5. Surface Water, Groundwater, and Sediments

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Highlights from 1996

The 1996 analysis results for the surface water program are consistent with past findings. The most notable observation for 1996 was a finding of low levels of high explosives in Frijoles Canyon at the Bandelier National Monument Headquarters. High explosives were also detected in Water Canyon below Technical Area 16. Gaging stations with automated samplers have recently been installed at numerous locations around the Los Alamos National Laboratory (LANL or the Laboratory). Beginning in 1996, environmental surveillance runoff samples are collected using the automated samplers. The samplers are actuated when a significant precipitation event causes flow in a drainage crossing the Laboratory's eastern or western boundaries. The sample collected on October 11, 1996, from the bank at the Rio Grande at Otowi contained americium-241 and plutonium-238 at levels close to the detection limits. 1995 sampling results indicated low levels of americium-241 at this station. These samples may reflect the presence of flood plain deposits from Los Alamos Canyon north of the current channel. Storm water runoff samples collected at Cañada del Buey at White Rock and Ancho Canyon near Bandelier contained unusually high uranium levels. Most of the uranium was present in the suspended sediments. The concentration in the suspended sediments was within the range of background uranium in Bandelier Tuff.

Groundwater sample results from the main aquifer were consistent with previous years' results. Results from water supply wells are discussed separately. Trace levels of tritium are present in test wells in a few areas where former or present liquid waste discharges occurred, notably beneath Los Alamos, Pueblo, and Mortandad Canyons. The highest main aquifer tritium level is about 2% of the drinking water standard and poses no health risk according to the US Public Health Service. Continued special sampling of test wells in which possible strontium-90 detections occurred in 1994 shows no detectable levels, suggesting that the 1994 values may not have been true detections. Nitrate (as nitrogen) levels in a test well beneath Pueblo Canyon continue to be high, but in 1996 were only about half the drinking water standard. Analysis results for alluvial and intermediate depth groundwaters are similar to those of past years. Waters near former or present effluent discharge areas show the effects of these discharges; however, radionuclide activities are below Department of Energy dose concentration guidelines for public exposure.

Analytical results from the 1996 sediment samples are consistent with historical data. The majority of the sediment samples collected outside known radioactive effluent release areas were within background levels that reflect worldwide fallout. Many sediment samples from known radioactive effluent release areas, including Acid/Pueblo, DP/Los Alamos, and Mortandad Canyons, exceeded worldwide fallout levels for tritium, strontium-90, cesium-137, plutonium, and americium-241, and alpha, beta, and gamma activities. Sediments from Mortandad Canyon sampling stations at GS-1, MCO-5, and MCO-7 showed cesium-137 values that exceeded screening action levels; however, these results are consistent with previously reported values. Results of the radiochemical analyses of the large 1 kg samples collected in 1996 from Heron, El Vado, Abiquiu, Cochiti, and Rio Grande Reservoirs are also similar to those from previous years. All of these sample results were below their respective background levels except for some of the Cochiti Reservoir samples. Samples from the upper, middle, and lower sediment stations in Cochiti Reservoir showed possible detections of strontium-90; while the sample from the middle station showed elevated levels for cesium-137, plutonium-238, and plutonium-239, -240 radioactivity.

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5. Surface Water, Groundwater, and Sediments

A. Description of Monitoring Program

Studies related to development of groundwater supplies began at Los Alamos in 1945 and 1946 under the direction of the US Geological Survey (USGS). Studies specifically aimed at environmental monitoring and at protecting groundwater quality were initiated as joint efforts between the Atomic Energy Commission (AEC), the Los Alamos Scientific Laboratory, and the USGS in about 1949. These initial efforts were 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 are used to evaluate the background quantities of radionuclides and radioactivity derived from natural rock-forming minerals and from fallout affecting northern New Mexico and southern Colorado. Groundwater samples are taken from wells and springs within or adjacent to the Laboratory and from the nearby Pueblo of San Ildefonso. The on-site stations are for the most part focused on areas of present or former radioactive waste disposal operations, particularly canyons (Figure 1-3). To provide 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. These canyons have been the subject of numerous studies to evaluate environmental and health effects of Laboratory operations, as well as continual surveillance monitoring since the early days of the Laboratory, and are a high priority for remedial work by the Environmental Restoration (ER) Project. These descriptions are not intended as a complete inventory of past Laboratory discharges.

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, discharged treated effluents that contained residual radionuclides. Most of the residual radioactivity from these releases is now associated with the sediments in Pueblo Canyon. Based on analysis of radiological sediment survey data using arithmetic means, the estimated total plutonium inventory in Acid Canyon, Pueblo Canyon, and Lower Los Alamos Canyon is about 630 ± 300 mCi; using geometric means, the value is 246 mCi (ESG 1981). The estimated plutonium releases were about 177 mCi, in satisfactory agreement with the plutonium 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. Several studies (ESG 1981, Ferenbaugh et al., 1994) have concluded that the plutonium does not present a health risk to the public.

Pueblo Canyon currently receives treated sanitary effluent from the Los Alamos County Bayo Sewage Treatment Plant in the middle reach of Pueblo Canyon. Water 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 the main 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.

Increased discharge of sanitary effluent from the county treatment plant, starting in 1990, 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 Pueblo of San Ildefonso 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 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/Pueblo of San Ildefonso 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. In the upper reach of Los Alamos Canyon there were releases of treated and untreated radioactive effluents during the earliest Manhattan Project operations at TA-1 (late 1940s) and some release of water and radionuclides from the research reactors at TA-2. 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. 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.

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-2, TA-53, and TA-21. Infiltration of NPDES-permitted effluents and natural runoff from the stream channel maintains a shallow body of groundwater in the alluvium of Los Alamos Canyon within the Laboratory boundary west of State Road 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. Alluvial perched groundwater also occurs in the lower portion of Los Alamos Canyon on the Pueblo of San Ildefonso lands. This alluvium is not continuous with the alluvium within the Laboratory.

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 and treated effluents from the TA-46 Sanitary Wastewater Systems Consolidation (SWSC) plant. These effluents support a continuous flow in a short reach of the upper part of the canyon, but only during summer thundershowers does stream flow reach the Laboratory boundary at State Road 4 and only during periods of heavy thunderstorms or snowmelt does surface flow from Sandia Canyon extend beyond the Laboratory boundary.

4. Mortandad Canyon

Mortandad Canyon has a small drainage area that heads at TA-3. Its drainage area presently receives inflow from natural precipitation and a number of NPDES-permitted effluents, including one from the radioactive Liquid Waste Treatment Facility at TA-50. The TA-50 facility began operations in 1963. The TA-50 effluents infiltrate 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 is on-site, about 1.6 km (1 mi) west of the Laboratory boundary with the Pueblo of San Ildefonso. In addition to residual radionuclides, the effluent contains nitrates that often cause groundwater concentrations to exceed the New Mexico groundwater standard of 10 mg/L (nitrate as nitrogen). The groundwater standard applies because the TA-50 effluent infiltrates the alluvium in the canyon. In order to address these problems, the Laboratory is working to upgrade the TA-50 treatment process.

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

The alluvium is less than 1.5 m (5 ft) thick in the upper reach of Mortandad Canyon and thickens to about 23 m (75 ft) at the easternmost extent of saturation. The saturated portion of the alluvium is perched on weathered and unweathered tuff and is generally no more than 3 m (10 ft) thick. 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 perched alluvial groundwater ranges from 18 m/day (59 ft/day) in the upper reach to about 2 m/day (7 ft/day) in the lower reach of the canyon (Purtymun 1974 and Purtymun et al., 1983). The top of the main aquifer is about 290 m (950 ft) below the perched alluvial groundwater.

5. Pajarito Canyon

In Pajarito Canyon, water in the alluvium is perched on the underlying tuff and is recharged mainly through snowmelt, thunderstorm runoff, and some NPDES-permitted effluents. 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 perched groundwater was found to be contained in the canyon bottom and did not extend under the mesa (Devaurs 1985).

6. Cañada del Buey

Cañada del Buey contains a shallow alluvial perched groundwater system of limited extent. The thickness of the alluvium ranges from 1.2 to 5 m (4 to 17 ft), but the underlying weathered tuff ranges in thickness from 3.7 to 12 m (12 to 40 ft). In 1992, saturation was found within only an 0.8-km (0.5-mi) long segment, and only two observation wells have ever contained water (ESP 1994). The apparent source of the saturation is purge water from nearby municipal water supply well PM-4, as the alluvium is dry upstream of the purge water entry point. Because treated effluent from the Laboratory's SWSC project 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 SWSC project was completed in late 1992.

B. Surface Water Sampling

1. Introduction

Surface waters from regional and Pajarito Plateau stations are monitored to evaluate the environmental effects of LANL operations. There are no perennial surface water flows that extend completely across the Laboratory in any of the canyons. Periodic natural surface runoff occurs in two modes: (1) spring snowmelt runoff that occurs over highly variable periods of time (days to weeks) at a low discharge rate and sediment load, and (2) summer runoff from thunderstorms that occurs over a short period of time (hours) at a high discharge rate and sediment load. None of the surface waters within the Laboratory are a source of municipal, industrial, or irrigation water. The waters are used by wildlife. Concentrations of radionuclides in surface water samples may be compared to either the DOE-Derived Concentration Guides (DCGs) or the New Mexico Water Quality Control Commission (NMWQCC) stream standards, which reference the New Mexico Health and Environment Department Environmental Improvement Division's New Mexico Radiation Protection Regulations (part 4, Appendix A). However, New Mexico radiation levels are in general two orders of magnitude greater than the DOE DCGs for public dose, so only the DCGs will be discussed here. The concentrations of nonradioactive constituents may be compared with the NMWQCC General, and Livestock Watering stream standards. The NMWQCC groundwater standards can also be applied in cases where groundwater discharge may affect stream water quality.

2. Monitoring Network

Two types of surface water samples are collected from regional stations and Pajarito Plateau stations surrounding the Laboratory. Surface water grab samples are collected annually from locations where effluent discharges or spring flows maintain stream flow. Runoff samples have historically been collected as grab samples during or shortly after precipitation events. As of 1996, runoff samples are collected using gaging stations with automated samplers (Shaull et al., 1996). Samples are collected when a significant precipitation event causes flow in a drainage crossing the Laboratory's eastern or western boundaries.

Regional surface water samples (Figure 5-1) were collected from five stations on the Rio Grande and the Jemez River. These waters provide background data from areas beyond the Laboratory boundary. Historically, samples have been collected at stations on the Rio Grande at Embudo, Otowi, Frijoles Canyon, Cochiti, and Bernalillo. In 1996, the stations on the Rio Grande at Embudo and Bernalillo and the station on the Rio Chama were not collected.

Surface water monitoring stations located on the Pajarito Plateau are shown in Figure 5-2. The stations monitor water quality effects of past or potential contaminant sources such as industrial or NPDES outfalls and effects of nonpoint sources, including possible soil contamination sites.

3. Radiochemical Analytical Results

The results of radiochemical analyses for surface water samples for 1996 are listed in Tables 5-1 and 5-2. All of these analytical results are below the DOE DCGs for public dose. The majority of the results are near or below the detection limits of the analytical methods used and are below the DOE DCGs for drinking water systems except for samples from Mortandad at GS-1 (plutonium-239, -240 and americium-241). Most of the measurements at or above detection limits are from locations with previously known contamination: Acid/Pueblo Canyon, DP/Los Alamos Canyon, and Mortandad Canyon.

Tables 5-3 and 5-4 contain lists of radionuclides detected in water samples and of possible detections, according to criteria discussed in Section 5.F.4. Because uranium, gross alpha, and gross beta are ubiquitous at detectable levels, occurrences of these measurements above significant levels (chosen to be below the EPA maximum contaminant levels [MCLs] or screening levels) are reported. The specific values are 5 µg/L for uranium, 10 pCi/L for gross alpha, and 40 pCi/L for gross beta.

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.

a. Radiochemical Analytical Results for Surface Water. In 1995 and 1996, samples collected at the Rio Grande at Otowi and the Rio Grande at Frijoles were collected from the bank and as a width integrated sample collected from a transect across the river. Historically, samples have only been collected from the bank. The bank samples have been collected from the western bank of the river. The Rio Grande at Otowi sample is taken upstream of Los Alamos Canyon and was expected to show no Laboratory-derived contamination. The analytical result from a water sample collected there on May 9, 1995, showed americium-241 at levels of 0.054 ± 0.017 pCi/L. A sample collected on September 15, 1995, at the same location contained americium-241 at 0.05 ± 0.03 pCi/L, a questionable result because of higher uncertainty. The sample collected on October 11, 1996, from the bank at the Rio Grande at Otowi contained americium-241 levels of 0.068 ± 0.028 pCi/L and plutonium-238 levels of 0.110 ± 0.027 pCi/L, both regarded as possible detections at 2.33 times the uncertainty (σ). (See Section 5.F.4. for an explanation of the 2.33 σ and 4.66 σ screening level.) Gross beta in the 1996 sample further suggests the presence of low levels of radionu-clides. With the exception of the gross beta value, these measurements are all very close to the detection limits, and none exceed any standards. None of these mea-surements meet the 4.66 σ detection criteria (except gross beta) but the repeated observation of contamina-tion suggests that there may be a low level source.

Graf (1993) indicates a flood plain deposit from Los Alamos Canyon just south of the Otowi Bridge along the west bank of the Rio Grande. The flood occurred in either 1958 or 1967. The presence of this deposit and the absence of radionuclides in the width-integrated sample are consistent with a LANL source. However, plutonium and americium are both present in worldwide fallout. The activities measured in these samples are so close to the detection limits that it is difficult to determine if these samples represent Laboratory influence, fallout, or random fluctuations in the detection limit.

Strontium-90 was a possible detection in the Jemez River at 3.2 ± 1.0 pCi/L. There is no obvious source of strontium-90 above this location except fallout. Past sampling at this location has shown no detections of strontium-90.

There were possible detections of americium-241 (0.056 ± 0.020 pCi/L) and plutonium-239, -240 (0.044 ± 0.016 pCi/L) at SCS-3 in Sandia Canyon and a detection of tritium (719 ± 80 pCi/L) at SCS-1. High gross gamma readings were also observed at SCS-2. Most of the values were very close to detection limits and were regarded as possible detections or detections because of low uncertainties associated with the measurements. There have been occasional detections of low levels of plutonium and americium in Sandia Canyon in the past.

Americium-241 was detected (0.055 ± 0.017) in surface water at Cañada del Buey in 1995. No sample was collected at this location in 1996 because there was no water at the station.

There was a detection of americium-241 at Frijoles Canyon at the Bandelier National Monument Head-quarters, slightly above the 4.66 σ level, (0.17 ± 0.035 pCi/L) from a sample collected on June 2, 1995. Two subsequent samples showed no detectable radiation.

b. Radiochemical Analytical Results for Runoff. Automated samplers were used to collect runoff samples whenever precipitation events caused significant runoff at the Laboratory boundaries. See Section 5.F.1 for a description of the runoff samplers and sampling protocols.

The distribution of contaminants between the dissolved and suspended phases was measured by filtering a sample and analyzing the filtrate and the portion retained by the filter. Total activity and the percent dissolved are reported at the bottom of Table 5-2. The total activity is the sum of dissolved activity and the suspended concentration. The suspended activity is converted to a per volume activity using the suspended sediment value. The value reported as the percent dissolved represents the fraction of contami-nants that passed through a 0.45 micron filter. If more than one analysis was performed, the average of the values is reported for the total.

The samples collected at Los Alamos Canyon near Los Alamos were inadvertently analyzed unfiltered, and only the total activity is reported. The total activity includes the radionuclides associated with the suspended sediments. Possible detections of cesium-137; plutonium-238; and detectable levels of strontium-90; americium-241; and plutonium-239, -240 were observed in runoff in Los Alamos Canyon and were consistent with earlier findings.

In 1996, there was a possible detection of cesium-137 (3.3 ± 1.3 pCi/L) in the runoff sample collected at Ancho Canyon near Bandelier (Table 5-4). Strontium-90 was below detection limits in this sample but was detected (50.9 pCi/L) in runoff collected in 1995.

