concentrations of strontium-90 were higher in one Area G colony than the RSRL. Additionally, concentrations of total uranium were higher than the RSRL in the other Area G colony.

b. DARHT.

Vegetation. We completed baseline concentrations of radionuclides and trace elements in vegetation (and soils, sediments, small mammals, birds, and bees) around the DARHT facility during the construction phase (1996 through 1999) in 2000 (Nyhan et al., 2001a). The Mitigation Action Plan for the DARHT facility at LANL mandated the establishment of baseline concentrations for potential environmental contaminants. These concentrations of radionuclides and trace elements now represent preoperational baseline statistical reference levels (BSRLs), which are calculated from the mean DARHT facility sample concentration plus two standard deviations.

In 2000, we collected unwashed overstory and understory vegetation samples during the operational phase within and around the DARHT facility. Collection, processing, submittal, and analysis of vegetation samples follow a set procedure described in Section C.3.a.i. Tables 6-29 and 6-30 present the results of radionuclides and trace elements, respectively. See Figure 6-3 for the locations of sampling points.

None of the radionuclide concentrations found in overstory and understory vegetation samples were above BSRLs (Fresquez et al., 2001b), except for the concentration of plutonium-239, -240 found in the overstory sample collected at the north sampling location. Even this sample was not significantly different than the BSRL concentration because it was within one standard deviation of the BSRL concentration. Table 6-30 shows that the trace element concentrations in many samples were less than regional background concentrations and BSRL concentrations, but three sets of values exceeded BSRL concentrations. One set had detection limits that were greater than BSRL values, thus these values could not be realistically compared with BSRL values. Examples from Table 6-30 are results for silver, arsenic, beryllium, cadmium, nickel, antimony, selenium, and thallium. A second set had values found to have a strong positive bias resulting from analytical problems, so we did not use them in these calculations. Examples from Table 6-30 are arsenic and selenium; this positive bias also meant that these values could not be realistically compared with BSRL values. The third set of values was legitimately greater than BSRL values. The concentration of copper in the overstory sample from the north location was greater than BSRL values, and all of the other vegetation samples were greater than the regional background concentrations for copper. The lead concentration in all understory samples was greater than regional background, and the sample from the west location was greater than the BSRL as well. In contrast, the concentration of lead from the overstory samples was less than regional background in all but the sample from the south location, and none of the overstory samples exceeded the BSRLs.

Bees. We sampled honey bees around the DARHT facility in 2000; however, the data are not yet available. Instead, we are reporting data from 1999, which was the third year of gaining baseline concentrations for a variety of radionuclides in bees. We collected bee samples from five colonies, established at the DARHT site approximately 100 m northwest of the DARHT facility. These samples were collected, processed, and analyzed for the constituents described in Section C.3.a.

Results show that one of the honey bee samples was higher than the RSRL for cesium-137, plutonium-238, and americium-241 (data not given but can be found in Haarmann 2001). Three of the honey bee samples were higher than the RSRL for plutonium-239, -240, and all five samples were higher than the RSRL for total uranium, silver, barium, lead, arsenic, and selenium.

4. Special Biological Monitoring Studies

a. Radionuclides and Nonradionuclides in Meat and Bone of a Raccoon Near Area G. We collected a raccoon (*Procyon lotor*) killed by an automobile near Area G at TA-54 and analyzed the meat (muscle) and bone for tritium; strontium-90; cesium-137; americium-241; plutonium-238; plutonium-239, -240; and total uranium. We compared these data from meat and bone samples with radionuclide concentration in meat and bone samples from a "background" raccoon killed on a roadway on the northern portion of the Los Alamos town site. The raccoons were collected during 1999, but because the analysis was not completed in time for publication in the 1999 ESR, we are presenting the data here. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, "Game Animal Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-003, R0, 1997. Laboratory group CST-9 analyzed the raccoon samples, and all QA/QC requirements were met.

See Table 6-31 for the radionuclide results of the meat and bone tissue of the raccoon collected from the TA-54 area. Plutonium-238, cesium-137, and especially tritium in meat of the raccoon collected at TA-54 were higher than the RSRL. Tritium in bone samples of the same raccoon was also elevated above background concentrations. All other radionuclides in meat and bone tissue of the raccoon collected at TA-54 were nondetectable or within RSRLs. Other media collected at TA-54 near Area G have been higher in tritium concentrations in past years: soils and vegetation (Fresquez et al., 1999a; Nyhan et al., 2000), field mice (Biggs et al., 1997; Bennett et al., 1998), pocket gophers (Gonzales et al., 2000b), and bees (Haarmann and Fresquez 1998, 1999, and 2000) are examples.

b. Biological Resources Management Plan Special Study: Organic Biocontaminants in Food Chains at Two Canyons at the Los Alamos National Laboratory. We conducted a range-finding study in DP and Sandia canyons to establish the upper range of PCBs, DDE, and other organic contaminants in biological organisms at LANL. We analyzed arthropods (insects and spiders), skinks (*Eumeces multivirgatus epipleurotus*), small mammals (shrews, voles, and mice), and great horned owls (*Bubo virginianus*) for PCB congeners and organochlorine pesticides. Generally, concentrations of contaminants in these organisms were below the levels associated with adverse effects in lab toxicity studies and field studies on species in the same class as those of interest in this study. Great horned owls assumed to live on-site had two orders of magnitude higher concentrations of PCBs than an owl assumed to live off-site. Pesticide concentrations were generally not different comparing on-site with off-site. This finding may further substantiate the dominant source of DDT on the Pajarito Plateau, including at LANL, as a single indiscriminate spraying in 1963. Skinks and owls generally had between one and two orders of magnitude more DDE than small mammals, and arthropods had between one and three orders of magnitude less dioxin-like PCBs than the other classes of organisms. This result implies that arthropods may be relatively poor accumulators of organic contaminants, and, thus, arthropods may be poor indicators of exposure. The data also imply that soil ingestion may be the dominant pathway for lipophyllic organic contaminants into nonhuman biota given that the types of organisms with higher levels of measured organic contaminants, e.g., shrews, have feeding habits that are conducive of high soil intake (Gonzales et al., 2001a).

c. The Effects of Depleted Uranium on Amphibian Growth and Development. DU is the by-product of an enrichment process that increases the percentage of the isotope uranium-235 in natural uranium ore. The release of DU into the environment at LANL occurred primarily when weapon components or munitions were explosively detonated or impacted against a metal target at firing sites. Uranium is poorly soluble, and the canyons adjacent to the firing sites lack a constant flow of water into and through them. Nevertheless, chemical toxicity information is needed about areas within the Laboratory where runoff creates standing water that can be used as breeding pools and drinking water for amphibians, aquatic invertebrates, and terrestrial invertebrates.

A prior study on the chemical effects of DU on the water flea (*Ceriodaphnia dubia*) and amphipod (*Hyalella azteca*) indicated the potential for adverse biological effects only at concentrations considerably higher than have been measured in surface water or runoff at LANL (Kuhne 2000). However, amphibians can be very sensitive to contaminants. Various life stages of amphibians have been used as sensitive indicators and are standardized models of contaminant exposure. In our study, we (researchers from LANL, the US Geological Survey, and New Mexico State University) are characterizing the acute and chronic effects of DU on embryonic development and growth of two species of amphibians. Using the South African Clawed Frog (*Xenopus laevis*), we are applying a standardized test, Frog Embryo Teratogenesis Assay—*Xenopus* (FETAX), and will comparatively evaluate the toxicological effects of DU on Xenopus and on a species of frog that is native to the LANL environment—the chorus frog (*Pseudacris triseriata*) (Figure 6-6). The objective of our two-year study is to develop DU/amphibian toxicity benchmarks to which direct comparisons of field data can be made. Using the human chorionic gonadotropin to induce amplexus (reproduction), clawed frogs have been successfully bred and used in a series of pilot studies to develop and refine the techniques in the FETAX protocol. We are studying chorus frogs collected in northern New Mexico (Figure 6-7) to develop a captive breeding capability in the laboratory. Acute exposure (1.6–50 mg/L DU in solution) range-finding toxicity tests

(96 hr LC-50) have revealed no trend or concentration-response in malformation or mortality to date. Additional acute and chronic assays are underway (Gonzales et al., 2001b).

d. Radionuclides in Soils and Water Near a Low-Level Disposal Site and Potential Ecological and Human Health Impacts. Area G is adjacent to Pueblo of San Ildefonso lands. Pueblo residents and LANL scientists are concerned about radiological doses resulting from uptake of Area G radionuclides by mule deer and Rocky Mountain elk, then consumption of deer and elk meat by humans. We collected tissue samples from deer and elk killed near Area G by automobiles and analyzed them for tritium; strontium-90; uranium; plutonium-238 and plutonium-239, -240; americium-241; and cesium-137. We used these data to estimate human doses based on meat consumption rate of 23 kg/yr. We also used RESRAD, starting from a soil source term, to model human doses, and we estimated dose rates to deer and elk with a screening model. Dose estimates to humans from tissue consumption were 2.9 × 10-3 mSv/yr (0.29 mrem/yr) and 1.6 × 10-3 mSv/yr (0.16 mrem/yr) from deer and elk, respectively, and RESRAD dose estimates were of the same order of magnitude. Estimated dose rates to deer and elk were 2.1 × 10-4 mGy/d and 4.7 × 10-4 mGy/d, respectively. All estimated doses were significantly less than established exposure limits or guidelines (Ferenbaugh et al., 1999 and 2001).

5. Ecological Risk Assessment

a. Approach. Ecological risk assessment is the qualitative or quantitative appraisal of real or potential effects of stressors such as contamination on flora, fauna, or populations, communities, or ecosystems. The relationship between ecological risk assessment and environmental surveillance is several-fold. First, the ESP provides contaminant data for assessing trend, exposure, and potential effects on ecological entities. The data collected for surveillance programs include concentrations of contaminants in living and nonliving media, both of which are useful in ecological risk assessments. The data on contaminant levels in living organisms can also validate ecological risk models by comparing the accuracy of model predictions with real data. Second, the results of ecological risk assessments can help identify gaps in the ESP. For example, ecological risk assessments on threatened and endangered (T&E) species at LANL established the need to develop an organic-contaminant focus area as a component of the LANL ESP (Gonzales et al., 1998). Another example is the need for knowledge of contaminant levels in reptiles and amphibians native to the LANL environment and related potential risk.

The monitoring of organics for the ESP will help to focus additional ecological risk assessments. Thus, the relationship between the ESP and ecological risk assessment is mutualistic and iterative. As does the ESP, ecological risk assessments help identify special studies that enhance the basis on which environmental compliance is founded, and this is probably the most useful outcome of ecological risk assessments.

b. History. The Laboratory is in the early stages of an ecological risk assessment program that develops multiple lines of evidence. Prior focus has been on related pieces or components of ecological risk assessment such as monitoring and modeling of contaminant release, fate, and transport. In 1996, the Environmental Impact Statement Record of Decision on the DARHT at LANL specified, among other things, the requirement for closer observance of the federal Endangered Species Act of 1973. As a result of this requirement, between 1996 and 1999, we completed risk assessments on four T&E species and initiated related field studies. Previous Environmental Surveillance Reports have contained summaries of the T&E assessments. In 2000, we used a similar approach in assessing risk to non-T&E species, and a summary of the study is discussed below.

c. Tier 2 Ecological Risk Assessment of LANL Institutional Issues on the Pajarito Plateau Using ECORSK.6. LANL uses multiple lines of evidence to manage biological resources that are potentially impacted by small levels of contamination occurring in environmental media in some areas of its 43 mi^2. Ecological risk assessment provides one line of evidence for making decisions on managing these resources. This information on potential impact to biota is relative and is best used to help focus field studies or additional assessments on the particular contaminants, geographical areas, or biological endpoints needing attention. Ecological risk assessment also helps to ensure good environmental stewardship and response to concerns by the general public.

ECORSK.6 is a custom FORTRAN model that was developed as a tool specifically for conducting ecological risk assessments at LANL (Gonzales et al., 2001c). ECORSK.6 integrates geographical information system (GIS) data on environmental contamination and animal distribution with many other types of information such as contaminant toxicity so that animal exposures to contaminants can be estimated and compared with animal "safe limits." In fiscal year 2000, we used ECORSK.6 to assess potential impact from three contaminant types (radionuclides, organic chemicals, and metals) to the Rocky Mountain elk, the American robin (*Turdus migratorius*), and the deer mouse (*Peromyscus maniculatus*) across expansive areas of semidesert and forested habitat ranging up to 192 km^2 (74 mi^2). We will use the results to support the development of the Biological Resources Management Plan.

Results indicate no appreciable potential impacts to elk or robin and a small potential for impact to the deer mouse; however, natural and regional background sources of contamination contributed the dominant portion of total risk, indicating that the safe limits used may have been overly conservative (too low). Using overly conservative limits is common in the current state of the science.

We have met our goals of further developing the ECORSK tool as a technical programmatic capability and increasing the realism of the assessment approach. Using a receptor selection process that included input from multiple agencies and interest groups, we selected 21 species as important indicators of risk on the basis of social, ecological, risk, and model criteria. The use of real animal density data for placement and distribution of animal focal points and nest sites is an important advancement because it enables us to distribute animals on the basis of the distribution of their prey or forage. The variability of results as a function of changes in the safe limits (or toxicity reference values) and contaminant transfer coefficients demonstrates that more emphasis is needed on the development of accurate chronic toxicity benchmarks (safe limits) and site-specific transfer coefficients. In another important improvement to the approach, we demonstrated a simple method for interpolating (predicting) contaminant levels in canyon sediment at points where we intuitively know contamination exists based on measurements taken up-channel, but for which previous assessments assumed zero or background levels of contamination. The interpolation method was demonstrated for Los Alamos Canyon and is currently being applied to other canyons.

D. Other Environmental Surveillance Program Activities and Special Studies around LANL

1. Surveys of Fire Effects and Rehabilitation Treatments: First Year after the Cerro Grande Fire

During the summer of 2000, we surveyed portions of the Sierra de los Valles for the effects of the Cerro Grande fire, the distribution of rehabilitation treatments, and the residual fire hazards that occur in unburned areas. To do this, we obtained the reconnaissance data listed below at previously established and at newly established permanent plots. A total of 115 plot samples were obtained from June 6 to October 16. Most of these data were derived from plots that had been established before the fire from 1997 to 1999. However, we also established 28 new plots, and, of the 115 samples, 11 plots were sampled twice during the field season. These plots ranged from unburned to severely burned. Each plot was established or located in the field and photographed. The list of sampled variables expanded throughout the summer. We collected the following categories of reconnaissance data at many or all of the plots: location and land ownership; physical characteristics of the site; plant community type and dominant plant species; presence of Cerro Grande fire effects and the intensity of effects; presence or absence of rehabilitation treatments; soil depth and evidence of soil erosion; percent canopy cover of the forest overstory; percent cover of graminoids, herbs, shrubs, ash, litter, duff, bare soil, mosses, lichens, and size-classes of lithic materials; frequency of elk and deer pellet groups; counts of dead trees; and samples of the first ten centimeters of soil material. We transported the data to the lab where we stored them in a computer database and summarized them. The soils went to Stephen F. Austin State University where they are being analyzed for levels of nutrients and to LANL's Environmental Dynamics and Spatial Analysis Group (EES-10) where they are being analyzed for carbon content. We are currently analyzing the quantitative data for trends. We are also utilizing them as inputs to remote sensing analyses of fire effects and fire hazards and for the development of a post-fire land cover map. Finally, we are using the sample database to select sample plots for resampling during the upcoming field season and to identify gaps in the data that will require the addition of new permanent plots (Balice et al., 2001).

2. Estimation of Soil Erosion in Burned Forest Areas Resulting from the Cerro Grande Fire

The East Jemez Region has experienced two major wildfires in the past five years, as well as the recent Cerro Grande fire in 2000. It has been estimated that broad-scale wildfires will recur in this region once every ten years. To address this potential hazard, the Environment, Safety and Health Division's Technology Development, Evaluation, and Application (TDEA) program has provided funding for "A Wildfire Behavior Model for the Los Alamos Region and an Evaluation of Options for Mitigating Fire Hazards." The primary objectives of the Wildfire TDEA project are to model fire behavior in the LANL region and to develop actions to mitigate potential hazards. Another objective of the Wildfire TDEA project is to estimate the risk of wildfire-induced soil erosion in the LANL region. Post-fire soil erosion and storm water runoff can result in contaminant transport and flooding of downstream facilities. Identification of potential problem areas will allow us to design and implement mitigation actions to protect our environment and facilities. We are comparing two methods for estimating wildfire-induced surface soil erosion hazards. The first is the method the Interagency Burned Area Emergency Rehabilitation (BAER) Team used on the Cerro Grande fire. In this method, pre-fire Universal Soil Loss Equation (USLE) estimates of soil loss, from the Terrestrial Ecosystem Surveys of the Santa Fe National Forest, multiplied by five factors to account for burn severity and hydrophobic soils, resulted in post-fire soil erosion estimates. The second method (Enhanced USLE Approach) made estimates of soil erosion that incorporated multiple precipitation zones and estimates of changes in ground and canopy cover.

Because much of the data used in both approaches were similar, such as the data layers for the Soil Erodibility and Topographic Factors, the two approaches have some inherent similarities. For the pre-fire case, the soil loss estimates made by the BAER Team and the Enhanced USLE approaches both showed much lower soil erosion rates across the area burned by the Cerro Grande fire. However, a much larger proportion of the area had tolerable soil erosion (<2 ton/acre/year) using the Enhanced USLE Approach than that discovered by the BAER Team.

When the post-Cerro Grande fire soil erosion estimates were compared, the following differences were observed:

- The BAER Team post-fire estimates of soil loss were generally lower than the results from the Enhanced USLE Approach.
- The Enhanced USLE Approach pinpointed discrete areas needing conservation measures (Nyhan et al., 2001b).

3. Assessing Potential Risks from Exposure to Natural Uranium in Well Water

Over 50% of the wells in the Nambe region of northern New Mexico exceed the EPA's recommended drinking water standard of 20 µg/L (ppb) for uranium-238; the highest in the area was measured at 1200 µg U/L. We estimated uranium uptake in tomato (*Lycopersicon esculentum*), squash (*Cucurbita pepo*), lettuce (*Lactuca scarriola*), and radish (*Raphanus sativus*) irrigated with Nambe well water containing <1, 150, 500, and 1200 µg U/L. We evaluated plant uptake and human dose and toxicity associated with ingestion of water and produce and inhalation of irrigated soil related to gardening activities. Uranium concentration in plants increased linearly with increasing uranium concentration in irrigation water, particularly in lettuce and radish. The estimated total committed effective dose for 70 years of maximum continuous exposure, by the three pathways to well water containing 1200 µg U/L, was 0.17 mSv (17 mrem/yr) with a corresponding kidney concentration of 0.8 µg U/g (ppm) kidney (Hayes et al., 2000 and 2001).

E. Acknowledgements

This year was very challenging because of the Cerro Grande fire—we collected many more samples and analyzed many more constituents than in previous years. Thanks to the staff of ESH-20, Rick Velasquez, and Louie Naranjo for collecting and processing samples; CST-9, George Brooks, Richard Robinson, Sam Garcia, Lydia Apodoca, Edward Gonzales, Anthony Sanchez, Claudine Armenta, Eva Birnbaum, Cecily Boyett-Reyes, Mark Kozubal, Kathy Lao, Barbara Lopez, and Kathy Straw for radionuclide and trace element analysis; and Paragon Analytics of Fort Collins, CO, and Axys Analytical Services, Ltd., in Sidney, B.C., Canada, for other organic chemical analysis. Also, thanks to many of the ESH-20 undergraduate students (David Lujan, Adrian Martinez, and Chris Rae) for helping summarize, tabulate, and QA the data.

Table 6-1. Radionuclide Concentrations in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations during 2000 (after fire)

Location	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	^{tot}U (µg/g dry)	^{238}Pu (pCi/g dry)	^{239,240}Pu (pCi/g dry)	^{241}Am (pCi/g dry)	Gross Alpha (pCi/g dry)	Gross Beta (pCi/g dry)	Gross Gamma (pCi/g dry)
Regional Background Stations:										
Embudo	0.03 (0.45)[a]	0.34 (0.09)	0.31 (0.05)	1.57 (0.16)	0.002 (0.001)	0.011 (0.002)	0.014 (0.004)	4.13 (1.25)	3.10 (1.04)	2.5 (0.2)
Cochiti	0.10 (0.46)	0.19 (0.09)	–0.03 (0.15)	1.58 (0.16)	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)	1.34 (0.63)	0.64 (0.40)	2.4 (0.2)
Jemez	–0.06 (0.44)[b]	0.17 (0.09)	0.20 (0.04)	2.50 (0.25)	0.001 (0.001)	0.007 (0.001)	0.005 (0.002)	1.06 (0.56)	0.34 (0.28)	2.9 (0.3)
Bandelier (Cerro Grande)	0.23 (0.47)	0.07 (0.09)	0.36 (0.05)	2.60 (0.26)	0.001 (0.001)	0.020 (0.002)	0.005 (0.002)	6.60 (1.73)	3.91 (1.18)	2.7 (0.3)
Mean (std dev)	0.08 (0.12)	0.19 (0.11)	0.21 (0.17)	2.06 (0.56)	0.001 (0.001)	0.010 (0.008)	0.007 (0.005)	3.28 (2.61)	2.02 (1.8)	2.6 (0.2)
RSRL[c]	0.60	0.71	0.51	3.30	0.008	0.019	0.013	8.4	7.2	4.1
SAL[d]	6,400.00[e]	5.70	5.30	100.00	49.00	44.00	39.00	– – –	– – –	– – –
Perimeter Stations:										
Otowi	0.02 (0.45)	0.19 (0.09)	0.45 (0.06)	0.75 (0.08)	0.004 (0.001)	0.125 (0.007)	0.048 (0.004)	2.83 (0.97)	2.24 (0.83)	3.3 (0.3)
TA-8 (GT Site)	0.14 (0.46)	0.40 (0.10)	0.50 (0.07)	2.35 (0.24)	0.002 (0.001)	0.028 (0.003)	0.011 (0.003)	7.65 (1.95)	5.05 (1.42)	3.5 (0.3)
Near TA-49 (BNP)	0.24 (0.47)	0.40 (0.10)	0.39 (0.05)	3.78 (0.38)	0.002 (0.001)	0.020 (0.002)	0.004 (0.001)	7.54 (1.93)	4.62 (1.34)	3.1 (0.3)
East Airport	0.42 (0.49)	0.26 (0.10)	0.24 (0.04)	2.98 (0.30)	0.001 (0.000)	0.030 (0.003)	0.006 (0.002)	5.94 (1.60)	3.64 (1.12)	2.1 (0.2)
West Airport	0.29 (0.48)	0.28 (0.10)	0.20 (0.04)	3.14 (0.31)	0.002 (0.001)	0.060 (0.005)	0.002 (0.001)	5.95 (1.61)	3.50 (1.09)	2.7 (0.3)
North Mesa	0.30 (0.48)	0.31 (0.10)	0.15 (0.03)	2.82 (0.28)	0.000 (0.000)	0.012 (0.002)	0.002 (0.001)	5.26 (1.47)	3.40 (1.07)	2.7 (0.3)
Sportsman’s Club	0.27 (0.48)	0.15 (0.09)	0.32 (0.05)	3.59 (0.36)	0.001 (0.001)	0.024 (0.003)	0.007 (0.002)	6.58 (1.74)	4.81 (1.38)	2.9 (0.3)
Tsankawi/PM-1	0.11 (0.46)	0.27 (0.09)	0.18 (0.04)	5.54 (0.55)	0.001 (0.001)	0.013 (0.002)	0.006 (0.001)	3.97 (1.20)	2.90 (0.96)	4.4 (0.4)
White Rock (East)	0.42 (0.49)	0.30 (0.10)	0.11 (0.02)	2.22 (0.22)	0.001 (0.001)	0.008 (0.001)	0.001 (0.001)	6.96 (1.81)	3.80 (1.16)	3.1 (0.3)
San Ildefonso	0.12 (0.46)	0.32 (0.10)	0.25 (0.04)	2.75 (0.28)	0.001 (0.001)	0.010 (0.002)	0.002 (0.001)	3.55 (1.11)	2.50 (0.87)	2.8 (0.3)
Mean (std dev)	0.23 (0.13)*[f]	0.29 (0.08)	0.28 (0.13)	2.99 (1.23)*	0.002 (0.001)	0.033 (0.036)	0.009 (0.014)	5.62 (1.69)	3.65 (0.96)	3.1 (0.6)*
On-Site Stations:										
TA-16 (S-Site)	0.10 (0. 46)	0.46 (0.10)	0.58 (0.07)	4.57 (0.46)	0.000 (0.001)	0.032 (0.003)	0.011 (0.003)	10.20 (2.44)	6.83 (1.78)	3.7 (0.4)
TA-21 (DP-Site)	1.51 (0.58)	0.23 (0.09)	0.25 (0.05)	4.50 (0.45)	0.003 (0.001)	0.096 (0.005)	0.056 (0.006)	6.49 (1.72)	3.44 (1.09)	3.0 (0.3)
Near TA-33	1.67 (0.60)	0.26 (0.09)	0.33 (0.05)	2.65 (0.27)	0.007 (0.001)	0.019 (0.002)	0.009 (0.002)	6.42 (1.71)	4.11 (1.23)	3.0 (0.3)
TA-50	0.76 (0.52)	0.20 (0.09)	0.07 (0.02)	3.16 (0.32)	0.001 (0.001)	0.039 (0.003)	0.013 (0.003)	6.34 (1.69)	3.48 (1.10)	3.1 (0.3)
TA-51	–0.09 (0.44)	0.36 (0.11)	0.36 (0.05)	4.15 (0.42)	0.002 (0.001)	0.026 (0.003)	0.008 (0.002)	6.51 (1.72)	4.29 (1.26)	3.3 (0.3)
West of TA-53	1.01 (0.54)	0.09 (0.10)	0.20 (0.04)	3.93 (0.39)	0.002 (0.001)	0.032 (0.003)	0.009 (0.002)	5.57 (1.54)	3.53 (1.11)	3.1 (0.3)
East of TA-53	0.57 (0.50)	0.21 (0.10)	0.53 (0.07)	3.18 (0.32)	0.001 (0.001)	0.042 (0.004)	0.015 (0.003)	5.41 (1.51)	3.76 (1.16)	3.3 (0.3)
East of TA-54	0.90 (0.53)	0.21 (0.09)	0.23 (0.04)	2.77 (0.28)	0.012 (0.002)	0.028 (0.003)	0.010 (0.002)	3.83 (1.19)	2.89 (0.97)	3.4 (0.3)
Potrillo Drive/TA-36	0.39 (0.49)	0.27 (0.10)	0.21 (0.03)	3.18 (0.32)	0.001 (0.001)	0.010 (0.001)	0.003 (0.001)	5.13 (1.44)	3.10 (1.01)	3.1 (0.3)
Near Test Well DT-9	–0.14 (0.44)	0.38 (0.10)	0.22 (0.04)	2.57 (0.26)	0.001 (0.001)	0.010 (0.002)	0.005 (0.002)	5.24 (1.47)	3.89 (1.19)	3.1 (0.3)
R-Site Road East	0.24 (0.47)	0.18 (0.11)	0.35 (0.05)	4.53 (0.45)	0.001 (0.001)	0.012 (0.002)	0.004 (0.001)	8.47 (2.09)	4.76 (1.35)	3.1 (0.3)
Two-Mile Mesa	0.11 (0.46)	0.33 (0.09)	0.23 (0.04)	2.83 (0.28)	0.001 (0.001)	0.016 (0.002)	0.007 (0.002)	6.49 (1.71)	3.73 (1.14)	3.0 (0.3)
Mean (std dev)	0.59 (0.60)*	0.27 (0.10)	0.30 (0.14)	3.50 (0.78)*	0.003 (0.003)	0.030 (0.023)	0.013 (0.014)	6.3 (1.65)*	3.98 (1.03)*	3.2 (0.2)*

Table 6-1. Radionuclide Concentrations in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations during 2000 (after fire) (Cont.)

Location	^{234}U (pCi/g dry)	^{235}U (pCi/g dry)	^{238}U (pCi/g dry)
Regional Background Stations:			
Embudo	0.459 (0.037)	0.0162 (0.0087)	0.459 (0.037)
Cochiti	0.490 (0.033)	0.0134 (0.0061)	0.460 (0.032)
Jemez	0.727 (0.033)	0.0283 (0.0063)	0.777 (0.035)
Bandelier (Cerro Grande)	0.249 (0.017)	0.0079 (0.0035)	0.235 (0.016)
Mean (std dev)	0.481 (0.196)	0.0165 (0.0086)	0.483 (0.223)
RSRL[c]	0.501	0.0337	0.929
SAL[d]	63.0	17.0	93.0
Perimeter Stations:			
Otowi	0.216 (0.015)	0.0066 (0.0037)	0.212 (0.015)
TA-8 (GT Site)	0.685 (0.052)	0.0470 (0.0138)	0.827 (0.058)
Near TA-49 (BNP)	1.170 (0.071)	0.0525 (0.0139)	1.221 (0.073)
East Airport	0.768 (0.044)	0.0287 (0.0080)	0.898 (0.048)
West Airport	0.863 (0.037)	0.0404 (0.0071)	0.932 (0.039)
North Mesa	0.822 (0.037)	0.0280 (0.0069)	0.796 (0.036)
Sportsman's Club	0.955 (0.036)	0.0369 (0.0063)	0.993 (0.037)
Tsankawi/PM-1	0.623 (0.031)	0.0224 (0.0060)	0.695 (0.033)
White Rock (East)	1.565 (0.060)	0.0632 (0.0094)	1.653 (0.062)
San Ildefonso	0.816 (0.035)	0.0394 (0.0070)	0.816 (0.035)
Mean (std dev)	0.848 (0.352)*	0.0365 (0.0161)*	0.904 (0.368)*
On-Site Stations:			
TA-16 (S-Site)	1.277 (0.051)	0.0523 (0.0086)	1.341 (0.053)
TA-21 (DP-Site)	1.279 (0.067)	0.0592 (0.0125)	1.303 (0.067)
Near TA-33	0.844 (0.037)	0.0496 (0.0081)	0.848 (0.037)
TA-50	0.923 (0.040)	0.0459 (0.0081)	0.981 (0.042)
TA-51	1.040 (0.046)	0.0382 (0.0080)	1.097 (0.048)
West of TA-53	0.926 (0.062)	0.0563 (0.0142)	1.027 (0.066)
East of TA-53	0.792 (0.033)	0.0378 (0.0065)	0.808 (0.033)
East of TA-54	0.858 (0.037)	0.0288 (0.0060)	0.808 (0.035)
Potrillo Drive/TA-36	0.894 (0.040)	0.0389 (0.0077)	0.936 (0.041)
Near Test Well DT-9	0.742 (0.047)	0.0488 (0.0117)	0.764 (0.047)
R-Site Road East	0.657 (0.045)	0.0307 (0.0111)	0.665 (0.045)
Two-Mile Mesa	0.781 (0.034)	0.0376 (0.0069)	0.866 (0.037)
Mean (std dev)	0.918 (0.195)*	0.0437 (0.0098)*	0.954 (0.209)*

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[a] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[b] See Appendix B for an explanation of the presence of negative values.

[c] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on data from 1995 to 1999.

[d] Los Alamos National Laboratory Screening Action Level (ER 2001).

[e] Equivalent to the SAL of 880 pCi/g dry soil at 12% moisture.

[f] Means within the same column followed by an * were statistically higher than regional background using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-2. Mean (±SD) Radionuclide Concentrations in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire[a]

Location Date	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	^{tot}U (µg/g dry)	^{238}Pu (pCi/g dry)	^{239,240}Pu (pCi/g dry)	^{241}Am (pCi/g dry)	Alpha (pCi/g dry)	Beta (pCi/g dry)	Gamma (pCi/g dry)
Regional Background Stations[b]										
1999[c]	0.21	0.30	0.23	1.78	0.001	0.012	0.011	3.1	2.8	2.1
	(0.64)	(0.07)	(0.06)	(0.18)	(0.001)	(0.002)	(0.003)	(0.6)	(0.3)	(0.2)
2000	0.03	0.34	0.31	1.57	0.002	0.011	0.014	4.1	3.2	2.5
	(0.45)	(0.09)	(0.05)	(0.16)	(0.001)	(0.002)	(0.004)	(1.3)	(1.0)	(0.2)
Perimeter Stations[d]										
1999[c]	0.32	0.34	0.45	2.93	0.007	0.039	0.007	5.0	4.3	4.4
	(0.09)	(0.18)	(0.29)	(0.58)	(0.006)	(0.040)	(0.004)	(1.1)	(1.2)	(1.6)
2000	0.23	0.29	0.28	2.99	0.002	0.033	0.009	5.6	3.7	3.1
	(0.13)	(0.08)	(0.13)	(1.23)	(0.001)	(0.036)	(0.014)	(1.7)	(1.0)	(0.6)
On-Site Stations (LANL)[e]										
1999[c]	0.39	0.42	0.36	4.12	0.005	0.025	0.014	5.9	4.1	3.4
	(0.59)	(0.18)	(0.16)	(1.75)	(0.006)	(0.015)	(0.015)	(1.4)	(1.2)	(0.7)
2000	0.59	0.27	0.30	3.50	0.003	0.032	0.013	6.3	4.0	3.2
	(0.60)	(0.10)	(0.14)	(0.78)	(0.004)	(0.023)	(0.015)	(1.7)	(1.0)	(0.2)

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[a] Data from Fresquez et al. (2000a). The mean radionuclide concentrations showed no statistical differences between the years using a Wilcoxon Rank Sum Test at the 0.05 probability level.

[b] Represents Embudo only; this was the only regional background station out of three that was located predominantly downwind of the Cerro Grande fire (and LANL).

[c] Fresquez and Gonzales (2000).

[d] Represents 10 perimeter stations; four located on north side, four on east side, one on west side, and one on southwest side of LANL.

[e] Represents 12 on-site (LANL) stations.

Table 6-3. Radionuclide Concentrations in Garden Tilled Surface (0- to 2-inch depth) Soils Collected from Regional Organic Farming Locations in Northern New Mexico after the Cerro Grande Fire

Location	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	^{tot}U (µg/g dry)	^{238}Pu (pCi/g dry)	^{239,240}Pu (pCi/g dry)	^{241}Am (pCi/g dry)	Alpha (pCi/g dry)	Beta (pCi/g dry)	Gamma (pCi/g dry)
Soils from Tilled Farming Areas Directly Downwind of the CG Fire										
Ojo Sarco	0.04	0.08	0.158	1.78	0.001	0.006	0.004	3.4	2.0	1.9
	(0.45)[a]	(0.09)	(0.033)	(0.18)	(0.000)	(0.001)	(0.001)	(1.1)	(0.8)	(0.2)
Embudo	0.00	0.04	0.124	1.22	0.002	0.006	0.002	2.7	2.0	1.7
	(0.45)	(0.09)	(0.035)	(0.12)	(0.001)	(0.001)	(0.001)	(0.9)	(0.8)	(0.2)
Española	0.06	0.02	0.036	1.94	0.000	0.011	0.012	3.1	2.4	1.9
	(0.45)	(0.09)	(0.022)	(0.19)	(0.000)	(0.002)	(0.002)	(1.0)	(0.9)	(0.2)
Abiquiu	0.03	0.11	0.420	2.44	0.007	0.013	0.003	2.4	1.9	5.5
	(0.45)	(0.09)	(0.055)	(0.24)	(0.001)	(0.002)	(0.001)	(0.9)	(0.7)	(0.6)
Soils from Tilled Farming Areas Not Directly Downwind of the CG Fire										
Cochiti	–0.17	0.04	0.122	2.06	0.002	0.003	0.001	2.8	2.5	3.4
	(0.45)[b]	(0.10)	(0.031)	(0.21)	(0.001)	(0.001)	(0.000)	(1.0)	(0.9)	(0.3)
Pecos	–0.13	0.21	0.225	3.61	0.000	0.007	0.002	4.9	2.9	3.5
	(0.45)	(0.10)	(0.037)	(0.36)	(0.000)	(0.001)	(0.001)	(1.4)	(1.0)	(0.3)

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[a] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[b] See Appendix B for an explanation of the presence of negative values.

Table 6-4. Total Recoverable Trace Element Concentrations (µg/g dry) in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations during 2000 (after fire)[a]

Location	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Background Stations												
Embudo	1.0[b]	5,700.0	1.1	1.5[b]	79.0	0.41	0.20[b]	3.7	7.0	3.7	7,900.0	0.01[b]
Cochiti	1.0[b]	11,000.0	3.4	1.5[b]	130.0	0.57	0.20[b]	5.5	9.2	7.5	14,000.0	0.01[b]
Jemez	1.0[b]	12,000.0	2.7	1.5[b]	150.0	0.63	0.20[b]	5.7	17.0	1.4	14,000.0	0.01[b]
Bandelier (Cerro Grande)	1.0[b]	8,900.0	1.8	1.5[b]	160.0	0.69	0.20[b]	5.5	6.6	3.7	9,600.0	0.02
Mean	1.0	9,400.0	2.3	1.5	129.8	0.58	0.20	5.1	10.0	4.1	11,375.0	0.01
(std dev)	(0.0)	(2,784.5)	(1.0)	(0.0)	(36.1)	(0.12)	(0.00)	(0.9)	(4.8)	(2.5)	(3,109.5)	(0.01)
RSRL[c]	<2.0	36,600.0	6.1	16.7	194.0	0.73	<0.40	6.7	14.7	11.0	21,800.0	0.04
SAL[d]	390.0	76,000.0	6.1	5,500.0	5,400.0	150.00	39.00	3,400.0	210.0	2,900.0	23,000.0	23.00
Perimeter Stations												
Otowi	1.0[b]	7,100.0	0.8	1.5[b]	76.0	0.58	0.20[b]	4.0	8.1	3.6	9,300.0	0.01[b]
TA-8 (GT Site)	1.0[b]	7,200.0	1.7	1.5[b]	98.0	0.52	0.20[b]	3.9	6.1	5.9	8,900.0	0.02
TA-49 (BNP)	1.0[b]	8,000.0	1.9	1.5[b]	130.0	0.76	0.20[b]	5.8	7.7	4.7	9,900.0	0.01
East Airport	1.0[b]	12,000.0	2.5	1.5[b]	97.0	0.95	0.20[b]	5.8	10.0	6.1	12,000.0	0.01
West Airport	1.0[b]	11,000.0	2.8	1.5[b]	140.0	0.96	0.20[b]	7.3	10.0	6.9	12,000.0	0.02
North Mesa	1.0[b]	11,000.0	3.2	1.5[b]	120.0	0.86	0.20[b]	7.2	11.0	6.2	14,000.0	0.02
Sportsman's Club	1.0[b]	9,200.0	2.3	1.5[b]	150.0	1.10	0.20[b]	14.0	8.6	5.5	12,000.0	0.02
Tsankawi/PM-1	1.0[b]	8,700.0	1.5	1.5[b]	37.0	0.92	0.20[b]	3.4	11.0	6.0	8,400.0	0.01
White Rock (East)	1.0[b]	9,500.0	2.4	1.5[b]	130.0	1.20	0.20[b]	4.7	7.3	6.1	9,900.0	0.00
San Ildefonso	1.0[b]	5,700.0	1.5	1.5[b]	78.0	0.67	0.20[b]	4.5	5.7	4.1	7,500.0	0.01
Mean	1.0	8,940.0	2.1	1.5	105.6	0.85*[e]	0.20	6.1	8.6	5.5	10,390.0	0.01
(std dev)	(0.0)	(2,002.3)	(0.7)	(0.0)	(35.0)	(0.22)	(0.00)	(3.1)	(1.9)	(1.0)	(2,027.8)	(0.01)

Table 6-4. Total Recoverable Trace Element Concentrations (μg/g dry) in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations during 2000 (after fire)[a] (Cont.)

Location	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
On-Site Stations												
TA-16 (S-Site)	1.0[b]	15,000.0	2.9	1.5[b]	160.0	1.00	0.20[b]	4.8	11.0	6.8	11,000.0	0.02
TA-21 (DP-Site)	1.0[b]	5,700.0	2.1	1.5[b]	89.0	0.59	0.20[b]	6.0	7.4	4.1	9,300.0	0.01
Near TA-33	1.0[b]	12,000.0	1.1	1.5[b]	110.0	0.78	0.20[b]	4.0	6.4	3.5	8,500.0	0.01
TA-50	1.0[b]	9,600.0	2.2	1.5[b]	110.0	0.90	0.53	4.5	7.8	4.6	9,900.0	0.01
TA-51	1.0[b]	12,000.0	2.2	1.5[b]	140.0	0.87	0.20[b]	6.9	10.0	6.1	12,000.0	0.02
West of TA-53	1.0[b]	8,900.0	0.8	1.5[b]	110.0	1.00	0.20[b]	7.0	8.7	5.2	11,000.0	0.02
East of TA-53	1.0[b]	4,400.0	2.1	1.5[b]	48.0	0.57	0.20[b]	1.7	3.1	2.0	4,500.0	0.01
Potrillo Drive/TA-36	1.0[b]	5,900.0	1.4	1.5[b]	57.0	0.62	0.20[b]	3.0	4.1	1.8	7,400.0	0.01[b]
East of TA-54	1.0[b]	16,000.0	3.7	1.5[b]	99.0	0.78	0.20[b]	7.2	17.0	5.9	14,000.0	0.02
Near Test Well DT-9	1.0[b]	8,800.0	2.0	1.5[b]	110.0	0.81	0.20[b]	5.5	7.9	3.5	11,000.0	0.01
R-Site Road	1.0[b]	11,000.0	2.7	1.5[b]	140.0	0.97	0.20[b]	6.7	9.6	4.9	12,000.0	0.02
Two-Mile Mesa	1.0[b]	18,000.0	4.4	1.5[b]	140.0	1.00	0.20[b]	8.2	14.0	6.6	16,000.0	0.02
Mean	1.0	10,608.3	2.3	1.5	109.4	0.82*	0.23	5.5	8.9	4.6	10,550.0	0.02
(std dev)	(0.0)	(4,253.7)	(1.0)	(0.0)	(33.6)	(0.16)	(0.10)	(1.9)	(3.9)	(1.7)	(3,001.9)	(0.01)

Table 6-4. Total Recoverable Trace Element Concentrations (µg/g dry) in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations during 2000 (after fire)[a] (Cont.)

Location	Mn	Mo	Ni	Pb	Sb	Se	Sn	Ti	Tl	V	Zn	CN
Regional Background Stations												
Embudo	190.0	2.5[b]	5.1	7.0	0.1[b]	0.4	2.5[b]	40.0	0.1[b]	12.0	23.0	0.2[b]
Cochiti	340.0	2.5[b]	6.5	7.0	0.1[b]	0.6	2.5[b]	63.0	0.1[b]	27.0	35.0	0.2[b]
Jemez	490.0	2.5[b]	9.8	8.0	0.1[b]	0.7	2.5[b]	59.0	0.1[b]	23.0	32.0	0.2[b]
Bandelier (Cerro Grande)	700.0	2.5[b]	6.2	14.0	0.1[b]	0.7	2.5[b]	170.0	0.1[b]	13.0	40.0	0.4
Mean	430.0	2.5	6.9	9.0	0.1	0.6	2.5	83.0	0.1	18.8	32.5	0.3
(std dev)	(217.7)	(0.0)	(2.0)	(3.0)	(0.0)	(0.1)	(0.0)	(58.9)	(0.0)	(7.4)	(7.1)	(0.1)
RSRL[c]	421.0	0.8	10.5	14.0	<0.4	0.6	15.9	200.7	<0.4	40.1	49.0	0.5
SAL[d]	3,200.0	390.0	1,600.0	400.0	31.0	390.0	47,000.0	NA	5.5	550.0	23,000.0	1,200.0
Perimeter Stations												
Otowi	240.0	2.5[b]	3.7	9.0	0.1[b]	0.2b	2.5[b]	300.0	0.1[b]	18.0	30.0	1.8
TA-8 (GT Site)	430.0	2.5[b]	5.0	16.0	0.1[b]	0.5	2.5[b]	200.0	0.1[b]	12.0	33.0	0.2[b]
TA-49 (BNP)	380.0	2.5[b]	5.9	14.0	0.1[b]	0.5	2.5[b]	130.0	0.2	16.0	23.0	0.2[b]
East Airport	380.0	2.5[b]	8.3	23.0	0.1[b]	0.6	2.5[b]	130.0	0.3	17.0	65.0	0.6
West Airport	480.0	2.5[b]	8.4	20.0	0.1[b]	0.6	2.5[b]	89.0	0.2	19.0	53.0	0.2
North Mesa	470.0	2.5[b]	7.7	17.0	0.1[b]	0.7	2.5[b]	180.0	0.2	23.0	41.0	0.2
Sportsman's Club	1,200.0	2.5[b]	8.8	18.0	0.1[b]	0.5	2.5[b]	46.0	0.3	19.0	34.0	0.6
Tsankawi/PM-1	220.0	2.5[b]	12.0	21.0	0.1[b]	0.5	2.5[b]	240.0	0.2	9.3	43.0	0.1[b]
White Rock (East)	300.0	2.5[b]	8.7	16.0	0.1[b]	0.6	2.5[b]	20.0	0.3	11.0	44.0	0.2
San Ildefonso	330.0	2.5[b]	4.1	11.0	0.1[b]	0.4	2.5[b]	42.0	0.1[b]	11.0	34.0	0.4
Mean	443.0	2.5	7.3	17.0*	0.1	0.5	2.5	137.7	0.2	15.5	40.0	0.5
(std dev)	(280.4)	(0.0)	(2.6)	(4.0)	(0.0)	(0.1)	(0.0)	(92.1)	(0.1)	(4.5)	(12.2)	(0.5)

Table 6-4. Total Recoverable Trace Element Concentrations (µg/g dry) in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations during 2000 (after fire)[a] (Cont.)

Location	Mn	Mo	Ni	Pb	Sb	Se	Sn	Ti	Tl	V	Zn	CN
On-Site Stations												
TA-16 (S-Site)	320.0	2.5[b]	8.3	13.0	0.1[b]	0.7	2.5[b]	280.0	0.6	17.0	34.0	0.4
TA-21 (DP-Site)	310.0	2.5[b]	6.0	19.0	0.1[b]	0.6	2.5[b]	83.0	0.1[b]	16.0	29.0	0.2[b]
Near TA-33	240.0	2.5[b]	6.0	11.0	0.1[b]	0.2[b]	2.5[b]	65.0	0.1[b]	9.2	25.0	0.2[b]
TA-50	250.0	2.5[b]	5.2	16.0	0.1[b]	0.2[b]	2.5[b]	97.0	0.5	14.0	42.0	0.2[b]
TA-51	480.0	2.5[b]	7.6	12.0	0.1[b]	0.5	2.5[b]	250.0	0.2	20.0	36.0	0.8
West of TA-53	460.0	2.5[b]	7.3	15.0	0.1[b]	0.2[b]	2.5[b]	80.0	0.2	17.0	28.0	0.2[b]
East of TA-53	160.0	2.5[b]	1.0[b]	11.0	0.1[b]	0.6	2.5[b]	7.0	0.1[b]	4.7	19.0	0.2[b]
Potrillo Drive/TA-36	280.0	2.5[b]	4.1	9.0	0.1[b]	0.5	2.5[b]	68.0	0.1[b]	7.4	35.0	0.6
East of TA-54	380.0	2.5[b]	9.7	16.0	0.1[b]	0.5	2.5[b]	340.0	0.3	28.0	39.0	0.2
Near Test Well DT-9	310.0	2.5[b]	5.1	13.0	0.1[b]	0.5	2.5[b]	110.0	0.2	15.0	26.0	0.2[b]
R-Site Road	510.0	2.5[b]	6.4	15.0	0.1[b]	0.6	2.5[b]	210.0	0.2	20.0	30.0	0.4
Two-Mile Mesa	460.0	2.5[b]	8.9	29.0	0.1[b]	0.6	2.5[b]	200.0	0.8	27.0	35.0	0.2
Mean	346.7	2.5	6.3	15.0*	0.1	0.5	2.5	149.2	0.3	16.3	31.5	0.3
(std dev)	(110.7)	(0.0)	(2.4)	(5.0)	(0.0)	(0.2)	(0.0)	(103.3)	(0.2)	(7.1)	(6.5)	(0.2)

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[a] Trace elements were digested using EPA method 3051 and analyzed using EPA method 6020 (Sb, Tl, Pb), 7000A (As, Se), 7471A (Hg) and 6010B (all others).

[b] All less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on data from 1992 to 1999 (Fresquez and Gonzales, 2000; Fresquez et al., 2001a).

[d] Los Alamos National Laboratory Screening Action Level (EPA 2000).

[e] Means within the same column followed by an * were statistically higher than regional background using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-5. Mean (±SD) Total Recoverable Trace Element Concentrations (μg/g dry) in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire[a,b]

Location/Date	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe
Regional Background Stations[c]										
1999[d]	1.0	2.9	1.0	87	0.62	0.20	4.3	12.0	5.7	1.4
2000	1.0	0.6	1.1	79	0.41	0.20	3.7	7.0	3.7	0.8
Perimeter Stations[e]										
1999[d]	1.0	3.3	1.9	91	0.84	0.23	4.7	8.1	5.9	1.2
	(0.00)	(0.09)	(0.8)	(29)	(0.25)	(0.09)	(1.7)	(3.2)	(1.5)	(0.23)
2000	1.0	0.9	2.1	106	0.85	0.20	6.1	8.6	5.5	1.0
	(0.00)	(0.02)	(0.7)	(35)	(0.22)	(0.00)	(3.1)	(1.9)	(1.0)	(0.02)
On-Site Stations (LANL)[f]										
1999[d]	1.0	3.4	2.4	109	0.87	0.23	5.2	7.7	6.0	1.3
	(0.0)	(0.46)	(0.7)	(29)	(0.16)	(0.09)	(1.4)	(2.5)	(1.8)	(0.25)
2000	1.0	1.1	2.3	109	0.82	0.23	5.5	8.9	4.6	1.1
	(0.0)	(0.04)	(1.0)	(34)	(0.16)	(0.10)	(1.9)	(3.9)	(1.7)	(0.03)

Table 6-5. Mean (±SD) Total Recoverable Trace Element Concentrations (μg/g dry) in Surface (0- to 2-inch depth) Soils Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire[a,b] (Cont.)

Location/Date	Hg	Mn	Ni	Pb	Sb	Se	Tl	V	Zn	CN
Regional Background Stations[c]										
1999[d]	0.01	229	6.4	12	0.1	0.2	0.1	20	26	
2000	0.01	190	5.1	7	0.1	0.4	0.1	12	23	0.20
Perimeter Stations[e]										
1999[d]	0.02	382	4.8	20	0.1	0.2	0.2	15	33	
	(0.01)	(135)	(2.2)	(7.8)	(0.07)	(0.00)	(0.08)	(6.7)	(8.4)	
2000	0.01	443	7.3	17	0.1	0.5	0.2	16	40	0.50
	(0.01)	(280)	(2.6)	(4.0)	(0.00)	(0.10)	(0.10)	(4.5)	(12.2)	(0.50)
On-Site Stations (LANL)[f]										
1999[c]	0.05	349	5.2	14	0.2	0.2	0.2	21	34	
	(0.13)	(129)	(1.7)	(2.8)	(0.00)	(0.00)	(0.06)	(4.5)	(7.4)	
2000	0.02	347	6.3	15	0.1	0.5	0.3	16	32	0.30
	(0.01)	(111)	(2.4)	(5.0)	(0.00)	(0.20)	(0.20)	(7.1)	(6.5)	(0.20)

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[a] All trace elements, with the exception of Al and Fe, are reported on a ppm basis. Al and Fe are reported on a percent basis.

[b] Data from Fresquez et al. (2000).

[c] Represents Embudo only; this was the only regional station out of three that was located predominantly downwind of the Cerro Grande fire (and LANL).

[d] Fresquez and Gonzales (2000).

[e] Represents 10 perimeter stations; four located on north side, four on east side, one on west side, and one on southwest side of LANL.

[f] Represents 12 on-site (LANL) stations.

Table 6-6. Organic Compound Concentrations in Surface (0- to 6-inch depth) Soils Collected from Regional, Perimeter, and On-Site Stations during 2000 (after fire)[a]

Location	VOC[b] (ppb)	SVOC[c] (ppb)	PEST[d] (ppb)	PCB[e] (ppb)	HE[f] (ppb)	Dioxins[g] (ppt)
Regional Background Stations						
Embudo	ND	ND[h]				OCDD (13.6)[i]
Cochiti	ND	ND				OCDD (12.0)
Jemez	ND	ND				
Bandelier (Cerro Grande)			ND	ND	ND	ND
Perimeter Stations						
Otowi	ND	ND				
TA-8 (GT Site)	ND	ND				
Near TA-49 (BNP)	ND	ND				
East Airport	ND	ND				
West Airport	ND	ND	ND	ND	ND	HpCDD (3.7)[j] OCDD (28.1)
North Mesa	ND	ND				
Sportsman’s Club	ND	ND				
Tsankawi/PM-1	ND	ND				
White Rock (East)	ND	ND	ND	ND	ND	
San Ildefonso	ND	ND				
On-Site Stations						
TA-16 (S-Site)	ND	ND	ND	ND	ND	OCDD (10.0)[k]
TA-21 (DP-Site)	ND	ND				
Near TA-33	ND	ND				
TA-50	ND	ND				
TA-51	ND	ND				
West of TA-53	ND	ND				
East of TA-53	ND	ND				
East of TA-54	ND	ND				
Potrillo Drive/TA-36	ND	ND				
Near Test Well DT-9	ND	ND				
R-Site Road East	ND	ND	ND	ND	ND	OCDD (10.0)[k]
Two-Mile Mesa	ND	ND	ND	ND	ND	OCDD (10.0)[k]

[a] Data from Fresquez et al. (2000).

[b] VOC = Volatile Organic Compounds (36 compounds).

[c] SVOC = Semivolatile Organic Compounds (71 compounds).

[d] PEST= Pesticides (organochlorine) (21 compounds).

[e] PCB = Polychlorinated biphenyls (7 compounds).

[f] HE = High Explosives (14 compounds).

[g] Dioxin and dioxin-like compounds (7 compounds).

[h] ND = Not Detected above reporting limits.

[i] OCDD = 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin.

[j] HpCDD = 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin.

[k] These data reflect concentrations of OCDD detected in a composite sample soil from TA-16 (S-Site), R-Site Road East, and Two-Mile Mesa soils.

Table 6-7. Total Recoverable Trace Element Concentrations (μg/g dry) in Garden Tilled Surface (0- to 2-inch depth) Soils Collected from Regional Organic Farming Locations in Northern New Mexico after the Cerro Grande Fire[a]

Location	Ag	As	Ba	Be	Cd	Co	Cr	Hg	Ni	Pb	Sb	Se	Tl	Zn
Soils from Tilled Organic Farming Areas Directly Downwind of the Cerro Grande Fire														
Ojo Sarco	1.0[b]	4.5	160	0.94	0.2[b]	5.5	14.0	0.005[b]	12.0	12.2	0.2[b]	0.2[b]	0.2[b]	43
Embudo	1.0[b]	3.1	68	0.52	0.2[b]	4.2	11.0	0.005[b]	10.0	6.7	0.2[b]	0.2[b]	0.2[b]	51
Española	1.0[b]	3.1	94	0.65	0.7	3.9	21.0	0.005[b]	12.0	7.8	0.2[b]	1.7	0.2[b]	52
Abiquiu	1.0[b]	6.8	180	1.20	0.2[b]	7.0	20.0	0.005[b]	16.0	13.2	0.2[b]	0.8	0.2[b]	60
Soils from Tilled Organic Farming Areas Not Directly Downwind of the Cerro Grande Fire (Control)														
Cochiti	1.0[b]	1.9	87	0.46	0.2[b]	3.3	6.6	0.005[b]	6.4	4.8	0.2[b]	0.2[b]	0.2[b]	22
Pecos	1.0[b]	5.8	150	1.50	0.2[b]	11.0	31.0	0.005[b]	20.0	20.0	0.2[b]	0.7	0.2[b]	100

[a] Trace elements were digested using EPA method 3051 and analyzed using EPA method 6020 (Sb, Tl, Pb), 7000A (As, Se), 7471A (Hg) and 6010B (all others).

[b] All less-than values were converted to one-half the concentration.

Table 6-8. Organic Compound Concentrations in Garden Tilled Surface (0- to 6-inch depth) Soils Collected from Regional Organic Farming Locations in Northern New Mexico after the Cerro Grande Fire

Location	PEST[a]	PCBs[b]	HE[c]	Dioxins[d]	PAHs[e]
Soils from Tilled Organic Farming Areas Directly Downwind of the Cerro Grande Fire					
Ojo Sarco	ND[f]	ND	ND	OCDD (19.1 pg/g)	ND
Embudo	ND	ND	ND	OCDD (13.6 pg/g)	ND
Española	ND	ND	ND	OCDD (11.9 pg/g)	ND
Abiquiu	4,4-DDE (63 ng/g)	ND	ND	OCDD (22.4 pg/g)	ND
Soils from Tilled Organic Farming Areas Not Directly Downwind of the Cerro Grande Fire (Control)					
Cochiti	ND	ND	ND	OCDD (12.0 pg/g)	ND
Pecos	4,4-DDE (21 ng/g)	ND	ND	OCDD (9.9 pg/g)	ND

[a] PEST = Pesticides (Alpha-BHC, Gamma-BHC [Lindane], Heptachlor, Aldrin, Beta-BHC, Delta-BHC, Heptachlor Epoxide, Endosulfan I, Gamma-Chloradane, Alpha-Chloradane, 4,4-DDE, Dieldrin, Endrin, 4,4-DDD, Endosulfan II, 4,4-DDT, Endrin Aldehyde, Methoxychlor, Endosulfan Sulfate, Endrin Ketone, Toxaphene).

[b] PCBs = Polychlorinated byphenals (Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260).

[c] HE = High explosives (HMX, RDX, 1,3,5-Trinitrobenzene, 1,3-Dinitrobenzene, Tetryl, Nitrobenzene, 2,4,6-Trinitrotoluene, 4-Amino-2,6-DNT, 4-Amino-4,6-DNT, 2,6-Dinitrotoluene, 2,4-Dinitrotoluene, 2-Nitrotoluene, 4-Nitrotoluene, 3-Nitrotoluene).

[d] Dioxin and dioxin-like compounds (2,3,7,8-Tetrachlorodibenzo-p-dioxin [TCDD], 1,2,3,7,8-Pentachlorodibenzo-p-dioxin [PeCDD], 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin [HxCDD], 1,2,3,4,7,8- Hexachlorodibenzo-p-dioxin [HxCDD], 1,2,3,7,8,9- Hexachlorodibenzo-p-dioxin [HxCDD], 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin [HpCDD], 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin [OCDD]).

[e] PAH = Polynuclear aromatic hydrocarbons (Naphathalene, Acenaphthylene, 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthrancene, Benzo(g,h,I)perylene, Indeno(1,2,3-cd)pyrene).

[f] ND = Not detected above reporting limits.

Table 6-9. Radionuclide Concentrations in Surface Soils Collected from Area G in 2000[a]

	Radionuclide						
Location	^{3}H (pCi/mL)[b]	^{241}Am (pCi/g dry)	^{137}Cs (pCi/g dry)	^{238}Pu (pCi/g dry)	$^{239,240}Pu$ (pCi/g dry)	^{90}Sr (pCi/g dry)	^{tot}U (μg/g dry)
1[c]	254.50 (8.40)	0.012 (0.004)	0.29 (0.05)	0.004 (0.001)	0.027 (0.003)	0.17 (0.05)	2.53 (0.25)
2	206.30 (7.00)	0.017 (0.004)	0.74 (0.10)	0.008 (0.002)	0.050 (0.004)	0.15 (0.05)	2.65 (0.27)
3	2.37 (0.60)	0.022 (0.006)	0.12 (0.03)	0.006 (0.002)	0.046 (0.004)	0.08 (0.05)	1.72 (0.17)
3b	1.02 (0.49)	0.006 (0.002)	0.29 (0.04)	0.004 (0.001)	0.026 (0.003)	0.00 (0.04)	2.67 (0.27)
4	0.68 (0.52)	2.034 (0.055)	0.30 (0.04)	0.390 (0.013)	17.595 (0.472)	0.24 (0.05)	2.74 (0.27)
5	506.00 (15.00)	0.068 (0.010)	0.00 (0.18)	0.012 (0.002)	0.424 (0.017)	0.02 (0.05)	1.74 (0.17)
6b	0.57 (0.44)	0.256 (0.015)	0.28 (0.04)	0.033 (0.003)	0.947 (0.033)	0.17 (0.05)	2.64 (0.26)
7a	14.70 (1.30)	0.023 (0.007)	0.07 (0.04)	0.044 (0.004)	0.073 (0.005)	0.07 (0.04)	3.11 (0.31)
7b	6.52 (0.87)	0.002 (0.001)	–0.01 (0.05)	0.015 (0.002)	0.055 (0.004)	0.04 (0.05)	3.06 (0.31)
7c	1.92 (0.57)	0.125 (0.012)	0.47 (0.06)	0.149 (0.008)	1.116 (0.040)	0.17 (0.05)	2.50 (.025)
8	0.30 (0.42)	0.024 (0.004)	0.03 (0.03)	0.038 (0.003)	0.149 (0.008)	0.08 (0.06)	3.45 (0.35)
G-29-03	3,422.00 (94.00)	0.006 (0.002)	0.19 (0.04)	0.003 (0.001)	0.013 (0.002)	0.02 (0.05)	0.22 (0.02)
G-31-01	275.90 (9.00)	0.022 (0.004)	0.69 (0.09)	0.006 (0.002)	0.082 (0.006)	0.43 (0.06)	3.01 (0.30)
G-41-02	0.44 (0.50)	0.177 (0.009)	0.45 (0.06)	5.224 (0.139)	1.004 (0.029)	0.21 (0.05)	3.96 (0.40)
G-43-01	0.65 (0.52)	0.079 (0.005)	0.30 (0.04)	0.190 (0.008)	0.295 (0.011)	0.46 (0.06)	2.86 (0.29)
G-48-02	2.10 (0.58)	0.176 (0.012)	0.29 (0.05)	0.134 (0.007)	1.003 (0.035)	0.20 (0.05)	2.61 (0.26)
G-58-01	1.02 (0.49)	–0.000 (0.002)	0.07 (0.03)	0.004 (0.001)	0.008 (0.002)	0.20 (0.06)	1.32 (0.13)
RBG[d]	0.08 (0.12)	0.007 (0.005)	0.21 (0.17)	0.001 (0.001)	0.010 (0.008)	0.19 (0.11)	2.06 (0.56)
RSRL[e]	0.60	0.013	0.51	0.008	0.019	0.71	3.30
SAL[f]	6,400.0	39.0	5.3	49.0	44.0	5.7	100.0

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[a] See Figure 6-2 for sample location points.