The total concentration of uranium in the runoff sample collected at Cañada del Buey near White Rock (25.3 ± 1.0 μg/L) exceeded the proposed EPA Primary Drinking Water Standard of 20 μg/L. The total concentration of uranium in the sample collected at Ancho Canyon near Bandelier (31.5 ± 1.1 μg/L) exceeded the proposed EPA Primary Drinking Water Standard (20 μg/L) and the DOE Drinking Water System DCG (30 μg/L). In these two samples, one and five percent, respectively, of the uranium was in the dissolved fraction. Both of these standards are established to protect potable water supplies and are not applicable to surface water runoff. The standards are mentioned here only to provide some perspective on the numbers. The levels of uranium in the dissolved fraction are well below standards.

Background concentrations of uranium in Bandelier Tuff range from 2 to 8 mg/kg (Longmire et al., 1996). The average concentrations of uranium in the runoff samples collected at Cañada del Buey near White Rock and Ancho Canyon near Bandelier were 2.8 and 6.5 mg/kg. This suggests that the uranium found in these samples may be naturally occurring in the Bandelier Tuff.

c. Technical Area 50 Discharges. The cumulative discharge of radionuclides from the TA-50 radioactive liquid waste treatment facility into Mortandad Canyon between 1963 and 1977, and yearly discharge data for 1994 through 1996 are given in Table 5-5. In addition to total annual activity released for 1994 through 1996, Table 5-5 also shows mean annual activities in effluent for each radionuclide, and the ratio of this activity to the DCG. In 1996 the DCG was exceeded for americium-241 and for plutonium-238. For 1996 the effluent nitrate concentration exceeded the New Mexico groundwater standard of 10 mg/L (nitrate as nitrogen).

d. Ingestion of Water from the Technical Area 50 Effluent and the Stream Below the Outfall. Table 5-6 presents the summary of the committed effective dose equivalent (CEDE) from the ingestion of water collected in 1996 from the TA-50 effluent. A surface water sample was collected at GS-1 in Mortandad Canyon and is used to estimate the CEDE for someone consuming water from the stream below the outfall. Because no water is derived from Mortandad Canyon for drinking, industrial, or agricultural purposes, comparisons with the standards for drinking water are inappropriate and were not made. The CEDEs provided below are based on a per liter of water intake and an exercise scenario where a jogger or hiker drinks from the TA-50 effluent or the stream directly below the outfall.

By providing the CEDE on a per liter basis, the reader is able to determine his or her own level of intake of water from these sources and multiply this intake by the CEDE figures provided in the table. The total CEDE on a per liter intake basis for these sources is 1.2 mrem and 0.048 mrem per liter of water consumed from the TA-50 effluent and the stream directly below the outfall, respectively. The radionuclides that contributed more than 5% to the CEDE are plutonium-238, plutonium-239, and americium-241.

Using an exercise scenario and an hourly intake rate of 0.3 ± 0.3 L/h (McNall 1974), the maximum amount of water consumed per year from each source is 16.1 L. The total CEDE for this scenario using this consumption rate is 19 mrem and 0.77 mrem for the TA-50 effluent and the stream directly below the outfall, respectively. The radionuclides that contributed more than 5% to these CEDEs are plutonium-238; plutonium-239, -240; and americium-241.

4. Nonradiochemical Analytical Results

a. Major Chemical Constituents. The results of major chemical constituents analyses in surface water and runoff samples for 1996 are listed in Tables 5-7 and 5-8, respectively. The results are generally consistent with those observed in previous years, with some variability. The measurements in waters from areas receiving effluents show the effects of these effluents. None of the results exceed standards except for some pH measurements above 8.5.

b. Trace Metals. The results of trace metal analyses on surface water and runoff samples for 1996 are listed in Tables 5-9 and 5-10, respectively. The levels are generally consistent with previous observations. As with the radiochemical samples, samples were collected from the bank and as width-integrated samples at the Rio Grande at Otowi and the Rio Grande at Frijoles.

In 1995, the EPA action level (15 μg/L) was exceeded for lead at the Rio Grande at Frijoles for the width-integrated sample. The sample collected from the bank showed a lead concentration a factor of three lower than the width-integrated sample. Both the width-integrated and the bank samples collected at the Rio Grande at Frijoles in 1996 were at or below the detection limits for lead.

In 1995, a barium concentration of 520 µg/L was measured in the sample collected at Water Canyon at Beta, compared to a NMWQCC groundwater limit of 1,000 µg/L. This sample also had an elevated level of nitrates. The presence of these contaminants and the proximity of the sample location to TA-16 suggested high explosives contamination. The sample collected at Water Canyon at Beta in 1996 also contains levels (about 400 mg/L) of barium that are higher than those normally observed in surface water on the Pajarito Plateau. Analyses confirm the presence of high explosives at Water Canyon at Beta (see discussion in Section 5.B.4.d).

In 1996, runoff samples collected at Cañada del Buey near White Rock and Ancho Canyon near Bandelier contained similarly high levels of barium (480 and 810 µg/L, respectively). No high explosives were detected in either of these samples.

In 1995, the NMWQCC groundwater limit was apparently exceeded for silver at all three stations in Sandia Canyon (SCS-1, SCS-2, and SCS-3), but high uncertainties associated with those measurements cast doubt on this conclusion. In 1996, no surface water samples exceeded standards for silver with all measurements below or near detection limits.

The analytical detection limit (0.2 µg/L) is not adequate to determine if mercury is present in excess of the New Mexico Wildlife Habitat stream standard of 0.012 µg/L. In 1996, mercury was not observed above the detection limit (0.2 µg/L) at any location with the exception of a measurement of 0.3 µg/L for one of two measurements in DP Canyon at DPS-4. The other measurement found the concentration to be below the detection limit.

Aluminum, iron, and manganese concentrations exceed EPA secondary drinking water standards at most locations. The results reflect the presence of suspended solids in the water samples. Because the metals analyses are performed on unfiltered water samples, the results are due to naturally occurring metals (e.g., aluminum, iron, and manganese), which comprise the suspended solids.

Lead values (17 and 45 µg/L) above the EPA action level (15 µg/L) were found in the runoff samples collected at Los Alamos Canyon near Los Alamos. This is the station just upstream of State Road 4 in Los Alamos Canyon. Because of a miscommunication with the analytical laboratory, both analyses were performed on turbid, unfiltered samples. The EPA action limit is not applicable to these sorts of samples but is provided here for perspective. A more appropriate standard, the New Mexico Livestock Watering Limit, is 100 µg/L.

Measurable selenium concentrations were reported for surface waters in 1996. Typically, selenium has not been detected in surface waters on the Pajarito Plateau. These selenium values are not attributed to analytical method changes. Selenium values exceeded the New Mexico Wildlife Habitat Stream Standard (2 µg/L) at numerous locations around the Laboratory. The highest selenium value (18 µg/L) was reported at Pueblo 3 below the Bayo Treatment Plant discharge (Table 5-9).

c. Organics. The locations where organics samples were collected in 1996 are summarized in Table 5-11. Table 5-12 summarizes the organic constituents detected in 1996. (See Section 5.F.2.c. for analytical methods and analytes.) Most of the organic compounds detected in surface waters were tentatively identified compounds (TICs). The number of TICs reported by the analytical laboratory are recorded on Table 5-11. The individual results for TICs are not reported. Phthalates were also measured at numerous locations. Phthalates are common analytical laboratory contaminants.

High explosives were detected at Water Canyon at Beta and at Frijoles at Bandelier Monument Headquarters.

5. Long-Term Trends

Long-term trends of the activity of tritium and total plutonium in surface water in Mortandad Canyon are depicted in Figure 5-3. These measurements were made on samples collected at the station Mortandad at GS-1, which is a short distance downstream of the TA-50 effluent discharge into Mortandad Canyon. Samples collected before 1996 were preserved in the field and filtered through a 0.45-micron filter in the laboratory. The 1996 measurements represented the total (unfiltered) activity. Plutonium values for 1962 to 1966 are for plutonium-239, -240 only. Plutonium-238 was not recorded for those years. If more than one sample is collected in a year, the average value for the year is plotted. In general, there has been a decrease in the combined levels of plutonium-238 and plutonium-239, -240 during the period. All plutonium values exceed the detection limit of 0.04 pCi/L; all tritium activities exceed the detection limit of 700 pCi/L except for a sample collected in April 1988.

C. 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. Accordingly, sediments are sampled in all canyons that cross the Laboratory, including those with either perennial or ephemeral flows. Furthermore, sediments from five regional reservoirs are sampled annually. Routine laboratory analyses for sediment samples include measurements for radioactivity, trace metals, organic compounds, and high-explosive (HE) residuals.

There are no federal or state regulatory standards for soil or sediment contaminants that can be used for direct comparison with analytical surveillance data. Instead, contaminant levels in sediments may be interpreted in terms of toxicity to humans, assuming the contaminated particles are either ingested or inhaled. The data can also be compared to levels attributable to worldwide fallout or natural background levels. Results of radionuclide analyses of sediment samples from regional stations collected annually from 1974 through 1986 were used to establish statistical limits for worldwide fallout levels (Purtymun et al., 1987). In addition, natural background levels have been established for total uranium in northern New Mexico. Fallout levels of radioactivity in sediments have also been established for tritium; strontium-90; cesium-137; uranium; plutonium-238; plutonium-239, -240; americium-241; and for gross alpha, gross beta, and gross gamma activity for the period 1974 to 1996 (McLin and Lyons 1997). The average activity level for each analyte in these samples, plus twice its standard deviation, has been adopted as an indicator of the approximate upper limit for worldwide fallout or natural background activity.

Screening action levels (SALs) are used by the Laboratory's ER Project to identify the presence of contaminants at levels of concern. SAL values are derived from toxicity values and exposure parameters using data from the EPA. Both background activity and SAL values for sediments are listed in tables summarizing analytical results.

Sediments in portions of Pueblo, Los Alamos, and Mortandad Canyons have been affected to varying degrees by contaminant releases from the Laboratory. These canyons have activities of radioactivity in sediments at levels that are significantly higher than levels attributable to worldwide fallout or natural background sources. In Mortandad Canyon, the bulk of contaminated sediments have not moved off-site because three sediment traps have prevented sediments from moving towards the eastern Laboratory boundary. Some of these radionuclides, however, may have migrated off-site onto Pueblo of San Ildefonso lands. Some radioactivity associated with sediments from Pueblo and Los Alamos Canyons has also moved off-site into the Rio Grande.

2. Monitoring Network

Sediment samples are collected from regional stations and Pajarito Plateau stations surrounding the Laboratory. Regional sediment sampling stations (Figure 5-1) are located within northern New Mexico and southern Colorado at distances up to 200 km (124 mi) from the Laboratory. Samples from regional stations provide a basis for determining conditions beyond the influence of Laboratory operations, such as background radionuclide concentrations resulting from fallout. Stations on the Pajarito Plateau (Figures 5-4 and 5-5) are located within about 4 km (2.5 mi) of the Laboratory boundary. They document conditions in areas potentially affected by Laboratory operations.

During 1996, sediment samples were collected from 24 regional and 68 Pajarito Plateau stations. Of the 24 regional samples, 9 are from rivers and 15 from the upper, middle, and lower portions of 5 regional reservoirs. These regional reservoirs include El Vado, Heron, and Abiquiu Reservoirs on the Rio Chama; Cochiti Reservoir on the Rio Grande; and Rio Grande Reservoir on the Rio Grande in southern Colorado.

Of the 68 Pajarito Plateau samples, 21 are specifically related to waste storage sites. Many of the sediment sampling stations on the Pajarito Plateau are located within canyons to monitor sediment transport that is possibly related to past or present effluent release sites. Fifteen plateau samples were collected from San Ildefonso Pueblo.

Sediments from drainages around two radioactive solid waste management areas are sampled. Nine sampling stations were established in 1982 outside the perimeter fence at TA 54, Area G (Figure 5-5a) to monitor possible transport of radionuclides by sheet erosion from the active waste storage and disposal area. From 1959 to 1961, hydronuclear experiments were conducted in underground shafts beneath the surface of the mesa at TA-49, designated Solid Waste Management Area AB (Purtymun and Stoker 1987, ESP 1988). Eleven stations were established in 1972 to monitor surface sediments in drainages surrounding the experimental area at TA-49 (Figure 5-5b). Another station (AB-4A) was added in 1981 as the surface drainage changed.

3. Radiochemical Analytical Result and Dose Equivalents for Sediments

a. Radiochemical Analytical Results. The results of radiochemical analyses of sediment samples collected during 1996 are listed in Table 5-13. Individual analytes that met detection criteria and are above background levels are also summarized in Tables 5-14 and 5-15. Results from the 1996 sediment samples are consistent with previous years' results. The majority of the sediment samples collected outside known radioactive effluent release areas were within background levels that reflect worldwide fallout (Purtymun et al., 1987 and McLin and Lyons 1997a). Many sediment samples from known radioactive effluent release areas, including Acid/Pueblo, DP/Los Alamos, and Mortandad Canyons, exceeded worldwide fallout levels for numerous constituents, including tritium, strontium-90, cesium-137, plutonium, and americium-241 radioactivity, and alpha, beta, and gamma activities. These observed levels are consistent with historical data. Three sediment samples from stations GS-1, MCO-5, and MCO-7 in Mortandad Canyon showed cesium-137 concentration levels that exceeded the SAL value. During 1996, no other sediment samples showed any values that exceeded respective SAL values, although reported values from stations GS-1 and MCO-5 were relatively high for tritium; plutonium-238; plutonium-239, -240; and americium-241 (that is, more than 100 times greater than background levels). These elevated values for radionuclides are consistent with historical values and reflect TA-50 effluent discharges into Mortandad Canyon since 1963.

At TA-54, Area G, a number of stations exceeded background levels for plutonium-238 and plutonium-239, -240. At TA-49, Area AB, a number of sediment stations showed above-background values for cesium-137; plutonium-238; plutonium-239, -240; and americium-241. These areas are known Laboratory contamination areas, and all of the reported values are consistent with earlier observations from these same stations.

In the samples from the regional stations, the sample from the Rio Grande at Otowi showed a possible detection strontium-90 value above background. This reported value could have originated from Laboratory contaminated sediment deposits within lower Los Alamos Canyon. These deposits may have been redistributed during snowmelt runoff resulting from backwater flooding effects from the Rio Grande. In future sampling efforts, the sediment station on the Rio Grande at Otowi will be relocated farther upstream so that possible backwater contamination effects are eliminated. The sample from the Rio Grande at Frijoles also showed a possible elevated strontium-90 value. However, all of these variations are consistent with data from previous years. None of the other Rio Grande sediment stations located between Otowi Bridge and Frijoles Canyon were sampled during 1996.

None of the Pajarito Plateau stations that are outside known contamination areas showed values above background for tritium, total uranium, plutonium-238, americium-241 radioactivity or for gross alpha, gross beta, or gross gamma activity. However, the sediment stations for Mortandad at MCO-9 and Mortandad at MCO-13 (A-5) showed above-background values for cesium-137 and plutonium-239, -240. Finally, the sediments from stations located above Ancho Spring and Frijoles at the Rio Grande showed possible detection of strontium-90 values above background. Frijoles at the Rio Grande also showed detections of cesium-137 and total uranium values that were above background. This station may have also been subjected to backwater flooding effects from the Rio Grande during 1996; therefore, in the future, this station will be located farther upstream in Frijoles Canyon. All of these possible detection values may be related to multiple sources, including natural variability, atmospheric fallout, surface deposition from air stack emissions, or surface transport from various Laboratory sources.

Results of the radiochemical analyses of the large 1-kg samples collected in 1996 from Heron, El Vado, Abiquiu, Cochiti, and Rio Grande Reservoirs are similar to those from previous years. All of these sample results were below their respective background levels except for some of the Cochiti Reservoir samples. The upper, middle, and lower sediment stations in Cochiti Reservoir showed possible detections of strontium-90, but only the middle station showed elevated levels of cesium-137; plutonium-238; and plutonium-239, -240 radioactivity. None of the other reservoir sediment samples exceeded background levels for other radionuclides, as seen in Table 5-13.