[b] Concentration for ^{3}H is based on soil moisture: a value of 6400 is equivalent to a value of 880 pCi/g ^{3}H for a soil at a water content of 12%.

[c] Samples without a G prefix collected at the 0- to 2-inch depth; samples with a G prefix collected at the 0- to 6-inch depth.

[d] Regional Background is the background concentration for samples from Embudo, Cochiti, and Jemez in 2000 (Table 6-1).

[e] Regional statistical reference level; this is the upper-level background concentrations (mean + 2 std dev) from 1995–1999.

[f] Screening Action Level (ER 2000).

Table 6-10. Radionuclide Concentrations in Surface Soils and Sediments Collected Around the DARHT Facility in 2000[a]

	Radionuclide						
Location	**^{3}H (pCi/mL)**	**^{90}Sr (pCi/g dry)**	**^{tot}U (µg/g dry)**	**^{137}Cs (pCi/g dry)**	**^{238}Pu (pCi/g dry)**	**^{239,240}Pu (pCi/g dry)**	**^{241}Am (pCi/g dry)**
Soil							
North	–0.09 (0.45)[b,c]	0.06 (0.05)	3.94 (0.39)	0.13 (0.04)	0.002 (0.001)	0.005 (0.001)	0.001 (0.000)
East	–0.16 (0.44)	0.24 (0.05)	8.28 (0.83)	0.49 (0.06)	0.001 (0.000)	0.023 (0.002)	0.012 (0.003)
South	–0.07 (0.45)	0.24 (0.05)	6.80 (0.68)	0.29 (0.05)	0.002 (0.001)	0.019 (0.002)	0.012 (0.004)
West	–0.21 (0.44)	0.11 (0.05)	4.31 (0.43)	0.17 (0.03)	0.001 (0.001)	0.007 (0.001)	0.000 (0.000)
Mean (SD)	–0.13 (0.06)	0.16 (0.09)	5.83 (2.07)	0.27 (0.16)	0.002 (0.001)	0.014 (0.008)	0.006 (0.006)
Sediment							
North	0.12 (0.47)	0.09 (0.05)	5.93 (0.59)	0.18 (0.04)	0.001 (0.001)	0.006 (0.001)	0.003 (0.002)
East	–0.17 (0.44)	0.09 (0.05)	6.34 (0.63)	0.27 (0.05)	0.021 (0.002)	0.054 (0.004)	0.005 (0.001)
South	0.06 (0.46)	0.13 (0.05)	7.83 (0.78)	0.61 (0.08)	0.002 (0.001)	0.019 (0.002)	0.004 (0.002)
South West	–0.16 (0.44)	0.17 (0.05)	7.68 (0.77)	0.25 (0.04)	0.002 (0.001)	0.028 (0.003)	0.000 (0.000)
Mean (SD)	–0.04 (0.15)	0.12 (0.04)	6.95 (0.95)	0.33 (0.19)	0.007 (0.009)	0.027 (0.02)	0.003 (0.002)
RBG[b]	0.08 (0.12)	0.19 (0.11)	2.06 (0.56)	0.21 (0.17)	0.001 (0.001)	0.010 (0.008)	0.007 (0.005)
Soil BSRL[c]	0.53	0.34	6.50	0.27	0.003	0.017	0.008
Sediment BSRL	0.90	0.26	9.99	0.51	0.005	0.026	0.015
SAL[d]	6,400.00	5.70	100.0	5.30	49.0	44.0	39.0

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[a] See Figure 6-3 for locations of sampling sites.

[b] Regional Background is the background concentration for samples from Embudo, Cochiti, and Jemez in 2000 (Table 6-1).

[c] Baseline Statistical Reference Level (Fresquez et al., 2001).

[d] Screening Action Level (ER 2001).

Table 6-11. Trace Element Concentrations (μg/g dry) in Surface Soils and Sediments Collected Around the DARHT Facility in 2000[a]

Location	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl
Soil													
North	1.0[b]	3.00	140.0	1.00	0.20[b]	14.0	5.2	0.01	7.1	10.3	0.02[b]	0.2[b]	0.2
East	1.0[b]	3.00	84.0	0.70	0.20[b]	8.3	5.8	0.01	1.0[b]	12.8	0.02[b]	0.9	0.1
South	1.0[b]	1.00	110.0	0.83	0.20[b]	6.3	5.1	0.005[b]	2.5	13.7	0.02[b]	0.2[b]	0.1
West	1.0[b]	1.60	110.0	0.78	0.20[b]	7.3	4.5	0.005[b]	6.0	9.8	0.02[b]	0.2[b]	0.1
Mean	1.0	2.15	111.0	0.83	0.20	8.9	5.2	0.008	4.2	11.7	0.02	0.4	0.1
(SD)	(0.0)	(1.01)	(22.9)	(0.13)	(0.00)	(3.5)	(0.5)	(.003)	(2.9)	(1.9)	(0.0)	0.4)	(0.1)
Sediment													
North	1.0[b]	2.1	80.0	0.56	0.20[b]	7.7	4.4	0.005[b]	4.5	35.0	0.1[b]	0.2[b]	0.2
East	1.0[b]	2.3	97.0	0.64	0.20[b]	7.8	4.8	0.015	2.5	14.0	0.1[b]	0.4	0.2
South	1.0[b]	1.1	77.0	0.62	0.20[b]	6.1	3.8	0.005[b]	1.0[b]	27.0	0.1[b]	0.2[b]	0.2
South West	1.0[b]	1.0	77.0	0.58	0.20[b]	6.8	5.3	0.012	2.5	25.0	0.1[b]	0.2[b]	0.1[b]
Mean	1.0	1.6	82.8	0.60	0.2	7.1	4.6	0.009	2.6	25.3	0.1	0.3	0.2
(SD)	(0.0)	(0.7)	(9.6)	(0.04)	(0.0)	(0.8)	(0.6)	(0.005)	(1.4)	(8.7)	(0.0)	(0.1)	(0.05)
RBG[c]	1.00	2.30	130	0.58	0.20	10.0	4.1	0.01	6.90	9.0[b]	0.10	0.60	0.10
Soil BSRL[e]	1.62	3.16	147	1.08	0.52	14.4	7.02	0.04	9.62	13.5	0.40	0.55	0.40
Sediment BSRL[e]	1.56	3.48	161	1.19	0.55	12.0	7.90	0.04	9.45	15.4	0.38	0.43	0.30
SAL[f]	390	6.1	5,400	150.0	39.0	210	2,900	23.0	1,600	400	31.0	390	5.5

[a] See Figure 6-3 for locations of sampling sites.

[b] Less than values are reported as one-half the detection limit.

[c] BG is the mean background concentration for samples from Embudo, Cochiti, and Jemez in 2000 (Table 6-4).

[d] NA = no analysis.

[e] Baseline Statistical Reference Level (Fresquez et al., 2001).

[f] Screening Action Level (EPA 2000).

Table 6-12. Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a]

Location	^{3}H (pCi/mL)		^{137}Cs (10^{-3} pCi/g dry)		^{90}Sr (10^{-3} pCi/g dry)		^{tot}U (ng/g dry)		^{238}Pu (10^{-5} pCi/g dry)		^{239}Pu (10^{-5} pCi/g dry)		^{241}Am (10^{-5} pCi/g dry)	
Regional Background Stations														
Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS):														
Apple (EV)	0.27	(0.15)[b]	–2.16	(8.5)[c]	1.08	(0.36)	1.37	(0.49)	–2.9	(10.1)	15.8	(12.2)	36.0	(23.4)
Apricot (EV)	0.24	(0.15)	21.32	(27.9)	3.28	(0.82)	7.22	(2.22)	68.9	(52.5)	124.6	(54.9)	109.9	(54.1)
Beet (OS)	–0.16	(0.15)	–2.64	(11.7)	15.40	(1.76)	4.84	(1.28)	30.8	(24.2)	17.6	(24.2)	48.8	(20.7)
Broccoli Rabe (OS)	0.40	(0.15)	11.97	(11.3)	[d]		31.12	(4.39)	58.5	(39.2)	13.3	(30.6)	53.2	(29.9)
Buckwheat (E)	0.32	(0.15)	2.04	(6.1)	35.70	(3.57)	[d]		23.5	(29.6)	39.8	(27.5)	102.0	(46.4)
Cherry (EV)	–0.40	(0.15)	–1.96	(16.2)	0.00	(0.49)	3.33	(1.37)	[d]		16.7	(21.6)	[d]	
Chile (EV)	–0.08	(0.15)	–32.12	(35.8)	10.22	(1.83)	4.96	(1.79)	34.3	(30.3)	48.2	(23.7)	65.7	(40.2)
Corn (EV)	0.12	(0.15)	10.88	(14.7)	3.20	(0.64)	1.09	(0.61)	35.8	(21.8)	19.8	(17.6)	65.9	(24.6)
Cucumber (LP)	0.11	(0.15)	–3.99	(15.3)	58.52	(5.32)	8.65	(2.13)	–7.9	(26.6)	38.6	(27.3)	125.0	(61.9)
Lettuce (A)	0.05	(0.15)	5.00	(41.3)	[d]		27.75	(5.13)	80.0	(72.5)	160.0	(101.3)	185.0	(75.0)
Peach (AS)	0.10	(0.15)	–0.76	(15.2)	3.80	(0.38)	4.94	(1.33)	–19.0	(17.1)	24.3	(17.1)	–25.8	(17.8)
Plum (OS)	0.35	(0.15)	–13.53	(20.3)	1.23	(0.62)	4.06	(1.42)	22.1	(42.4)	28.3	(38.1)	20.9	(39.4)
Ruby Chard (OS)	0.38	(0.16)	–7.02	(13.7)	6.24	(0.78)	2.42	(0.94)	33.5	(22.6)	7.8	(17.6)	11.7	(26.1)
Squash (EV)	0.32	(0.16)	7.86	(22.9)	7.86	(0.66)	6.81	(2.03)	55.0	(59.6)	10.5	(43.9)	144.1	(78.6)
Squash (EV)	0.12	(0.15)	–17.03	(42.6)	17.03	(1.97)	13.36	(2.88)	–5.2	(26.9)	19.7	(26.9)	–5.2	(54.4)
Sweet Pea (A)	0.20	(0.15)	0.00	(15.2)	42.90	(3.90)	6.79	(1.60)	3.1	(32.4)	42.1	(39.0)	43.7	(23.8)
Tomato (LP)	0.03	(0.15)	–3.00	(18.0)	4.00	(0.50)	2.80	(1.25)	9.0	(20.5)	–13.0	(20.5)	0.0	(55.0)
Winter Wheat (E)	0.00	(0.15)	0.60	(3.4)	2.80	(0.30)	1.72	(0.38)	8.2	(7.5)	–3.8	(4.2)	15.6	(6.3)
Mean (std dev)	0.13	(0.21)	–0.78	(12.7)	13.33	(17.30)	7.84	(8.70)	25.2	(28.5)	33.9	(42.8)	58.6	(57.7)
RSRL[e]	0.55		88.50		136.4		26.8		30.0		41.2		70.3	

Table 6-12. Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Perimeter Stations							
Los Alamos:							
Apple	0.28 (0.15)	0.00 (18.0)	8.64 (1.08)	2.05 (0.88)	46.8 (19.8)	4.3 (13.3)	61.2 (28.8)
Apricot	0.40 (0.16)	6.56 (27.9)	16.40 (1.64)	10.66 (2.95)	–22.9 (60.7)	131.2 (90.2)	101.7 (65.6)
Cherry	0.23 (0.15)	17.64 (16.2)	5.88 (0.49)	4.02 (1.37)	–34.3 (27.4)	–5.9 (27.4)	84.3 (45.7)
Crab Apple	0.33 (0.15)	–14.40 (8.8)	7.60 (0.80)	1.16 (0.60)	14.0 (14.4)	29.6 (17.0)	52.0 (24.0)
Peach	0.22 (0.15)	–3.80 (20.9)	9.88 (1.14)	4.10 (1.22)	34.2 (28.5)	28.1 (28.9)	129.2 (49.4)
Plum	0.46 (0.16)	–3.69 (20.9)	13.53 (1.85)	3.32 (1.48)	–12.3 (43.1)	33.2 (30.1)	41.8 (33.8)
Squash	0.15 (0.15)	26.20 (21.0)	9.17 (1.97)	2.62 (1.31)	157.2 (85.2)	65.5 (55.7)	128.4 (58.3)
Mean (std dev)	0.30 (0.11)*	4.07 (13.9)	10.16 (3.62)	3.99 (3.13)	26.1 (65.0)	40.9 (45.9)	85.5 (36.7)
White Rock (WR)/Pajarito Acres (PA):							
Apricot (WR)	0.18 (0.15)	9.84 (27.1)	8.20 (1.64)	12.14 (2.95)	147.6 (82.0)	29.5 (56.6)	44.3 (32.8)
Cherry (WR)	0.38 (0.16)	3.92 (15.7)	1.96 (0.98)	1.18 (0.69)	17.6 (24.5)	0.0 (22.1)	7.8 (20.1)
Chile (PA)	0.43 (0.16)	–10.95 (24.5)	5.84 (1.10)	1.46 (0.99)	32.1 (26.7)	7.3 (25.2)	79.6 (25.2)
Green Bean (PA)	0.22 (0.15)	[d]	21.06 (2.34)	4.13 (1.41)	21.1 (28.9)	42.1 (29.6)	53.0 (21.5)
Lettuce (PA)	0.18 (0.15)	7.50 (112.5)	65.00 (7.50)	31.50 (6.88)	–62.5 (92.5)	115.0 (97.5)	185.0 (75.0)
Rhubard (PA)	0.14 (0.15)	–2.34 (12.9)	31.98 (3.12)	4.29 (1.17)	11.7 (22.2)	0.0 (22.2)	44.5 (23.0)
Tomato (PA)	0.16 (0.15)	–4.00 (19.0)	6.00 (1.00)	2.80 (1.25)	–20.0 (31.0)	2.0 (30.5)	0.0 (50.0)
Mean (std dev)	0.24 (0.12)	0.66 (7.8)	20.00 (22.48)	8.21 (10.91)	21.1 (64.4)	28.0 (41.7)	59.2 (61.7)
Cochiti (C)/Peña Blanca (PB)/ Sile (S):							
Apricot (PB)	0.44 (0.16)	21.32 (28.7)	4.92 (0.82)	7.05 (2.38)	36.1 (45.1)	90.2 (51.7)	86.9 (77.1)
Cabbage (S)	0.36 (0.15)	15.00 (70.0)	47.50 (5.00)	5.00 (3.13)	–17.5 (75.0)	132.5 (96.3)	[d]
Cherry (C)	0.35 (0.15)	0.98 (26.5)	6.86 (0.98)	5.78 (1.62)	2.9 (22.1)	2.9 (22.1)	11.8 (37.2)
Chile (S)	0.13 (0.15)	–2.92 (12.1)	1.46 (1.10)	1.68 (0.88)	12.4 (24.5)	18.3 (24.5)	[d]
Lettuce (S)	0.32 (0.15)	10.00 (48.8)	50.00 (5.00)	89.75 (11.13)	–52.5 (90.0)	200.0 (113.8)	300.0 (137.5)
Nectarine (S)	0.11 (0.15)	–2.34 (14.4)	2.34 (0.39)	2.73 (1.56)	117.0 (46.8)	1.6 (21.5)	[d]
Peach (S)	0.01 (0.15)	–3.80 (11.4)	1.52 (0.38)	3.12 (1.26)	1.5 (23.9)	29.6 (25.1)	22.0 (19.8)
Tomato (S)	0.30 (0.15)	10.00 (17.0)	2.00 (0.50)	1.50 (1.25)	112.0 (50.0)	22.0 (30.5)	[d]
Mean (std dev)	0.25 (0.15)	6.03 (9.4)	14.58 (21.19)	14.58 (30.44)	26.5 (59.9)	62.1 (72.2)	105.2 (134.1)

Table 6-12. Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Perimeter Stations (Cont.)							
San Ildefonso (SI)/El Rancho (ER):							
Apple (SI)	0.29 (0.15)	–2.16 (11.5)	0.72 (0.54)	1.91 (0.65)	26.3 (16.2)	0.0 (9.4)	23.0 (8.1)
Apricot (ER)	0.27 (0.15)	–1.64 (25.4)	6.56 (0.82)	5.90 (2.22)	–1.6 (41.0)	90.2 (51.7)	14.8 (42.6)
Corn (SI)	0.35 (0.15)	4.48 (13.8)	2.56 (0.64)	1.98 (0.83)	52.5 (28.8)	14.1 (19.5)	25.6 (21.4)
Peach (SI)	0.39 (0.15)	3.80 (9.9)	6.84 (0.76)	7.45 (1.71)	–6.1 (18.6)	13.7 (18.6)	57.0 (33.4)
Squash (SI)	0.32 (0.15)	–1.31 (28.2)	31.44 (3.28)	4.72 (1.71)	95.6 (50.4)	58.9 (38.7)	91.7 (40.6)
Mean (std dev)	0.32 (0.05)*	0.63 (3.2)	9.62 (12.47)	4.39 (2.43)	33.3 (42.1)	35.4 (37.9)	42.4 (31.9)
On-Site Stations							
LANL (Mesa):							
Apple (TA-52)	0.58 (0.16)	1.44 (6.1)	2.16 (0.36)	1.08 (0.42)	–2.2 (7.2)	5.4 (7.2)	28.8 (17.1)
Apricot (TA-35)	1.14 (0.18)	3.28 (28.7)	29.52 (2.46)	3.44 (1.64)	47.6 (41.8)	37.7 (42.6)	13.1 (40.2)
Nectarine (TA-3)	0.28 (0.15)	2.34 (6.6)	1.56 (0.39)	1.48 (0.86)	–8.6 (28.1)	36.7 (23.8)	–14.8 (24.5)
Peach (TA-3)	0.44 (0.16)	–9.12 (11.4)	2.28 (0.38)	0.91 (0.84)	72.9 (34.2)	–5.3 (18.6)	41.8 (30.2)
Peach (TA-35)	5.50 (0.40)	–0.76 (12.2)	9.12 (0.76)	2.74 (1.07)	22.8 (19.0)	12.2 (15.9)	–3.8 (32.7)
Mean (std dev)	1.59 (2.21)*	–0.56 (5.0)	8.93 (11.92)	1.93 (1.11)	26.5 (34.2)	17.3 (19.2)	13.0 (23.1)

Table 6-12. Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	^{234}U (10^{-3} pCi/g dry)	^{235}U (10^{-4} pCi/g dry)	^{238}U (10^{-3} pCi/g dry)
Regional Background Stations			
Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS):			
Apple (EV)	0.49 (0.17)	0.86 (0.87)	0.44 (0.15)
Apricot (EV)	2.48 (0.72)	2.13 (3.45)	2.41 (0.70)
Beet (OS)	1.32 (0.40)	3.17 (1.96)	1.58 (0.40)
Broccoli Rabe (OS)	15.69 (1.86)	15.16 (5.79)	10.24 (1.40)
Buckwheat (E)	d	d	d
Cherry (EV)	0.68 (0.44)	2.94 (2.84)	1.09 (0.41)
Chile (EV)	2.41 (0.66)	–0.29 (3.25)	1.68 (0.55)
Corn (EV)	0.63 (0.24)	1.28 (1.38)	0.35 (0.19)
Cucumber (LP)	5.05 (0.87)	6.78 (3.66)	2.79 (0.67)
Lettuce (A)	14.25 (2.13)	3.25 (5.25)	9.25 (1.63)
Peach (AS)	2.81 (0.57)	3.50 (2.17)	1.60 (0.42)
Plum (OS)	1.40 (0.54)	–1.11 (1.97)	1.40 (0.45)
Ruby Chard (OS)	2.65 (0.51)	–0.62 (2.11)	0.81 (0.28)
Squash (EV)	3.93 (0.92)	3.01 (2.23)	2.36 (0.66)
Squash (EV)	5.90 (1.12)	2.36 (3.41)	4.45 (0.92)
Sweet Pea (A)	4.13 (0.67)	1.95 (2.26)	2.26 (0.51)
Tomato (LP)	1.60 (0.60)	3.60 (2.80)	0.88 (0.38)
Winter Wheat (E)	0.84 (0.15)	1.24 (0.59)	0.56 (0.12)
Mean (std dev)	3.90 (4.46)	2.90 (3.68)	2.60 (2.88)
RSRL[e]	6.5	2.6	5.6

Table 6-12. Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	^{234}U (10^{-3} pCi/g dry)	^{235}U (10^{-4} pCi/g dry)	^{238}U (10^{-3} pCi/g dry)
Perimeter Stations			
Los Alamos:			
Apple	0.68 (0.31)	0.50 (1.73)	0.68 (0.27)
Apricot	2.13 (0.82)	9.68 (5.17)	3.44 (0.90)
Cherry	0.91 (0.41)	2.35 (2.40)	1.32 (0.42)
Crab Apple	0.72 (0.24)	0.52 (1.22)	0.38 (0.19)
Peach	1.60 (0.46)	0.84 (1.67)	1.37 (0.38)
Plum	1.85 (0.62)	3.81 (2.83)	1.07 (0.46)
Squash	0.26 (0.53)	10.09 (4.06)	0.73 (0.38)
Mean (std dev)	1.16 (0.70)	3.97 (4.21)	1.28 (1.02)
White Rock (WR)/Pajarito Acres (PA):			
Apricot (WR)	3.61 (0.90)	18.37 (6.48)	3.77 (0.90)
Cherry (WR)	1.60 (0.38)	1.18 (1.23)	0.39 (0.21)
Chile (PA)	0.80 (0.40)	4.09 (2.56)	0.42 (0.30)
Green Bean (PA)	2.96 (0.63)	4.76 (2.97)	1.33 (0.43)
Lettuce (PA)	11.50 (2.38)	20.00 (10.75)	10.25 (2.13)
Rhubard (PA)	2.18 (0.47)	2.65 (2.03)	1.41 (0.37)
Tomato (PA)	1.70 (0.60)	3.60 (2.75)	0.87 (0.38)
Mean (std dev)	3.48 (3.66)	7.81 (7.87)	2.63 (3.55)
Cochiti (C)/Peña Blanca (PB)/ Sile (S):			
Apricot (PB)	3.12 (0.90)	4.26 (4.35)	2.31 (0.73)
Cabbage (S)	2.83 (1.14)	–6.75 (5.63)	1.78 (0.97)
Cherry (C)	1.37 (0.47)	6.86 (3.29)	1.85 (0.49)
Chile (S)	1.24 (0.44)	4.89 (2.52)	0.49 (0.25)
Lettuce (S)	38.75 (4.25)	10.25 (8.88)	30.00 (3.63)
Nectarine (S)	1.09 (0.47)	8.27 (3.47)	0.78 (0.47)
Peach (S)	1.90 (0.50)	6.08 (3.80)	0.94 (0.36)
Tomato (S)	0.70 (0.50)	8.60 (3.50)	0.37 (0.36)
Mean (std dev)	6.38 (13.11)	5.31 (5.26)	4.82 (10.20)

Table 6-12. Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	^{234}U (10^{-3} pCi/g dry)	^{235}U (10^{-4} pCi/g dry)	^{238}U (10^{-3} pCi/g dry)
Perimeter Stations (Cont.)			
San Ildefonso (SI)/El Rancho (ER):			
Apple (SI)	1.12 (0.25)	2.27 (1.17)	0.61 (0.20)
Apricot (ER)	2.13 (0.73)	–5.58 (3.20)	2.07 (0.71)
Corn (SI)	1.41 (0.38)	–1.79 (1.35)	0.69 (0.26)
Peach (SI)	2.43 (0.61)	4.71 (2.93)	2.43 (0.53)
Squash (SI)	2.49 (0.72)	9.56 (4.13)	1.43 (0.51)
Mean (std dev)	1.92 (0.62)	1.83 (5.84)	1.45 (0.81)
On-Site Stations			
LANL (Mesa):			
Apple (TA-52)	0.31 (0.15)	1.33 (1.01)	0.35 (0.13)
Apricot (TA-35)	1.72 (0.65)	8.86 (3.94)	1.03 (0.20)
Nectarine (TA-3)	0.76 (0.30)	0.39 (1.37)	0.49 (0.26)
Peach (TA-3)	0.72 (0.29)	2.20 (1.67)	0.27 (0.26)
Peach (TA-35)	0.54 (0.36)	0.53 (1.86)	0.92 (0.33)
Mean (std dev)	0.81 (0.54)	2.66 (3.54)	0.61 (0.34)

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[a] There are no concentration guides for produce, and, with the exception of tritium, there were no statistical differences in any of the mean values from perimeter and on-site locations when compared with regional background at the 0.05 probability level using a Wilcoxon Rank Sum Test. Means followed by an * were statistically higher than regional background.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] See Appendix B for an explanation of the presence of negative values.

[d] Sample lost in analysis, not analyzed, or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

[e] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on data from 1994 to 1999.

Table 6-13. Mean (±SD) Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire

Location/Date	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Regional Background Stations							
Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco:							
1999[a]	–0.03 (0.22)	8.49 (7.0)*[b]	175.2 (169.4)*	11.0 (10.1)	–17.1 (30.6)	4.1 (26.6)	–8.17 (15.0)
2000	0.13 (0.21)	–0.78 (12.7)	13.3 (17.3)	7.8 (8.7)	25.2 (28.5)*	33.9 (42.8)*	58.62 (57.7)*
Perimeter Stations							
Los Alamos:							
1999[a]	0.19 (0.36)	4.50 (6.6)	25.8 (59.5)	1.8 (1.3)	75.2 (50.0)	5.2 (16.8)	–5.01 (7.4)
2000	0.30 (0.11)	4.07 (13.9)	10.2 (3.6)	4.0 (3.1)	26.1 (65.0)	40.8 (45.9)	85.51 (36.7)*
White Rock (WR)/Pajarito Acres (PA):							
1999[a]	–0.03 (0.26)	17.19 (13.7)*	144.2 (87.6)*	2.3 (2.5)	133.3 (153.1)	2.0 (9.9)	0.55 (6.7)
2000	0.24 (0.12)*	0.66 (7.8)	20.0 (22.5)	8.2 (10.9)	21.1 (64.4)	28.0 (41.7)	59.17 (61.7)*
Cochiti/Peña Blanca/Sile:							
1999[a]	0.04 (0.29)	13.21 (15.3)	53.7 (31.5)*	2.0 (2.8)	97.4 (118.4)	–12.5 (18.6)	–6.14 (10.7)
2000	0.25 (0.15)	6.03 (9.4)	14.6 (21.2)	14.6 (30.4)	26.5 (59.9)	62.1 (72.2)*	105.18 (134.1)*
San Ildefonso/El Rancho:							
1999[a]	–0.12 (0.31)	–3.29 (20.5)	64.9 (69.6)	14.9 (13.6)	57.7 (73.6)	–11.9 (9.8)	–16.12 (14.0)
2000	0.32 (0.05)*	0.63 (3.2)	9.6 (12.5)	4.4 (2.4)	33.3 (42.1)	35.4 (37.9)*	42.42 (31.9)*
On-Site Stations							
LANL (Mesa):							
1999[a]	1.49 (1.11)	7.34 (7.3)	20.4 (15.2)	1.2 (0.8)	7.8 (12.9)	9.6 (7.3)	2.89 (6.4)
2000	1.59 (2.21)	–0.56 (5.0)	8.9 (11.9)	1.9 (1.1)	26.5 (34.2)	17.3 (19.2)	13.02 (23.1)

Table 6-13. Mean (±SD) Radionuclide Concentrations in Produce Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire (Cont.)

Location/Date	^{234}U (10^{-3} pCi/g dry)	^{235}U (10^{-4} pCi/g dry)	^{238}U (10^{-3} pCi/g dry)
Regional Background Stations			
Abiquiu/Arroyo Seco/Embudo/Española Valley/La Puebla/Ojo Sarco:			
1999[a]	4.47 (3.24)	1.65 (1.86)	3.63 (3.35)
2000	3.90 (4.46)	2.90 (3.68)	2.60 (2.88)
Perimeter Stations			
Los Alamos:			
1999[a]	0.50 (0.61)	0.51 (1.06)	0.60 (0.43)
2000	1.16 (0.70)	3.97 (4.21)*	1.28 (1.02)
White Rock/Pajarito Acres:			
1999[a]	0.93 (0.81)	0.60 (1.50)	0.75 (0.82)
2000	3.48 (3.66)	7.81 (7.87)*	2.63 (3.55)
Cochiti/Peña Blanca/Sile: :			
1999[a]	0.60 (0.76)	–1.37 (1.25)	0.70 (0.90)
2000	6.38 (13.11)	5.31 (5.26)*	4.82 (10.20)
San Ildefonso/El Rancho:			
1999[a]	6.02 (5.91)	1.65 (1.95)	4.97 (4.50)
2000	1.92 (0.62)	1.83 (5.84)	1.45 (0.81)
On-Site Stations			
LANL (Mesa):			
1999[a]	0.52 (0.47)	–0.09 (0.45)	0.40 (0.27)
2000	0.81 (0.54)	2.66 (3.54)	0.61 (0.34)

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[a] Fresquez and Gonzales (2000).