The results of the reservoir analyses are best interpreted in conjunction with information from a study by Purtymun et al., (1987) and McLin and Lyons (1997), which provide a regional context for analyses of reservoir sediments. The conclusions of greatest significance for interpreting the current samples from the five reservoirs are: (1) the mean plutonium-238 concentrations from Cochiti Reservoir are significantly higher than corresponding values from Abiquiu, El Vado, Heron, and Rio Grande Reservoirs; (2) the mean plutonium-239, -240 concentrations from Cochiti

Reservoir are significantly higher than corresponding values from Abiquiu, El Vado, and Heron Reservoirs; and (3) Abiquiu and El Vado Reservoirs exhibit significantly lower mean concentrations for strontium-90 than corresponding values from Cochiti Reservoir. These results also suggest that radionuclide deposition from fallout is not homogeneous but varies with differences in weather, altitude, erosion, sediment transport conditions, grain size distribution, total organic content, and cation exchange capacity.

Summary data from reservoir sediment plutonium analyses are shown in a long-term context in Table 5-16. Abiquiu Reservoir historically has had some of the lowest plutonium concentration ranges and isotopic ratios observed, but Cochiti Reservoir has some of the highest. The other sampled reservoirs tend to fall between these two extremes. These data clearly suggest that mean plutonium-238 and plutonium-239, -240 concentration levels are significantly higher in Cochiti Reservoir than in Abiquiu Reservoir. An important question is raised here: Are these differences primarily a result of Laboratory releases or to natural variations in atmospheric fallout? To help answer this question, additional future sediment samples and analyses will be performed in all reservoirs. These samples will be analyzed for radionuclide and metal concentrations, grain size distribution, total organic carbon, cation exchange capacity, and sediment surface area. Small grain sizes and high values for the other parameters enhance the capacity of the sediments to adsorb plutonium and may help explain the large variability in plutonium concentration levels between reservoirs.

b. Dose Equivalents from Exposure to Sediments in Mortandad Canyon. Radioanalytical results for sediments collected from Mortandad Canyon in 1996 were modeled using the RESRAD model, version 5.61 (see Chapter 3). The pathways evaluated are the external gamma pathway from radioactive material deposited in the sediments, the inhalation pathway from materials resuspended by winds, and the soil ingestion pathway. Because water in the canyon is not used for drinking water or irrigation and there are no cattle grazing in the canyon or gardens in the canyon, the drinking water, meat ingestion, and fruit/vegetable ingestion pathways were not considered.

The RESRAD model was run for each sampled location and for the entire canyon system with 10 to 14 samples per analyte collected throughout the canyon. For modeling purposes, it is assumed that the area of interest around each monitored location is 100 m^2, the site is part of an industrial complex where access to the monitored location is somewhat limited and thus the amount of time a person spends in the canyon is limited to approximately 87 hours per year (Robinson and Thomas 1991), and there is no cover material over the site of interest that would reduce external exposure to radionuclides. The input parameters for the RESRAD model are summarized in Table 5-17. RESRAD calculates the daughter radionuclides based on the initial radionuclide concentrations and time since placement of material.

The total effective dose equivalent (TEDE) (i.e., the sum of the effective dose equivalents from the external gamma, and the inhalation and soil ingestion pathways) is presented in Table 5-18. For comparison, the 1995 TEDE for each monitoring location is also shown. The TEDE using the average concentration of all monitoring locations in Mortandad Canyon and using the RESRAD input parameters in Table 5-17 is 6.0 mrem. The error term associated with this average value is extremely large, indicating a high degree of variability in the concentrations throughout the canyon. In 1996, the maximum TEDE (average TEDE plus twice the error term) (Table 5-19) ranged from 0.19 mrem (<0.2% of the DOE 100 mrem public dose limit [PDL]) near the Chemical and Metallurgy Research (CMR) building to 27 mrem (27% of the DOE PDL) at the GS-1 sampling location. This compares to the 1995 range of 0.089 mrem at the A-10 sampling location and 43 mrem at the GS-1 sampling location. The maximum TEDE for monitoring sites surrounding the GS-1 site (i.e., west of GS-1, MCO-5, MCO-7, and MCO-9) increased in 1996 over the 1995 values. These five monitoring locations represent 96% of the 1996 maximum TEDE for the entire canyon system. The only radionuclide that contributed more than 5% to the TEDE at these locations is cesium-137 for each of the five sites. For the other monitoring locations (i.e., near the CMR building, MCO-13 (A-5), A-6, A-7, A-9, and A-11), the naturally occurring radionuclides of uranium, and strontium-90 and cesium-137 from nuclear atmospheric testing contributed more than 5% to the TEDE at these monitoring locations. Averaged over the entire canyon system, cesium-137 and americium-241 contributed more than 5% to the canyon TEDE. The external pathway contributed more than 88% (with the cesium-137 contribution being more than 86%) to the total TEDE for the entire canyon system. Because there is a pathway approximately 3 m from the stream channel and the external component falls off with distance from the source, the estimated TEDE is reduced to approximately 6 mrem in a year (i.e., 2.7 mrem from the external pathway and 3.3 mrem from all other pathways considered).

4. Nonradiochemical Analytical Results

a. Trace Metals. Beginning in 1992, sediments were analyzed for trace metals. Trace metal results for the sediment samples collected in 1996 are presented in Table 5-20. None of the results show any significant accumulations of metals, and results are comparable to previously collected data. Laboratory sample preparation methods for metals analyses changed in 1993. Therefore, the 1992 sediment metals data should not be compared to the 1993 to 1996 metals data because of these differences in laboratory procedures.

Reported detection limits for antimony, mercury, and molybdenum increased from 1992 to 1996 (that is, from about 0.05 to 0.2 mg/kg; 0.01 to 0.1 mg/kg; and 0.30 to 2.0 mg/kg, respectively). These differences were the result of changes in sample preparation procedures. In addition, there was a decrease in the typical channel sediment sample size from 250 mg in 1992 to 125 mg in 1996.

b. Organic Analyses. Beginning in 1993, sediments were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Starting in 1995, selected sediment samples were also analyzed for HE residuals. This HE analysis effort was expanded in 1996; these new sampling stations tend to be located within the Laboratory boundary immediately upstream of the intersection of State Route 4 and the respective stream channels. Lists of individual organic compound analytes were previously given. In 1996, sediment samples were analyzed for VOCs, SVOCs, PCBs, and HE residuals from about one-sixth of the regional and local stations. The analytical results showed that there were no VOC, SVOC, PCBs, or HE residuals detected above the respective limit of quantitation (LOQ) in any of the sediment samples collected during 1996. The sampled stations are listed in Table 5-21.

5. Long-Term Trends

The concentrations of radioactivity in sediments from Acid, Pueblo, and lower Los Alamos Canyons that may be transported off-site are fully documented (ESG 1981). The data indicate that concentrations of radionuclides in sediments from Acid, Pueblo, and lower Los Alamos Canyons have been relatively constant at each location since 1980, given some degree of yearly fluctuation in the data. The total plutonium concentrations (plutonium-238 plus plutonium-239, -240) observed since 1980 in sediments at four indicator locations are shown in Figure 5-6.

Figure 5-6 also depicts total plutonium concentrations at four sediment stations in Mortandad Canyon from 1980 to 1996. MCO-5 and MCO-7 are located downstream of the TA-50 discharge point and upstream of the sediment traps. MCO-9 and MCO-13 are between the sediment traps and the Pueblo of San Ildefonso boundary. Values of plutonium at MCO-5 and MCO-7 are above background values resulting from Laboratory discharges at TA-50, but values from stations MCO-9 and MCO-13 are at or near atmospheric fallout levels. These results suggest that there has been little or no transport of plutonium from TA-50 below the sediment traps in Mortandad Canyon. Analyses of sediments collected at station Mortandad A-6 show plutonium-239, -240 concentration levels that are at background levels and are consistent with historical data.

D. Groundwater Sampling

1. Introduction

Groundwater resource management and protection efforts at the Laboratory are focused on the main (or regional) aquifer underlying the region (see Section 1.A.3), but also consider groundwater found within canyon alluvium and above the regional aquifer at intermediate depths.

The early groundwater management efforts by the USGS evolved with the growth of the Laboratory's current Groundwater Protection Management Program, required by DOE Order 5400.1 (DOE 1988b), which addresses environmental monitoring, resource management, aquifer protection, and geohydrologic investigations. Formal documentation for the program, the "Groundwater Protection Management Program Plan," was issued in April 1990 and revised in 1996 (LANL 1996a). During 1996 the Laboratory developed and submitted an extended groundwater characterization plan to the New Mexico Environment Department (NMED) (LANL 1996b).

Concentrations of radionuclides in environmental water samples from the main aquifer, the alluvial perched groundwater in the canyons, and the intermediate-depth perched systems may be evaluated by comparison with DCGs for ingested water calculated from DOE's PDL (see Appendix A for a discussion of standards). The NMWQCC has established standards for groundwater quality (NMWQCC 1993). Concentrations of radioactivity in samples of water from the water supply wells completed in the Los Alamos main aquifer are also compared to New Mexico Environmental Improvement Board (NMEIB) 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 to NMWQCC groundwater standards and to the NMEIB and EPA drinking water standards, even though these latter standards are only directly applicable to the public water supply. The supply wells in the main aquifer are the source of the Los Alamos public water supply. Although it is not a source of municipal or industrial water, shallow alluvial groundwater results in return flow to surface water and springs used by livestock and wildlife, and may be compared to the Standards for Groundwater or the Livestock and Wildlife Watering Stream Standards established by the NMWQCC (NMWQCC 1993, NMWQCC 1995). These standards are for the most part based on dissolved concentrations, but many of the results reported here include both dissolved and suspended solids concentrations, which may be higher.

2. Monitoring Network

Groundwater sampling locations are divided into three principal groups, related to the three modes of groundwater occurrence: the main (or regional) aquifer, perched alluvial groundwater in the canyons, and localized intermediate-depth perched groundwater systems. The sampling locations for the main aquifer and the intermediate-depth perched groundwater systems are shown in Figure 5-7. The sampling locations for the canyon alluvial perched groundwater systems are shown in Figure 5-8. The springs and wells are described by Purtymun (1995).

Sampling locations for the main aquifer include test wells, supply wells, and springs. Eight deep test wells, completed within the main aquifer, are routinely sampled. The Laboratory located the test wells to detect possible infiltration of contaminants from effluent disposal operations. These test wells were drilled by the USGS between 1949 and 1960 using the cable tool method. The wells penetrate only a few hundred feet into the upper part of the main aquifer, and the casings are not cemented, which would seal off surface infiltration.

Samples are collected from eleven deep water supply wells in three well fields that produce water for the Laboratory and community. The well fields include the Guaje Well Field and the on-site Pajarito and Otowi Well Fields. The Guaje Well Field, located northeast of the Laboratory, contains seven wells, five of which had significant production during 1996. The five wells of the Pajarito Well Field are located in Sandia and Pajarito Canyons and on mesa tops between those canyons. Otowi-1 and Otowi-4, the first wells in a new field designated as the Otowi Well Field, were completed in 1990. Otowi-4 resumed production in 1996 after pump problems were repaired. Otowi-1 had a new pump installed during 1996 and was being prepared for production at the end of the year. Additional main aquifer samples were taken from wells located on the Pueblo of San Ildefonso.

Numerous springs near the Rio Grande are sampled because they represent natural discharge from the main 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 groups, three of which (I, II, and III) have similar, aquifer-related chemical quality. The chemical quality of springs in Group IV reflects local conditions in the aquifer, probably related to discharge through faults in volcanics. Two additional springs, Indian and Sacred Springs, are west of the river in lower Los Alamos Canyon.

Beginning in 1995, approximately half of the White Rock Canyon springs were sampled in each year. Larger springs and springs on Pueblo of San Ildefonso lands are sampled annually, with the remainder scheduled for alternate years.

The perched alluvial groundwater in five canyons (Pueblo, Los Alamos, Mortandad, and Pajarito Canyons, and Cañada del Buey) is sampled by means of shallow observation wells to determine the impact of NPDES and past industrial discharges on water quality. In any given year, some of these alluvial observation wells may be dry, and thus no water samples can be obtained. Observation wells in Water, Fence, and Sandia Canyons have been dry since their installation in 1989. Most of the wells in Cañada del Buey are 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. Samples are obtained from two test wells and one spring. The well and spring locations were selected 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. During the winter of 1996–97, a falling tree broke the connecting pipe, and the water now flows down the Water Canyon drainage.

3. Radiochemical Analytical Results for Groundwater

The results of radiochemical analyses of groundwater samples for 1996 are listed in Table 5-22. Tables 5-23 and 5-24 contain lists of radionuclides detected in water samples and of possible detections, according to criteria discussed in Section 5.F. Because uranium, gross alpha, and gross beta are ubiquitous at detectable levels, occurrences of these measurements above significant levels (chosen to be below the EPA MCLs or screening levels) are reported. The specific values are 5 µg/L for uranium, 10 pCi/L for gross alpha, and 40 pCi/L for gross beta. Discussion of the results will address the main aquifer, the canyon alluvial groundwater, and finally the intermediate perched groundwater system.

a. Radiochemical Constituents in the Main Aquifer. For samples from wells or springs in the main aquifer, most of the results for tritium; strontium-90; uranium; plutonium-238; plutonium-239, -240; americium-241; and gross beta were below the DOE DCGs or the EPA or New Mexico standards applicable to a drinking water system. The exceptions are discussed below. In addition, most of the results were near or below the detection limits of the analytical methods used. Dissolved uranium is a common constituent of groundwater (Hem 1989), so only occurrences close to the proposed EPA MCL of 20 µg/L are discussed here.

The 1994 surveillance sampling of three test wells, TW-3, TW-4, and TW-8, showed unexpected levels of strontium-90 (ESP 1996a). Several of the sampling results were suspect because there were no corroborating measurements such as correspondingly elevated gross beta measurements in some of the samples. Special time-series sampling was carried out in 1995 to evaluate possible aquifer contamination near these wells, during which no strontium-90 was detected (ESP 1996b). These wells were sampled four times during 1996, with no radionuclides detected, except naturally occurring uranium and trace levels of tritium. The tritium results are discussed in Section 5.D.3.c.

Test Well 1 had a tritium detection of 749 pCi/L. Tritium values in this range cannot be accurately quantified by the analytical method, but the result does indicate a detection of tritium. The results of previous low-detection-limit tritium measurements done by the University of Miami on samples from this well have ranged from 277 to 366 pCi/L (ESP 1995; ESP 1996b). Water supply well G-2 showed a possible americium-241 detection; however, the americium-241 values found at small levels this year are suspect because of similar levels found in field blank samples (see Section 5.F).

Strontium-90 was detected in Sandia Spring. Spring 5A showed evidence of plutonium-238. La Mesita Spring has a significant uranium concentration of 10 µg/L. Samples from springs in this area have always contained a relatively high concentration of natural uranium (Purtymun et al., 1980). However, the uranium concentration for La Mesita Spring is below the proposed EPA primary drinking water MCL of 20 µg/L. The spring also has a high gross alpha value of about 14 pCi/L, near the EPA primary drinking water standard of 15 pCi/L.

In 1995, water supply well G-1A had an apparent strontium-90 detection of 3.9 ± 0.7 pCi/L. This value is just above the strontium-90 detection limit of 3 pCi/L. Another 1995 analysis gave a result of 7.4 ± 3.5 pCi/L, which has a very high uncertainty, making interpretation of this result difficult. No previous strontium-90 data are available for this well for comparison. The results of 1996 samples indicate no trace of strontium-90 in samples from this well.

All cesium-137 measurements of samples from the main aquifer wells and springs for 1994 are less than 5% of the DCG applicable to DOE Drinking Water Systems and less than the detection limit of 4 pCi/L.

b. Total Committed Effective Dose Equivalent from the Ingestion of Drinking Water from Los Alamos and White Rock. Table 5-25 presents the summary of the CEDE from the ingestion of drinking water collected in 1996. The CEDE for 1995 is presented for comparison. Because drinking water aquifers are regional, there is no “background” drinking water source available to determine the total net positive CEDE between the monitored source and a “background” source. The total annual CEDEs (i.e., the annual CEDE, without any error term, summed over all radionuclides) for all drinking water samples collected from Los Alamos water distribution wells are below 4 mrem. No samples collected exceeded the radioactive MCLs for drinking water systems (EPA 1989). The maximum annual CEDE (i.e., the total CEDE plus 2 sigma) using the two liters per day drinking water consumption rate for samples collected in 1996 is 0.12 mrem as modified by the percent contribution to the distribution system for each monitored well. The radionuclides that contributed to more than 5% of the total CEDE in 1996 are strontium-90, cesium-137, total uranium, plutonium-238, plutonium-239, and americium-241.

c. Tritium Sampling of Test Wells. The 1994 surveillance sampling of three test wells, TW-3, TW-4, and TW-8, showed unexpected levels of strontium-90 (ESP 1996a). Several of the sampling results were suspect, because there were no corroborating measurements such as corresponding elevated levels of gross beta in some of the samples. Special time-series sampling was carried out in 1995 to evaluate possible aquifer contamination near these wells, during which no strontium-90 was detected (ESP 1996b). These wells were sampled four times during 1996, with no radionuclides detected, except for trace levels of tritium and naturally occurring uranium. This section discusses the trace-level tritium results, with analyses done by the University of Miami Tritium Laboratory.

The following information provides a perspective on tritium levels occurring in New Mexico. Before atmospheric testing of nuclear weapons began, tritium levels in precipitation were about 20 pCi/L (Adams et al., 1995). This is 5 to 10 times the tritium levels detected in the Los Alamos public water supply wells, for example. By the mid-1960s, tritium in atmospheric water in northern New Mexico reached a peak level of about 6,500 pCi/L. At present, general atmospheric levels in northern New Mexico are about 30 pCi/L, and those in the Los Alamos vicinity range from 20 to 450 pCi/L (Adams et al., 1995). Groundwaters that contain between 16 and 65 pCi/L of tritium most likely show the effects of recent recharge, that is, within the last four decades (Blake et al., 1995). Waters with tritium concentrations below about 1.6 pCi/L are likely to be old: the ages of these waters are more than 3,000 years, but there may be large errors associated with small tritium concentrations. With a tritium concentration below 0.5 pCi/L, modeled ages are more than 10,000 years, but this is at the limit of tritium age determinations. Waters with tritium concentrations more than 1,000 pCi/L and collected after 1990 cannot have their ages modeled and can only be the result of contamination (Blake et al., 1995).

The 1995 time series results suggested that tritium is present in trace amounts in the aquifer at TW-3 and -8, but not at TW-4. Tritium has previously been observed in TW-8. The presence of tritium in TW-3 in 1995 was a new discovery, because tritium was not noted in this well during sampling in 1993. The level of tritium in these wells is far below the EPA tritium drinking water standard of 20,000 pCi/L and even below the detection limit of the EPA-specified analytical method for tritium, which is 700 pCi/L. Evaluation of tritium activities in this trace level range was carried out for purposes of evaluating flow paths and hydrological connections within groundwater flow systems.

The 1996 sampling results continue to show naturally occurring trace levels of tritium in TW-4 and slightly higher tritium levels in TW-3 and TW-8 that suggest some contribution of recent recharge from the surface (Table 5-26). The 1995 tritium values in TW-3 ranged from 53 pCi/L down to 0.2 pCi/L, compared to the 1996 range of 15 pCi/L to 0.2 pCi/L. For TW-8, the 1995 range was 16 pCi/L down to 5.2 pCi/L, compared to a 1996 range of 26 pCi/L to 5.5 pCi/L. Thus, the results suggest a continual presence of a small recharge contribution from the surface in the main aquifer at TW-3 and TW-8. Considering that past surface water tritium activities in DP Canyon (near TW-3) and Mortandad Canyon (above TW-8) have been in the range of up to 10^6 pCi/L as recently as the mid 1980s, the effect of surface water tritium levels on the regional aquifer at these locations has been minimal.

Several other test well samples were analyzed for tritium by low-detection-limit methods. Table 5-26 shows these results. Previous analytical results for tritium were published in ESP (1995). Test wells DT-9 and DT-10 both showed higher tritium values in 1995 than in previous years. The 1993 values for test wells DT-9 and DT-10 were 0.45 and 1.3 pCi/L, compared to 1995 values of 1.5 and 3.2 pCi/L. These tritium values fall into a possible age range between 40 and 3,000 years. Test well DT-5A had a 1993 value of 0.23 pCi/L. The 1996 results for DT-5A, DT-9, and DT-10 are at the low end of the ranges previously observed. These 1996 tritium levels suggest that the main aquifer is isolated from surface recharge in the area of these three wells.

d. Radiochemical Constituents in Alluvial Groundwaters. None of the radionuclide activities in alluvial groundwater are above the DOE DCGs for Public Dose for Ingestion of Environmental Water. Except for strontium-90 values in samples from Mortandad Canyon, none of the radionuclide activities exceed DOE DCGs applicable to a drinking water system. Levels of tritium; cesium-137; uranium; plutonium-238; plutonium-239, -240; strontium-90; and gross alpha, beta, and gamma are all within the range of values observed in recent years.

The samples of the alluvial groundwater in Los Alamos Canyon show residual contamination, as has been seen since the original installation of the monitoring wells in the 1960s. In particular, for LAO-2 and LAO-3A, the activity of strontium-90 exceeds the EPA Primary Drinking Water Standard MCL of 8 pCi/L. Plutonium-239, -240 was detected in LAO-0.7; cesium-137 was possibly detected at LAO-0.7; and several of the wells showed gross alpha or beta activities exceeding drinking water standards.

The alluvial groundwater samples from Mortandad Canyon showed levels of radionuclides within the ranges observed previously. Tritium; strontium-90; plutonium-238; plutonium-239, -240; americium-241; gross alpha; and gross beta are either detected or possibly detected in many of the wells. Well MCO-4 was not in service, so samples from nearby well MCO-4B are used in its place. The radionuclide levels are in general highest at well MCO-4B, which is nearest to the TA-50 outfall, and are lower further down the canyon. The levels of tritium, strontium-90, gross alpha, and gross beta 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. There are no EPA drinking water criteria for plutonium-238; plutonium-239, -240; or americium-241. The DOE Drinking Water System DCGs for these latter radionuclides were not exceeded in Mortandad Canyon alluvial groundwater.

Pueblo Canyon well APCO-1 had a 1996 plutonium-239, -240 level (.087 ± 0.02 pCi/L) above the detection limit, as was observed in 1994 and 1995. Only one well in Pajarito Canyon was sampled in 1996 because wells PCO-2 and PCO-3 were dry.

e. Radiochemical Constituents in Intermediate-Depth Perched Groundwater. Taken over time, the radionuclide activity measurements in samples from TW-1A, 2A, and Basalt Spring in the intermediate-depth perched zones in Pueblo Canyon indicate a connection with surface water and alluvial groundwaters in Pueblo Canyon. Intermediate-depth perched zone waters have long been known to be influenced by contaminated surface water in the canyon based on measurements of major inorganic ions. TW-2A, furthest upstream and closest to the historical discharge area in Acid Canyon, has shown the highest levels. The 1996 tritium measurement obtained by conventional methods was 2253 pCi/L. In previous years this has been confirmed by the low detection limit measurements of about 2,300 pCi/L (ESP 1996a). Neither TW-1A nor TW-2A had detectable plutonium-239, -240 levels, in contrast to 1995. Basalt Spring did show detectable plutonium-239, -240. Because the sample at Basalt Spring is collected in contact with the canyon soils, the source of the plutonium could be surface sediments rather than groundwater.

The sample from the Water Canyon gallery was consistent with previous results, showing no evidence of radionuclides from Los Alamos operations.

4. Nonradiochemical Analytical Results

The results of general chemical analyses of groundwater samples for 1995 are listed in Table 5-27, and results of total recoverable metal analyses are listed in Table 5-28. Discussion of the results will address the main aquifer, the canyon alluvial groundwaters, and the intermediate perched groundwater system. Finally, results of organic analyses will be discussed. Because of instrument problems on the part of the analytical laboratory, some of the trace metals were analyzed at detection limits higher than is ordinarily the case during 1996, particularly cadmium, lead, thallium, and antimony. This problem will be rectified for 1997 sampling.

a. Nonradiochemical Constituents in the Main Aquifer. Values for all parameters measured in the water supply wells were within drinking water limits, with the following exceptions. In 1995, a nitrate (as nitrogen) value of 9.9 mg/L was found in well G-1A; values of this size have never been observed previously in this well, and no such values were found in the regular Safe Drinking Water Act (SDWA) sampling. The 1996 results show a nitrate (as nitrogen) concentration of 0.48 mg/L, which is consistent with background levels. The pH values in wells G-1, G-1A, and Otowi-1 were above the EPA secondary standard limit of 8.5. Well Otowi-1 was being tested during this sample collection period and had not been connected to the water supply system. In well G-1, the silver value was 53 μg/L, compared to the NMWQCC groundwater limit of 50 μg/L; the thallium level was 6 μg/L compared to the EPA primary drinking water standard of 2 μg/L. For well G-2, the arsenic level was about 76% of the standard of 50 μg/L and was similar to previous measurements. The vanadium level in well G-2 of 84 μg/L is within the EPA health advisory range of 80 to 110 μg/L but is lower than the 1993 value of 260 μg/L. The lead level in Otowi-4 was 12 μg/L, compared to the EPA action level of 15 μg/L.

The test wells in the main aquifer showed levels of several constituents that approach or exceed standards for drinking water distribution systems. However, the test wells are used for monitoring purposes only and are not part of the water supply system. TW-1 had a nitrate value of 5.5 mg/L, below the EPA primary drinking water standard of 10 mg/L (nitrate as nitrogen). 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 discharged 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.

TW-2 had values of sodium, chloride, sulfate, arsenic, and boron that were about ten times the usual ranges for these values. The total dissolved solids and conductance for this sample were in the usual range. Thus, the total dissolved solids value contradicts the values reported for these other analytes because it is much smaller than the sum of the sodium, chloride, and sulfate values. The source of these discrepancies has not been discovered.

Levels of trace metals that approach water quality standards in some of the test wells are believed to be associated with the more than 40-yr-old steel casings and pump columns. In the last few years, iron, manganese, cadmium, nickel, antimony, and zinc have been high in several of the main aquifer test wells. These trace metal values represent total, rather than dissolved concentrations, in that they include the composition of any suspended sediment contained in the water samples. Several of the test wells have occasionally had elevated lead levels in previous years. In 1995, lead levels exceeded the EPA action level in TW-1, 2, 3, and 4. In 1996, TW-1 (at 62 µg/L) and TW-4 (at 57 µg/L) had lead levels above the 15 µg/L EPA action level. However, the higher detection limit used for many of the measurements may have been insufficient to define the lead levels in these wells. TW-3 had one lead measurement at 11 µg/L. The lead levels appear to be due to flaking from piping installed in the test wells and do not represent lead in solution in the water (ESP 1996a). There are no known sources of lead near these wells, and dissolved lead levels in natural waters of near neutral pH (pH ~7) are commonly extremely low (Hem 1989).

In general, trace metal levels in unfiltered samples for test well DT-5A were low. This well had the highest lead levels in 1993. One sample from this well had a chromium concentration of 63 µg/L, compared to the NMWQCC groundwater limit of 50 µg/L.

Samples collected for metals analysis from the White Rock Canyon springs were filtered in 1996. In recent years, samples from a few springs in White Rock Canyon showed aluminum, iron, and manganese levels that exceed NMWQCC Livestock and Wildlife Watering Standards or drinking water standards. These levels were total rather than dissolved concentrations and reflect the composition of suspended sediments. Many of the springs have very low flow rates, and samples are collected in small pools in contact with the surrounding soils. The 1996 samples from Sandia Spring, La Mesita Spring, and Spring 1 were unfiltered and showed levels of aluminum and iron that would exceed standards for drinking water systems. Of the filtered spring samples, Spring 3A had a cadmium level above the drinking water MCL.

b. Nonradiochemical Constituents in Alluvial Groundwater. Alluvial canyon groundwater in Pueblo, Los Alamos, and Mortandad Canyons, which receive effluents, showed the effects of those effluents because values of some constituents were elevated above natural levels. Mortandad Canyon alluvial ground-water samples exceeded or approached the NMWQCC Groundwater Standards for fluoride and nitrate. The nitrate source is nitric acid that is used in plutonium processing at TA-55 and enters the TA-50 waste stream. Improvements to the TA-50 treatment process are planned, so that the effluent will not exceed water quality standards in the future. Mortandad Canyon alluvial groundwater is also high in sodium. Only one well in Pajarito Canyon was sampled in 1996 because wells PCO-2 and PCO-3 were dry.

Overall, trace metal levels in alluvial groundwater samples were much lower than for 1993 and 1994. As with past samples from the White Rock Canyon Springs, several of the alluvial groundwater samples showed levels of aluminum, iron, and manganese that would exceed standards for drinking water systems. These metal concentrations reflect the presence of suspended sediment that had entered the well casings.

c. Nonradiochemical Constituents in Intermediate-Depth Perched Groundwater. In 1996, the nitrate values for TW-1A, 2A, and Basalt Spring were well below NMWQCC Groundwater and EPA Drinking Water Standards. These sample locations have occasionally shown higher nitrate values in recent years.

TW-2A had levels of iron, lead, manganese, and zinc approaching or exceeding water quality standards. Again, the detection of these metals in TW-2A probably reflects flaking of metals from pump hardware and the well casing rather than the existence of dissolved metals in the groundwater. TW-1A had iron, and Basalt Spring had aluminum and manganese concentrations approaching or exceeding water quality standards. Otherwise, the intermediate perched groundwater and the Water Canyon gallery did not show any concentrations of trace metals that are of concern.

d. Organic Constituents in Groundwater. Analyses for organic constituents were performed on selected springs and test wells in 1996. The stations sampled are listed in Table 5-29. Samples were analyzed for VOCs, SVOCs, and PCBs. Test wells and most springs were analyzed for HE constituents. The laboratory also reports tentatively identified organic compounds, reflecting measurements that do not correspond to any of the cataloged organic compounds that may not have been analyzed specifically. These compounds are not listed here although the number for each station is given. The samples where organics were detected above the analytical LOQ are listed in Table 5-30.

HE constituents were detected in Ancho Spring during 1995 sampling, but not in 1996. This spring is below the explosives testing sites in the southern portion of the Laboratory. The Water Quality and Hydrology Group (ESH-18) will conduct additional analyses for HE in this area. Most of the possible organic detections reported by the Organic Analysis Group (CST-12) were rejected because the compounds were either detected in method blanks (introduced during laboratory analysis) or detected in trip blanks.

There were three organic detections that were not rejected. Toluene was found at low concentrations in Test Well DT-5A. However, this compound was found in method blanks for numerous other samples, indicating that it had inadvertently been introduced during laboratory analysis, as was butanone [2-] which was found in Spring 1. The Otowi House well had a detection of trichloroethane [1,1,1-].

5. Long-Term Trends

a. Main Aquifer. The long-term trends of the water quality in the main aquifer have shown little impact resulting from Laboratory operations. Except for low levels of tritium contamination found at four locations in Los Alamos and Pueblo Canyons and one location in Mortandad Canyon, no concentrations of radionuclides above detection limits have been measured on water samples from the production wells or test wells that reach the main aquifer other than an occasional analytical outlier not confirmed by analysis of subsequent samples. The apparent detection of strontium-90 in TW-3 in 1994 (ESP 1996a) presently appears to be due to analytical error because the gross beta measurement does not support the strontium result. The apparent detection of strontium-90 in TW-4 in 1994 (ESP 1996a) has not been substantiated by previous or subsequent measurements.

Measurements of tritium by extremely low detection limit analytical methods (ESP 1995; ESP 1996a) show the presence of some recent recharge (meaning within the last four decades) in water samples from six wells into the main aquifer at Los Alamos. The levels measured range from less than 2% to less than a 0.01% of current drinking water standards and are all less than levels that could be detected by the EPA-specified analytical methods normally used to determine compliance with drinking water regulations. Recent detection of lead in the main aquifer test wells appears to have resulted from contamination by well casings, pumps, and monitoring devices (ESP 1995). Nitrate concentrations in TW-1 have been near the EPA MCL since 1980.