[b] Means within the same column and location followed by an * were statistically different from each other using a using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-14. Total Recoverable Trace Element Concentrations (μg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Regional Background Stations												
Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS):												
Apple (EV)	1.0[b]	0.25[b]	2.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.0	1.7	0.20[b]	0.20[b]	1.9
Apricot (EV)	1.0[b]	0.25[b]	9.30	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	2.7	0.20[b]	0.20[b]	7.2
Beet (OS)	1.0[b]	0.25[b]	63.50	0.10[b]	0.50[b]	0.50[b]	0.03[b]	11.0	6.5	0.40	0.20[b]	18.1
Broccoli Rabe (OS)	1.0[b]	0.25[b]	141.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.0	0.7	0.50	0.20[b]	34.3
Cherry (EV)	1.0[b]	0.25[b]	2.60	0.10[b]	0.50[b]	0.50[b]	0.03[b]	9.0	2.1	0.20[b]	0.20[b]	4.6
Chile (EV)	1.0[b]	0.25[b]	2.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	1.5	0.40	0.20[b]	19.1
Corn (EV)	1.0[b]	0.25[b]	0.60	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.0	20.8	0.20[b]	0.20[b]	20.9
Cucumber (LP)	1.0[b]	0.25[b]	21.70	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	0.6	0.20[b]	0.20[b]	29.9
Lettuce (A)	1.0[b]	0.25[b]	15.30	0.10[b]	1.00	0.50[b]	0.03[b]	1.0[b]	2.8	0.60	0.20[b]	59.2
Peach (AS)	1.0[b]	0.25[b]	2.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	2.0	0.6	0.40	0.20[b]	5.4
Peas (A)	1.0[b]	0.25[b]	4.60	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	1.5	0.50	0.20[b]	36.3
Plum (OS)	1.0[b]	0.25[b]	4.40	0.10[b]	0.50[b]	9.00	0.03[b]	49.0	2.0	1.00	0.20[b]	10.1
Ruby Chard (OS)	1.0[b]	0.25[b]	42.10	0.10[b]	0.50[b]	0.50[b]	0.03[b]	6.0	3.2	0.50	0.20[b]	32.9
Squash (Ev)	1.0[b]	0.25[b]	9.50	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	0.6	0.60	0.20[b]	52.2
Squash (EV)	1.0[b]	0.25[b]	5.20	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	2.1	0.20[b]	0.20[b]	24.7
Tomato (LP)	1.0[b]	0.03[b]	3.80	0.10[b]	0.50[b]	1.00	0.03[b]	47.0	14.4	0.20[b]	0.20[b]	19.1
Winter Wheat (E)	1.0[b]	0.25[b]	2.80	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.0	11.0	0.40	0.20[b]	40.3
Mean	1.0	0.25	19.65	0.10	0.53	1.03	0.03	8.9	4.4	0.39	0.20	24.5
(std dev)	(0.0)	(0.00)	(35.46)	(0.00)	(0.12)	(2.06)	(0.00)	(15.0)	(5.7)	(0.22)	(0.00)	(16.7)
RSRL[c]	1.3	0.57	19.49	0.45	0.65	1.56	0.06	21.9	15.9	0.63	0.27	22.3
Perimeter Stations												
Los Alamos:												
Apple	1.0[b]	0.25[b]	2.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	4.1	2.5	1.00	0.20[b]	4.2
Apricot	1.0[b]	0.25[b]	4.50	0.10[b]	0.50[b]	3.20	0.03[b]	91.0	35.0	1.00	0.20[b]	7.6
Cherry	1.0[b]	0.25[b]	2.70	0.10[b]	0.50[b]	2.70	0.03[b]	23.0	4.3	1.40	0.20[b]	4.9
Crab Apple	1.0[b]	0.25[b]	17.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.3	26.0	1.20	0.20[b]	5.7
Peach	1.0[b]	0.25[b]	2.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	15.2	1.50	0.20[b]	9.1
Plum	1.0[b]	0.25[b]	2.30	0.10[b]	0.50[b]	3.30	0.03[b]	23.0	6.3	0.80	0.20[b]	4.6
Squash	1.0[b]	0.25[b]	5.20	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.1	5.4	1.40	0.20[b]	31.0
Mean	1.0	0.25	5.23	0.10	0.50	1.60	0.03	21.5	13.5	1.19	0.20	9.6
(std dev)	(0.0)	(0.00)	(5.32)	(0.00)	(0.00)	(1.38)	(0.00)	(32.0)	(12.5)	(0.26)*[d]	(0.00)	(9.6)

Table 6-14. Total Recoverable Trace Element Concentrations (µg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Perimeter Stations (Cont.)												
White Rock (WR)/Pajarito Acres (PA):												
Apricot (WR)	1.0[b]	0.25[b]	6.70	0.10[b]	0.50[b]	1.80	0.03[b]	10.8	12.9	1.30	0.20[b]	6.8
Cherry (WR)	1.0[b]	0.25[b]	5.80	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	1.6	1.00	0.20[b]	5.7
Chile (PA)	1.0[b]	0.25[b]	1.00	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	2.3	1.30	0.20[b]	18.4
Green Bean (PA)	1.0[b]	0.25[b]	4.70	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	0.2[b]	2.00	0.20[b]	37.2
Lettuce (PA)	1.0[b]	0.25[b]	7.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	7.5	1.2	1.10	0.20[b]	20.0
Rhubarb (PA)	1.0[b]	0.25[b]	15.20	0.10[b]	0.50[b]	4.20	0.03[b]	8.6	3.7	1.40	0.20[b]	11.7
Tomato (PA)	1.0[b]	0.25[b]	4.70	0.10[b]	0.50[b]	0.50[b]	0.03[b]	8.1	5.8	1.20	0.20[b]	14.7
Mean	1.0	0.25	6.50	0.10	0.50	1.21	0.03	6.3	4.0	1.33	0.20	16.4
(std dev)	(0.0)	(0.00)	(4.35)	(0.00)	(0.00)	(1.40)	(0.00)	(3.2)	(4.4)	(0.33)*	(0.00)	(10.7)
Cochiti (C)/Peña Blanca (PB)/Sile (S):												
Apricot (PB)	1.0[b]	0.25[b]	1.40	0.10[b]	0.50[b]	1.40	0.03[b]	9.3	4.7	0.90	0.20[b]	7.7
Cabbage (S)	1.0[b]	0.25[b]	6.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	4.0	0.80	0.20[b]	15.0
Cherry (C)	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]
Chile (S)	1.0[b]	0.25[b]	0.91	0.10[b]	0.50[b]	0.50[b]	0.03[b]	1.0[b]	1.2	1.00	0.20[b]	22.0
Lettuce (S)												
Nectarine (S)	1.0[b]	0.25[b]	1.40	0.10[b]	0.50[b]	1.90	0.03[b]	10.0	6.0	0.80	0.20[b]	10.0
Peach (S)	1.0[b]	0.25[b]	1.70	0.10[b]	0.50[b]	0.50[b]	0.03[b]	7.7	3.7	0.90	0.20[b]	5.9
Tomato (S)	1.0[b]	0.25[b]	1.90	0.10[b]	0.50[b]	1.30	0.03[b]	1.0[b]	1.9	0.90	0.20[b]	15.0
Mean	1.0	0.25	2.37	0.10	0.50	1.02	0.03	5.0	3.6	0.88	0.20	12.6
(std dev)	(0.0)	(0.00)	(2.25)	(0.00)	(0.00)	(0.60)	(0.00)	(4.4)	(1.8)	(0.08)*	(0.00)	(5.9)
San Ildefonso Pueblo (SI)/El Rancho (ER):												
Apples (SI)	1.0[b]	0.25[b]	2.40	0.10[b]	0.49	0.67	0.03[b]	1.0[b]	2.6	0.50	0.20[b]	5.3
Apricot (ER)	1.0[b]	0.25[b]	2.30	0.10[b]	0.53	2.40	0.03[b]	5.3	1.1	0.50	0.20[b]	17.0
Corn (SI)	1.0[b]	0.25[b]	0.65	0.10[b]	0.65	0.25[b]	0.03[b]	1.0[b]	4.0	1.10	0.20[b]	25.0
Peach (SI)	1.0[b]	0.25[b]	1.70	0.10[b]	0.20[b]	2.10	0.03[b]	13.0	4.2	0.70	0.20[b]	12.0
Squash (SI)	1.0[b]	0.25[b]	11.00	0.10[b]	0.80	0.73	0.03[b]	1.0[b]	2.3	1.00	0.20[b]	26.0
Mean	1.0	0.25	3.61	0.10	0.53	1.23	0.03	4.3	2.8	0.76	0.20	17.1
(std dev)	(0.0)	(0.00)	(4.19)	(0.00)	(0.22)	(0.96)	(0.00)	(5.2)	(1.3)	(0.28)*	(0.00)	(8.8)

Table 6-14. Total Recoverable Trace Element Concentrations (μg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations during the 2000 Growing Season (after fire)[a] (Cont.)

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
On-Site Stations												
LANL (Mesa):												
Apple (TA-52)	1.0[b]	0.25[b]	4.20	0.10[b]	0.50[b]	0.50[b]	0.03[b]	4.8	1.4	1.20	0.20[b]	3.7
Apricot (TA-35)	1.0[b]	0.25[b]	5.10	0.50[b]	0.50[b]	4.20	0.03[b]	26.0	2.6	0.70	0.20[b]	5.3
Nectarine (TA-3)	1.0[b]	0.25[b]	6.90	0.10[b]	0.50[b]	0.50[b]	0.03[b]	3.0	1.6	1.30	0.20[b]	9.8
Peach (TA-3)	1.0[b]	0.25[b]	8.60	0.10[b]	0.50[b]	1.40	0.03[b]	11.0	3.2	1.20	0.20[b]	7.8
Peach (TA-35)	1.0[b]	0.25[b]	3.40	0.10[b]	0.50[b]	0.50[b]	0.03[b]	5.8	0.8	1.40	0.20[b]	14.0
Mean	1.0	0.25	5.64	0.18	0.50	1.42	0.03	10.1	1.9	1.16	0.20	8.1
(std dev)	(0.0)	(0.00)	(2.11)	(0.18)	(0.00)	(1.60)	(0.00)	(9.4)	(1.0)	(0.27)*	(0.00)	(4.0)

[a] Analysis by EPA Method 3051 for total recoverable metals.

[b] Less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on data from 1994 to 1999.

[d] Means within the same column followed by an * were statistically higher than regional background using a using a Wilcoxon Rank Sum Test at the 0.05 probability level.

[e] Sample lost in analysis or not analyzed or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

Table 6-15. Mean (±SD) Total Recoverable Trace Element Concentrations (µg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire

Location/Date	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
Regional Background Stations												
Abiquiu (A)/Arroyo Seco (AS)/Embudo (E)/Española Valley (EV)/La Puebla (LP)/Ojo Sarco (OS):												
1999^a	1.0	0.25	7.6	0.10	0.50	0.80	0.03	4.4	8.6	0.20	0.20	19.5
	(0.0)	(0.00)	(6.2)	(0.00)	(0.00)	(0.73)	(0.00)	(7.7)	(12.8)	0.00	(0.00)	(14.2)
2000	1.0	0.25	19.7	0.10	0.53	1.03	0.03	8.88	4.4	0.39	0.20	24.5
	(0.0)	(0.00)	(35.5)	(0.00)	(0.12)	(2.06)	(0.00)	(15.00)	(5.7)	(0.22)*^{b}	(0.00)	(16.7)
Perimeter Stations												
Los Alamos:												
1999^a	1.00	0.25	4.7	0.10	0.50	0.50	0.03	3.4	9.2	0.20	0.20	16.2
	(0.0)	(0.00)	(3.1)	(0.00)	(0.00)	(0.00)	(0.00)	(6.5)	(8.9)	(0.00)	0.00	(18.4)
2000	1.0	0.25	5.2	0.10	0.50	1.60	0.03	21.5	13.5	1.19	0.20	9.6
	(0.0)	(0.00)	(5.3)	(0.00)	(0.00)	(1.38)	(0.00)	(32.0)	(12.5)	(0.26)*	(0.00)	(9.6)
White Rock/Pajarito Acres:												
1999^a	1.0	0.25	7.2	0.10	0.50	0.58	0.03	3.5	7.5	0.20	0.20	20.0
	(0.0)	(0.00)	(10.0)	(0.00)	(0.00)	(0.20)	(0.00)	(6.1)	(6.6)	(0.00)	0.00	(11.6)
2000	1.0	0.25	6.5	0.10	0.50	1.21	0.03	6.3	4.0	1.33	0.20	16.4
	(0.0)	(0.00)	(4.4)	(0.00)	(0.00)	(1.40)	(0.00)	(3.2)	(4.4)	(0.33)*	(0.00)	(10.7)
Cochiti/Peña Blanca:												
1999^a	1.0	0.25	4.4	0.10	0.50	0.72	0.03	2.3	4.8	0.20	0.20	19.0
	(0.0)	(0.00)	(7.1)	(0.00)	(0.00)	(0.49)	(0.00)	(1.2)	(3.2)	(0.00)	0.00	(12.0)
2000	1.0	0.25	2.4	0.10	0.50	1.02	0.03	5.0	3.6	0.88	0.20	12.6
	(0.0)	(0.00)	(2.3)	(0.00)	(0.00)	0.60)	(0.00)	(4.4)	(1.8)	(0.08)*	(0.00)	(5.9)
San Ildefonso Pueblo:												
1999^a	1.0	0.25	7.7	0.10	0.50	0.50	0.03	4.6	6.9	0.20	0.20	19.6
	(0.0)	(0.00)	(9.0)	(0.00)	(0.00)	(0.00)	(0.00)	(7.00)	(5.1)	(0.00)	0.00	(10.3)
2000	1.0	0.25	3.6	0.10	0.53	1.23	0.03	4.3	2.8	0.76	0.20	17.1
	(0.0)	(0.00)	(4.2)	(0.00)	(0.22)	(0.96)	(0.00)	(5.2)	(1.3)	(0.28)*	(0.00)	(8.8)

Table 6-15. Mean (±SD) Total Recoverable Trace Element Concentrations (µg/g dry) in Produce Collected from Regional Background, Perimeter, and On-Site Locations Before (1999) and After (2000) the Cerro Grande Fire (Cont.)

Location/Date	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Se	Tl	Zn
On-Site Stations												
LANL (Mesa):												
1999[a]	1.0	0.25	6.5	0.10	0.50	0.50	0.03	1.0	4.8	0.20	0.20	6.0
	(0.0)	(0.00)	(4.9)	(0.00)	(0.00)	(0.00)	(0.00)	(0.0)	(1.9)	(0.00)	0.00	(2.8)
2000	1.0	0.25	5.6	0.18	0.50	1.42	0.03	10.1	1.9	1.16	0.20	8.1
	(0.0)	(0.00)	(2.1)	(0.18)	(0.00)	(1.60)	(0.00)	(9.4)	(1.0)	(0.27)*	(0.00)	(4.0)

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[a] Fresquez and Gonzales (2000).

[b] Means within the same column and location followed by an * were statistically different from each other using a using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-16. Radionuclide Concentrations in Goat's Milk Collected from Regional Background and Perimeter Locations Before (1999) and After (2000) the Cerro Grande Fire[a]

	Perimeter (White Rock/Pajarito Acres)				Regional Background (Peña Blanca)				
Radionuclide	1999[a]		2000		1999[a]		2000		RSRL[b]
^{238}Pu (pCi/L)	0.0071	(0.0083)[c]	–0.0042	(0.0054)[d]	–0.0240	(0.0137)	0.0000	(0.0069)	0.012
^{239}Pu (pCi/L)	0.0064	(0.0060)	0.0077	(0.0054)	–0.0146	(0.0075)	0.0037	(0.0049)	0.014
^{90}Sr (pCi/L)	2.04	(0.35)	0.52	(1.3)	0.86	(0.21)	–0.22	(1.1)	3.32
^{234}U (pCi/L)	0.14	(0.0149)[e]	0.038	(0.0119)	0.26	(0.0259)[e]	0.023	(0.0125)	0.48
^{235}U (pCi/L)	0.0057	(0.0006)[e]	0.0050	(0.0077)	0.0109	(0.0011)[e]	0.0010	(0.0035)	0.02
^{238}U (pCi/L)	0.1227	(0.0133)[e]	0.0172	(0.0078)	0.2321	(0.0232)[e]	0.0200	(0.0063)	0.43
^{tot}U (µg/L)	0.37	(0.04)[e]	0.05	(0.003)	0.70	(0.07)e	0.06	(0.02)	1.31
^{3}H (pCi/mL)	0.31	(0.63)	–0.09	(0.42)	–0.70	(0.61)	0.00	(0.00)	0.40
^{137}Cs (pCi/L)	14.00	(10.00)	1.13	(7.21)	7.70	(12.00)	0.00	(38.7)	64.23
^{131}I (pCi/L)	19.00	(10.00)	–2.0	(31.4)	–4.00	(77.00)	10.8	(16.4)	18.2
^{241}Am (pCi/L)	0.054	(0.017)	0.0007	(0.0011)	–0.011	(0.059)	–0.0120	(0.0541)	–0.0100

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[a] Data from Fresquez and Gonzales (2000).

[b] Regional Statistical Reference Level; this is the upper-limit background (mean + 2 std dev) based on data from 1998 through 2000.

[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[d] See Appendix B for an explanation of the presence of negative values.

[e] 1998 data (Fresquez 1999).

Table 6-17. Radionuclide Concentrations in Game (Predators) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory during 2000 (after fire)

Location Date	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Game Fish (Predators)						
Upstream (Abiquiu Reservoir):						
9-7-00						
Crappie	0.73 (2.78)[a]	0.00 (4.32)	3.63 (1.44)	–9.68 (9.68)	7.26 (12.10)	–20.57 (21.78)
Bass	–1.09 (2.66)[b]	–1.59 (13.41)	2.42 (1.37)	–1.21 (16.94)	8.47 (15.73)	–27.83 (32.67)
Bass	–1.69 (2.30)	–0.50 (1.72)	1.69 (1.19)	–9.68 (8.47)	1.21 (10.89)	–33.88 (27.83)
Walleye	1.57 (2.78)	–1.25 (4.77)	0.79 (0.87)	14.52 (12.10)	7.26 (10.89)	–12.10 (13.31)
Walleye	0.00 (4.24)	0.27 (0.48)	1.85 (1.23)	85.91 (19.36)	9.68 (14.52)	–20.57 (21.78)
Mean (std dev)	–0.10 (1.32)	–0.61 (0.80)	2.08 (1.05)	15.97 (40.33)	6.78 (3.27)	–22.99 (8.25)
RSRL[c]	17.0	27.7	6.5	23.6	28.3	28.9
Downstream (Cochiti Reservoir):						
6-29-00						
Bass	6.90 (5.32)	–0.24 (1.91)	6.05 (1.21)	–14.52 (7.26)	–1.21 (10.89)	–8.47 (6.05)
Bass	3.27 (3.99)	–1.23 (10.73)	7.26 (1.21)	–4.84 (14.52)	–2.42 (12.10)	18.15 (8.47)
Pike	–1.21 (3.39)	0.38 (1.04)	2.42 (1.21)	–2.42 (8.47)	3.63 (10.89)	–15.73 (8.47)
Pike	–1.09 (3.75)	–0.54 (1.73)	3.63 (1.21)	–2.42 (8.47)	15.73 (10.89)	–22.99 (18.15)
Walleye	2.42 (3.51)	[d]	2.42 (1.21)	–21.78 (2.42)	–3.63 (12.10)	–8.47 (6.05)
Mean (std dev)	2.06 (3.38)	–0.41 (0.67)	4.36 (2.20)	–9.20 (8.62)	2.42 (7.93)	–7.50 (15.55)
7-27-00						
Crappie	–1.21 (4.11)	0.90 (1.37)	8.47 (1.21)	–2.42 (6.05)	8.47 (8.47)	–1.21 (2.42)
Bass	3.51 (4.24)	0.30 (1.00)	4.84 (1.21)	–1.21 (6.05)	9.68 (7.26)	–24.20 (12.10)
Bass	0.00 (4.11)	0.00 (5.53)	7.26 (1.21)	–20.57 (20.57)	–22.99 (26.62)	–4.84 (4.84)
Bass	–3.27 (4.72)	–1.86 (4.19)	6.05 (1.21)	32.67 (14.52)	14.52 (8.47)	–14.52 (8.47)
Walleye	1.45 (4.96)	0.39 (1.34)	2.42 (1.21)	4.84 (10.89)	18.15 (12.10)	–22.99 (14.52)
Mean (std dev)	0.10 (2.58)	–0.05 (1.06)	5.81 (2.33)*	2.66 (19.27)	5.57 (16.43)	–13.55 (10.39)

Table 6-17. Radionuclide Concentrations in Game (Predators) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory during 2000 (after fire) (Cont.)

Location Date	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Game Fish (Predators) (Cont.)						
Downstream (Cochiti Reservoir): (Cont.)						
8-29-00						
Walleye	1.09 (3.51)	1.57 (1.05)	6.15 (1.52)	3.63 (8.47)	–2.42 (4.84)	–2.42 (3.63)
Bass	5.93 (3.51)	1.15 (0.80)	3.82 (1.40)	13.31 (14.52)	–4.84 (13.31)	–33.88 (27.83)
Bass	4.11 (6.66)	–0.06 (0.40)	8.54 (1.91)	116.16 (53.24)	–26.62 (24.20)	[d]
Mean (std dev)	3.71 (2.44)*[e]	0.89 (0.85)*	6.17 (2.36)*	44.37 (62.36)	–11.29 (13.33)	–18.15 (22.25)
Nongame Fish (Bottom Feeders)						
Upstream (Abiquiu Reservoir):						
9-7-00						
Sucker	4.09 (2.47)	–0.32 (0.84)	3.56 (1.12)	3.80 (6.65)	18.05 (8.55)	7.60 (3.80)
Carp	3.61 (1.81)	–0.33 (1.24)	1.95 (2.10)	62.70 (15.20)	4.75 (9.50)	–7.60 (4.75)
Catfish	6.94 (3.14)	–1.69 (4.35)	10.91 (1.75)	18.05 (9.50)	6.65 (8.55)	0.00 (1.90)
Catfish	2.76 (2.28)	–0.18 (0.71)	12.94 (2.00)	47.50 (16.15)	21.85 (9.50)	–5.70 (6.65)
Catfish	1.81 (3.14)	–1.31 (3.70)	12.20 (1.82)	28.50 (12.35)	9.50 (11.40)	–1.90 (2.85)
Mean (std dev)	3.84 (1.94)	–0.77 (0.69)	8.31 (5.20)	32.11 (23.37)	12.16 (7.43)	–1.52 (5.92)
RSRL	13.2	26.9	16.2	9.8	19.2	16.1
Downstream (Cochiti Reservoir):						
6-29-00						
Catfish	6.94 (3.23)	0.56 (0.95)	11.40 (0.95)	3.80 (6.65)	16.15 (8.55)	–2.85 (2.85)
Catfish	–3.33 (3.23)	0.45 (0.71)	10.45 (0.95)	–8.55 (4.75)	6.65 (8.55)	–11.40 (6.65)
Carp	–0.10 (3.04)	–0.60 (4.08)	24.70 (2.85)	1.90 (14.25)	8.55 (15.20)	–20.90 (16.15)
Carp	5.70 (3.90)	0.00 (3.33)	21.85 (1.90)	–4.75 (11.40)	3.80 (6.65)	–30.40 (125.40)
Sucker	–2.76 (3.80)	–0.28 (1.14)	6.65 (0.95)	1.90 (8.55)	11.40 (10.45)	30.40 (8.55)
Mean (std dev)	1.29 (4.77)	0.03 (0.49)	15.01 (7.82)	–1.14 (5.26)	9.31 (4.72)	–7.03 (23.32)

Table 6-17. Radionuclide Concentrations in Game (Predators) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory during 2000 (after fire) (Cont.)

Location Date	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Nongame Fish (Bottom Feeders) (Cont.)						
Downstream (Cochiti Reservoir): (Cont.)						
7-27-00						
Sucker	8.17 (5.42)	–0.28 (0.75)	4.75 (0.95)	–10.45 (10.45)	5.70 (9.50)	–37.05 (893.00)
Sucker	1.43 (3.80)	–0.95 (3.39)	5.70 (0.95)	8.55 (7.60)	4.75 (8.55)	–7.60 (4.75)
Carp	–0.19 (4.37)	–0.50 (2.58)	5.70 (0.95)	–9.50 (4.75)	1.90 (9.50)	–0.95 (1.90)
Catfish	–2.57 (4.56)	0.67 (0.84)	9.50 (0.95)	5.70 (6.65)	19.00 (8.55)	–14.25 (9.50)
Catfish	–1.81 (3.80)	–1.10 (2.36)	5.70 (0.95)	–11.40 (3.80)	1.90 (8.55)	–11.40 (6.65)
Mean (std dev)	1.01 (4.29)	–0.43 (0.70)	6.27 (1.85)	–3.42 (9.70)	6.65 (7.11)	–14.25 (13.68)
8-29-00						
Catfish	–0.48 (3.14)	–1.14 (2.23)	2.51 (1.07)	176.70 (34.20)	–8.55 (15.20)	44.65 (13.30)
Catfish	3.42 (4.18)	–0.12 (0.67)	17.34 (2.32)	1.90 (10.45)	2.85 (11.40)	38.95 (27.55)
Sucker	0.48 (3.71)	0.00 (5.91)	12.46 (1.99)	–3.80 (7.60)	15.20 (11.40)	[d]
Mean (std dev)	1.14 (2.03)	–0.42 (0.63)	10.77 (7.56)	58.27 (102.61)	3.17 (11.88)	41.80 (4.03)*

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[a] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[b] See Appendix B for an explanation of the presence of negative values.

[c] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on data from 1981–1999.

[d] Sample lost in analysis or not analyzed or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean.

[e] Means within the same column and fish type followed by an * were significantly different from Abiquiu (background) using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-18. Mean (±SD) Radionuclide Concentrations in Game (Predators) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory Before (1999) and After (2000) the Cerro Grande Fire

Location Date	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Game Fish (Predators)						
Upstream (Abiquiu Reservoir):						
1999[a]	1.57 (2.4)	0.90 (0.41)	2.7 (0.61)	11.2 (1.5)	22.39 (14.7)*[c]	22.3 (21.6)*
2000[b]	–0.10 (1.3)	–0.61 (0.80)	2.1 (1.05)	15.9 (40.3)	6.78 (3.3)	–22.9 (8.3)
Downstream (Cochiti Reservoir):						
1999[a]	3.73 (2.5)	0.54 (0.79)	4.6 (1.99)	17.6 (31.3)	30.55 (22.1)*	67.9 (103.3)
2000[b]	1.69 (3.0)	0.06 (0.97)	5.3 (2.24)	7.7 (35.5)	0.48 (13.7)	–11.7 (13.6)
Nongame Fish (Bottom Feeders)						
Upstream (Abiquiu Reservoir):						
1999[a]	5.24 (2.3)	0.24 (0.23)	10.3 (3.96)	2.5 (25.8)	10.93 (11.8)	14.4 (12.2)*
2000[b]	3.84 (1.9)	–0.77 (0.69)	8.3 (5.20)	32.1 (23.4)*	12.16 (7.4)	–1.5 (5.9)
Downstream (Cochiti Reservoir):						
1999[a]	4.56 (3.0)	0.05 (0.23)	21.1 (10.13)*	11.4 (5.9)	22.80 (13.5)*	30.2 (42.7)
2000[b]	1.15 (3.8)	–0.25 (0.60)	10.7 (6.85)	11.7 (50.1)	6.87 (7.3)	–1.9 (26.4)

[a] Data from Fresquez and Gonzales (2000).

[b] Year 2000 data are the mean and standard deviation of three sampling dates at Cochiti Reservoir.

[c] Means within the same column, fish type, and location followed by an * were significantly different from each other using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-19. Total Recoverable Trace Element Concentrations (μg/g wet weight) in Bottom-Feeding Fish (Muscle) Collected Upstream and Downstream of Los Alamos National Laboratory in 2000 (after fire)[a]

Location/Date	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	CN
Upstream (Abiquiu Reservoir)												
9-7-00												
Carp	1.0[b]	0.50	0.20	0.10[b]	1.10	0.50[b]	0.16	1.0[b]	0.20[b]	0.20[b]	1.60	1.60
Sucker	1.0[b]	0.50	3.20	0.10[b]	1.60	2.20	0.15	1.0[b]	0.20[b]	0.20[b]	2.00	1.60
Catfish	1.0[b]	0.25[b]	0.20	0.10[b]	1.10	0.50[b]	0.07	1.0[b]	0.20[b]	0.20[b]	1.00	1.80
Catfish	1.0[b]	0.90	0.10[b]	0.10[b]	1.60	2.20	0.03[b]	1.0[b]	0.20[b]	0.20[b]	1.00	2.00
Catfish	1.0[b]	0.60	0.10[b]	0.10[b]	1.40	1.40	0.08	1.0[b]	0.20[b]	0.20[b]	1.20	2.80
Mean	1.0	0.55	0.76	0.10	1.36	1.36	0.10	1.0	0.20	0.20	1.36	1.96
(std dev)	(0.0)	(0.23)	(1.36)	(0.00)	(0.25)	(0.85)	(0.06)	(0.0)	(0.00)	(0.00)	(0.43)	(0.50)
RSRL[c]	1.4	0.62	1.30	1.20	1.50	1.80	0.48	1.5	3.50	1.74	1.48	2.96
Downstream (Cochiti Reservoir)												
6-29-00												
Catfish	1.0[b]	0.25[b]	0.85	0.10[b]	0.50[b]	0.50[b]	0.15	1.0[b]	0.60	0.20[b]	0.60	2.40
Catfish	1.0[b]	0.25[b]	1.10	0.10[b]	0.50[b]	1.10	0.17	1.0[b]	0.60	0.20[b]	0.20[b]	1.20
Carp	1.0[b]	0.25[b]	2.00	0.10[b]	0.50[b]	0.50[b]	0.16	1.0[b]	0.60	0.20[b]	0.20[b]	1.20
Carp	1.0[b]	0.25[b]	1.40	0.10[b]	0.50[b]	1.00	0.51	1.0[b]	4.00	0.20[b]	0.40	2.00
Sucker	1.0[b]	0.25[b]	1.50	0.10[b]	0.50[b]	0.50[b]	0.08	1.0[b]	1.20	0.20[b]	0.20[b]	1.60
Mean	1.0	0.25	1.37	0.10	0.50	0.72	0.21	1.0	1.40	0.20	0.32	1.78
(std dev)	(0.0)	(0.00)	0.44	(0.00)	(0.00)	(0.30)	(0.17)	(0.0)	(1.48)	(0.00)	(0.18)	(0.52)
7-27-00												
Carp	1.0[b]	0.25[b]	1.90	0.10[b]	0.50[b]	0.50[b]	0.22	1.0[b]	1.1	0.20[b]	0.20[b]	1.20
Carp	1.0[b]	0.25[b]	0.71	0.10[b]	0.50[b]	0.50[b]	0.11	2.1	0.8	0.20[b]	0.20[b]	0.60
Carp	1.0[b]	0.25[b]	4.70	0.10[b]	0.50[b]	0.50[b]	0.13	3.7	1.5	0.20[b]	0.20[b]	0.60
Catfish	1.0[b]	0.25[b]	0.64	0.10[b]	0.50[b]	0.50[b]	0.16	1.0[b]	1.1	0.20[b]	0.20[b]	1.00
Catfish	1.0[b]	0.25[b]	1.10	0.10[b]	0.50[b]	0.50[b]	0.21	1.0[b]	0.6	0.20[b]	0.20[b]	2.00
Mean	1.0	0.25	1.81	0.10	0.50	0.50	0.17	1.8	1.0	0.20	0.20	1.08
(std dev)	(0.0)	(0.00)	(1.69)	(0.00)	(0.00)	(0.00)	(0.05)	(1.2)	(0.3)	(0.00)	(0.00)	(0.58)

Table 6-19. Total Recoverable Trace Element Concentrations (μg/g wet weight) in Bottom-Feeding Fish (Muscle) Collected Upstream and Downstream of Los Alamos National Laboratory in 2000 (after fire)[a] (Cont.)