The long-term trends of water levels in the water supply and test wells in the main aquifer indicate that there is no major depletion of the resource as a result of pumping for the Los Alamos water supply (McLin et al., 1997).

b. Alluvial Perched Groundwater in Mortandad Canyon. Long-term trends of radionuclide concentrations in shallow alluvial perched groundwater in Mortandad Canyon (downstream from the NPDES-permitted outfall for the radioactive waste treatment facility at TA-50) are depicted in Figure 5-9. The samples are from observation well MCO-6 in the middle reach of the canyon. The combined total of plutonium-238 and plutonium-239, -240 activities has been relatively constant, fluctuating up and down in response to variations in the treatment plant effluent and storm runoff that causes some dilution in the shallow alluvial water. Note that the current plutonium detection limit of 0.04 pCi/L applies to the separate analyses of plutonium-238 and plutonium-239, -240, and might be doubled for the addition of these values because results are often at or near the detection limit. The tritium concentration has fluctuated almost in direct response (with a time lag of about one year) to the average annual concentration of tritium in the TA-50 effluent.

E. Groundwater and Sediment Sampling at the Pueblo of San Ildefonso

To document the potential impact of Laboratory operations on lands belonging to the Pueblo of San Ildefonso, DOE entered into a Memorandum of Understanding 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. The groundwater, surface water, and sediment stations sampled on the Pueblo of San Ildefonso are shown in Figures 5-10 and 5-11. Aside from stations listed in the accompanying tables, the Memorandum of Understanding also specifies collection and analysis of additional water and sediment samples from sites that have long been included in the routine environmental sampling program, as well as special sampling of storm runoff in Los Alamos Canyon. These locations are shown in Figures 5-1, 5-2, 5-4, and 5-7, and the results of analyses are discussed in previous sections.

1. Groundwater

Radiochemical analyses of the 1996 groundwater samples are shown in Table 5-22. Tables 5-23 and 5-24 contain lists of radionuclides detected in water samples and of possible detections, according to criteria discussed in Section 5.F.4. Because uranium, gross alpha, and gross beta are ubiquitous at detectable levels, occurrences of these measurements above significant levels (chosen to be below the EPA MCLs or screening levels) are reported. The specific values are 5 µg/L for uranium, 10 pCi/L for gross alpha, and 40 pCi/L for gross beta.

Most of the groundwater stations (wells and springs) listed in the Memorandum of Understanding are discussed in Section 5.D. The Bureau of Indian Affairs wellpoints were not sampled in 1996 because high water turbidity made the samples of questionable value and because the ER Project has installed several new wells in the vicinity as part of the Resource Conservation and Recovery Act Facility Investigation Workplan for Los Alamos and Pueblo Canyons. The present section focuses on the Pueblo of San Ildefonso water supply wells.

As in previous years, the groundwater data indicate the widespread presence of naturally occurring uranium at levels approaching or in excess of proposed EPA drinking water limits. Naturally occurring uranium concentrations approaching or many times above the proposed MCL of 20 µg/L are prevalent in well water throughout the Pojoaque area. The high gross alpha readings for these wells are related to uranium occurrence.

In previous years, the Pueblo of San Ildefonso water supply well data have suggested the occasional detection of trace levels of plutonium and americium. In most cases, these values are near the detection limit of the analytical method when it is uncertain whether or not a detection has occurred and when precise quantification of the amount detected is not possible. For 1995, detection limits for plutonium-238 and americium-241 were exceeded in several wells. The possibility that these were detections is in doubt for two reasons: there were high values for americium-241 in the trip blank, and values for plutonium-238 and americium-241 in the New Community well sample and a duplicate sample differed widely. These two observations emphasize the questionable precision of the laboratory analyses at these extremely low levels. For 1996 sampling, the only possible detection of radionuclides in the Pueblo of San Ildefonso water supply wells, other than uranium, was for plutonium-239, -240 in the Sanchez House well, at a value only slightly above the detection limit.

The 1995 Westside Artesian well sample had a strontium-90 value of 8.4 pCi/L. This value exceeded the EPA MCL of 8 pCi/L. This 1995 analysis should be viewed with caution: first, because of the possibility of analytical error, in light of the relatively high detection limit for strontium-90; and second, because strontium-90 has not been previously found in any of these wells. The 1996 sample analysis did not detect strontium-90.

The Westside Artesian and New Community wells had uranium concentrations near or exceeding the proposed EPA primary drinking water standard of 20 µg/L. Uranium concentrations at the Pajarito Pump 1 and Sanchez House wells were about half of the proposed EPA standard. These measurements are consistent with the levels in previous samples and with relatively high levels of naturally occurring uranium in other wells and springs in the area.

The gross alpha level in samples from the Westside Artesian, Pajarito Pump 1, Don Juan Playhouse, New Community, and Sanchez House wells approached or exceeded the EPA primary drinking water standard of 15 pCi/L. The gross alpha levels are apparently attributable to the presence of uranium.

The chemical quality of the groundwater, shown in Table 5-27, is consistent with previous observations. The samples from the Westside Artesian and Pajarito Pump wells exceeded or were near the drinking water standard for total dissolved solids; these levels are similar to those previously measured.

The fluoride values for some wells are near (Sanchez House) or greatly exceed (Westside Artesian and LA-1B) the NMWQCC Groundwater Standard of 1.6 mg/L, again similar to previous values. Several of the wells have alkaline pH values, above the EPA secondary standard range of 6.8 to 8.5; again, these values do not represent a change from those previously observed in the area. None of the sampled wells had nitrate values approaching drinking water limits of 10 mg/L (nitrate as nitrogen).

Trace metal analyses are shown in Table 5-28. Well LA-1B and Pajarito Pump 1 had much lower arsenic values in 1995 and again in 1996, compared to previous values of about 40 µg/L, just below the EPA drinking water standard of 50 µg/L. Boron values in two wells, Westside Artesian and Pajarito Pump 1, exceeded the NMWQCC groundwater limit of 750 µg/L. These values are similar to those of past years. Boron, arsenic, and fluoride are common constituents of water in volcanic areas or in thermal springs (Hem 1989). The thermal waters discharging from the Valles Caldera have been shown to discharge through the Jemez River drainage, and other wells and springs in the area have far higher boron, arsenic, and fluoride levels (Goff et al., 1988). The only other trace metal occurrence of note was antimony that was detected in the New Community well at 5 µg/L compared to the EPA Primary Drinking Water Standard of 6 µg/L.

Samples from Eastside Artesian, Halladay House, Pajarito Pump 1, Don Juan Playhouse, and the Otowi House wells were analyzed for VOCs, SVOCs, and PCBs (Table 5-29). The only sample in which there was a trace detection was the Otowi House well (Table 5-30). The compound detected is trichloroethane [1,1,1-] at 23 µg/L.

2. Total Committed Effective Dose Equivalent from the Ingestion of Drinking Water Collected at the Pueblo of San Ildefonso

Table 5-31 presents the summary of the CEDE from the ingestion of drinking water collected in 1996. The CEDE for 1995 is presented for comparison. Because the Federal Guidance Report #11 is "intended for general use in assessing average individual committed doses in any population. . ." (EPA 1988), the dose conversion factors listed in this report are used in assessing drinking water from non-DOE sources. Because drinking water aquifers are regional, there is no "background" drinking water source available to determine the total net positive CEDE between the monitored source and a "background" source.

The total annual CEDEs (i.e., the annual CEDE, without any error term, summed over all radionuclides) for all drinking water samples collected from the Pueblo of San Ildefonso ranged from 0.26 mrem from the Halla

day House to 3.1 mrem from the New Community well. For samples collected at the Pueblo, the uranium contribution to the total CEDE ranged from 34% from the Halladay House sample to 91% from the Westside Artesian sample. The maximum annual CEDE (i.e., the total CEDE plus 2 sigma) using the 2 liters/day drinking water consumption rate for the samples collected in 1996 ranged from 0.66 mrem from the Halladay House sample to 4.1 mrem from the New Community Well sample.

3. Sediments

Sediments from Mortandad Canyon were collected in 1996 from seven permanent sampling stations, as seen in Figure 5-11. The results of these and other sediment sample analyses for radiochemicals and trace metals are shown in Tables 5-13, 5-14, 5-15, and 5-20. Related information is presented in Section 5.C. Results are comparable to sediment data collected from these same stations in previous years.

Data discussed in Section 5.C suggest that radionuclide concentrations in sediments on Laboratory land just upstream of the Pueblo of San Ildefonso boundary (near station MCO-13) are the result of worldwide fallout rather than of Laboratory operations. None of the Pueblo of San Ildefonso sediment stations in Mortandad Canyon showed levels of strontium-90, total uranium, americium-241, gross alpha, gross beta, or gross gamma that exceeded the background values attributed to fallout (or naturally occurring uranium) in northern New Mexico (Purtymun et al., 1987). This value is consistent with historical observations from this station.

Sediments from sampling stations in Los Alamos Canyon located on the Pueblo of San Ildefonso lands at Los Alamos at State Road 502, Los Alamos at Totavi, and Los Alamos at Otowi showed levels of cesium-137; plutonium-238; plutonium-239, -240; and americium-241 above background and are clearly from Laboratory sources. All of these levels are consistent with previous samples collected from these same stations (see Section 5.C).

Analytical results from the sediment sampling locations in Guaje, Bayo, and Sandia Canyons are all within the range of values expected from worldwide fallout. These findings are consistent with current and previous measurements of sediments from these canyons where they flow across State Road 502. Sediment samples collected from the Pueblo of San Ildefonso in 1996 were also analyzed for trace metals, as reported in Table 5-20. These results, which are all within the general ranges found in geologic materials from Pajarito Plateau, suggest natural origins for all trace metals, including total uranium (Longmire et al., 1996).

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

1. Sampling

Stoker (1990) is the basic document covering sampling procedures and quality assurance (QA). Detailed container and preservation requirements are documented in a handbook by Williams (1990). More focused guidance is provided in formal procedures developed to address sampling procedures for each sample matrix (Mullen and Naranjo 1996, 1997). 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. The Laboratory's samples are submitted to the Chemical Science and Technology (CST) analytical laboratory. Detailed analytical methods are published in Gautier (1995). Beginning in 1995, samples were submitted using blind sample numbers to prevent possible bias by the analyst through knowledge of the sampled location.

Samples collected at the White Rock Canyon springs were filtered in the field. The "Code" column on the tables of analytical results shows a "U" for unfiltered samples and an "F" for filtered samples. The White Rock Canyon Springs samples are collected to represent groundwater surfacing at the springs. These samples were filtered in the field to minimize the effects of surface contamination.

Runoff was collected using automated samplers located at recently installed gaging stations (Shaull et al., 1996). If adequate water was collected by the automated sampler, two sets of samples were then submitted to the analytical laboratory. One set was preserved when the samples were transferred from the automated sampler bottles to the sample bottles. The other set was submitted unfiltered and unpreserved. The analytical laboratory filtered the samples and preserved them. If insufficient water for two sample sets was collected by the automated sampler, only one set of unfiltered samples was submitted to the analytical laboratory. The analytical laboratory filtered the samples through a 0.45-micron filter. The filtrate (the dissolved portion that passes through the filter) was preserved and analyzed to quantify the dissolved constituents. The portion remaining on the filter (suspended solids) was analyzed separately to quantify the constituents associated with the suspended solids.

When the samples were transferred from the automated sampler bottles to the sample bottles, the contents of all the bottles collected by the automated sampler were first transferred to a churn splitter. The churn splitter agitates the samples to ensure that they are well mixed and that the sediments are suspended.

2. Analytical Procedures

a. Metals and Major Chemical Constituents. Metals and major chemical constituents are analyzed using EPA SW-846 methods. Filtering and digestion methods have changed over time. Before 1993, water samples were preserved in the field and filtered in the lab before digestion. From 1993 forward, water samples have not been filtered in the field or in the analytical laboratory, with the exception of the White Rock Spring samples as described above, and the results reported have been for total concentrations. As described in "Environmental Surveillance at Los Alamos during 1994" (ESP 1996a), from September of 1992 through the spring of 1994, SW-846 digestion method 3050 was used for sediments, and 3005 was used for waters. After the spring of 1994, digestion method 3051 was used for sediments, and 3015 was used for waters. The methods are considered equivalent. Methods 3015 and 3051 use microwave digestion, and 3005 and 3050 use a steam bath.

b. Radionuclides. Radiochemical analysis has been performed using the methods as updated in Gautier (1995). Sediment samples are screened through a Number 12 US Standard Testing sieve before digestion. The sieves are brass with seamless frames and soldered wire cloths meeting American Society for Testing and Materials E-11 specifications. This sieve screens out materials larger than 1.7 mm (0.066 in.). Ten-gram samples are analyzed from stream channels; 1,000-g samples are analyzed from reservoirs. There is a 10-fold improvement in detection limits of plutonium-238 and plutonium-239, -240 for reservoir samples.

Negative values are reported for some radiological measurements. Negative numbers occur because measurements of radiochemical samples require that analytical or instrumental backgrounds be subtracted to obtain net values. Consequently, individual measurement values can result in positive or negative numbers. Although negative values do not represent a physical reality they are reported as they are received from the analytical laboratory. Valid long-term averages can be obtained only if the values less than the detection limit and the negative values are included in the analytical results.

Water samples submitted for radiochemical analyses are preserved in the field by adding nitric acid to lower the pH of the sample to two or less. Before 1996, water samples were filtered shortly after the analytical laboratory received them. After filtering, the sample was digested before analysis. Samples collected in 1996 were preserved in the field as before but were digested without filtering. Except for the White Rock Canyon Springs and some surface water runoff, the analytical results reported in 1996 are for the total sample and include the radionuclides adsorbed to the sediments and those dissolved in solution. At the analytical laboratory, both water and sediment radiochemical samples are completely digested in a mixture of nitric and hydrofluoric acids.

When very accurate trace level tritium analyses are required, samples are shipped to the University of Miami Tritium Laboratory. These samples are collected and analyzed according to procedures described (Tritium Laboratory 1996).

c. Organics. Organics are analyzed for using SW-846 methods as shown on Table A-9. This table shows the number of analytes included in each analytical suite. The specific compounds that are analyzed in each suite are listed in Tables A-10 through A-13. All organic samples are collected in glass bottles, and the volatile organics sample is preserved with hydrochloric acid. A trip blank always accompanies the volatile organic sample.

3. Data Management and Quality Assurance

As analytical data are generated by the analysts in CST, they are transferred to the Analytical Services Group (CST-3), the sample management group. CST-3 transfers the data to ESH-18 as a hard copy. The data are also transferred electronically every week to the Facility for Information Management, Analysis, and Display (FIMAD). The electronic data are screened by FIMAD and stored in an Oracle database table. The table in FIMAD contains all the analytical data generated by CST for the current year. Data are extracted from the table and downloaded to ESH-18 using commercially available software. The sample location name, the sample barcode number, and the field data are stored in a separate table on ESH-18 personal computers and in FIMAD. This table provides the link for associating a blind sample barcode number with a location name.

Each analytical batch (20 samples or less) contains at least one blank, matrix spike, and a duplicate as dictated by SW-846 protocols. These samples are provided by CST-3 and submitted along with environmental surveillance samples. For water samples, ESH-18 also submits blanks and field-prepared duplicates. These samples are submitted blind and are identical to all other samples. CST participates in numerous interlaboratory quality assurance programs. The programs, laboratory results, and expected results are summarized quarterly in Gautier (1996).

Lead, antimony, and thallium are generally analyzed by inductively coupled plasma mass spectrometry (ICPMS) to provide detection limits below water quality standards. For part of the year, the analytical laboratories' ICPMS was not functional, and these analyses were performed by inductively coupled plasma emission spectroscopy (ICPES) with higher detection limits.