Location/Date	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	CN
Downstream (Cochiti Reservoir)												
8-29-00												
Catfish	2.0[b]	0.25[b]	0.20[b]	0.10[b]	1.20	2.20	0.28	1.0[b]	0.20[b]	0.20[b]	2.00	0.60
Sucker	1.0[b]	0.25[b]	0.28	0.10[b]	0.50[b]	0.50[b]	0.25	1.0[b]	0.20[b]	0.20[b]	1.30	1.00
Catfish	1.0[b]	0.25[b]	0.44	0.10[b]	1.20	1.30	0.03[b]	1.0[b]	0.20[b]	0.20[b]	1.00	1.40
Catfish	1.0[b]	0.25[b]	0.26	0.10[b]	1.20	2.00	0.03[b]	1.0[b]	0.20[b]	0.20[b]	1.20	1.40
Catfish	1.0[b]	0.25[b]	0.22	0.10[b]	0.50[b]	1.10	0.03[b]	1.0[b]	0.20[b]	0.20[b]	1.50	1.60
Mean	1.2	0.25	0.28	0.10	0.92	1.42	0.12	1.0	0.20	0.20	1.40	1.20
(std dev)	(0.4)	(0.00)	(0.09)	(0.00)	(0.38)	(0.69)	(0.13)	(0.0)	(0.00)	(0.00)	(0.38)	(0.40)

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[a] There were no statistical differences in any of the mean trace element concentrations in fish collected downstream of LANL when compared with upstream using a Wilcoxon Rank Sum Test at the 0.05 probability level.

[b] Less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level is the upper-limit background (mean plus two standard deviations) from data collected from 1991 through 2000. CN is from present data.

Table 6-20. Mean (±SD) Total Recoverable Trace Element Concentrations (μg/g wet weight) in Bottom-Feeding Fish (Muscle) Collected Upstream and Downstream of Los Alamos National Laboratory Before (1999) and after (2000) the Cerro Grande Fire

Location Date	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	CN
Upstream (Abiquiu Reservoir)												
1999[a]	0.5 (0.4)	0.2 (0.1)	0.3 (0.5)	0.4 (0.5)	0.1 (0.1)	0.5 (0.5)	0.3 (0.1)	0.9 (0.3)	1.2 (1.4)	0.8 (0.7)	0.3 (0.1)	
2000[b]	1.0 (0.0)*[c]	0.6 (0.2)*	0.8 (1.4)	0.1 (0.0)	1.4 (0.3)*	1.4 (0.9)	0.1 (0.1)	1.0 (0.0)	0.2 (0.0)	0.2 (0.0)	1.4 (0.4)*	2.0 (0.5)
Downstream (Cochiti Reservoir)												
1999[a]	0.5 (0.3)	0.1 (0.1)	0.3 (0.2)	0.3 (0.4)	0.1 (0.1)	2.2 (4.2)	0.2 (0.1)	0.9 (0.3)	0.6 (0.7)	0.5 (0.6)	0.3 (0.1)	
2000[b]	1.1 (0.3)*	0.3 (0.0)	1.2 (1.2)*	0.1 (0.0)	0.6 (0.3)*	0.9 (0.6)	0.2 (0.1)	1.3 (0.7)	0.9 (1.0)	0.2 (0.0)	0.6 (0.6)	1.3 (0.5)

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[a] Because Hg was the only element analyzed in 1999, the data for all of the other elements are the average of 1991 through 1997. Mercury data are from 1991 through 1999, and the average is similar to 1999 values.

[b] Average of all three sampling dates.

[c] Means within the same column and reservoir followed by an * were statistically different from one another using a Wilcoxon Rank Sum Test at the 0.05 probability level.

Table 6-21. Radionuclide Concentrations in Muscle and Bone Tissues of Elk Collected from On-Site and Regional Background Areas during 1999

Tissue/Location Sample	^{3}H (pCi/mL)[a]	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
LANL Elk							
TA-16	0.01 (0.62)[b]	0.88 (0.44)	11.2 (3.6)	26.0 (17.2)	1.8 (8.4)	7.9 (7.9)	–9.2 (6.6)[c]
Regional Background Elk							
Mean (std dev)[d]	0.21 (0.16)	0.83 (0.68)	95.1 (113.1)	0.7 (1.6)	–1.1 (2.5)	–0.5 (1.0)	4.4 (5.1)
RSRL[d]	0.53	2.19	321.4	3.9	3.9	1.6	14.5
Leg Bone:							
LANL Elk							
TA-16	–0.02 (0.62)	5.80 (5.80)	28.4 (18.0)	2,001.0 (208.8)	[e]	0.0 (103.4)	[e]
Regional Background Elk							
Mean (std dev)[d]	–0.01 (0.26)	2.29 (1.96)	43.1 (77.5)	1,300.7 (882.5)	13.7 (47.5)	–6.0 (8.2)	41.0 (5.3)
RSRL[d]	0.51	6.21	198.2	3,065.7	108.8	10.4	51.6

[a] pCi/mL of tissue moisture.

[b] (± counting uncertainty); values are the uncertainty of the analytical results at 65% confidence level.

[c] See Appendix B for an explanation of the presence of negative values.

[d] The mean (std dev) and the Regional Statistical Reference Level (mean + 2 std dev) are based on data collected from 1991 to 1998 (Fresquez et al., 1998b).

[e] Sample lost in analysis or not analyzed or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

Table 6-22. Radionuclide Concentrations in Muscle and Bone Tissues of Deer Collected from On-Site and Regional Background Areas during 1999

Tissue/Location Sample	^{3}H (pCi/mL)[a]	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
LANL Deer							
TA-49	0.14 (0.61)[b]	1.80 (0.45)	21.2 (5.4)	36.9 (17.6)	4.5 (7.7)	–1.8 (6.3)[c]	–6.3 (4.1)
Regional Background Deer							
Mean (std dev)[d]	0.15 (0.25)	1.10 (0.66)	14.5 (7.3)	14.2 (12.3)	–1.8 (2.8)	3.5 (5.7)	6.2 (10.7)
RSRL[d]	0.65	2.42	29.0	38.8	3.7	14.8	27.5
Leg Bone:							
LANL Deer							
TA-49	–0.02 (0.62)	0.00 (4.40)	21.1 (13.6)	1,456.4 (140.8)	0.0 (1,896.4)	0.0 (1,843.6)	[e]
Regional Background Deer							
Mean (std dev)[d]	0.07 (0.25)	2.03 (2.10)	10.3 (25.7)	907.5 (106.1)	–5.9 (10.2)	0.6 (1.0)	59.5 (28.5)
RSRL[d]	0.57	6.23	61.8	1,119.7	14.5	2.7	116.5

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[a] pCi/mL of tissue moisture.

[b] (±1counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] See Appendix B for an explanation of the presence of negative values.

[d] The mean (std dev) and the Regional Statistical Reference Level (mean + 2 std dev) are based on data collected from 1991 to 1998 (Fresquez et al., 1998b).

[e] Sample lost in analysis or not analyzed or outlier omitted. An outlier was omitted when the result was greater than three standard deviations of the mean (99% confidence level).

Table 6-23. Radionuclide Concentrations in Honey Collected from Perimeter and Regional Background Locations during 2000 (after fire)

	Perimeter		Regional Background			
Radionuclide	**Los Alamos[a]**	**White Rock**	**Jemez**	**Española (La Puebla)**	**Española (Riverside)**	**RSRL[b]**
^{3}H (pCi/mL)[c]	0.08	0.30	0.03	0.03	0.12	5.25
	(0.67)[d]	(0.42)	(0.39)	(0.39)	(0.40)	
^{137}Cs (pCi/L)	[e]	14.0	7.0	–29.1	0.0	305.28
	(11.6)	(14.8)	(64.2)	(128.0)		
^{238}Pu (pCi/L)	0.016	0.025	0.024	0.025	0.017	0.07
	(0.018)	(0.009)	(0.011)	(0.009)	(0.004)	
^{239}Pu (pCi/L)	–0.002	0.026	0.023	0.026	0.008	0.12
	(0.016)[f]	(0.009)	(0.012)	(0.010)	(0.003)	
^{241}Am (pCi/L)	[e]	0.001	–0.019	–0.009	–0.014	0.05
	(0.002)	(0.019)	(0.006)	(0.008)		
^{90}Sr (pCi/L)	–5.47	–4.48	–1.11	0.83	–5.90	5.04
	(5.69)	(3.25)	(3.03)	(5.06)	(4.40)	
^{234}U (pCi/L)	[e]	0.25	0.18	0.22	1.13	2.12
	(0.09)	(0.09)	(0.05)	(0.10)		
^{235}U (pCi/L)	[e]	–0.00	–0.00	0.01	0.04	0.08
	(0.06)	(0.03)	(0.02)	(0.03)		
^{238}U (pCi/L)	[e]	0.25	0.15	0.24	0.90	1.66
	(0.06)	(0.03)	(0.05)	(0.09)		
^{tot}U (µg/L)	[e]	0.75	0.46	0.73	2.71	5.00
		(0.18)	(0.10)	(0.14)	(0.26)	

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[a] This is a reanalysis of selected radionuclides of a sample collected in 1999.

[b] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on data from 1979 to 1995 (Fresquez et al., 1997a); U isotopes are from present data.

[c] pCi/mL of honey moisture; honey contains approximately 18% water and has a density of 1,860 g/L.

[d] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[e] Sample lost in analysis or not analyzed or outlier omitted. An outlier is a result greater than three standard deviations of the mean.

[f] See Appendix B for an explanation of the presence of negative values.

Table 6-24. Radionuclide Concentrations in Prickly Pear (Fruit) Collected from Regional Background and Perimeter Areas during the 1999 Growing Season

Location	^{3}H (pCi/mL)[a]	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Regional Background:							
Española/Santa Fe/ Jemez	–0.09 (0.59)[a,b]	6.8 (1.28)	–9.6 (56.1)	704.0 (79.2)	–3.3 (5.6)	–4.8 (10.4)	1.6 (2.4)
RSRL[c]	0.55	26.8	88.5	136.4	30.0	41.2	70.3
RSRL[d]	1.09	9.4	102.6	862.4	7.9	16.0	6.4
Off-Site Perimeter:							
San Ildefonso	0.29 (0.61)	32.3 (2.72)	9.7 (6.0)	1,064.0 (91.2)	–7.2 (8.8)	–3.2 (8.0)	6.4 (4.0)
Los Alamos	–0.14 (0.58)	20.3 (2.12)	–3.3 (40.6)	1,008.8 (80.0)	–4.0 (8.0)	–11.2 (11.2)	–9.6 (6.4)
White Rock/ Pajarito Acres	0.03 (0.59)	28.0 (2.61)	2.6 (6.8)	372.0 (46.4)	–2.4 (7.2)	0.0 (0.0)	–21.6 (20.0)

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[a] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[b] See Appendix B for an explanation of the presence of negative values.

[c] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on produce data from 1994 to 1999 (Table 6-12).

[d] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on prickly pear data in 1999.

Table 6-25. Total Recoverable Trace Element Concentrations (µg/g dry) in Prickly Pear (Fruit) Collected from Regional Background and Perimeter Areas during the 1999 Growing Season[a]

Location	Ag	As	Ba	Be	Cd	Cu	Hg	Ni	Pb	Sb	Se	Tl
Regional Background:												
Española/Santa Fe/Jemez	1.0[b]	0.25[b]	23.0	0.10[b]	0.50[b]	0.50[b]	0.03[b]	57.0	54.0	0.40	0.20[b]	0.20[b]
RSRL[c]	1.3	0.57	19.5	0.45	0.46	8.50[d]	0.06	23.5	22.0	0.60	0.30	0.20
RSRL[e]	1.0[b]	0.25[b]	27.6	0.10[b]	0.50[b]	0.50[b]	0.03[b]	68.4	58.0	1.20	0.20[b]	0.20[b]
Off-Site Perimeter:												
San Ildefonso	1.0[b]	0.25[b]	120.0	0.10[b]	0.50[b]	1.50	0.03[b]	3.3	16.8	0.20[b]	0.20[b]	0.20[b]
Los Alamos	1.0[b]	0.25[b]	120.0	0.10[b]	0.50[b]	2.00	0.03[b]	4.7	3.0	0.40	0.20[b]	0.20[b]
White Rock/Pajarito Acres	1.0[b]	0.25[b]	59.0	0.10[b]	0.50[b]	1.80	0.03[b]	41.0	58.4	0.20[b]	0.40	0.20[b]

[a] Analysis by EPA Method 3051 for total recoverable metals.

[b] Less-than values were converted to one-half the concentration.

[c] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on produce data from 1994 to 1999 (Table 6-13).

[d] No Cu data in produce could be located; therefore, the RSRL is from native grass species (Fresquez et al., 1990).

[e] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on prickly pear data from 1999.

Table 6-26. Radionuclide Concentrations in Herbal Teas Collected from Regional Background Locations during 2000 Growing Season (after fire)

	Regional Background				
Radionuclide	**Saint John's Wort (La Puebla)**		**Elderberry (La Puebla)**		**RSRL[a] (Navajo Tea)**
^{238}Pu (pCi/L)	–0.003	(0.008)[b,c]	0.000	(0.007)	0.024
^{239}Pu (pCi/L)	0.008	(0.006)	0.017	(0.008)	0.039
^{90}Sr (pCi/L)	0.21	(1.69)	0.11	(1.36)	2.55
^{234}U (pCi/L)	0.53	(0.03)	0.39	(0.03)	1.90
^{235}U (pCi/L)	0.01	(0.01)	0.02	(0.01)	0.08
^{238}U (pCi/L)	0.29	(0.02)	0.23	(0.02)	1.70
^{tot}U (µg/L)	0.87	(0.07)	0.70	(0.07)	5.12
^{3}H (pCi/mL)	0.51	(0.44)	0.51	(0.44)	0.13
^{137}Cs (pCi/L)	0.0	(72.7)	–2.6	(50.7)	27.9
^{241}Am (pCi/L)	–0.001	(0.001)	–0.006	(0.004)	0.085

[a] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on Navajo Tea from 1996 to 1999.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] See Appendix B for an explanation of the presence of negative values.

Table 6-27. Concentration (pg/g fresh wt.) of PCBs in Whole-Body Fish and TEQs for Common Carp and Carp Suckers Collected from Cochiti and Abiquiu Reservoirs[a]

IUPAC No.:	**#77**		**#81**		**#105**		**#114**		**#118**		**#123**		**#126**	
Compound:	**3,3',4,4'-TeCB**		**3,4,4',5-TeCB**		**2,3,3',4,4'-PeCB**		**2,3,4,4',5-PeCB**		**2,3',4,4',5-PeCB**		**2',3,4,4',5-PeCB**		**3,3',4,4',5-PeCB**	
Sample ID[b]	**Conc.**	**TEQ**	**Conc.**	**TEQ**	**Conc.**	**TEQ**	**Conc.**	**TEQ**	**Conc.**	**TEQ**	**Conc.**	**TEQ**	**Conc.**	**TEQ**
Cochiti Reservoir														
Common Carp:														
6CRCARP1	121	1.21E-02	5.58	5.58E-04	1,810	1.81E-01	98.3	4.92E-02	4,960	4.96E-01	188	1.88E-02	22.4	2.24E+00
6CRCARP2	166	1.66E-02	9.73	9.73E-04	3,160	3.16E-01	177	8.85E-02	8,860	8.86E-01	311	3.11E-02	36.7	3.67E+00
6CRCARP3	20.7	2.07E-03	1.14	1.14E-04	234	2.34E-02	12.4	6.20E-03	593	5.93E-02	30.9	3.09E-03	4.61	4.61E-01
Carp Sucker:														
7CRCARP1S	37.7	3.77E-03	1.83	1.83E-04	364	3.64E-02	18.4	9.20E-03	888	8.88E-02	33.2	3.32E-03	6.66	6.66E-01
7CRCARP2S	31.3	3.13E-03	2.29	2.29E-04	480	4.80E-02	27.3	1.37E-02	1,210	1.21E-01	62.8	6.28E-03	7.66	7.66E-01
7CRCARP3S	19.4	1.94E-03	1.42	1.42E-04	227	2.27E-02	12.0	6.00E-03	559	5.59E-02	23.0	2.30E-03	3.55	3.55E-01
7CRCARP4S	32.1	3.21E-03	2.30	2.30E-04	662	6.62E-02	40.2	2.01E-02	1,790	1.79E-01	47.4	4.74E-03	7.74	7.74E-01
7CRCARP5S	91.2	9.12E-03	4.53	4.53E-04	1,030	1.03E-01	54.6	2.73E-02	2,440	2.44E-01	89.8	8.98E-03	16.3	1.63E+00
Common Carp:														
8CRCARP1	91.2	9.12E-03	7.07	7.07E-04	1,910	1.91E-01	121	6.05E-02	5,700	5.70E-01	196	1.96E-02	19.9	1.99E+00
8CRCARP2	34.5	3.45E-03	2.12	2.12E-04	480	4.80E-02	26.9	1.35E-02	1,250	1.25E-01	54.6	5.46E-03	6.86	6.86E-01
Carp Sucker:														
8CRCARPS3	17.7	1.77E-03	1.30	1.30E-04	229	2.29E-02	11.3	5.65E-03	566	5.66E-02	22.2	2.22E-03	4.57	4.57E-01
8CRCARPS4	19.2	1.92E-03	1.25	1.25E-04	206	2.06E-02	10.1	5.05E-03	492	4.92E-02	21.1	2.11E-03	3.69	3.69E-01
8CRCARPS5	33.0	3.30E-03	2.24	2.24E-04	347	3.47E-02	19.0	9.50E-03	834	8.34E-02	33.6	3.36E-03	5.72	5.72E-01
Abiquiu Reservoir														
Common Carp:														
9ARCARP1	4.81	4.81E-04	0	0.0	63.4	6.34E-03	4.43	2.22E-03	204	2.04E-02	6.29	6.29E-04	2.27	2.27E-01
9ARCARP2	10.8	1.08E-03	1.02	1.02E-04	130	1.30E-02	8.29	4.15E-03	396	3.96E-02	10.2	1.02E-03	4.43	4.43E-01
9ARCARP3	1.55	1.55E-04	0.131	1.31E-05	27.5	2.75E-03	1.90	9.50E-04	93.8	9.38E-03	2.77	2.77E-04	0.902	9.02E-02
Carp Sucker:														
9ARCARPS1	5.92	5.92E-04	0.86	8.59E-05	105	1.05E-02	0.0	0.0	316	3.16E-02	6.53	6.53E-04	3.90	3.90E-01
9ARCARPS2	7.02	7.02E-04	1.00	9.96E-05	96.8	9.68E-03	0.0	0.0	284	2.84E-02	6.02	6.02E-04	3.45	3.45E-01

Table 6-27. Concentration (pg/g fresh wt.) of PCBs in Whole-Body Fish and TEQs for Common Carp and Carp Suckers Collected from Cochiti and Abiquiu Reservoirs[a] (Cont.)

IUPAC No.:	#156		#167		#169		#170		#180		#189		Total	Total
Compound:	2,3,3',4,4',5-HxCB		2,3',4,4',5,5'-HxCB		3,3',4,4',5,5'-HxCB		2,2',3,3',4,4',5-HpCB		2,2',3,4,4',5,5'-HpCB		2,3,3',4,4',5,5'-HpCB		Conc.	TEQ
Sample ID[b]	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	Conc.	TEQ	(µg/g)	(µg/g)
Cochiti Reservoir														
Common Carp:														
6CRCARP1	715	3.58E-01	375	3.75E-03	0.00	0.00	1,900	1.90E-01	5,460	5.46E-02	54.3	5.43E-03	1.57E-02	3.61E-06
6CRCARP2	1,260	6.30E-01	661	6.61E-03	24.3	2.43E-01	3,140	3.14E-01	9,690	9.69E-02	85.2	8.52E-03	2.76E-02	6.31E-06
6CRCARP3	87.2	4.36E-02	49.1	4.91E-04	0.00	0.00	135	1.35E-02	390	3.90E-03	5.09	5.09E-04	1.56E-03	6.17E-07
Carp Sucker:														
7CRCARPS1	141	7.05E-02	69.3	6.93E-04	0.00	0.00	350	3.50E-02	970	9.70E-03	11.0	1.10E-03	2.89E-03	9.25E-07
7CRCARPS2	180	9.00E-02	81.3	8.13E-04	0.00	0.00	344	3.44E-02	983	9.83E-03	11.5	1.15E-03	3.42E-03	1.09E-06
7CRCARPS3	84.2	4.21E-02	37.4	3.74E-04	0.00	0.00	158	1.58E-02	428	4.28E-03	5.03	5.03E-04	1.56E-03	5.07E-07
7CRCARPS4	320	1.60E-01	150	1.50E-03	0.00	0.00	717	7.17E-02	2,150	2.15E-02	25.4	2.54E-03	5.94E-03	1.30E-06
7CRCARPS5	372	1.86E-01	179	1.79E-03	0.00	0.00	834	8.34E-02	2,260	2.26E-02	25.5	2.55E-03	7.40E-03	2.32E-06
Common Carp:														
8CRCARP1	793	3.97E-01	423	4.23E-03	0.00	0.00	1,970	1.97E-01	5,180	5.18E-02	56.4	5.64E-03	1.65E-02	3.50E-06
8CRCARP2	189	9.45E-02	88.9	8.89E-04	5.13	5.13E-02	370	3.70E-02	980	9.80E-03	12.6	1.26E-03	3.50E-03	1.08E-06
Carp Sucker:														
8CRCARPS3	94.9	4.75E-02	44.2	4.42E-04	0.00	0.00	200	2.00E-02	492	4.92E-03	7.21	7.21E-04	1.69E-03	6.20E-07
8CRCARPS4	75.6	3.78E-02	35.5	3.55E-04	0.00	0.00	163	1.63E-02	423	4.23E-03	5.25	5.25E-04	1.46E-03	5.07E-07
8CRCARPS5	138	6.90E-02	62.8	6.28E-04	0.00	0.00	309	3.09E-02	827	8.27E-03	10.1	1.01E-03	2.62E-03	8.16E-07
Abiquiu Reservoir														
Common Carp:														
9ARCARP1	33.5	1.68E-02	21.0	2.10E-04	6.11	6.11E-02	138	1.38E-02	656	6.56E-03	5.31	5.31E-04	1.15E-03	3.56E-07
9ARCARP2	54.8	2.74E-02	33.9	3.39E-04	6.80	6.80E-02	209	2.09E-02	674	6.74E-03	6.54	6.54E-04	1.55E-03	6.26E-07
9ARCARP3	18.0	9.00E-03	12.3	1.23E-04	2.24	2.24E-02	84.4	8.44E-03	337	3.37E-03	3.18	3.18E-04	5.86E-04	1.47E-07
Carp Sucker:														
9ARCARPS1	53.2	2.66E-02	33.4	3.34E-04	4.47	4.47E-02	172	1.72E-02	562	5.62E-03	7.01	7.01E-04	1.27E-03	5.29E-07
9ARCARPS2	47.5	2.38E-02	28.4	2.84E-04	4.25	4.25E-02	160	1.60E-02	551	5.51E-03	6.18	6.18E-04	1.20E-03	4.73E-07

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[a] U = Not detected; R = peak detected, but did not meet quantification criteria; E = exceeds calibrated linear range, see dilution data; D = dilution data.

[b] Note: The number at the beginning of each sample ID indicates the month in which that sample was collected; i.e., 6 = June, 7 = July, 8 = August, 9 = September.

Table 6-28. Concentration (ng/g fresh wt.) of Organochlorine Pesticides in Whole-Body Fish (Carp and Carp Suckers) Collected from Cochiti and Abiquiu Reservoirs[a]

Sample ID[b]	Hexachloro-benzene	Alpha HCH	Beta HCH	Gamma HCH	Heptachlor	Aldrin	Oxychlordane	trans-Chlordane
Cochiti Reservoir								
Common Carp:								
6CRCARP1	1.32	0.260	U	0.166	U	U	0.549	5.64
6CRCARP2	1.43	0.263	U	0.141	U	U	0.605	6.94
6CRCARP3	0.682	0.147	U	0.148	U	U	U	0.483
Carp Sucker:								
7CRCARP1S	1.21	0.229	U	0.131	1.05	U	0.400	5.29
7CRCARP2S	0.878	0.168	U	0.337	0.184	0.151	0.777	4.03
7CRCARP3S	0.798	0.191	U	0.154	0.317	U	0.647	3.36
7CRCARP4S	1.18	0.176	U	0.189	U	U	U	1.82
7CRCARP5S	2.20		U	U	U	U		4.71
Abiquiu Reservoir								
Common Carp:								
8CRCARP1	1.09		U	U	U	U	U	5.20
8CRCARP2	1.39		U	U	U	U	U	4.91
Carp Sucker:								
8CRCARP3S	0.874	U	U	U	U	U	U	2.25
8CRCARP4S	0.850	U	U	U	U	U	U	3.16
8CRCARP5S	1.44	0.278	U	0.221	0.786	U	1.03	4.62
Common Carp:								
9ARCARP1	0.415	0.115	U	U	U	U	U	U
9ARCARP2	0.671		U	U	U	U	U	0.296
9ARCARP3	0.150	U	U	U	U	U	U	U
Carp Sucker:								
9ARCARPS1	0.846	0.174	U	U	U	U	U	0.319
9ARCARPS2	1.380	0.220	U	U	U	U	U	0.543

Table 6-28. Concentration (ng/g fresh wt.) of Organochlorine Pesticides in Whole-Body Fish (Carp and Carp Suckers) Collected from Cochiti and Abiquiu Reservoirs[a] (Cont.)

Sample ID[b]	cis-Chlordane	DDT	DDD	DDE	trans-Nonachlor	cis-Nonachlor	Mirex
Cochiti Reservoir							
Common Carp:							
6CRCARP1	7.66	1.94	14.29	111.713	9.12	3.31	0.392
6CRCARP2	9.25	2.03	12.34	142.15	13.4	4.56	0.499
6CRCARP3	0.683	0.893	2.981	22.26	0.965	0.377	0.108
Carp Sucker:							
7CRCARP1S	5.80	2.27	5.175	29.322	3.93	1.36	0.098
7CRCARP2S	5.55	4.03	5.64	44.468	5.22	1.58	0.0983
7CRCARP3S	3.65	1.39	4.648	21.696	3.35	1.21	0.0535
7CRCARP4S	2.16	3.03	7.07	47.612	2.40	0.970	0.192
7CRCARP5S	6.64	4.15	12.09	68.73	6.77	2.46	0.211
Abiquiu Reservoir							
Common Carp:							
8CRCARP1	7.79	4.06	11.5	100.504	7.19	3.00	0.302
8CRCARP2	6.35	3.79	7.48	46.312	4.45	1.95	0.146
Carp Sucker:							
8CRCARP3S	2.88	2.746	5.161	21.149	3.11	1.13	0.0827
8CRCARP4S	3.44	1.771	4.779	16.911	3.56	1.21	U
8CRCARP5S	5.23	3.911	5.88	42.019	3.60	1.15	0.108
Common Carp:							
9ARCARP1	0.378	0.523	0.4414	12.3675	0.565	0.300	0.136
9ARCARP2	0.661	0.835	0.884	32.421	1.47	0.678	0.239
9ARCARP3	U	0.343	0.128	8.66	0.280	0.106	0.152
Carp Sucker:							
9ARCARPS1	0.822	2.171	1.187	25.914	1.97	0.823	0.231
9ARCARPS2	1.240	2.592	2.298	21.867	3.00	1.20	0.201

Table 6-28. Concentration (ng/g fresh wt.) of Organochlorine Pesticides in Whole-Body Fish (Carp and Carp Suckers) Collected from Cochiti and Abiquiu Reservoirs[a] (Cont.)

Sample ID[b]	Alpha-Endo-sulphan(I)	Dieldrin	Endrin	Beta-Endo-sulphan (II)	Endo-sulphan Sulphate	Methoxy-chlor	Delta HCH	Heptachlor Epoxide
Cochiti Reservoir								
Common Carp:								
6CRCARP1	0.102	0.404	0.023	U	0.653	U	U	0.121
6CRCARP2	0.129	0.380	0.018	0.065	0.528	U	U	0.109
6CRCARP3	0.053	0.199	0.011	U	0.379	U	U	0.069
Carp Sucker:								
7CRCARP1S	0.165	0.364	0.028	U	0.965	U	U	0.287
7CRCARP2S	0.089	0.324	U	U	0.373	U	U	0.160
7CRCARP3S	0.118	0.243	U	U	0.783	U	U	0.225
7CRCARP4S	0.146	0.350	0.018[R]	0.085[R]	1.00	U	U	0.146
7CRCARP5S								
Abiquiu Reservoir								
Common Carp:								
8CRCARP1	U	0.28	U	U	0.33	U	U	0.20
8CRCARP2	0.10	0.26	U	U	0.52	U	U	0.21
Carp Sucker:								
8CRCARP3S	0.14	0.26	U	U	0.81	U	U	0.25
8CRCARP4S	0.12	0.25	U	U	0.94	U	U	0.30
8CRCARP5S								
Common Carp:								
9ARCARP1	U	0.06	0.02	U	0.32	0.14	U	0.04
9ARCARP2	U	0.14	U	U	0.24	U	U	0.09
9ARCARP3	U	0.02	U	U	0.05	U	U	U
Carp Sucker:								
9ARCARPS1	U	0.24	0.04	U	0.70	U	U	0.14
9ARCARPS2	0.16	0.37	U	U	0.84	U	U	0.23

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[a] U = not detected; E = exceeds calibrated linear range, see dilution data; D = dilution data R = peak detected, but did not meet quantification criteria.

[b] Note: The number at the beginning of each sample ID indicates the month in which that sample was collected; i.e., 6 = June, 7 = July, 8 = August, 9 = September.

Table 6-29. Radionuclide Concentrations in Overstory (OS) and Understory (US) Vegetation Collected Around the DARHT Facility in 2000[a]

	Radionuclide						
Sample Location	**^{3}H (pCi/mL)**	**^{90}Sr (pCi/g dry)**	**^{tot}U (μg/g dry)**	**^{137}Cs (pCi/g dry)**	**^{238}Pu (pCi/g dry)**	**^{239,240}Pu (pCi/g dry)**	**^{241}Am (pCi/g dry)**
North							
OS	0.24 (0.44)	1.19 (0.24)	1.56 (0.08)	–0.50 (1.34)	–0.001 (0.001)	0.006 (0.002)	0.006 (0.003)
US	0.15 (0.43)	1.80 (0.44)	0.54 (0.04)	0.07 (0.13)	0.003 (0.002)	0.002 (0.002)	0.007 (0.012)
East							
OS	0.33 (0.44)	0.12 (0.22)	0.04 (0.02)	–0.16 (0.76)	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)
US	0.06 (0.42)	1.65 (0.40)	2.13 (0.10)	0.13 (0.06)	–0.001 (0.001)	0.003 (0.001)	–0.018 (0.051)
South							
OS	0.24 (0.44)	2.78 (0.33)	1.03 (0.06)	0.11 (0.25)	–0.000 (0.002)	0.003 (0.002)	0.003 (0.003)
US	0.15 (0.43)	0.95 (0.38)	0.53 (0.04)	–0.17 (0.49)	–0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
West							
OS	–0.03 (0.41)	2.42 (0.34)	0.29 (0.03)	0.00 (0.51)	0.002 (0.001)	0.003 (0.001)	–0.001 (0.001)
US	–0.03 (0.41)	0.84 (0.39)	0.54 (0.04)	0.00 (0.37)	0.002 (0.001)	0.004 (0.001)	–0.002 (0.022)
RBG[b]							
OS	0.063 (0.64)	2.08 (0.32)	0.373 (0.040)	0.39 (0.59)	0.001 (0.001)	0.002 (0.001)	0.005 (0.002)
US	0.287 (0.66)	2.08 (0.39)	0.240 (0.027)	0.23 (0.47)	0.001 (0.001)	0.003 (0.002)	0.004 (0.002)
BSRL[c]							
OS	1.02	8.03	1.97	1.33	0.028	0.006	0.016
US	0.99	4.75	2.89	0.98	0.004	0.013	0.011

[a] See Figure 6-3 for locations of sample sites.

[b] RBG is the mean background concentration for samples from Embudo, Cochiti, and Jemez collected in 1999 (Fresquez and Gonzales 2000).

[c] BSRL is the Baseline Statistical Reference Level (Fresquez et al., 2001b).

Table 6-30. Total Trace Element Concentrations (μg/g dry) in Overstory (OS) and Understory (US) Vegetation Collected Around the DARHT Facility in 2000[a]

Location	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl
North													
OS	1.00[b]	1.40[c]	58.0	0.10[b]	0.50[b]	0.50[b]	8.4	0.03[b]	1.00[b]	2.7	0.2[b]	2.10[c]	0.2[b]
US	1.00[b]	0.80[c]	44.0	0.10[b]	0.50[b]	0.50[b]	2.3	0.03[b]	1.00[b]	1.6	0.2[b]	2.00[c]	0.2[b]
East													
OS	1.00[b]	0.80[c]	18.0	0.10[b]	0.50[b]	0.50[b]	3.4	0.03[b]	1.0[b]	1.6	0.2[b]	0.90[c]	0.2[b]
US	1.00[b]	0.40[c]	45.0	0.56	0.50[b]	1.60	7.6	0.03[b]	2.7	1.8	0.8	2.00[c]	0.7
South													
OS	1.00[b]	2.00[c]	28.0	0.10[b]	0.50[b]	0.50[b]	2.9	0.03[b]	1.00[b]	2.6	0.2[b]	1.60[c]	0.2[b]
US	1.00[b]	0.70[c]	22.0	0.10[b]	0.50[b]	0.50[b]	5.9	0.03[b]	1.00[b]	0.7	0.2[b]	2.00[c]	0.2[b]
West													
OS	1.00[b]	0.50[c]	20.0	0.10[b]	0.50[b]	0.50[b]	2.6	0.03[b]	1.00[b]	4.5	0.2[b]	1.40[c]	0.2[b]
US	1.00[b]	2.00[c]	38.0	0.10[b]	0.50[b]	0.50[b]	7.9	0.03[b]	1.00[b]	3.7	0.2[b]	1.70[c]	0.2[b]
RBG													
OS[d]	0.13	0.1	32.5	0.06	0.13	0.63		0.05	1.10	0.4	0.20	0.20	0.5
US[e]	0.13	0.1	69.0	0.06	0.25	0.63	4.8	0.05	1.10	0.7	0.20	0.20	0.5
BSRL[f]													
OS	1.03	0.28	67.9	0.13	0.56	1.00	4.60	0.06	4.95	6.10	8.55	0.35	0.27
US	1.11	0.28	82.0	0.12	0.56	0.77	12.4	0.09	5.58	3.19	8.54	0.27	0.27

[a] See Figure 6-3 for locations of sample sites.

[b] Less than values are reported as one-half the detection limit.

[c] Analyses that were found to have a strong positive bias resulting from analytical problems and were not used in these calculations.

[d] Overstory vegetation samples were not collected in 2000; overstory RBG samples were collected in 1996 (Fresquez et al., 1997c).

[e] Understory vegetation samples were not collected in 2000; understory RBG samples were collected in 1996 (Fresquez et al., 1997c).

[f] BSRL is the Baseline Statistical Reference Level (Fresquez et al., 2001b).

Table 6-31. Radionuclide Concentrations in Raccoons Collected from On-Site and Perimeter Locations during 2000 (before fire)

Tissue Radionuclide	On-Site (TA-54)		Perimeter (Los Alamos)		RSRL[a]
Muscle					
^{238}Pu (pCi/g ash)	0.0053	(0.0015)[b]	0.0000	(0.0007)	0.0014
^{239}Pu (pCi/g ash)	0.0010	(0.0009)	0.0002	(0.0006)	0.0014
^{90}Sr (pCi/g ash)	–2.52	(1.55)[c]	–0.81	(1.06)	1.3
^{tot}U (µg/g ash)	0.03	(0.01)	0.03	(0.01)	0.05
^{3}H (pCi/mL)	10.20	(1.20)	–0.17	(0.45)	0.73
^{137}Cs (pCi/g ash)	1.99	(0.34)	0.23	(0.18)	0.59
^{241}Am (pCi/g ash)	–0.001	(0.001)	–0.004	(0.017)	0.03
Bone					
^{238}Pu (pCi/g ash)	–0.0001	(0.0007)	–0.0001	(0.0008)	0.0015
^{239}Pu (pCi/g ash)	0.0014	(0.0010)	0.0015	(0.0008)	0.0031
^{90}Sr (pCi/g ash)	3.04	(0.76)	1.03	(1.11)	3.3
^{tot}U (µg/g ash)	0.03	(0.01)	0.02	(0.01)	0.04
^{3}H (pCi/mL)	10.10	(1.20)	–0.04	(0.46)	0.88
^{137}Cs (pCi/g ash)	–0.03	(0.20)	–0.02	(0.11)	0.20
^{241}Am (pCi/g ash)	–0.001	(0.001)	–0.003	(0.005)	0.01

[a] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) based on present (perimeter) data.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] See Appendix B for an explanation of the presence of negative values.

G. Figures

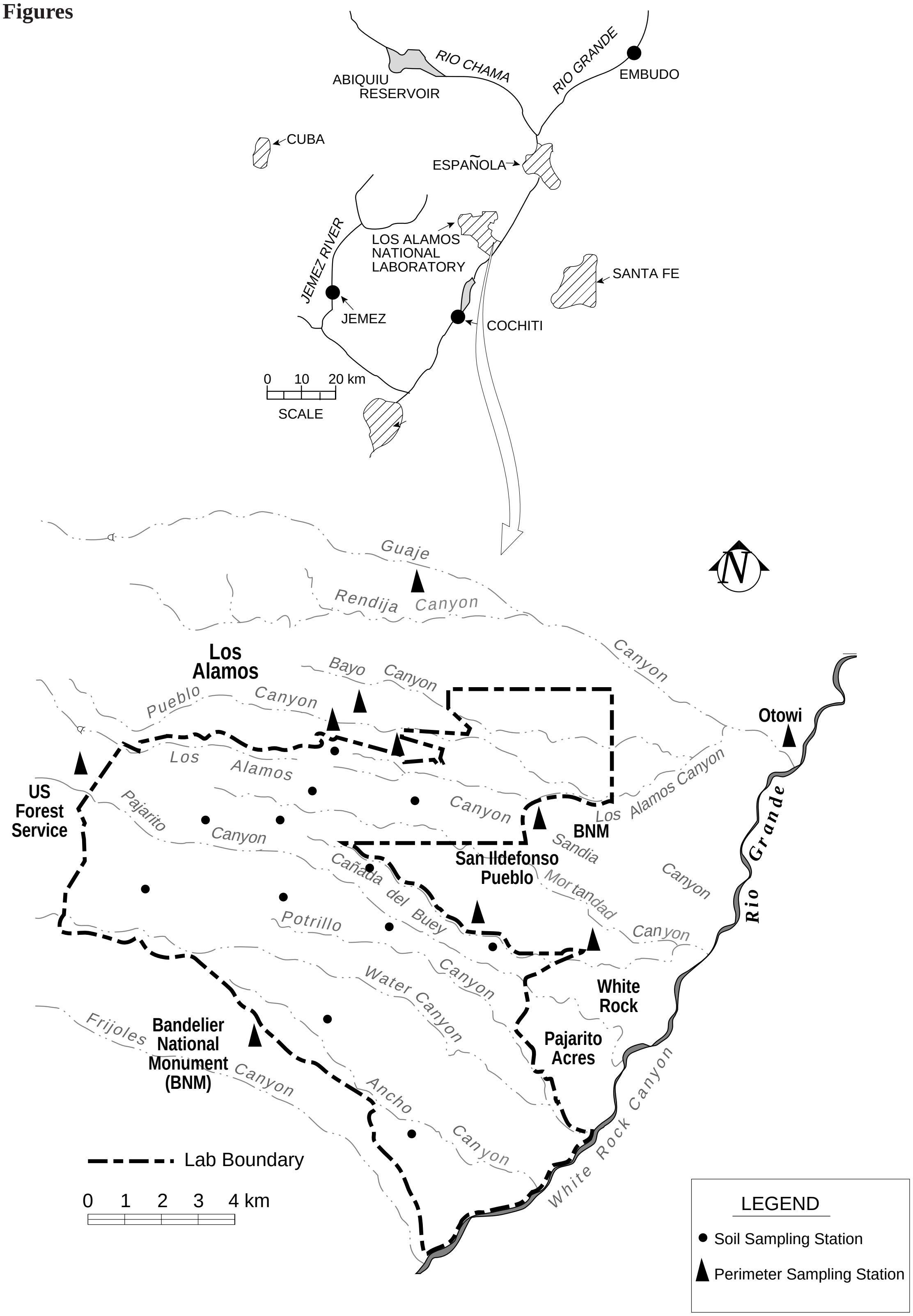

Figure 6-1. Off-site regional (top) and perimeter and on-site (bottom) Laboratory soil sampling locations.

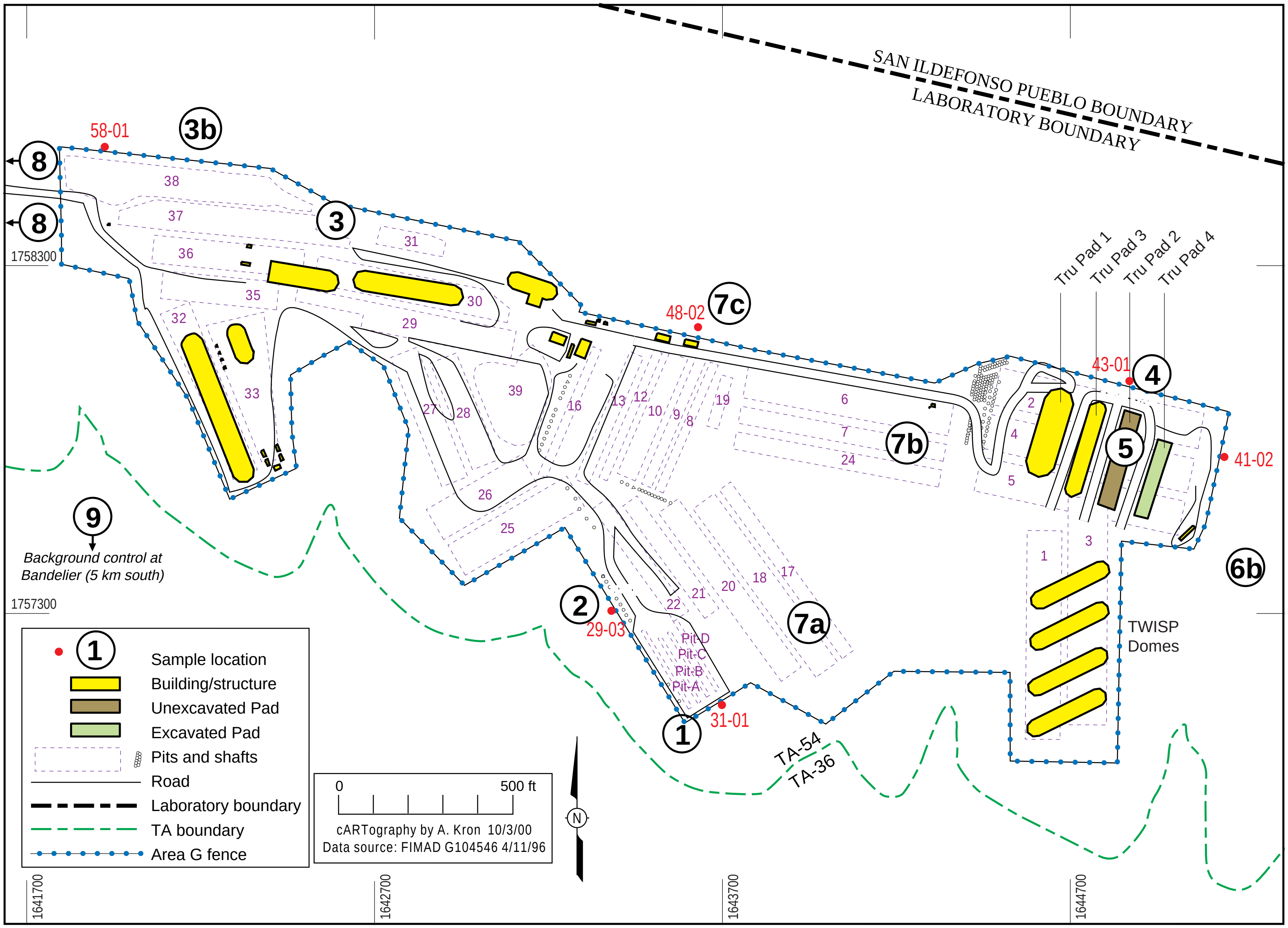

Figure 6-2. Site/sample locations of soils and vegetation at Area G. Site #8 is located farther west and Site #9 is located farther south than what is shown here.

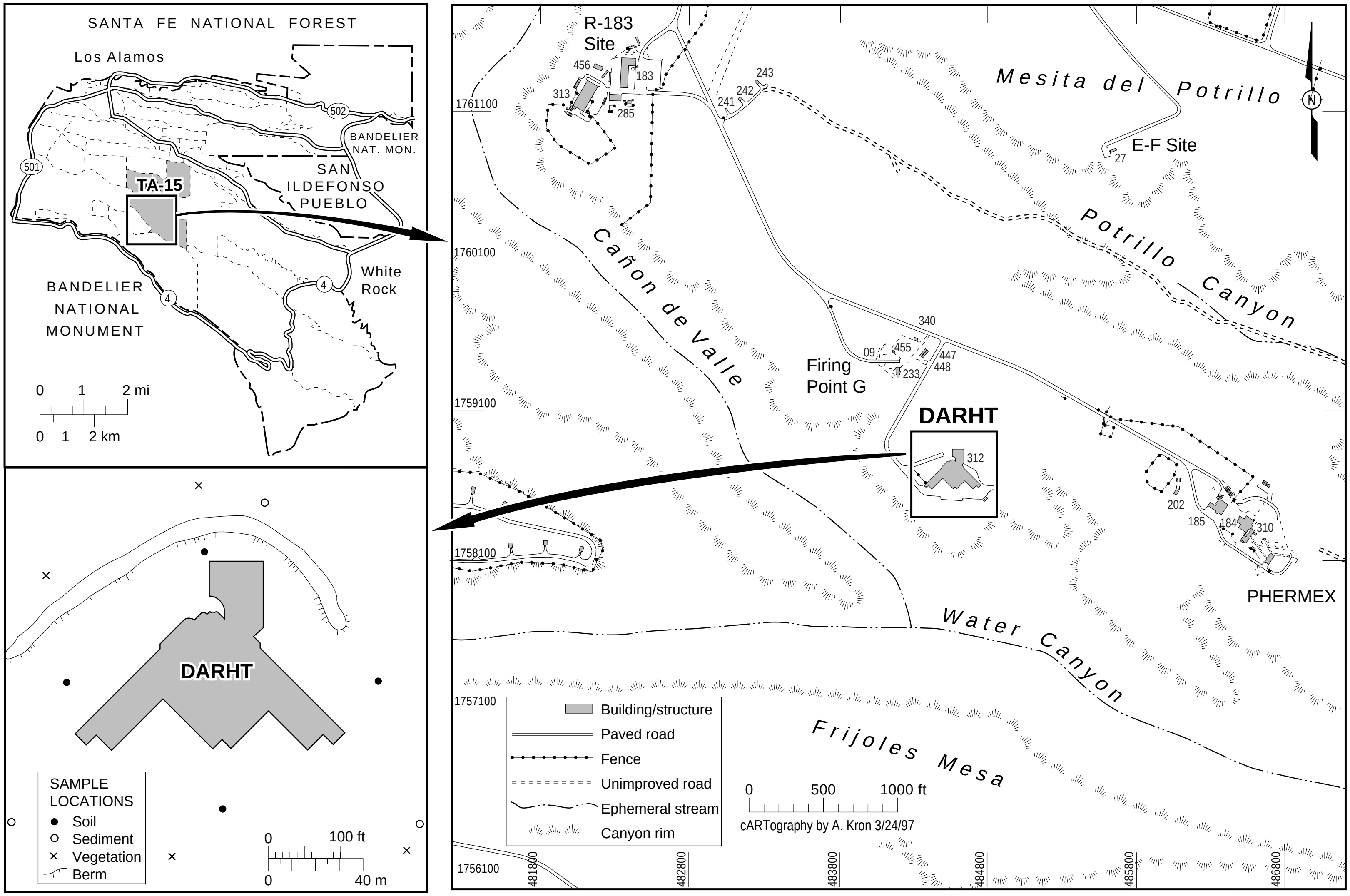

Figure 6-3. Sampling locations at the DARHT facility at TA-15.

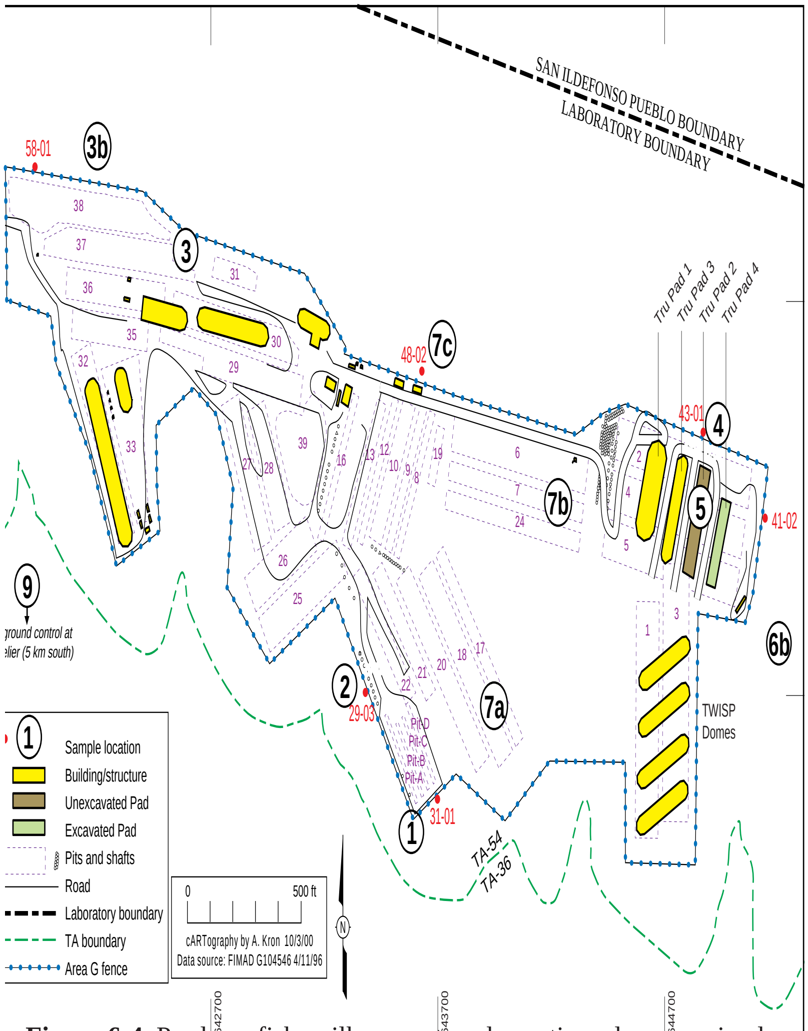

Figure 6-4. Produce, fish, milk, eggs, tea, domestic and game animals, and beehive sampling locations. (Map denotes general locations only.)

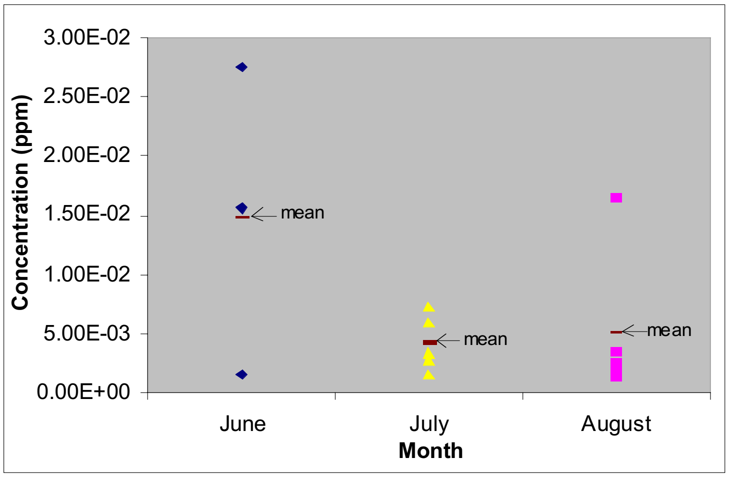

Figure 6-5. Concentrations of total PCBs measured in common carp and carp sucker in Cochiti Reservoir in 2000.

Fig. 6-6. Adult chorus frog.

Fig. 6-7. Chorus frog collection location – Canjillon, New Mexico.

H. References

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Appendix A

Standards for Environmental Contaminants

Throughout this report, we compare concentrations of radioactive and chemical constituents in air and water samples with pertinent standards and guidelines in regulations of federal and state agencies. No comparable standards for soils, sediments, or foodstuffs are available. Los Alamos National Laboratory (LANL or the Laboratory) operations are conducted in accordance with directives for compliance with environmental standards. These directives are contained in Department of Energy (DOE) Orders 5400.1, "General Environmental Program;" 5400.5, "Radiation Protection of the Public and the Environment;" 5480.1, "Environmental Protection, Safety, and Health Protection Standards;" 5480.11, "Requirements for Radiation Protection for Occupational Workers;" 5484.1, "Environmental Radiation Protection, Safety, and Health Protection Information Reporting Requirements," Chap. III, "Effluent and Environmental Monitoring Program Requirements," and 231.1, "Environmental Safety and Health Reporting."

Radiation Standards. DOE regulates radiation exposure to the public and the worker by limiting the radiation dose that can be received during routine Laboratory operations. Because some radionuclides remain in the body and result in exposure long after intake, DOE requires consideration of the dose commitment caused by inhalation, ingestion, or absorption of such radionuclides. This evaluation involves integrating the dose received from radionuclides over a standard period of time. For this report, 50-yr dose commitments were calculated using the DOE dose factors from DOE 1988a and DOE 1988b. The dose factors DOE adopted are based on the recommendations of Publication 30 of the International Commission on Radiological Protection (ICRP 1988).

In 1990, DOE issued Order 5400.5, which finalized the interim radiation protection standard (RPS) for the public (NCRP 1987). Table A-1 lists currently applicable RPSs, now referred to as public dose limits (PDLs), for operations at the Laboratory. DOE's comprehensive PDL for radiation exposure limits the effective dose equivalent (EDE) that a member of the public can receive from DOE operations to 100 mrem per year. The PDLs and the DOE dose factors are based on recommendations in ICRP (1988) and the National Council on Radiation Protection and Measurements (NCRP 1987).

The EDE is the hypothetical whole-body dose that would result in the same risk of radiation-induced cancer or genetic disorder as a given exposure to an individual organ. It is the sum of the individual organ doses, weighted to account for the sensitivity of each organ to radiation-induced damage. The weighting factors are taken from the recommendations of the ICRP. The EDE includes doses from both internal and external exposure.

Radionuclide concentrations in air or water are compared to DOE's Derived Concentration Guides (DCGs) to evaluate potential impacts to members of the public. The DCGs for air are the radionuclide concentrations in air that, if inhaled continuously for an entire year, would give a dose of 100 mrem. Similarly, the DCGs for water are those concentrations in water that if consumed at a maximum rate of 730 liters per year, would give a dose of 100 mrem per year. Derived air concentrations (DACs) were developed for protection of workers and are the air concentrations that, if inhaled throughout a "work year," would give the limiting allowed dose to the worker. Table A-2 shows the DCGs and DACs.

In addition to DOE standards, in 1985 and 1989, the EPA established the National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities, 40 CFR 61, Subpart H. This regulation states that emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr. DOE has adopted this dose limit (Table A-1). This dose is calculated at the location of a residence, school, business or office. In addition, the regulation requires monitoring of all release points that can produce a dose of 0.1 mrem to a member of the public. A complete listing a 40 CFR 61 Subpart H is available in ESH-17 2000.

Nonradioactive Air Quality Standards. Table A-3 shows federal and state ambient air quality standards for nonradioactive pollutants.

National Pollutant Discharge Elimination System. Table A-4 presents a summary of the outfalls, the types of monitoring required under National Pollutant Discharge Elimination System (NPDES), and the limits established for sanitary and industrial outfalls. Table A-5 presents NPDES annual water quality parameters for all outfalls.

Drinking Water Standards. For chemical constituents in drinking water, regulations and standards are issued by the Environmental Protection Agency (EPA) and adopted by the New Mexico Environment Department (NMED) as part of the New Mexico Drinking Water Regulations (Table A-6) (NMEIB 1995). EPA's secondary drinking water standards, which are not included in the New Mexico Drinking Water Regulations and are not enforceable, relate to contaminants in drinking water that primarily affect aesthetic qualities associated with public acceptance of drinking water (EPA 1989b). There may be health effects associated with considerably higher concentrations of these contaminants.

Radioactivity in drinking water is regulated by EPA regulations contained in 40 CFR 141 (EPA 1989b) and New Mexico Drinking Water Regulations, Sections 206 and 207 (NMEIB 1995). These regulations provide that combined radium-226 and radium-228 may not exceed 5 pCi per liter. Gross alpha activity (including radium-226, but excluding radon and uranium) may not exceed 15 pCi per liter.

A screening level of 5 pCi per liter for gross alpha is established to determine when analysis specifically for radium isotopes is necessary. In this report, plutonium concentrations are compared with both the EPA gross alpha standard for drinking water (Table A-6) and the DOE guides calculated for the DCGs applicable to drinking water (Table A-2).

For man-made beta- and photon-emitting radionuclides, EPA drinking water standards are limited to concentrations that would result in doses not exceeding 4 mrem per year, calculated according to a specified procedure. In addition, DOE Order 5400.5 requires that persons consuming water from DOE-operated public water supplies do not receive an EDE greater than 4 mrem per year. DCGs for drinking water systems based on this requirement are in Table A-2.

Surface Water Standards. Concentrations of radionuclides in surface water samples may be compared to either the DOE DCGs (Table A-2) or the New Mexico Water Quality Control Commission (NMWQCC) stream standard, which references the state's radiation protection regulations. However, New Mexico radiation levels are in general two orders of magnitude greater than DOE's DCGs for public dose, so only the DCGs will be discussed here. The concentrations of nonradioactive constituents may be compared with the NMWQCC Livestock Watering and Wildlife Habitat stream standards (NMWQCC 1995). (See Tables A-7 and A-8.) The NMWQCC groundwater standards can also be applied in cases where discharges may affect groundwater.

Organic Analysis of Surface and Groundwaters: Methods and Analytes. Organic analyses of surface waters, groundwaters, and sediments are made using SW-846 methods as shown in Table A-9. This table shows the number of analytes included in each analytical suite. The specific compounds analyzed in each suite are listed in Tables A-10 through A-13.

Table A-1. Department of Energy Public Dose Limits for External and Internal Exposures

	Effective Dose Equivalent[a] at Point of Maximum Probable Exposure
Exposure of Any Member of the Public[b]	
All Pathways	100 mrem/yr[c]
Air Pathway Only[d]	10 mrem/yr
Drinking Water	4 mrem/yr
Occupational Exposure[b]	
Stochastic Effects	5 rem (annual EDE[e])
Nonstochastic Effects	
Lens of eye	15 rem (annual EDE[e])
Extremity	50 rem (annual EDE[e])
Skin of the whole body	50 rem (annual EDE[e])
Organ or tissue	50 rem (annual EDE[e])
Unborn Child	
Entire gestation period	0.5 rem (annual EDE[e])

[a] As used by DOE, effective dose equivalent (EDE) includes both the EDE from external radiation and the committed EDE to individual tissues from ingestion and inhalation during the calendar year.

[b] In keeping with DOE policy, exposures must be limited to as small a fraction of the respective annual dose limits as practicable. DOE's public dose limit (PDL) applies to exposures from routine Laboratory operation, excluding contributions from cosmic, terrestrial, and global fallout; self-irradiation; and medical diagnostic sources of radiation. Routine operation means normal, planned operation and does not include actual or potential accidental or unplanned releases. Exposure limits for any member of the general public are taken from DOE Order 5400.5 (DOE 1990). Limits for occupational exposure are taken from 10 CFR 835, Occupational Radiation Protection.

[c] Under special circumstances and subject to approval by DOE, this limit on the EDE may be temporarily increased to 500 mrem/yr, provided the dose averaged over a lifetime does not exceed the principal limit of 100 mrem per year.