In addition to routine quality assurance samples, ESH-18 submitted blanks of deionized (DI) water and spiked samples as surveillance samples to the analytical laboratory. The analytical results are presented in Table 5-32. From the results in Table 5-32, it is apparent that there was a high bias in the americium-241 results for 1996. A plutonium-242 tracer is used in the americium-241 analysis. A small, but measurable, portion of the tracer had decayed to americium-241 resulting in slightly elevated levels of americium-241 in the analytical results. Tritium analyses also showed a high bias. This is probably due to the tritium present in the nitric acid used to preserve the sample collected for all the radionuclide analyses.

The DI blanks were submitted as regular samples, without any identification that they were blanks. They went through the same sample analysis process as the regular field samples. The DI blanks were measured with the same background contributions from reagents and biases as the surveillance samples and gave an estimate of background and systematic analytical errors. The DI blanks were used to correct the radiochemical sample analyses results by subtracting the average of the blanks from the reported sample value. The tables of detections of radionuclides present the corrected and uncorrected values. The sample value for the other radiochemical results may be recovered by adding the average blank value to the value reported in the tables.

Blanks submitted for trace metals and chemical quality were generally reported as less than detection limits with one exception. The analytical results for the blank submitted on September 8 showed strikingly high values for metals. The only explanation was that the digestion vessel was not adequately cleaned between analyses.

One sample of DI water was spiked and submitted as a surveillance sample. The analytical results were typically close to the amount spiked. A notable exception was the value of 6.8 ± 1.1 pCi/L reported for cesium-137. No cesium-137 was spiked in this sample. This result would be regarded as a detection at the 4.66 σ level. These examples emphasize that apparent detections should be confirmed by follow-up sampling.

The following compounds were commonly found in the organics trip blanks and DI blanks; bis(2-ethylhexyl)phthalate, acetone, butanone [2-], chloroethane, methylene chloride, toluene. Analytical results suggesting that these compounds were present in the sample should be viewed skeptically.

In 1996, increased emphasis was placed on reporting TICs. As a result more TICs were identified than in past years. TICs present in analytical laboratory blanks suggest that some TICs may have been introduced in the analytical laboratory.

4. Determination of Radiochemical Detections

Analytical uncertainties are reported in the tables for radiological data. These uncertainties are reported by the CST analyst for each radiological measurement. These numbers are predominantly counting uncertainties and represent the uncertainty associated with counting photon emissions from a blank and the sample. Counting uncertainties do not include the other sources of error in an analytical measurement.

Counting uncertainties vary with time and from one instrument to another. One standard deviation (one sigma) counting uncertainty is typically reported. Through 1995, the uncertainties reported for tritium in the tables have been identified as representing one standard deviation (one sigma). Recent communications with CST show that this value has been reported incorrectly. For tritium results, the value reported as the one sigma uncertainty should have been reported as a three sigma uncertainty.

CST has determined detection limits for each analytical method. Radiological detection limits are based on Currie's formula (Currie 1968). Detection limits are reported at the bottom of the tables summarizing the radiochemical analytical results. The CST detection limits include average uncertainties associated with the entire analytical method and include average counting uncertainties, sample preparation effects, digestion, dilutions, and spike recoveries. The CST detection limits, reported in 1995 and 1996, have been changed from those reported in previous years. Some detection limits were higher (plutonium and americium) and others lower (cesium). These changes reflect changes in aliquot sizes, recent evaluations of detector backgrounds and efficiencies, and evaluations of recoveries.

In 1995 (ESP 1996b) CST detection limits were compared to the counting uncertainties to evaluate the validity of the reported detection limits. In general, the comparison validated the detection limits reported by CST. The CST detection limits for cesium-137 in water and for tritium appeared to be too low. The evaluation conducted in 1995 suggested tritium detection limits as high as 2,000 pCi/L may be reasonable. The detection limits reported at the bottom of the tables summarizing radionuclide analytical results in 1995 (ESP 1996b) corresponded to the estimated detection limits calculated and not to the detection limits reported by CST.

To identify Laboratory impacts as early as possible, it is important to determine when contaminants are present in areas where contamination has not been identified previously. The Surface Water, Groundwater, and Sediments section of this report each contain tables identifying detections of radionuclides in two groups. Possible detections are defined as being above the detection limit and greater than 2.33 times the uncertainty (σ) but less than 4.66 σ. Detections are defined as being above the detection limit and greater than 4.66 σ. These tables are presented to focus on those cases where radionuclides were detected. The rationale for choosing these cutoff levels is described below.

There are two approaches to determining when an analyte is detected in a sample. For the purpose of this discussion a 95% confidence level is assumed. The lower level is often called the limit of detection (LOD) or critical level (L_C). This is the lowest level that is statistically different from a blank. When the LOD is used as a decision point, 5% of the analytical results will be falsely identified as containing the analyte of interest when it is not present (Keith 1991, Taylor 1987, Currie 1968). That is, 5% of the values exceeding L_C are false positives.

The reliable detection limit (RDL or L_D) is the level where there is little chance of failing to detect an analyte that is present at or above this concentration. When the RDL is used as a decision point, an analyte that is present at a concentration equal to the RDL will not be detected 5% of the time.

For radiological analyses, a background measurement is subtracted from the instrument reading generated by the sample. This corrects for background radiation, such as cosmic rays. The uncertainty in the background measurement must be included in the uncertainty for the sample measurement. For background corrected radiological measurements for one-tailed, paired observations at the 95% confidence level, the LOD or L_C is 2.33 times the uncertainty (σ) and the RDL or L_D is 4.66 σ.

The LOQ (or L_Q) is the level where the true concentration of an analyte can be established. Using the same criteria as above (95% confidence, one-tailed, paired observations) the LOQ for radiological measurements is 14.1 σ. The importance of this number is demonstrated when analytical results are compared against standards; the analytical result should be greater than 14.1 σ for the comparison to be meaningful.

The uncertainties reported with our data are predominantly counting uncertainties. The detection limits reported by the analytical laboratory are found at the bottom of the tables of radiological results. These detection limits reflect a typical detection limit and allow for sources of error in addition to counting uncertainties. The criteria we used to determine if an analyte is present in a sample includes both the counting uncertainties and the detection limit. If the sample value reported by the analytical laboratory is greater than the detection limit and greater than 2.33 σ, the sample value is reported as detected above the LOD or as a possible detection. If the sample value reported by the analytical laboratory is greater than the detection limit and greater than 4.66 σ, the sample value is reported as detected.

G. Unplanned Releases

All unplanned releases were investigated by ESH-18. Upon cleanup, personnel from NMED-DOE/OB (Oversight Bureau) inspected the unplanned release site to ensure adequate cleanup. NMED-DOE/OB administratively closed 12 of the 26 unplanned releases that occurred in 1996. It is anticipated that the rest of the unplanned release investigations will be closed when NMED-DOE/OB personnel become available for inspections.

1. Radiochemical Liquid Materials

There was one unplanned radioactive release in 1996.

- Two gal. of mixed waste that consisted of chromium and 185 nCi/L of radioactivity at TA-35-2 on April 3, 1996.

2. Nonradiochemical Liquid Materials

There were 25 unplanned releases of nonradioactive liquid in 1996. The following is a summary of these discharges.

- Eight unplanned releases of noncontact cooling water and treated cooling water including 3,000 gal. at TA-16-410 on December 24, 1996; 100 gal. at TA-53-63 on December 20, 1996; 1,000 gal. at TA-21-150 on July 11, 1996; 9,000 gal. at TA-53-622 on June 23, 1996; 12,500 gal. at TA-3-127 on June 17, 1996; 2,800 gal. at TA-35-213 on April 16, 1996; 50 gal. at TA-53-60 on April 16, 1996; and 240 gal. at TA-21 on February 6, 1996.
- Seven releases of sanitary sewage (less than 1,000 gal. each) from the Laboratory's Sanitary Wastewater Systems Consolidation (SWSC) Plant.
- Three releases of potable water that originated from the line disinfection of wells, water lines, and other sources in the Los Alamos water supply system.
- Three releases of cement/mud slurry, fill material, and soil that were eroded into a watercourse.
- Two releases with oil sheen that originated from well-flushing activities.
- One release of diesel resulting from a leak in a storage tank.
- One release of 1-2 dichloroethane from a septic tank leach field.

H. Special Studies

1. Main Aquifer Hydrologic Properties Study: Water Production Records

Monthly water production records are provided to the State Engineer Office under State of New Mexico requirements specified in the water rights permit held by DOE for the Los Alamos municipal water supply system. During 1996, total water production from 14 wells in the Guaje, Pajarito, and Otowi municipal well fields, the Water Canyon Gallery, and Los Alamos and Guaje Reservoirs was 5.21 million m^3 (1,376 million gal., or 4,222 acre-ft). This total production amounts to 76.2% of the total water right of 6.8 million m^3 (5,541 acre-ft) that is available to DOE under its permit. Except for the Otowi-1 supply well, all other production wells were used during 1996 for municipal and industrial water supplies. The Otowi-1 well did not contribute to water supply during 1996. Details of the performance of the water supply wells and their operation are published in a series of separate reports.

The most recent report is entitled "Water Supply at Los Alamos during 1995" (McLin et al., 1997).

2. Main Aquifer Hydraulic Properties Study: Measurement of Main Aquifer Water Levels

In October 1992, the Laboratory began measuring and recording water level fluctuations in test wells completed into the main aquifer below Pajarito Plateau and in various other monitoring wells completed within intermediate and alluvial groundwaters located throughout the facility. These data are automatically recorded at hourly intervals using calibrated pressure transducers. Data are presented in the Laboratory report entitled "Water Supply at Los Alamos during 1995" (McLin et al., 1997), which summarizes the locations, start and end dates for data collection, and final water levels recorded during 1996.

3. Surface Water Data at Los Alamos National Laboratory: 1996 Water Year

Surface water discharge data were collected from 17 stream-gaging stations that cover most of the Laboratory. The data, published in the report "Surface Water Data at Los Alamos National Laboratory: 1996 Water Year" (Shaull et al., 1996), show less runoff than do data for the 1995 water year. Water chemistry data from larger storm events occurring at some stations are also published in that report.

The second annual water data report from LANL contains flow data. The data collection focused on the Laboratory's downstream boundary, close to State Road 4; the upstream boundary is approximated by State Road 501. Some of the gaging stations are within Laboratory boundaries and were originally installed to assist groups other than ESH-18 that also conduct site-specific earth science research.

Group ESH-18 developed and installed the stream-gaging network; the USGS Water Resources Division designed and installed the necessary data collection structures. The network is operated by the Storm Water Team of ESH-18.

Table 5-1. Radiochemical Analysis of Surface Waters for 1996 (pCi/L)

Station Name	Date	Code[a]		^{3}H	^{90}Sr	^{137}Cs	U (μg/L)	^{238}Pu	$^{239, 240}$Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Regional Stations													
Rio Grande at Otowi (bank)	10/11	U	1	−239 ± 135[b]	0.3 ± 0.4	0.8 ± 3.0	3.0 ± 0.3	0.110 ± 0.027	0.002 ± 0.014	0.068 ± 0.028	7.2 ± 3.3	124.7 ± 14.0	193 ± 60
			2					−0.005 ± 0.004	0.004 ± 0.011				
			D1										43 ± 50
Rio Grande at Otowi (wdth intgrt)	10/11	U	1	−62 ± 136	0.9 ± 0.7	1.5 ± 4.0	2.7 ± 0.3	0.015 ± 0.014	0.010 ± 0.012	0.014 ± 0.025	1.6 ± 0.9	8.1 ± 1.0	223 ± 60
			2					−0.006 ± 0.002	−0.015 ± 0.006	−0.014 ± 0.011			
			D1			−1.8 ± 0.8							
			R1	−140 ± 136			2.7 ± 0.3	−0.003 ± 0.006	0.016 ± 0.013	−0.030 ± 0.009	4.7 ± 2.2	7.3 ± 0.9	
Rio Grande at Frijoles (bank)	10/09	F	1	562 ± 139	0.4 ± 0.3	−2.0 ± 0.8	2.8 ± 0.3	0.017 ± 0.009	0.020 ± 0.013	−0.009 ± 0.012	4.1 ± 2.1	5.9 ± 0.7	−68 ± 50
			R1								2.6 ± 1.3	6.1 ± 0.8	
Rio Grande at Frijoles (wdth intgrt)	10/09	F	1	92 ± 136	0.4 ± 0.3	−2.5 ± 0.8	3.0 ± 0.3	−0.001 ± 0.006	−0.002 ± 0.009	−0.012 ± 0.012	2.6 ± 1.3	8.4 ± 1.0	−98 ± 50
Rio Grande at Cochiti	12/24	U	1	28 ± 137	0.6 ± 0.3		3.8 ± 0.4	0.005 ± 0.009	0.000 ± 0.009	−0.023 ± 0.015	5.3 ± 2.8	10.5 ± 1.9	−78 ± 50
			R1	211 ± 139				−0.007 ± 0.012	−0.002 ± 0.010	−0.021 ± 0.014			
Jemez River	11/14	U	1	−427 ± 138	3.2 ± 1.0	−1.8 ± 0.8	1.3 ± 0.1	−0.004 ± 0.005	0.005 ± 0.009	−0.021 ± 0.013	14.9 ± 7.0	15.7 ± 2.0	−18 ± 50
			R1										−18 ± 50
Jemez River at Pueblo Intakes	11/14	U	1	−246 ± 139	1.7 ± 0.9	2.5 ± 1.3	1.4 ± 0.1	−0.003 ± 0.006	0.013 ± 0.012	0.020 ± 0.023	9.7 ± 4.2	11.7 ± 1.0	−8 ± 50
Pajarito Plateau													
Guaje Canyon:													
Guaje Canyon	12/12	U	1	106 ± 143	−0.1 ± 0.4	−1.3 ± 0.8	0.1 ± 0.0	0.001 ± 0.006	−0.016 ± 0.003	−0.003 ± 0.013	0.9 ± 0.2	3.0 ± 0.4	−58 ± 50
			R1										−98 ± 50
Pueblo Canyon:													
Acid Weir	12/10	Insufficient water, sampled volatile organics only											
Pueblo 1	12/10	Insufficient water, sampled volatile organics only											
Pueblo 2	12/10	No Flow											
Pueblo 3	12/10	U	1	−214 ± 140	−0.3 ± 0.4	3.0 ± 0.9	0.6 ± 0.1	−0.007 ± 0.004	0.056 ± 0.016	0.000 ± 0.017	1.2 ± 0.7	21.3 ± 3.8	−68 ± 50
			D1			1.8 ± 0.8							
			R1								5.4 ± 3.4	23.7 ± 4.6	
DP/Los Alamos Canyon:													
Los Alamos Canyon Reservoir	12/12	U	1	−448 ± 139	−0.7 ± 1.1	0.0 ± 0.3	0.1 ± 0.0	−0.005 ± 0.006	−0.004 ± 0.008	−0.035 ± 0.010	0.8 ± 0.2	2.9 ± 0.4	−68 ± 50
			R1				0.1 ± 0.0						
DPS-1	07/09	U	1	369 ± 71	8.5 ± 0.8	2.9 ± 1.0	0.4 ± 0.0	0.016 ± 0.009	0.081 ± 0.019	0.263 ± 0.040	2.3 ± 0.8	30.9 ± 3.7	−108 ± 50
			D1			2.1 ± 0.9							
			R1					0.007 ± 0.008	0.113 ± 0.023	0.323 ± 0.050	2.0 ± 0.8	32.8 ± 4.0	
DPS-4	07/09	U	1	318 ± 71	31.0 ± 2.1	1.4 ± 3.8	0.5 ± 0.1	0.013 ± 0.010	0.078 ± 0.020	0.155 ± 0.034	1.3 ± 0.5	95.5 ± 11.5	−98 ± 50
			D1				0.5 ± 0.1						
			R1										−88 ± 50
Sandia Canyon:													
SCS-1	06/04	U	1	719 ± 80	−0.4 ± 0.2	−0.3 ± 1.3	0.3 ± 0.0	0.005 ± 0.007	0.008 ± 0.010	0.002 ± 0.013	1.2 ± 0.5	13.2 ± 1.6	−48 ± 50
			D1			−0.7 ± 0.8							
			R1	−172 ± 69									−88 ± 50

Table 5-1. Radiochemical Analysis of Surface Waters for 1996 (pCi/L) (Cont.)