[d] This level is from EPA's regulations issued under the Clean Air Act, (40 CFR 61, Subpart H) (EPA 1989a).

[e] Annual EDE is the EDE received in a year.

Table A-2. Department of Energy's Derived Concentration Guides for Water and Derived Air Concentrations[a]

Nuclide	f_1[b]	DCGs for Water Ingestion in Uncontrolled Areas (pCi/L)	DCGs for Drinking Water Systems (pCi/L)	DCGs for Air Inhalation by the Public (μCi/mL)	Class[b]	DACs for Occupational Exposure (μCi/mL)
^{3}H	—	2,000,000	80,000	1×10^{-7}[c]	—	2×10^{-5}[c]
^{7}Be	5×10^{-3}	1,000,000	40,000	4×10^{-8}	Y	8×10^{-6}
^{89}Sr	2×10^{-5}	20,000	800	3×10^{-10}	Y	6×10^{-8}
^{90}Sr[b]	1×10^{-6}	1,000	40	9×10^{-12}	Y	2×10^{-9}
^{137}Cs	1×10^{0}	3,000	120	4×10^{-10}	D	7×10^{-8}
^{234}U	5×10^{-2}	500	20	9×10^{-14}	Y	2×10^{-11}
^{235}U	5×10^{-2}	600	24	1×10^{-13}	Y	2×10^{-11}
^{238}U	5×10^{-2}	600	24	1×10^{-13}	Y	2×10^{-11}
^{238}Pu	1×10^{-3}	40	1.6	3×10^{-14}	W	3×10^{-12}
^{239}Pu[b]	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}
^{240}Pu	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}
^{241}Am	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}

[a] Guides for uncontrolled areas are based on DOE's public dose limit for the general public (DOE 1990); those for occupational exposure are based on radiation protection standards in 10 CFR 835. Guides apply to concentrations in excess of those occurring naturally or that are due to worldwide fallout.

[b] Gastrointestinal tract absorption factors (f_1) and lung retention classes (Class) are taken from ICRP30 (ICRP 1988). Codes: Y = year, D = day, W = week.

[c] Tritium in the HTO form.

Table A-3. National (40 CFR 50) and New Mexico (20 NMAC 2.3) Ambient Air Quality Standards

Pollutant	Averaging Time	Unit	New Mexico Standard	Federal Standards Primary	Federal Standards Secondary
Sulfur dioxide	Annual	ppm	0.02	0.030[a]	
	24 hours	ppm	0.10	0.14[b]	
	3 hours	ppm			0.5[b]
Hydrogen sulfide	1 hour	ppm	0.010[b]		
Total reduced sulfur	1/2 hour	ppm	0.003[b]		
Total Suspended Particulates	Annual	µg/m^3	60	50	50
	30 days	µg/m^3	90		
	7 days	µg/m^3	110		
	24 hours	µg/m^3	150		
PM_{10}[c]	Annual	µg/m^3		50	50
	24 hours	µg/m^3		150	150
$PM_{2.5}$[d]	Annual	µg/m^3		15[e]	15[e]
	24 hours	µg/m^3		65[e]	65[e]
Carbon monoxide	8 hours	ppm	8.7	9[b]	
	1 hour	ppm	13.1	35[b]	
Ozone[f]	1 hour	ppm		0.12	0.12
	8 hours	ppm		0.08	0.08
Nitrogen dioxide	Annual	ppm	0.05	0.053	0.053
	24 hours	ppm	0.10		
Lead and lead compounds	Calendar quarter	µg/m^3		1.5	1.5

[a] Not to be exceeded in a calendar year.

[b] Not to be exceeded more than once in a calendar year.

[c] Particles ≤10 µm in diameter.

[d] Particles ≤2.5 µm in diameter.

[e] Applicable when the EPA approves changes to the NM State Implementation Plan.

[f] As the result of a May 14, 1999, court ruling, EPA does not have the authority to implement the eight-hour ozone standard. Currently, LANL must meet the one-hour ozone standard. EPA has appealed the court decision.

Table A-4. Limits Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary and Industrial Outfall Discharges for 2000

Discharge Category	Permit Parameter		Daily Average		Daily Maximum	
Sanitary						
13S TA-46 SWS Facility	BOD[a]	concentration	30	mg/L	45	mg/L
		loading limit	100	lb/day	N/A[b]	
	TSS[c]	concentration	30	mg/L	45	mg/L
		loading limit	100	lb/day	N/A	
	Fecal coliform bacteria[d]		500	colonies/100 mL	500	colonies/100 mL
	pH		6.0–9.0 s.u.		6.0–9.0 s.u.	
	Flow[e]		Report		Report	

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
Industrial						
001 Power Plant	1	Monthly	TSS	30	100	mg/L
			Free available CL_2	0.2	0.5	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
02A Boiler Blowdown	1	Every 3 months	TSS	30	100	mg/L
			Total Fe	10	40	mg/L
			Total Cu	1.0	1.0	mg/L
			Total P	20	40	mg/L
			Sulfite	35	70	mg/L
			Total Cr	1.0	1.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
03A Treated Cooling Water	16	Every 3 months	TSS	30	100	mg/L
			Free available Cl	0.2	0.5	mg/L
			Total P	20	40	mg/L
			Total As	0.04	0.04	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
04A Noncontact Cooling Water	13	Every 3 months	pH	6.0–9.0	6.0–9.0	s.u.
			Total residual CL_2	Report[f]	Report	mg/L
051 Radioactive Liquid Waste Treatment Facility (TA-50)	1	Variable: weekly to monthly	COD[g]	94	156	lb/day
			TSS	18.8	62.6	lb/day
			Total Cd	0.06	0.30	lb/day
			Total Cr	0.19	0.38	lb/day
			Total Cu	0.63	0.63	lb/day
			Total Fe	1.0	2.0	lb/day
			Total Pb	0.06	0.15	lb/day
			Total Hg	0.003	0.09	lb/day
			Total Zn	0.62	1.83	lb/day
			TTO[h]	1.0	1.0	mg/L
			Total Ni[f]	Report	Report	mg/L
			Total N[f]	Report	Report	mg/L
			Nitrate-Nitrate as N[f]	Report	Report	mg/L
			Ammonia (as N)[f]	Report	Report	mg/L

Table A-4. (Cont.)

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
051 (Cont.)			pH	6.0–9.0	6.0–9.0	s.u.
			COD	125	125	mg/L
			Total Cd	0.2	0.2	mg/L
			Total Cr	5.1	5.1	mg/L
			Total Cu	1.6	1.6	mg/L
			Total Pb	0.4	0.4	mg/L
			Total Zn	95.4	95.4	mg/L
			^{226}Ra and ^{228}Ra	30.0	30.0	pCi/L
05A High Explosive Wastewater	2	Every 3 months	Oil & Grease	15	15	mg/L
			COD	125	125	mg/L
			TSS	30.0	45.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
06A Photo Wastewater	1	Every 3 months	Total Ag	0.5	1.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.

[a] Biochemical oxygen demand.
[b] Not applicable.
[c] Total suspended solids.
[d] Logarithmic mean.
[e] Discharge volumes are reported to EPA but are not subject to limits.
[f] Concentrations are reported to EPA but are not subject to limits.
[g] Chemical oxygen demand.
[h] Total toxic organics.
Note: Sampling frequency for the sanitary outfall varies from once a week to once every three months, depending on the parameter.

Table A-5. Annual Water Quality Parameters Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary and Industrial Outfall Discharges for 2000

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
All Outfall Categories: Annual Water Quality Parameters	36	Annually	Total Al	5.0	5.0	mg/L
			Total As	0.04	0.04	mg/L
			Total B	5.0	5.0	mg/L
			Total Cd	0.2	0.2	mg/L
			Total Cr	5.1	5.1	mg/L
			Total Co	1.0	1.0	mg/L
			Total Cu	1.6	1.6	mg/L
			Total Pb	0.4	0.4	mg/L
			Total Hg	0.01	0.01	mg/L
			Total Se	0.05	0.05	mg/L
			Total V	0.1	0.1	mg/L
			Total Zn	95.4	95.4	mg/L
			^{226}Ra and ^{228}Ra	30.0	30.0	pCi/L
			^{3}H[a]	3,000,000	3,000,000	pCi/L

[a] When accelerator produced.

Table A-6. Safe Drinking Water Act Maximum Contaminant Levels in the Water Supply for Radiochemicals, Inorganic Chemicals, and Microbiological Constituents

Contaminants	Level
Radiochemical:	**Maximum Contaminant Level**
Gross alpha	15 pCi/L
Gross beta & photon	4 mrem/yr
^{226}Ra & ^{228}Ra	5 pCi/L
U	30 µg/L[a]
Radon	300/4000 pCi/L[b]
	Screening Level
Gross alpha	5 pCi/L
Gross beta	50 pCi/L
Inorganic Chemical:	
Primary Standards	**Maximum Contaminant Level (mg/L)**
Asbestos	7 million fibers/L (longer than 10 µm)
As	0.05[c]
Ba	2
Be	0.004
Cd	0.005
CN	0.2
Cr	0.1
F	4
Hg	0.002
Ni	0.1
NO_3 (as N)	10
NO_2 (as N)	1
SO_4	500[d]
Se	0.05
Sb	0.006
Tl	0.002
	Action Levels (mg/L)
Pb	0.015
Cu	1.3
Secondary Standards	**(mg/L)**
Cl	250
Cu	1
Fe	0.3
Mn	0.05
Zn	5
Total Dissolved Solids	500
pH	6.5–8.5
Microbiological:	**Maximum Contaminant Level**
Presence of total coliforms	5% of samples/month
Presence of fecal coliforms or Escherichia coli	No coliform-positive repeat samples following a fecal coliform-positive sample

[a] Effective December 2003.

[b] Radon standard is 4000 pCi/L with an approved state Multimedia Mitigation program and 300 pCi/L in states without an approved program.

[c] Proposed standard. Scheduled for revision in 2001.

[d] The proposed MCL for sulfate was suspended by the EPA on August 6, 1996.

Table A-7. Livestock Watering Standards[a]

Livestock Contaminant	Concentration	
Dissolved Al	5	mg/L
Dissolved As	0.2	mg/L
Dissolved B	5	mg/L
Dissolved Cd	0.05	mg/L
Dissolved Cr	1	mg/L
Dissolved Co	1	mg/L
Dissolved Cu	0.5	mg/L
Dissolved Pb	0.1	mg/L
Total Hg	0.01	mg/L
Dissolved Se	0.05	mg/L
Dissolved V	0.1	mg/L
Dissolved Zn	25	mg/L
^{226}Ra and ^{228}Ra	30	pCi/L
^{3}H	20,000	pCi/L
Gross alpha	15	pCi/L

[a]NMWQCC 1995.

Table A-8. Wildlife Habitat Stream Standards[a]

The following narrative standard shall apply:

1. Except as provided below in Paragraph 2 of this section, no discharge shall contain any substance, including, but not limited to selenium, DDT, PCBs, and dioxin, at a level which, when added to background concentrations, can lead to bioaccumulation to toxic levels in any animal species. In the absence of site-specific information, this requirement shall be interpreted as establishing a stream standard of 2 µg per liter for total recoverable selenium and of 0.012 µg per liter for total mercury.
2. The discharge of substances that bioaccumulate in excess of levels specified above in Paragraph 1 is allowed if, and only to the extent that, the substances are present in the intake waters which are diverted and utilized prior to discharge, and then only if the discharger utilizes best available treatment technology to reduce the amount of bioaccumulating substances which are discharged.
3. Discharges to waters which are designated for wildlife habitat uses, but not for fisheries uses, shall not contain levels of ammonia or chlorine in amounts which reduce biological productivity and/or species diversity to levels below those which occur naturally and in no case shall contain chlorine in excess of 1 mg per liter nor ammonia in excess of levels that can be accomplished through best reasonable operating practices at existing treatment facilities.
4. A discharge which contains any heavy metal at concentrations in excess of the concentrations set forth in Section 3101.J.1 of these standards shall not be permitted in an amount, measured by total mass, which exceeds by more than 5% the amount present in the intake waters which are diverted and utilized prior to the discharge, unless the discharger has taken steps (an approved program to require industrial pretreatment or a corrosion program) appropriate to reduce influent concentration to the extent practicable.

[a]NMWQCC 1995.

Table A-9. Organic Analytical Methods

Test	SW-846 Method	Number of Compounds
Volatiles	624, 8260B	68
Semivolatiles	625, 8270C	69
PCB[a]	608, 8082, 8081	8
HE[b]	8330	14

[a] Polychlorinated biphenyls.

[b] High explosives.

Table A-10. Volatile Organic Compounds

Analytes	Limit of Quantitation Water (μg/L)
1,1,1,2-Tetrachloroethane	1
1,1,1-Trichloroethane	1
1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloroethane	1
1,1-Dichloroethane	1
1,1-Dichloroethylene	1
1,1-Dichloropropene	1
1,2,3-Trichloropropane	1
1,2,4-Trimethylbenzene	1
1,2-Dibromo-3-chloropropane	1
1,2-Dibromoethane	1
1,2-Dichlorobenzene	1
1,2-Dichloroethane	1
1,2-Dichloropropane	1
1,3,5-Trimethylbenzene	1
1,3-Dichlorobenzene	1
1,3-Dichloropropane	1
1,4-Dichlorobenzene	1
2,2-Dichloropropane	1
2-Butanone	5
2-Chloroethylvinyl ether	5
2-Chlorotoluene	1
2-Hexanone	5
4-Chlorotoluene	1
4-Isopropyltoluene	1
4-Methyl-2-pentanone	5
Acetone	5
Acrolein	10
Acrylonitrile	10
Benzene	1

Table A-10. Volatile Organic Compounds (Cont.)

Analytes	Limit of Quantitation Water (µg/L)
Bromobenzene	1
Bromochloromethane	1
Bromodichloromethane	1
Bromoform	1
Bromomethane	1
Carbon disulfide	5
Carbon tetrachloride	1
Chlorobenzene	1
Chloroethane	1
Chloroform	1
Chloromethane	1
cis-1,3-Dichloropropylene	1
Dibromochloromethane	1
Dibromomethane	1
Dichlorodifluoromethane	1
Ethylbenzene	1
Hexachlorobutadiene	1
Iodomethane	5
Isopropylbenzene	1
m,p-Xylenes	2
Methylene chloride	5
Naphthalene	1
n-Butylbenzene	1
n-Propylbenzene	1
o-Xylene	1
sec-Butylbenzene	1
Styrene	1
tert-Butylbenzene	1
Tetrachloroethylene	1
Toluene	1
Toluene-d8	1
trans-1,2-Dichloroethylene	1
trans-1,3-Dichloropropylene	1
Trichloroethylene	1
Trichlorofluoromethane	1
Trichlorotrifluoroethane	5
Vinyl chloride	1
Xylenes (total)	3

Table A-11. Semivolatile Organic Compounds

Analytes	Limit of Quantitation Water (μg/L)	Limit of Quantitation Sediments (mg/kg)
1,2,4-Trichlorobenzene	10	0.33
1,2-Dichlorobenzene	10	0.33
1,2-Diphenylhydrazine	10	0.33
1,3-Dichlorobenzene	10	0.33
1,4-Dichlorobenzene	10	0.33
2,4,5-Trichlorophenol	10	0.33
2,4,6-Trichlorophenol	10	0.33
2,4-Dichlorophenol	10	0.33
2,4-Dimethylphenol	10	0.33
2,4-Dinitrophenol	20	0.67
2,4-Dinitrotoluene	10	0.33
2,6-Dinitrotoluene	10	0.33
2-Chloronaphthalene	1	0.03
2-Chlorophenol	10	0.33
2-Methyl-4,6-dinitrophenol	10	0.33
2-Methylnaphthalene	1	0.03
2-Nitrophenol	10	0.33
2-Picoline	10	0.33
3,3'-Dichlorobenzidine	10	0.33
4-Bromophenylphenylether	10	0.33
4-Chloro-3-methylphenol	10	0.33
4-Chloroaniline	10	0.33
4-Chlorophenylphenylether	10	0.33
4-Nitrophenol	10	0.33
Acenaphthene	1	0.03
Acenaphthylene	1	0.03
Aniline	10	0.33
Anthracene	1	0.03
Benzidine	50	1.67
Benzo(a)anthracene	1	0.03
Benzo(a)pyrene	1	0.03
Benzo(b)fluoranthene	1	0.03
Benzo(ghi)perylene	1	0.03
Benzo(k)fluoranthene	1	0.03
Benzoic acid	20	0.67
Benzyl alcohol	10	0.33
bis(2-Chloroethoxy)methane	10	0.33
bis(2-Chloroethyl) ether	10	0.33
bis(2-Chloroisopropyl)ether	10	0.33
bis(2-Ethylhexyl)phthalate	10	0.03
Butylbenzylphthalate	10	0.33
Chrysene	1	0.03
Dibenzo(a,h)anthracene	1	0.03
Dibenzofuran	10	0.33

Table A-11. Semivolatile Organic Compounds (Cont.)

Analytes	Limit of Quantitation Water (μg/L)	Sediments (mg/kg)
Diethylphthalate	10	0.33
Dimethylphthalate	10	0.33
Di-n-butylphthalate	10	0.33
Di-n-octylphthalate	10	0.33
Fluoranthene	1	0.03
Fluorene	1	0.03
Hexachlorobenzene	10	0.33
Hexachlorobutadiene	10	0.33
Hexachlorocyclopentadiene	10	0.33
Hexachloroethane	10	0.33
Indeno(1,2,3-cd)pyrene	1	0.03
Isophorone	10	0.33
m-Nitroaniline	10	0.33
Naphthalene	1	0.03
Nitrobenzene	10	0.33
N-Methyl-N-nitrosomethylamine	10	0.33
N-Nitrosodiphenylamine	10	0.07
N-Nitrosodipropylamine	10	0.33
o-Nitroaniline	10	0.33
p-(Dimethylamino)azobenzene	10	0.33
Pentachlorophenol	10	0.33
Phenanthrene	1	0.03
Phenol	10	0.33
Pyrene	1	0.03
Pyridine	10	0.33

Table A-12. Polychlorinated Biphenyls

Analytes	Limit of Quantitation Water (μg/L)	Sediments (mg/kg)
Aroclor 1016	0.5	0.003
Aroclor 1221	0.5	0.003
Aroclor 1232	0.5	0.003
Aroclor 1242	0.5	0.003
Aroclor 1248	0.5	0.003
Aroclor 1254	0.5	0.003
Aroclor 1260	0.5	0.003
Aroclor 1262	0.5	0.003

Table A-13. High-Explosives Compounds

	Limit of Quantitation	
Analytes	Water (μg/L	Sediments (mg/kg)
1,3,5-Trinitrobenzene	0.105	0.08
2,4,6-Trinitrotoluene	0.105	0.08
2,4-Dinitrotoluene	0.105	0.08
2,6-Dinitrotoluene	0.105	0.08
2-Amino-4,6-dinitrotoluene	0.105	0.08
4-Amino-2,6-dinitrotoluene	0.105	0.08
HMX	0.105	0.08
Nitrobenzene	0.105	0.08
RDX	0.105	0.08
Tetryl	0.105	0.08
m-Dinitrobenzene	0.105	0.08
m-Nitrotoluene	0.105	0.08
o-Nitrotoluene	0.105	0.08
p-Nitrotoluene	0.105	0.08

References

DOE 1988a: US Department of Energy, “Internal Dose Conversion Factors for Calculation of Dose to the Public,” US Department of Energy report DOE/EH-0071 (July 1988).

DOE 1988b: US Department of Energy, “External Dose-Rate Conversion Factors for Calculation of Dose to the Public,” US Department of Energy report DOE/EH-0070 (July 1988).

DOE 1990: US Department of Energy, “Radiation Protection of the Public and the Environment,” US Department of Energy Order 5400.5 (February 8, 1990).

EPA 1989a: US Environmental Protection Agency, “40CFR 61, National Emission Standards for Hazardous Air Pollutants, Radionuclides; Final Rule and Notice of Reconsideration,” Federal Register 54, 51 653-51 715 (December 15, 1989).

EPA 1989b: US Environmental Protection Agency, “National Interim Primary Drinking Water Regulations,” Code of Federal Regulations, Title 40, Parts 141 and 142 (1989), and “National Secondary Drinking Water Regulations,” Part 143 (1989).

ESH-17 2000: Air Quality Group, “Quality Assurance Project Plan for the Rad-NESHAP Compliance Project,” Air Quality Group Document ESH-17-RN, R1 (January 2000).

ICRP 1988: International Commission on Radiological Protection, “Limits for Intakes of Radionuclides by Workers,” ICRP Publication 30, Parts 1, 2, and 3, and their supplements, Annals of the ICRP 2(3/4) -8(4) (1979-1982), and Publication 30, Part 4, 19(4) (1988).

NCRP 1987: National Council on Radiation Protection and Measurements, “Recommendations on Limits for Exposure to Ionizing Radiation,” NCRP report No. 91 (June 1987).

NMEIB 1995: New Mexico Environmental Improvement Board, “New Mexico Drinking Water Regulations,” (as amended through January 1995).

NMWQCC 1995: New Mexico Water Quality Control Commission, “State of New Mexico Water Quality Standards for Interstate and Intrastate Streams,” Section 3-101.K (as amended through January 23, 1995).

Appendix B

Units of Measurement

Throughout this report the International System of Units (SI) or metric system of measurements has been used, with some exceptions. For units of radiation activity, exposure, and dose, US Customary Units (that is, curie [Ci], roentgen [R], rad, and rem) are retained as the primary measurement because current standards are written in terms of these units. The equivalent SI units are the becquerel (Bq), coulomb per kilogram (C/kg), gray (Gy), and sievert (Sv), respectively.

Table B-1 presents prefixes used in this report to define fractions or multiples of the base units of measurements. Scientific notation is used in this report to express very large or very small numbers. Translating from scientific notation to a more traditional number requires moving the decimal point either left or right from the number. If the value given is 2.0×10^3, the decimal point should be moved three numbers (insert zeros if no numbers are given) to the **right** of its present location. The number would then read 2,000. If the value given is 2.0×10^{-5}, the decimal point should be moved five numbers to the **left** of its present location. The result would be 0.00002.

Table B-2 presents conversion factors for converting SI units into US Customary Units. Table B-3 presents abbreviations for common measurements.

Data Handling of Radiochemical Samples

Measurements of radiochemical samples require that analytical or instrumental backgrounds be subtracted to obtain net values. Thus, net values are sometimes obtained that are lower than the minimum detection limit of the analytical technique. Consequently, individual measurements can result in values of positive or negative numbers. Although a negative value does not represent a physical reality, a valid long-term average of many measurements can be obtained only if the very small and negative values are included in the population calculations (Gilbert 1975).

For individual measurements, uncertainties are reported as one standard deviation. The standard deviation is estimated from the propagated sources of analytical error.

Standard deviations for the station and group (off-site regional, off-site perimeter, and on-site) means are calculated using the following equation:

$$s = \sqrt{\frac{\sum_{i=1}^{N} \left(\bar{\mathrm{c}} - \mathrm{c}_{\mathrm{i}}\right)^2}{(N - 1)}},$$

where

c_{i} = sample i,

$\bar{\mathrm{c}}$ = mean of samples from a given station or group, and

N = number of samples a station or group comprises.

This value is reported as one standard deviation (1*s*) for the station and group means.

Tables

Table B-1. Prefixes Used with SI (Metric) Units

Prefix	Factor	Symbol
mega	1 000 000 or 10^6	M
kilo	1 000 or 10^3	k
centi	0.01 or 10^{-2}	c
milli	0.001 or $10^{-}3$	m
micro	0.000001 or 10^{-6}	µ
nano	0.000000001 or 10^{-9}	n
pico	0.000000000001 or 10^{-12}	p
femto	0.000000000000001 or 10^{-15}	f
atto	0.000000000000000001 or 10^{-18}	a

Table B-2. Approximate Conversion Factors for Selected SI (Metric) Units

Multiply SI (Metric) Unit	by	to Obtain US Customary Unit
celsius (°C)	9/5 + 32	fahrenheit (°F)
centimeters (cm)	0.39	inches (in.)
cubic meters (m^3)	35.3	cubic feet (ft^3)
hectares (ha)	2.47	acres
grams (g)	0.035	ounces (oz)
kilograms (kg)	2.2	pounds (lb)
kilometers (km)	0.62	miles (mi)
liters (L)	0.26	gallons (gal.)
meters (m)	3.28	feet (ft)
micrograms per gram (µg/g)	1	parts per million (ppm)
milligrams per liter (mg/L)	1	parts per million (ppm)
square kilometers (km^2)	0.386	square miles (mi^2)

Table B-3. Common Measurement Abbreviations and Measurement Symbols

aCi	attocurie
Bq	becquerel
Btu/yr	British thermal unit per year
Ci	curie
cm^3/s	cubic centimeters per second
cpm/L	counts per minute per liter
fCi/g	femtocurie per gram
ft	foot
ft^3/min	cubic feet per minute
ft^3/s	cubic feet per second
kg	kilogram
kg/h	kilogram per hour
lb/h	pound per hour
lin ft	linear feet
m^3/s	cubic meter per second
µCi/L	microcurie per liter
µCi/mL	microcurie per milliliter
µg/g	microgram per gram
$µg/m^3$	microgram per cubic meter
mL	milliliter
mm	millimeter
µm	micrometer
µmho/cm	micro mho per centimeter
mCi	millicurie
mg	milligram
mR	milliroentgen

Table B-3. Common Measurement Abbreviations and Measurement Symbols (Cont.)

m/s	meters per second
mrad	millirad
mrem	millirem
mSv	millisievert
nCi	nanocurie
nCi/dry g	nanocurie per dry gram
nCi/L	nanocurie per liter
ng/m^3	nanogram per cubic meter
pCi/dry g	picocurie per dry gram
pCi/g	picocurie per gram
pCi/L	picocurie per liter
pCi/m^3	picocurie per cubic meter
pCi/mL	picocurie per milliliter
pg/g	picogram per gram
pg/m^3	picogram per cubic meter
PM$_{10}$	small particulate matter (less than 10 μm diameter)
PM$_{2.5}$	small particulate matter (less than 2.5 μm diameter)
R	roentgen
s, SD or σ	standard deviation
s.u.	standard unit
sq ft (ft^2)	square feet
TU	tritium unit
>	greater than
<	less than
≥	greater than or equal to
≤	less than or equal to
±	plus or minus
~	approximately

Reference

Gilbert 1975: R. O. Gilbert, "Recommendations Concerning the Computation and Reporting of Counting Statistics for the Nevada Applied Ecology Group," Batelle Pacific Northwest Laboratories report BNWL-B-368 (September 1975).

Appendix C

Description of Technical Areas and Their Associated Programs

Locations of the technical areas (TAs) operated by the Laboratory in Los Alamos County are shown in Figure 1-2. The main programs conducted at each of the areas are listed in this Appendix.

TA-0: The Laboratory has about 180,000 sq ft of leased space for training, support, architectural engineering design, and unclassified research and development in the Los Alamos town site and White Rock. The publicly accessible Community Reading Room and the Bradbury Science Museum are also located in the Los Alamos town site.

TA-2, Omega Site: Omega West Reactor, an 8-MW nuclear research reactor, is located here. It was placed into a safe shutdown condition in 1993 and was removed from the nuclear facilities list. The reactor will be transferred to the institution for placement into the decontamination and decommissioning (D&D) program beginning in 2006.

TA-3, Core Area: The Administration Complex contains the Director's office, administrative offices, and support facilities. Laboratories for several divisions are in this main TA of the Laboratory. Other buildings house central computing facilities, chemistry and materials science laboratories, earth and space science laboratories, physics laboratories, technical shops, cryogenics laboratories, the main cafeteria, and the Study Center. TA-3 contains about 50% of the Laboratory's employees and floor space.

TA-5, Beta Site: This site contains some physical support facilities such as an electrical substation, test wells, several archaeological sites, and environmental monitoring and buffer areas.

TA-6, Two-Mile Mesa Site: The site is mostly undeveloped and contains gas cylinder staging and vacant buildings pending disposal.

TA-8, GT Site (or Anchor Site West): This is a dynamic testing site operated as a service facility for the entire Laboratory. It maintains capability in all modern nondestructive testing techniques for ensuring quality of material, ranging from test weapons components to high-pressure dies and molds. Principal tools include radiographic techniques (x-ray machines with potentials up to 1,000,000 V and a 24-MeV betatron), radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.

TA-9, Anchor Site East: At this site, fabrication feasibility and physical properties of explosives are explored. New organic compounds are investigated for possible use as explosives. Storage and stability problems are also studied.

TA-11, K Site: Facilities are located here for testing explosives components and systems, including vibration testing and drop testing, under a variety of extreme physical environments. The facilities are arranged so that testing may be controlled and observed remotely and so that devices containing explosives or radioactive materials, as well as those containing nonhazardous materials, may be tested.

TA-14, Q Site: This dynamic testing site is used for running various tests on relatively small explosive charges for fragment impact tests, explosives sensitivities, and thermal responses.

TA-15, R Site: This is the home of PHERMEX (the pulsed high-energy radiographic machine emitting x-rays), a multiple-cavity electron accelerator capable of producing a very large flux of x-rays for weapons development testing. It is also the site where DARHT (the dual-axis radiographic hydrotest facility) is being constructed. This site is also used for the investigation of weapons functioning and systems behavior in nonnuclear tests, principally through electronic recordings.

TA-16, S Site: Investigations at this site include development, engineering design, prototype manufacture, and environmental testing of nuclear weapons warhead systems. TA-16 is the site of the Weapons Engineering Tritium Facility for tritium handled in gloveboxes. Development and testing of high explosives, plastics, and adhesives and research on process development for manufacture of items using these and other materials are accomplished in extensive facilities.

TA-18, Pajarito Laboratory Site: This is a nuclear facility that studies both static and dynamic behavior of multiplying assemblies of nuclear materials. The Category I quantities of special nuclear materials (SNM) are used to support a wide variety of programs such as Stockpile Management, Stockpile Stewardship, Emergency Response, Nonproliferation, Safeguards, etc. Experiments near critical are operated by remote control using low-power reactors called critical assemblies. The machines are housed in buildings known as kivas and are used primarily to provide a controlled means of assembling a critical amount of fissionable material so that the effects of various shapes, sizes, and configurations can be studied. These machines are also used as a large-quantity source of fission neutrons for experimental purposes. In addition, this facility provides the capability to perform hands-on training and experiments with SNM in various configurations below critical.

TA-21, DP Site: This site has two primary research areas: DP West and DP East. DP West has been in the D&D program since 1992, and six buildings have been demolished. The programs conducted at DP West, primarily in inorganic and biochemistry, were relocated during 1997, and the remainder of the site was scheduled for D&D in future years. DP East is a tritium research site.

TA-22, TD Site: This site is used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with initiating high explosives and research in rapid shock-induced reactions.