Station Name	Date	Code[a]	^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Sandia Canyon (Cont.):												
SCS-2	06/04	U 1	−106 ± 70	0.0 ± 0.3	−1.7 ± 0.8	0.5 ± 0.1	−0.001 ± 0.006	0.001 ± 0.010	−0.029 ± 0.006	2.7 ± 1.2	21.0 ± 2.6	463 ± 80
		D1			0.0 ± 1.8					7.2 ± 3.0	18.5 ± 2.3	
		R1		0.2 ± 0.3								
SCS-3	06/04	U 1	149 ± 74	0.2 ± 0.3	−1.4 ± 0.8	0.5 ± 0.1	0.021 ± 0.011	0.044 ± 0.016	0.056 ± 0.020	−0.6 ± 0.2	17.9 ± 2.2	−18 ± 50
		R1					0.010 ± 0.009	0.025 ± 0.013	−0.004 ± 0.020			
		R2					0.010 ± 0.009	0.025 ± 0.013				
Mortandad Canyon:												
Mortandad at GS-1	08/05	U 1	13,281 ± 206	11.5 ± 1.4	30.6 ± 3.4	0.9 ± 0.1	2.673 ± 0.174	1.520 ± 0.115	2.190 ± 0.142	28.9 ± 11.0	123.7 ± 14.0	−78 ± 50
Mortandad at Rio Grande (A-11)	10/07	F 1	52 ± 135	0.6 ± 0.3	1.1 ± 3.5	1.8 ± 0.2	0.003 ± 0.007	−0.005 ± 0.006	−0.013 ± 0.014	0.4 ± 0.2	6.3 ± 0.8	23 ± 50
		D1										−118 ± 50
		R1								0.7 ± 0.3	6.1 ± 0.8	
Cañada del Buey:												
Cañada del Buey		No Water (6/4/96, 10/1/96, 12/17/96)										
Pajarito Canyon:												
Pajarito Canyon	12/11	U 1	−192 ± 140	1.1 ± 0.6	−0.8 ± 0.6	0.2 ± 0.0	0.006 ± 0.011	−0.007 ± 0.011	0.023 ± 0.020	1.4 ± 0.5	6.4 ± 0.9	−68 ± 50
		R1										−78 ± 50
Pajarito at Rio Grande	10/07	F 1	−50 ± 135	1.1 ± 0.4	−1.7 ± 0.8	1.2 ± 0.1	−0.006 ± 0.004	−0.002 ± 0.006	−0.008 ± 0.014	0.0 ± 0.0	3.8 ± 0.5	73 ± 50
Water Canyon:												
Water Canyon at Beta	11/08	U 1	145 ± 139	1.0 ± 0.9	−0.4 ± 1.2	0.6 ± 0.1	0.002 ± 0.009	0.007 ± 0.011	−0.028 ± 0.025	5.4 ± 2.0	7.6 ± 0.9	73 ± 50
		R1	−285 ± 136				0.006 ± 0.013	0.031 ± 0.021	−0.017 ± 0.011			
Ancho Canyon:												
Ancho at Rio Grande	10/08	F 1	−122 ± 134	1.0 ± 0.4	−0.1 ± 0.3	0.3 ± 0.0	0.010 ± 0.008	−0.007 ± 0.007	−0.017 ± 0.012	−0.4 ± 0.1	2.9 ± 0.4	−148 ± 50
Frijoles Canyon:												
Frijoles at Monument HQ	06/04	U 1	459 ± 77	−0.5 ± 0.2	−1.4 ± 0.8	0.1 ± 0.0	0.008 ± 0.016	0.007 ± 0.010	0.030 ± 0.024	0.6 ± 0.1	1.6 ± 0.2	−68 ± 50
		2					−0.006 ± 0.001	−0.001 ± 0.013	0.046 ± 0.020	±		
		D1				0.1 ± 0.0						
Frijoles at Rio Grande	10/09	F 1	233 ± 137	0.5 ± 0.3	−0.6 ± 0.9	0.1 ± 0.0	0.014 ± 0.011	0.009 ± 0.012	0.007 ± 0.018	0.9 ± 0.3	2.6 ± 0.3	−78 ± 50
Detection Limits			700	3	2	0.1	0.04	0.04	0.04	3	3	
Water Quality Standards[c]												
DOE DCG for Public Dose			2,000,000	1,000	3,000	800	40	30	30			
DOE Drinking Water System DCG			80,000	40	120	30	1.6	1.2	1.2			
EPA Primary Drinking Water Standard			20,000	8		20				15		
EPA Screening Level											50	
NM Livestock Watering Limit			20,000							15		
NMWQCC Groundwater Limit						5000						

[a] Codes: U–unfiltered, F–filtered, d–field duplicate, 1–primary analysis, 2–secondary analysis, R1–lab replicate, D1–lab duplicate.
[b] Radioactivity counting uncertainties (1 standard deviation) follow the ± sign.
[c] Standards given here for comparison only, see Appendix A.

Table 5-2. Radiochemical Analysis of Runoff Water Samples in 1996

Station Name	Date	Codes[b]	Flow (cfs)	^{3}H (pCi/L)	^{90}Sr (pCi/L)	^{137}Cs (pCi/L)	U (µg/L)	^{238}Pu (pCi/L)	^{239,240}Pu (pCi/L)	^{241}Am (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Gross Gamma (pCi/L)
Water													
LA Canyon near LA	08/22	U 1	2.2	−220 ± 136[b]	9.9 ± 1.3	4.1 ± 1.0	0.79 ± 0.08	0.119 ± 0.032	1.074 ± 0.100	1.082 ± 0.084	24.9 ± 11.0	80.7 ± 10.0	−18 ± 50
		R1					0.34 ± 0.04	0.176 ± 0.040	1.578 ± 0.140	1.166 ± 0.090			−8 ± 50
LA Canyon near LA		U 1		94 ± 138	8.5 ± 1.4	3.7 ± 1.1	0.05 ± 0.01	0.122 ± 0.039	1.187 ± 0.120	1.316 ± 0.220	31.9 ± 13.0	60.7 ± 7.0	−48 ± 50
Cañada del Buey at WR	07/08	F 1	46	−232 ± 70	−0.3 ± 0.2	−1.3 ± 0.8	0.21 ± 0.02	−0.001 ± 0.004	0.010 ± 0.009	−0.012 ± 0.018	0.3 ± 0.1	5.4 ± 0.7	−68 ± 50
		D1				0.2 ± 2.1	0.20 ± 0.02						
		R1									0.1 0.0	5.3 0.6	−98 ± 50
Ancho Canyon near Bandelier	06/29	F 1	107	−41 ± 73	1.2 ± 0.4	1.0 ± 0.9	1.53 ± 0.15	0.002 ± 0.005	0.039 ± 0.013	−0.014 ± 0.020	1.4 ± 0.3	14.7 ± 1.8	−118 ± 50
		D1				0.5 ± 0.8	1.49 ± 0.15						
		R1									1.2 ± 0.3	13.3 ± 1.6	
Limits of Detection in Water Samples				700	3	2	0.1	0.04	0.04	0.04	3	3	

Station Name	Date	Codes[b]	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)	U (mg/kg)	^{238}Pu (pCi/g)	^{239,240}Pu (pCi/g)	^{241}Am (pCi/g)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Gross Gamma (pCi/g)
Suspended Solids											
Cañada del Buey at WR	07/08	1	0.0 ± 0.3	−0.5 ± 0.8	2.42 ± 0.24	0.003 ± 0.001	0.018 ± 0.002	0.007 ± 0.002	11.5 ± 0.2	5.6 ± 0.7	3.9 ± 0.5
		2				0.002 ± 0.001	0.024 ± 0.004	0.011 ± 0.008			
		D1		0.2 ± 0.2	3.09 ± 0.31						
		R1	0.3 ± 0.2						12.6 ± 4.2	7.1 ± 0.9	
Ancho Canyon near Bandelier	06/29	1	0.3 ± 0.2	0.6 ± 0.2	6.44 ± 0.64	0.004 ± 0.001	0.029 ± 0.003	0.008 ± 0.010	16.2 ± 7.5	11.5 ± 1.4	4.2 ± 0.5
		D1		0.5 ± 0.1	6.61 ± 0.66						
		R1	0.4 ± 0.3						13.1 ± 5.5	12.9 ± 1.6	
Limits of Detection in Sediment Samples			1	0.05	0.02	0.002	0.002	0.002	1.5	1.5	

Table 5-2. Radiochemical Analysis of Runoff Water Samples in 1996 (Cont.)

Station Name	Date	Codes[b]	Suspended Sediment (mg/L)	^{90}Sr Total[c] (pCi/L)	%D[d]	^{137}Cs Total (pCi/L)	%D	U Total (µg/L)	%D	^{238}Pu Total (pCi/L)	%D	^{239,240}Pu Total (pCi/L)	%D	^{241}Am Total (pCi/L)	%D	Gross Alpha (pCi/g)	%D	Gross Beta (pCi/g)	%D	Gross Gamma (pCi/g)	%D
Total in Solution and Percent Dissolved																					
LA Canyon near LA	08/22		680 ± 70	9.2	NA[e]	3.9	NA	0.39	NA	0.139	NA	1.280	NA	1.188	NA	28.4	NA	70.7	NA	−24.7	
Uncertainty in Total[f]				1.9		1.5		0.09		0.064		0.210		0.252		17.0		12.2		86.6	
Cañada del Buey at WR	07/08		9100 ± 900	1.1	0[g]	−1.9		25.28	1	0.022	0	0.201	5	0.070	0	109.9	0	63.1	8	−47.5	
Uncertainty in Total				1.0		2.6		0.98		0.900		0.900		0.900		4.3		1.7		70.7	
Ancho Canyon near Bandelier	06/29		4600 ± 500	2.8	42.7	3.3	22.9	31.53	5	0.020	10	0.172	23	0.023	−61	68.7	2	70.1	20	−98.7	120
Uncertainty in Total				0.7		1.3		1.07		0.500		0.500		0.500		9.3		3.3		50.0	
Water Quality Standards[h]																					
DOE DCG for Public Dose			2,000,000	1,000		3,000		800		40		30		30		30		1000			
DOE Drinking Water System DCG			80,000	40		120		30		1.6		1.2		1.2				40			
EPA Primary Drinking Water Standard			20,000	8				20								15					
EPA Screening level																		50			
NM Livestock Watering limit			20,000													15					
NMWQCC Groundwater Limit								5000													

[a]Codes: U—unfiltered, F—filtered, d—field duplicate, 1—primary analysis, 2–secondary analysis, R1—lab replicate, D1—lab duplicate.
[b]Radioactivity counting uncertainties (1 standard deviation) follow the ± sign.
[c]Total is the sum of dissolved and sediments corrected for total suspended solids. At LA Canyon near LA only unfiltered samples were analyzed and the average is reported for the total.
[d]Percent dissolved.
[e]NA–Not applicable; insufficient information to calculate percent dissolved.
[f]Propagated uncertainty for Total concentration.
[g]Value replaced by zero if % dissolved result is negative due to negative values for dissolved fraction.
[h]Standards given here for comparison only, see Appendix A.

Table 5-3. Detections of Radionuclides in Surface Water for 1996[a]

Station Name	Date	Code[b]		Analyte	Blank Corrected	Lab Value	Uncertainty (σ)	Units	Detection Limit
Rio Grande at Otowi (bank)	10/11	U	1	Beta	124.7	125.0	14.0	pCi/L	3
DPS-1	07/09	U	1	^{241}Am	0.263	0.307	0.040	pCi/L	0.04
			R1	^{241}Am	0.323	0.367	0.050	pCi/L	0.04
			R1	^{239,240}Pu	0.113	0.125	0.023	pCi/L	0.04
			1	^{90}Sr	8.5	8.6	0.8	pCi/L	3
DPS-4	07/09	U	1	Beta	95.5	95.8	11.5	pCi/L	3
			1	^{90}Sr	31.0	31.1	2.1	pCi/L	3
SCS-1	06/04	U	1	^{3}H	719	921	80	pCi/L	700
SCS-2	06/04	U	1	Gamma	463	580	80	pCi/L	120
Mortandad at GS-1	08/05	U	1	^{241}Am	2.190	2.234	0.142	pCi/L	0.04
			1	Beta	123.7	124.0	14.0	pCi/L	3
			1	^{137}CS	30.6	31.8	3.4	pCi/L	4
			1	^{3}H	13,281	13,483	206	pCi/L	700
			1	^{238}Pu	2.673	2.677	0.174	pCi/L	0.04
			1	^{239,240}Pu	1.520	1.532	0.115	pCi/L	0.04
			1	^{90}Sr	11.5	11.6	1.4	pCi/L	3
LA Canyon near LA	08/22	U	1	^{241}Am	1.082	1.126	0.084	pCi/L	0.04
			R1	^{241}Am	1.166	1.210	0.090	pCi/L	0.04
			1	Beta	80.7	81.0	10.0	pCi/L	3
			1	^{239,240}Pu	1.074	1.086	0.100	pCi/L	0.04
			R1	^{239,240}Pu	1.578	1.590	0.140	pCi/L	0.04
			1	^{90}Sr	9.9	10.0	1.3	pCi/L	3
LA Canyon near LA	08/22	U	1	^{241}Am	1.316	1.360	0.220	pCi/L	0.04
			1	Beta	60.7	61.0	7.0	pCi/L	3
			1	^{239,240}Pu	1.187	1.199	0.120	pCi/L	0.04
			1	^{90}Sr	8.5	8.6	1.4	pCi/L	3
Cañada del Buey at WR	07/08	T		Alpha	109.9		4.3	pCi/L	1.5
				Beta	63.1		1.7	pCi/L	1.5
				U	25.3		1.0	µg/L	0.1
Ancho Canyon near Bandelier	06/29	T		Alpha	68.7		9.3	pCi/L	1.5
				Beta	70.1		3.3	pCi/L	1.5
				U	31.5		1.1	µg/L	0.1

[a] Detection defined as sample value - average blank >4.66 σ and >detection limit, except values for Uranium > 5 µg/L, for Gross Beta >40 pCi/l, and for Gross Alpha >10 pCi/L.

[b] Codes: U–unfiltered, F–filtered, T–Total as calculated on Table 5-2, d–field duplicate; 1–primary analysis; R1–lab replicate; D1–lab duplicate.

Table 5-4. Possible Detections of Radionuclides in Surface Water for 1996[a]

Station Name	Date	Code[b]		Analyte	Blank Corrected[c]	Lab Value	Uncertainty (σ)	Units	Detection Limit
Rio Grande at Otowi (bank)	10/11	U	1	^{241}Am	0.068	0.112	0.028	pCi/L	0.04
			1	Gamma	193	310	60	pCi/L	120
			1	^{238}Pu	0.110	0.115	0.027	pCi/L	0.04
Rio Grande at Otowi (wdth intgrt)	10/11	U	1	Gamma	223	340	60	pCi/L	120
Jemez River	11/14	U	1	^{90}Sr	3.2	3.3	1.0	pCi/L	3
Pueblo 3	12/10	U	1	$^{239,240}Pu$	0.056	0.069	0.016	pCi/L	0.04
DPS-1	07/09	U	1	$^{239,240}Pu$	0.081	0.093	0.019	pCi/L	0.04
			1	^{90}Sr	8.5	8.6	0.8	pCi/L	3
DPS-4	07/09	U	1	^{241}Am	0.155	0.199	0.034	pCi/L	0.04
			1	$^{239,240}Pu$	0.078	0.090	0.020	pCi/L	0.04
SCS-3	06/04	U	1	^{241}Am	0.056	0.100	0.020	pCi/L	0.04
			1	$^{239,240}Pu$	0.044	0.056	0.016	pCi/L	0.04
Mortandad at GS-1	08/05	U	1	Alpha	28.9	29.0	11.0	pCi/L	3
LA Canyon near LA	08/22	U	1	^{137}Cs	4.1	5.2	1.0	pCi/L	2
			1	^{238}Pu	0.119	0.123	0.032	pCi/L	0.04
			R1	^{238}Pu	0.176	0.180	0.040	pCi/L	0.04
LA Canyon near LA	08/22	U	1	Alpha	31.9	32.0	13.0	pCi/L	3
			1	^{238}Pu	0.122	0.127	0.039	pCi/L	0.04
Ancho Canyon near Bandelier	06/29	T		^{137}Cs	3.3		1.3	pCi/L	2

[a] Possible detection defined as 2.33 σ < (sample value–average blank) < 4.66 σ and > detection limit, except values for Uranium >5 μg/L, for Gross Beta >40 pCi/L, and for Gross Alpha >10 pCi/L.
[b] Codes: U–unfiltered, F–filtered, T–Total as calculated on Table 5-2, d–field duplicate; 1–primary analysis; R1–lab replicate; D1–lab duplicate.
[c] Refer to Section 5.F.3.