TA-28, Magazine Area A: This is an explosives storage area.

TA-33, HP Site: An old, high-pressure, tritium-handling facility located here is being phased out. An intelligence technology group and the National Radio Astronomy Observatory's Very Large Baseline Array Telescope are located at this site.

TA-35, Ten Site: This site is divided into five facility management units. Work here includes nuclear safeguards research and development that are concerned with techniques for nondestructive detection, identification, and analysis of fissionable isotopes. Research is also done on reactor safety, laser fusion, optical sciences, pulsed-power systems, high-energy physics, tritium fabrication, metallurgy, ceramic technology, and chemical plating.

TA-36, Kappa Site: Phenomena of explosives, such as detonation velocity, are investigated at this dynamic testing site.

TA-37, Magazine Area C: This is an explosives storage area.

TA-39, Ancho Canyon Site: The behavior of nonnuclear weapons is studied here, primarily by photographic techniques. Investigations are also made into various phenomenological aspects of explosives, interactions of explosives, explosions involving other materials, shock wave physics, equation state measurements, and pulsed-power systems design.

TA-40, DF Site: This site is used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with the physics of explosives.

TA-41, W Site: Personnel at this site engage primarily in engineering design and development of nuclear components, including fabrication and evaluation of test materials for weapons.

TA-43, Health Research Laboratory: This site is adjacent to the Los Alamos Medical Center in the town site. Research performed at this site includes structural, molecular, and cellular radiobiology, biophysics, mammalian radiobiology, mammalian metabolism, biochemistry, and genetics. The Department of Energy Los Alamos Area Office is also located within TA-43.

TA-46, WA Site: This TA contains two facility management units. Activities include applied photochemistry research including the development of technology for laser isotope separation and laser enhancement of chemical processes. A new facility completed during 1996 houses research in inorganic and materials chemistry. The Sanitary Wastewater System Facility is located at the east end of this site. Environmental management operations are also located here.

TA-48, Radiochemistry Site: Laboratory scientists and technicians perform research and development (R&D) activities at this site on a wide range of chemical processes including nuclear and radiochemistry, geochemistry, biochemistry, actinide chemistry, and separations chemistry. Hot cells are used to produce medical radioisotopes.

TA-49, Frijoles Mesa Site: This site is currently restricted to carefully selected functions because of its location near Bandelier National Monument and past use in high-explosive and radioactive materials experiments. The Hazardous Devices Team Training Facility is located here.

TA-50, Waste Management Site: This site is divided into two facility management units, which include managing the industrial liquid and radioactive liquid waste received from Laboratory technical areas and activities that are part of the waste treatment technology effort.

TA-51, Environmental Research Site: Research and experimental studies on the long-term impact of radioactive waste on the environment and types of waste storage and coverings are performed at this site.

TA-52, Reactor Development Site: A wide variety of theoretical and computational activities related to nuclear reactor performance and safety are done at this site.

TA-53, Los Alamos Neutron Science Center: The Los Alamos Neutron Science Center, including the linear proton accelerator, the Manuel Lujan Jr. Neutron Scattering Center, and a medical isotope production facility is located at this TA. Also located at TA-53 are the Accelerator Production of Tritium Project Office, including the Low-Energy Demonstration Accelerator, and R&D activities in accelerator technology and high-power microwaves.

TA-54, Waste Disposal Site: This site is divided into two facility management units for the radioactive solid and hazardous chemical waste management and disposal operations and activities that are part of the waste treatment technology effort.

TA-55, Plutonium Facility Site: Processing of plutonium and research on plutonium metallurgy are done at this site.

TA-57, Fenton Hill Site: This site is located about 28 miles west of Los Alamos on the southern edge of the Valles Caldera in the Jemez Mountains and was the location of the Laboratory’s now decommissioned Hot Dry Rock geothermal project. The site is used for the testing and development of downhole well-logging instruments and other technologies of interest to the energy industry. The high elevation and remoteness of the site make Fenton Hill a choice location for astrophysics experiments. A gamma ray observatory is located at the site.

TA-58: This site is reserved for multiuse experimental sciences requiring close functional ties to programs currently located at TA-3.

TA-59, Occupational Health Site: Occupational health and safety and environmental management activities are conducted at this site. Emergency management offices are also located here.

TA-60, Sigma Mesa: This area contains physical support and infrastructure facilities, including the Test Fabrication Facility and Rack Assembly and the Alignment Complex.

TA-61, East Jemez Road: This site is used for physical support and infrastructure facilities, including the Los Alamos County sanitary landfill.

TA-62: This site is reserved for multiuse experimental science, public and corporate interface, and environmental research and buffer zones.

TA-63: This is a major growth area at the Laboratory with expanding environmental and waste management functions and facilities. This area contains physical support facilities operated by Johnson Controls Northern New Mexico.

TA-64: This is the site of the Central Guard Facility and headquarters for the Laboratory Hazardous Materials Response Team.

TA-66: This site is used for industrial partnership activities.

TA-67: This is a dynamic testing area that contains significant archeological sites.

TA-68: This is a dynamic testing area that contains archeological and environmental study areas.

TA-69: This undeveloped TA serves as an environmental buffer for the dynamic testing area.

TA-70: This undeveloped TA serves as an environmental buffer for the high-explosives test area.

TA-71: This undeveloped TA serves as an environmental buffer for the high-explosives test area.

TA-72: This is the site of the Protective Forces Training Facility.

TA-73: This area is the Los Alamos Airport.

TA-74, Otowi Tract: This large area, bordering the Pueblo of San Ildefonso on the east, is isolated from most of the Laboratory and contains significant concentrations of archeological sites and an endangered species breeding area. This site also contains Laboratory water wells and future well fields.

Related Websites

For more information on environmental topics at Los Alamos National Laboratory, access the following Web sites:

http://lib-www.lanl.gov/pubs/la-13891.htm provides access to *Environmental Surveillance at Los Alamos during 2000*.

http://lib-www.lanl.gov/la-pubs/lalp-01-198.pdf provides access to *Overview of Environmental Surveillance at Los Alamos during 2000*.

http://www.lanl.gov reaches the Los Alamos National Laboratory Web site.

http://www.energy.gov reaches the national Department of Energy Web site.

http://labs.ucop.edu provides information on the three laboratories managed by the University of California.

http://www.esh.lanl.gov/~AirQuality accesses LANL's Air Quality Group.

http://www.esh.lanl.gov/~esh18/ accesses LANL's Water Quality and Hydrology Group.

http://www.esh.lanl.gov/~esh19/ accesses LANL's Hazardous and Solid Waste Group.

http://www.esh.lanl.gov/%7Eesh20/ accesses LANL's Ecology Group.

http://erproject.lanl.gov provides information on LANL's Environmental Restoration Project.

Glossary of Terms

activation products	Radioactive products generated as a result of neutrons and other subatomic particles interacting with materials such as air, construction materials, or impurities in cooling water. These activation products are usually distinguished, for reporting purposes, from fission products.
albedo dosimeters	Albedo dosimeters are used to measure neutrons around TA-18. They use a neutron-sensitive polyethylene phantom to capture neutron backscatter to simulate the human body.
alpha particle	A positively charged particle (identical to the helium nucleus) composed of two protons and two neutrons that are emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.
ambient air	The surrounding atmosphere as it exists around people, plants, and structures. It is not considered to include the air immediately adjacent to emission sources.
aquifer	A saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.
artesian well	A well in which the water rises above the top of the water-bearing bed.
background radiation	Ionizing radiation from sources other than the Laboratory. This radiation may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; worldwide fallout; and radiation from medical diagnostic procedures.
beta particle	A negatively charged particle (identical to the electron) that is emitted during decay of certain radioactive atoms. Most beta particles are stopped by 0.6 cm of aluminum.
biota	The types of animal and plant life found in an area.
blank sample	A control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. The measured value or signals in blanks for the analyte is believed to be caused by artifacts and should be subtracted from the measured value. This process yields a net amount of the substance in the sample.
blind sample	A control sample of known concentration in which the expected values of the constituent are unknown to the analyst.
BOD	Biochemical (biological) oxygen demand. A measure of the amount of oxygen in biological processes that breaks down organic matter in water; a measure of the organic pollutant load. It is used as an indicator of water quality.
CAA	Clean Air Act. The federal law that authorizes the Environmental Protection Agency (EPA) to set air quality standards and to assist state and local governments to develop and execute air pollution prevention

	and control programs.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Also known as Superfund, this law authorizes the federal government to respond directly to releases of hazardous substances that may endanger health or the environment. The EPA is responsible for managing Superfund.
CFR	Code of Federal Regulations. A codification of all regulations developed and finalized by federal agencies in the *Federal Register*.
COC	Chain-of-Custody. A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition.
contamination	(1) Substances introduced into the environment as a result of people's activities, regardless of whether the concentration is a threat to health (see pollution). (2) The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.
controlled area	Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.
Ci	Curie. Unit of radioactivity. One Ci equals 3.70×10^{10} nuclear transformations per second.
cosmic radiation	High-energy particulate and electromagnetic radiations that originate outside the earth's atmosphere. Cosmic radiation is part of natural background radiation.
CWA	Clean Water Act. The federal law that authorizes the EPA to set standards designed to restore and maintain the chemical, physical, and biological integrity of the nation's waters.
DOE	US Department of Energy. The federal agency that sponsors energy research and regulates nuclear materials used for weapons production.
dose	A term denoting the quantity of radiation energy absorbed.
EDE	Effective dose equivalent. The hypothetical whole-body dose that would give the same risk of cancer mortality and serious genetic disorder as a given exposure but that may be limited to a few organs. The effective dose equivalent is equal to the sum of individual organ doses, each weighted by degree of risk that the organ dose carries. For example, a 100-mrem dose to the lung, which has a weighting factor of 0.12, gives an effective dose that is equivalent to $100 \times 0.12 = 12$ mrem. CEDE: committed effective dose equivalent TEDE: total effective dose equivalent
maximum individual dose	The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to an individual at or outside the Laboratory boundary where the highest dose rate occurs. It takes into

	account shielding and occupancy factors that would apply to a real individual.
population dose	The sum of the radiation doses to individuals of a population. It is expressed in units of person-rem. (For example, if 1,000 people each received a radiation dose of 1 rem, their population dose would be 1,000 person-rem.)
whole body dose	A radiation dose commitment that involves exposure of the entire body (as opposed to an organ dose that involves exposure to a single organ or set of organs).
EA	Environmental Assessment. A report that identifies potentially significant environmental impacts from any federally approved or funded project that may change the physical environment. If an EA shows significant impact, an Environmental Impact Statement is required.
effluent	A liquid waste discharged to the environment.
EIS	Environmental Impact Statement. A detailed report, required by federal law, on the significant environmental impacts that a proposed major federal action would have on the environment. An EIS must be prepared by a government agency when a major federal action that will have significant environmental impacts is planned.
emission	A gaseous waste discharged to the environment.
environmental compliance	The documentation that the Laboratory complies with the multiple federal and state environmental statutes, regulations, and permits that are designed to ensure environmental protection. This documentation is based on the results of the Laboratory's environmental monitoring and surveillance programs.
environmental monitoring	The sampling of contaminants in liquid effluents and gaseous emissions from Laboratory facilities, either by directly measuring or by collecting and analyzing samples in a laboratory.
environmental surveillance	The sampling of contaminants in air, water, sediments, soils, foodstuffs, and plants and animals, either by directly measuring or by collecting and analyzing samples in a laboratory.
EPA	Environmental Protection Agency. The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure protection of human health and the environment.
exposure	A measure of the ionization produced in air by x-ray or gamma ray radiation. (The unit of exposure is the roentgen.)
external radiation	Radiation originating from a source outside the body.
gallery	An underground collection basin for spring discharges.

gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other electromagnetic radiation (such as microwaves, visible light, and radiowaves) has longer wavelengths (lower energy) and cannot cause ionization.
GENII	Computer code used to calculate doses from all pathways (air, water, foodstuffs, and soil).
gross alpha	The total amount of measured alpha activity without identification of specific radionuclides.
gross beta	The total amount of measured beta activity without identification of specific radionuclides.
groundwater	Water found beneath the surface of the ground. Groundwater usually refers to a zone of complete water saturation containing no air.
^3H	Tritium.
half-life, radioactive	The time required for the activity of a radioactive substance to decrease to half its value by inherent radioactive decay. After two half-lives, one-fourth of the original activity remains (1/2 × 1/2), after three half-lives, one-eighth (1/2 × 1/2 × 1/2), and so on.
hazardous waste	Wastes exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or yielding toxic constituents in a leaching test. In addition, EPA has listed as hazardous other wastes that do not necessarily exhibit these characteristics. Although the legal definition of hazardous waste is complex, the term generally refers to any waste that EPA believes could pose a threat to human health and the environment if managed improperly. Resource Conservation and Recovery Act (RCRA) regulations set strict controls on the management of hazardous wastes.
hazardous waste constituent	The specific substance in a hazardous waste that makes it hazardous and therefore subject to regulation under Subtitle C of RCRA.
HSWA	Hazardous and Solid Waste Amendments of 1984 to RCRA. These amendments to RCRA greatly expanded the scope of hazardous waste regulation. In HSWA, Congress directed EPA to take measures to further reduce the risks to human health and the environment caused by hazardous wastes.
hydrology	The science dealing with the properties, distribution, and circulation of natural water systems.
internal radiation	Radiation from a source within the body as a result of deposition of radionuclides in body tissues by processes such as ingestion, inhalation, or implantation. Potassium-40, a naturally occurring radionuclide, is a major source of internal radiation in living organisms. Also called self-irradiation.
ionizing radiation	Radiation possessing enough energy to remove electrons from the substances through which it passes. The primary contributors to

	ionizing radiation are radon, cosmic and terrestrial sources, and medical sources such as x-rays and other diagnostic exposures.
isotopes	Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons. Isotopes of an element have similar chemical behaviors but can have different nuclear behaviors. • <u>long-lived isotope</u> - A radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years). • <u>short-lived isotope</u> - A radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).
LLW	Low-level waste. The level of radioactive contamination in LLW is not strictly defined. Rather, LLW is defined by what it is not. It does not include nuclear fuel rods, wastes from processing nuclear fuels, transuranic (TRU) waste, or uranium mill tailings.
MCL	Maximum contaminant level. Maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system (see Appendix A and Table A-6). The MCLs are specified by the EPA.
MEI	Maximally exposed individual. The average exposure to the population in general will always be less than to one person or subset of persons because of where they live, what they do, and their individual habits. To try to estimate the dose to the MEI, one tries to find that population subgroup (and more specifically, the one individual) that potentially has the highest exposure, intake, etc. This becomes the MEI.
mixed waste	Waste that contains a hazardous waste component regulated under Subtitle C of the RCRA and a radioactive component consisting of source, special nuclear, or byproduct material regulated under the federal Atomic Energy Act (AEA).
mrem	Millirem. See definition of rem. The dose equivalent that is one-thousandth of a rem.
NEPA	National Environmental Policy Act. This federal legislation, passed in 1969, requires federal agencies to evaluate the impacts of their proposed actions on the environment before decision making. One provision of NEPA requires the preparation of an EIS by federal agencies when major actions significantly affecting the quality of the human environment are proposed.
NESHAP	National Emission Standards for Hazardous Air Pollutants. These standards are found in the CAA; they set limits for such pollutants as beryllium and radionuclides.
nonhazardous waste	Chemical waste regulated under the Solid Waste Act, Toxic Substances Control Act, and other regulations, including asbestos, PCB, infectious

	wastes, and other materials that are controlled for reasons of health, safety, and security.
NPDES	National Pollutant Discharge Elimination System. This federal program, under the Clean Water Act, requires permits for discharges into surface waterways.
nuclide	A species of atom characterized by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, number of neutrons, and energy content—or alternately, by the atomic number, mass number, and atomic mass. To be a distinct nuclide, the atom must be capable of existing for a measurable length of time.
outfall	The location where wastewater is released from a point source into a receiving body of water.
PCB	Polychlorinated biphenyls. A family of organic compounds used since 1926 in electric transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCB are extremely persistent in the environment because they do not break down into new and less harmful chemicals. PCB are stored in the fatty tissues of humans and animals through the bioaccumulation process. EPA banned the use of PCB, with limited exceptions, in 1976.
PDL	Public Dose Limit. The new term for Radiation Protection Standards, a standard for external and internal exposure to radioactivity as defined in DOE Order 5400.5 (see Appendix A and Table A-1).
perched groundwater	A groundwater body above a slow-permeablity rock or soil layer that is separated from an underlying main body of groundwater by a vadose zone.
person-rem	A quantity used to describe the radiological dose to a population. Population doses are calculated according to sectors, and all people in a sector are assumed to get the same dose. The number of person-rem is calculated by summing the modeled dose to all receptors in all sectors. Therefore, person-rem is the sum of the number of people times the dose they receive.
pH	A measure of the hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.
pollution	Levels of contamination that may be objectionable (perhaps because of a threat to health [see contamination]).
point source	An identifiable and confined discharge point for one or more water pollutants, such as a pipe, channel, vessel, or ditch.
ppb	Parts per billion. A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or ng/mL. Also used to express the weight/weight ratio as ng/g or µg/kg.
ppm	Parts per million. A unit measure of concentration equivalent to the

	weight/volume ratio expressed as mg/L. Also used to express the weight/weight ratio as µg/g or mg/kg.
QA	Quality assurance. Any action in environmental monitoring to ensure the reliability of monitoring and measurement data. Aspects of quality assurance include procedures, interlaboratory comparison studies, evaluations, and documentation.
QC	Quality control. The routine application of procedures within environmental monitoring to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.
rad	Radiation absorbed dose. The rad is a unit for measuring energy absorbed in any material. Absorbed dose results from energy being deposited by the radiation. It is defined for any material. It applies to all types of radiation and does not take into account the potential effect that different types of radiation have on the body. 1 rad = 1,000 millirad (mrad)
radionuclide	An unstable nuclide capable of spontaneous transformation into other nuclides through changes in its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.
RESRAD	A computer modeling code designed to model radionuclide transport in the environment.
RCRA	Resource Conservation and Recovery Act of 1976. RCRA is an amendment to the first federal solid waste legislation, the Solid Waste Disposal Act of 1965. In RCRA, Congress established initial directives and guidelines for EPA to regulate hazardous wastes.
release	Any discharge to the environment. Environment is broadly defined as water, land, or ambient air.
rem	Roentgen equivalent man. The rem is a unit for measuring dose equivalence. It is the most commonly used unit and pertains only to people. The rem takes into account the energy absorbed (dose) and the biological effect on the body (quality factor) from the different types of radiation. rem = rad × quality factor 1 rem = 1,000 millirem (mrem)
SAL	Screening Action Limit. A defined contaminant level that if exceeded in a sample requires further action.
SARA	Superfund Amendments and Reauthorization Act of 1986. This act modifies and reauthorizes CERCLA. Title III of this act is known as the Emergency Planning and Community Right-to-Know Act of 1986.

saturated zone	Rock or soil where the pores are completely filled with water, and no air is present.
SWMU	Solid waste management unit. Any discernible site at which solid wastes have been placed at any time, regardless of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid wastes have been routinely and systematically released, such as waste tanks, septic tanks, firing sites, burn pits, sumps, landfills (material disposal areas), outfall areas, canyons around LANL, and contaminated areas resulting from leaking product storage tanks (including petroleum).
terrestrial radiation	Radiation emitted by naturally occurring radionuclides such as internal radiation source; the natural decay chains of uranium-235, uranium-238, or thorium-232; or cosmic-ray-induced radionuclides in the soil.
TLD	Thermoluminescent dosimeter. A material (the Laboratory uses lithium fluoride) that emits a light signal when heated to approximately 300°C. This light is proportional to the amount of radiation (dose) to which the dosimeter was exposed.
TRU	Transuranic waste. Waste contaminated with long-lived transuranic elements in concentrations within a specified range established by DOE, EPA, and Nuclear Regulatory Agency. These are elements shown above uranium on the chemistry periodic table, such as plutonium, americium, and neptunium, that have activities greater than 100 nanocuries per gram.
TSCA	Toxic Substances Control Act. TSCA is intended to provide protection from substances manufactured, processed, distributed, or used in the United States. A mechanism is required by the act for screening new substances before they enter the marketplace and for testing existing substances that are suspected of creating health hazards. Specific regulations may also be promulgated under this act for controlling substances found to be detrimental to human health or to the environment.
tuff	Rock formed from compacted volcanic ash fragments.
uncontrolled area	An area beyond the boundaries of a controlled area (see controlled area in this glossary).
unsaturated zone	See vadose zone in this glossary.
UST	Underground storage tank. A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10% or more of the volume of the tank system is below the surface of the ground.
vadose zone	The partially saturated or unsaturated region above the water table that does not yield water for wells. Water in the vadose zone is held to rock

	or soil particles by capillary forces and much of the pore space is filled with air.
water table	The water level surface below the ground at which the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer would fill with water.
water year	October through September.
watershed	The region draining into a river, a river system, or a body of water.
wetland	A lowland area, such as a marsh or swamp, that is inundated or saturated by surface water or groundwater sufficient to support hydrophytic vegetation typically adapted for life in saturated soils.
wind rose	A diagram that shows the frequency and intensity of wind from different directions at a particular place.
worldwide fallout	Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

Acronyms and Abbreviations

AA-2	Internal Assessment Group (LANL)
AEC	Atomic Energy Commission
AIP	Agreement in Principle
AIRFA	American Indian Religious Freedom Act
AIRNET	Air Monitoring Network
AL	Albuquerque Operations Office (DOE)
AO	Administrative Order
AQCR	Air Quality Control Regulation (New Mexico)
ARPA	Archeological Resources Protection Act
ATDSR	Agency for Toxic Substances and Disease Registry
BAER	Burned Area Rehabilitation Team
BCG	Biota Concentration Guides
BEIR	biological effects of ionizing radiation
BOD	biochemical/biological oxygen demand
BRMP	Biological Redources Management Plan
BSRL	baseline statistical reference level
BTEX	total aromatic hydrocarbon
Btu	British thermal unit
C	Chemistry Division
CAA	Clean Air Act
C-ACS	Analytical Chemistry Services Group
CAS	Connected Action Statement
CCNS	Concerned Citizens for Nuclear Safety
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRO	Community Relations Office (LANL)
CMR	Chemistry and Metallurgy Research (LANL building)
CO	compliance order
COC	chain-of-custody
COD	chemical oxygen demand
COE	Army Corps of Engineers
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
CY	calendar year
DAC	derived air concentration (DOE)
DARHT	Dual Axis Radiographic Hydrotest facility
DCG	Derived Concentration Guide (DOE)
D&D	decontamination and decommissioning
DEC	DOE Environmental Checklist
DOE	Department of Energy
DOE-EM	DOE, Environmental Management
DOU	Document of Understanding

EA	Environmental Assessment
EDE	effective dose equivalent
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Restoration
ESH	Environment, Safety, & Health
ESH-4	Health Physics Measurements Group (LANL)
ESH-13	ESH Training Group (LANL)
ESH-14	Quality Assurance Support Group (LANL)
ESH-17	Air Quality Group (LANL)
ESH-18	Water Quality & Hydrology Group (LANL)
ESH-19	Hazardous & Solid Waste Group (LANL)
ESH-20	Ecology Group (LANL)
ESO	Environmental Stewardship Office (LANL)
EST	Ecological Studies Team (ESH-20)
FFCA	Federal Facilities Compliance Agreement
FFCAct	Federal Facilities Compliance Act
FFCAgreement	RCRA Federal Facility Compliance Agreement
FFCO	Federal Facility Compliance Order
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FIMAD	Facility for Information Management, Analysis, and Display
FONSI	Finding of No Significant Impact
FWO	Facilities and Waste Operations Division (LANL)
FY	fiscal year
GENII	Generation II
GIS	geographic information system
G/MAP	gaseous/mixed air activation products
GPS	global positioning system
GWPMPP	Groundwater Protection Management Program Plan
HAP	hazardous air pollutants
HAZWOPER	hazardous waste operations (training class)
HE	high-explosive
HEWTP	High-Explosive Wastewater Treatment Plant
HMPT	Hazardous Materials Packaging and Transportation
HPTL	High Pressure Tritium Labortory
HPAL	Health Physics Analytical Laboratory
HSWA	Hazardous and Solid Waste Amendments
HWA	Hazardous Waste Act (New Mexico)
HWMR	Hazardous Waste Management Regulations (New Mexico)
ICRP	International Commission on Radiological Protection
IRMP	Integrated Resources Management Plan

JCNNM	Johnson Controls Northern New Mexico
JENV	JCNNM Environmental Laboratory
LAAO	Los Alamos Area Office (DOE)
LANSCE	Los Alamos Neutron Science Center
LANL	Los Alamos National Laboratory (or the Laboratory)
LEDA	Low-Energy Demonstration Accelerator
LLW	low-level radioactive waste
LLMW	low-level mixed waste
LOD	limits of detection
LOQ	limit of quantitation
MAP	Mitigation Action Plan
MCL	maximum contaminant level
MDA	minimum detectable activity
MEI	maximally exposed individual
MRL	minimum risk level
MSGP	Multi-Sector General Permit
NAGPRA	Native American Grave Protection and Repatriation Act
NCB	NEPA, Cultural, and Biological
NCF	neutron correction factor
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NERF	NEPA Review Form
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEWNET	Neighborhood Environmental Watch Network
NHPA	National Historic Preservation Act
NMDA	New Mexico Department of Agriculture
NMDOB	New Mexico DOE Oversight Bureau
NMED	New Mexico Environment Department
NMED-SWQB	New Mexico Environment Department’s Surface Water Quality Bureau
NMEIB	New Mexico Environmental Improvement Board
NMWQCA	New Mexico Water Quality Control Act
NMWQCC	New Mexico Water Quality Control Commission
NPDES	National Pollutant Discharge Elimination System
NRC	US Nuclear Regulatory Commission
NTISV	Nontraditional In Situ Vitrification
NWP	Nationwide Work Permit
OB/OD	open burning/open detonation
OCP	organochlorine pesticides
ODS	ozone depleting substance
O&G	oil and grease
OHL	Occupational Health Laboratory (LANL)
OSHA	Occupational Safety and Health Act/Administration
PCB	polychlorinated biphenyls
PDL	public dose limit

PE	performance evaluation
PHERMEX	Pulsed high-energy radiographic machine emitting x-rays
ppb	parts per billion
ppm	parts per million
PRS	potential release site
P/VAP	particulate/vapor activation products
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
RAC	Risk Assessment Corporation
RAWS	Remote Automated Weather System
RCRA	Resource Conservation and Recovery Act
RD&D	research, development, and demonstration
RESRAD	residual radioactive material computer code
RLWTF	Radioactive Liquid Waste Treatment Facility (LANL)
RSRL	regional statistical reference level
SA	supplement assessment
SAL	screening action level
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SEA	Special Environmental Analysis
SHPO	State Historic Preservation Officer (New Mexico)
SLD	Scientific Laboratory Division (New Mexico)
SOC	synthetic organic compound
SOW	statement of work
SPCC	Spill Prevention Control and Countermeasures
SVOC	semivolatile organic compound
SWA	Solid Waste Act
SWEIS	site-wide environmental impact statement
SWIPO	Site-Wide Projects Office
SWPP	Storm Water Prevention Plan
SWMR	solid waste management regulations
SWMU	solid waste management unit
SWS	Sanitary Wastewater Systems Facility (LANL)
TA	Technical Area
TDS	total dissolved solids
T&E	threatened and endangered
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
TLDNET	thermoluminescent dosimeter network
TRI	toxic chemical release inventory
TRU	transuranic waste
TRPH	total recoverable petroleum hydrocarbon
TSCA	Toxic Substances Control Act
TSFF	Tritium Science and Fabrication Facility

TSS	total suspended solids
TTHM	total trihalomethane
TWISP	Transuranic Waste Inspectable Storage Project (LANL)
UC	University of California
USFS	United States Forest Service
USGS	United States Geological Survey
UST	underground storage tank
VAP	vaporous activation products
VCA	voluntary corrective action
VOC	volatile organic compound
WASTENET	Waste Management Areas Network (for air monitoring)
WETF	Weapons Engineering Tritium Facility
WM	Waste Management (LANL)
WSC	Waste Stream Characterization
WWW	World Wide Web

Elemental and Chemical Nomenclature

Actinium	Ac
Aluminum	Al
Americium	Am
Argon	Ar
Antimony	Sb
Arsenic	As
Astatine	At
Barium	Ba
Berkelium	Bk
Beryllium	Be
Bicarbonate	HCO_3
Bismuth	Bi
Boron	B
Bromine	Br
Cadmium	Cd
Calcium	Ca
Californium	Cf
Carbon	C
Cerium	Ce
Cesium	Cs
Chlorine	Cl
Chromium	Cr
Cobalt	Co
Copper	Cu
Curium	Cm
Cyanide	CN
Carbonate	CO_3
Dysprosium	Dy
Einsteinium	Es
Erbium	Er
Europium	Eu
Fermium	Fm
Fluorine	F
Francium	Fr
Gadolinium	Gd
Gallium	Ga
Germanium	Ge
Gold	Au
Hafnium	Hf
Helium	He
Holmium	Ho
Hydrogen	H
Hydrogen oxide	H_2O
Indium	In
Iodine	I
Iridium	Ir
Iron	Fe
Krypton	Kr
Lanthanum	La
Lawrencium	Lr (Lw)
Lead	Pb
Lithium	Li
Lithium fluoride	LiF
Lutetium	Lu
Magnesium	Mg
Manganese	Mn
Mendelevium	Md
Mercury	Hg
Molybdenum	Mo
Neodymium	Nd
Neon	Ne
Neptunium	Np
Nickel	Ni
Niobium	Nb
Nitrate (as Nitrogen)	NO_3-N
Nitrite (as Nitrogen)	NO_2-N
Nitrogen	N
Nitrogen dioxide	NO_2
Nobelium	No
Osmium	Os
Oxygen	O
Palladium	Pd
Phosphaeus	P
Phosphate (as Phosphous)	PO_4-P
Platinum	Pt
Plutonium	Pu
Polonium	Po
Potassium	K
Praseodymium	Pr
Promethium	Pm
Protactinium	Pa
Radium	Ra
Radon	Rn
Rhenium	Re
Rhodium	Rh
Rubidium	Rb
Ruthenium	Ru
Samarium	Sm
Scandium	Sc
Selenium	Se
Silicon	Si
Silver	Ag
Sodium	Na
Stronium	Sr
Sulfate	SO_4
Sulfite	SO_3
Sulfur	S
Tantalum	Ta
Technetium	Tc
Tellurium	Te
Terbium	Tb
Thallium	Tl
Thorium	Th
Thulium	Tm
Tin	Sn
Titanium	Ti
Tritiated water	HTO
Tritium	^3H
Tungsten	W
Uranium	U
Vanadium	V
Xenon	Xe
Ytterbium	Yb
Yttrium	Y
Zinc	Zn
Zirconium	Zr

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