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

	1963–1977	1994			1995			1996		
Radionuclide	**Total Activity Released (mCi)[b]**	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG**	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG**	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG**
^{3}H	25,150	2,230	107,000	0.05	731	41,400	0.02	1,020	61,700	0.03
^{241}Am	7	3.1	147	4.9	1.4	79.4	2.65	1.99	120	4.00
^{137}Cs	848	8.5	408	0.14	6.6	375	0.13	2.20	133	0.04
^{238}Pu	51	2.8	135	3.38	3.4	195	4.88	2.25	136	3.40
^{239}Pu	39	0.4	21.4	0.71	0.6	35.6	1.19	0.39	23.8	0.79
^{89}Sr	<1	2.0	9.4	0.005	0.1	6.9	0.0003	0.66	40.2	0.002
^{90}Sr	295	0.3	13.7	0.01	0.6	36.9	0.04	0.60	36.1	0.04
^{234}U	NA	0.1	5.6	0.01	0.2	14.3	0.03	0.19	11.7	0.02
^{235}U	2	0.01	0.72	.001	.009	0.53	0.0009	0.003	0.18	0.0003
Constituent		**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration MCL**	**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration to MCL**	**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration to MCL**
NO_3-N		947	45.5	4.5	718	35.6	3.5	1,260	76.4	7.6
Total effluent volume ($\times 10^7$ liters)		2.08			1.76			1.65		

[a]Compiled from Radioactive & Industrial Wastewater Science Group (CST-13) Annual Reports. Data for 1996 are preliminary.
[b]DOE, 1979; decay corrected through 12/77.

Table 5-6. Total Committed Effective Dose Equivalent (CEDE) from the Consumption of Water from the TA-50 Effluent and the Stream below the Outfall during 1996

	Committed Effective Dose Equivalent (mrem/yr)[a]			
	1995		1996	
	TA-50 Effluent	Stream below Outfall	TA-50 Effluent	Stream below Outfall
Per Liter	1.3	0.49[b]	1.2	0.048[c]
Exercise Scenario[d]	21	7.8[b]	19	0.77[c]

[a] Based on DOE dose conversion factors (DOE 1988a).

[b] Instead of using the surface water result, the CEDE for 1995 was estimated using the average annual storm runoff into Mortandad Canyon to dilute the TA-50 effluent. [Purtymun et al., 1983].

[c] The average +2 sigma from sample collected at GS-1. The CEDE using the average annual storm runoff into Mortandad Canyon to dilute the TA-50 effluent results in an estimate that is approximately 10 times higher than actual stream measurements.

[d] Maximum consumption rate is 16.1 L/year (0.8 L/event). See text for assumptions.

Table 5-7. Chemical Quality of Surface Waters for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Regional Stations																					
Rio Grande at Otowi (bank)	10/11	U	1	17	44.8	8.6	2.3	21.8	7.9	71.4	<5[f]	110.0	0.4	0.1	0.0	<0.01	250.0	50.0	148.0	8.4	381
Rio Grande at Otowi (wdth intgrt)	10/11	U	1	17	45.0	8.4	2.4	21.7	7.9	72.8	<5	120.0	0.4	0.0	0.1	<0.01	260.0	61.0	147.0	8.5	378
Rio Grande at Frijoles (bank)	10/09	F	1	19	39.0	8.2	2.0	20.0	8.7	67.6	<5	116.0	0.4	<0.02	<0.02	<0.01	310.0	35.0	131.0	8.4	363
			R1						8.6	68.8											
Rio Grande at Frijoles (wdth intgrt)	10/09	F	1	19	49.0	10.0	3.0	24.0	9.0	71.9	<5	115.0	0.4	0.0	0.1	<0.01	310.0	110.0	164.0	7.7	619
Rio Grande at Cochiti	12/24	U	1	28	43.2	9.6	3.9	25.8	11.1	49.8	<5	130.0	0.5	<0.02	0.6	<0.01	230.0	46.0	147.0	8.2	365
			R1		41.5	8.7	3.9	24.6						<0.02	0.6				138.0		
Jemez River	11/14	U	1	44	33.0	3.9	6.4	43.5	53.7	10.7	<5	127.0	0.9	<0.02	0.1	<0.01	310.0	12.0	98.0	8.5	436
			R1										0.9								
Pajarito Plateau																					
Guaje Canyon:																					
Guaje Canyon	12/12	U	1	38	7.4	2.8	1.8	7.3	6.7	4.9	<5	43.0	0.1	0.1	0.5	<0.01	88.0	<1	30.0	7.7	14
			R1									44.0			0.5						
Pueblo Canyon:																					
Acid Weir	12/10	Insufficient water, sampled volatile organics only																			
Pueblo 1	12/10	Insufficient water, sampled volatile organics only																			
Pueblo 2	12/10	No Flow																			
Pueblo 3	12/10	U	1	85	21.3	6.4	12.3	65.8	42.0	25.8	<5	230.0	0.5	5.0	0.3	<0.01	360.0	87.0	79.5	7.4	614
DP/Los Alamos Canyon:																					
Los Alamos Canyon Reservoir	12/12	U	1	38	7.7	3.0	1.9	6.5	6.6	4.9	<5	44.0	0.1	0.1	0.1	<0.01	100.0	<1	31.2	7.7	13
DPS-1	07/09	U	1		16.9	1.3	4.1	21.0											48.0		
			R1		16.9	1.4	4.7	21.0													
DPS-4	07/09	U	1		12.5	1.5	6.4	19.6											37.0		
Sandia Canyon:																					
SCS-1	06/04	U	1	97	15.9	4.6	9.7	60.0	47.4	36.8	12.0	120.0	0.7	0.3	0.8	<0.01	370.0	13.0	58.7	8.6	459
			R1		15.8	4.5	10.1	61.2			7.0	114.0									
SCS-2	06/04	U	1	83	22.3	4.9	11.8	100.0	66.0	96.8	11.0	140.0	1.3	3.3	0.0	<0.01	500.0	11.0	75.9	8.9	668
SCS-3	06/04	U	1	83	22.2	5.0	11.7	100.0	64.0	90.2	<5	146.0	1.3	3.3	0.1	0.0	500.0	22.0	76.0	8.6	658
Mortandad Canyon:																					
Mortandad at GS-1	08/05	U	1	50	25.2	2.6	5.0	30.0	8.7	14.2	<3	107.0	0.7	0.1	3.0	<0.01	290.0	14.0	73.0	7.6	662
Mortandad at Rio Grande (A-11)	10/07	F	1	86	31.0	7.9	14.0	85.0	73.8	33.1	<5	134.0	1.1	5.3	6.5	<0.01	440.0	24.0	111.0	8.0	182
Cañada del Buey:																					
Cañada del Buey		No Flow (6/4/96, 10/1/96, 12/17/96)																			
Pajarito Canyon:																					
Pajarito Canyon	12/11	U	1	29	19.2	6.6	2.7	27.0	46.6	14.4	<5	57.0	0.1	<0.02	0.9	<0.01	180.0	41.0	75.0	6.8	295
			R1													<0.01	180.0				
Pajarito at Rio Grande	10/07	F	1	69	22.0	5.1	1.5	15.0	9.0	7.4	<5	84.0	0.5	0.0	0.8	<0.01	170.0	2.0	74.9	8.4	197

Table 5-7. Chemical Quality of Surface Waters for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (μS/cm)
Water Canyon:																				
Water Canyon at Beta	11/08	U 1	35	11.7	4.5	3.9	17.0	17.7	6.9	<5	48.0	0.2	0.1	0.0	<0.01	190.0	3.8	47.7	7.5	163
		R1		10.8	4.2	3.5	15.5													
Ancho Canyon:																				
Ancho at Rio Grande	10/08	F 1	75	13.4	3.4	1.2	11.1	6.1	3.8	16.0	67.0	0.4	<0.02	0.0	<0.01	180.0	1.2	47.5	9.1	143
		R1										0.4					1.2			
Frijoles Canyon:																				
Frijoles at Monument HQ	06/04	U 1	62	<0.191	<0.044	0.6	<0.323	4.8	4.1	<5	62.0	0.2	0.1	0.6	<0.01	140.0	6.0	0.0	8.0	11
		R1	63					4.8	4.4			0.2	0.0	0.6	<0.01	130.0				
Frijoles at Rio Grande	10/09	F 1	63	808.0	3.2	1.2	10.4	6.3	3.6	<5	53.0	0.2	0.1	0.0	<0.01	130.0	2.8	35.2	8.4	36
Water Quality Standards[g]																				
EPA Primary Drinking Water Standard									500			4		10	0.2					
EPA Secondary Drinking Water Standard								250	250			2				500			6.8–8.5	
NMWQCC Groundwater Limit								250	600			1.6		10	0.2	1000			6-9	

[a] Except where noted.
[b] Codes: d–field duplicate, 1–primary analysis, R1–lab replicate, D1–lab duplicate.
[c] Total dissolved solids.
[d] Total suspended solids.
[e] Standard units.
[f] Less than symbol (<) means measurement was below the analytical uncertainty.
[g] Standards given here for comparison only, see Appendix A.

Table 5-8. Chemical Quality of Runoff for 1996

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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Waters (mg/L)																				
LA Canyon near LA	08/22	U 1	<10[f]	9.6	2.2	5.0	9.0	7.9	4.0	<5	35.0	0.2	0.1	0.6	<0.01	100.0	680.0	33.0	7.7	94
		U 1		11.8	2.9	6.2	9.6						0.2	0.5	<0.01			41.0		
Cañada del Buey at WR	07/08	U 1	18	11.0	1.2	<3.88	3.0	<0.5	2.5	<5	77.0	<0.1	0.6	1.3	<0.01	280.0	9100.0	32.4	8.4	
Ancho Canyon near Bandelier	06/29	U 1	15	7.3	2.2	4.8	5.0	8.3	8.7	<5	<5	0.3				1800.0	4600.0	27.0	6.9	
Suspended Solids (mg/kg)																				
Cañada del Buey at WR	07/08	U 1		7.1	5.1	5.2	0.3													
		R1		6.1	4.7	4.7	0.3													
Ancho Canyon near Bandelier	06/29	U 1		4.5	3.2	3.4	0.5													
Water Quality Standards[g] (mg/L)																				
EPA Primary Drinking Water Standard									500			4		10	0.2					
EPA Secondary Drinking Water Standard								250	250			2				500			6.8–8.5	
NMWQCC Groundwater Limit								250	600			1.6		10	0.2	1000			6–9	

[a] Except where noted.
[b] Codes: d–field duplicate, 1–primary analysis, R1–lab replicate, D1– lab duplicate.
[c] Total dissolved solids.
[d] Total suspended solids.
[e] Standard units.
[f] Less than symbol (<) means measurement was below the analytical uncertainty.
[g] Standards given here for comparison only, see Appendix A.

Table 5-9. Total Recoverable Trace Metals in Surface Waters for 1996 (μg/L)

Station Name	Date	Code[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations															
Rio Grande at Otowi (bank)	10/11	U	1	<4[b]	1,890	4	42	104	<3	<2	<6	<3	<10	1,340	<0.2
			R1												<0.2
Rio Grande at Otowi (wdth intgrt)	10/11	U	1	<4	1,350	4	37	102	<3	<2	<6	3	<10	1,060	<0.2
			R1												<0.2
Rio Grande at Frijoles (bank)	10/09	F	1	<4	1,970	5	51	97	<3	<2	<3	<3	<10	1,200	<0.2
			R1												<0.2
Rio Grande at Frijoles (wdth intgrt)	10/09	F	1	<4	4,030	5	57	140	<3	<2	4	4	<10	2,300	<0.2
			R1												<0.2
Rio Grande at Cochiti	12/24	U	1	<10	4,558	<3	66.1	106.4	<2	<10	<10	<15	<10	2,692	<0.2
			R1	<10	3,670	<2	66.7	99.8	<2	<8	<8	<7	<10	2,190	<0.2
Jemez River	11/14	U	1	<10	505	53	438	58.4	<2	<7	<8	<7	<10	399.7	<0.2
	11/14	U	R1												<0.2
Pajarito Plateau															
Guaje Canyon:															
Guaje Canyon	12/12	U	1	<10	<500	<4	<20	20.8	<2	<7	<8	<7	<10	281	<0.2
			R1												<0.2
Pueblo Canyon:															
Acid Weir	12/10		Insufficient water, sampled volatile organics only												
Pueblo 1	12/10		Insufficient water, sampled volatile organics only												
Pueblo 2	12/10		No Flow												
Pueblo 3			1	<10	1,884	7	299.9	53	<2	<7	<8	<8	42.6	1,150	<0.2
	12/10	U	R1												<0.2
DP/Los Alamos Canyon:															
Los Alamos Canyon Reservoir	12/12	U	1	<10	<500	<4	<20	21.4	<2	<7	<10	<10	<10	1,902	<0.5
			R1												<0.5
DPS-1	07/09	U	1	<10	1,410	<2	47	55	<1	<2	<30	<10	<13	803	<0.4
			R1	<2	1,890	<2	36	55	<1	<2	<3	<10	<13	1,090	<0.4
DPS-4	07/09	U	1	<2	3,850	3.7	44	53	<1	<2	<3	<10	<13	1,840	<0.2
			R1												0.3
Sandia Canyon:															
SCS-1	06/04	U	1	<3.9	231	5.3	59.5	26.1	<1	<2	<3	<10	13.9	279	<0.2
			R1	<3	194	5.3	54.1	26.4	<1	<2	<3	11.6	21.4	264	<0.2
SCS-2	06/04	U	1	3.6	682	6.5	75.7	33.3	<1	<2	<3	17.5	<13	700	<0.2
			R1												<0.2

Table 5-9. Total Recoverable Trace Metals in Surface Waters for 1996 (μg/L) (Cont.)

tation Name	Date	Code[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Sandia Canyon (Cont.):														
SCS-3	06/04	U 1	3.7	277	6.4	70.3	31	<1	<2	<3	13.8	<13	440	<0.2
		R1												<0.2
Mortandad Canyon:														
Mortandad at GS-1	08/05	U 1	<2	2,650	2	72	35	<1	<2	<3	<10	<13	1,490	<0.2
		R1												<0.2
Mortandad at Rio Grande (A-11)	10/07	F 1	<4	700	4	410	93	<3	<2	<3	3	20	450	<0.2
		R1												<0.2
Cañada del Buey:		No Flow (6/4/96, 10/1/96, 12/17/96)												
Pajarito Canyon:														
Pajarito Canyon	12/11	U 1	<4	959	<2	41.8	80.6	<3	<2	<3	<3	<10	704	<0.4
		R1			<2									<0.4
Pajarito at Rio Grande	10/07	F 1	6	<280	3	49	50	<3	2	<3	5	<10	120	<0.2
		R1												<0.2
Water Canyon:														
Water Canyon at Beta	11/08	U 1	<4	12,000	4	49	400	<3	3	<3	<10	<10	5,630	<0.2
		R1	<4	10,900	4	45	370	<3	<3	<3	<3	<10	5,120	<0.2
Ancho Canyon:														
Ancho at Rio Grande	10/08	F 1	<4	<280	4	27	32	<3	<2	<3	<3	<10	<100	<0.2
		R1												<0.2
Frijoles Canyon:														
Frijoles at Monument HQ	06/04	U 1	<2	<90	<2.7	<6	<1	<1	<2	<3	<10	<13	<47	<0.2
		R1												<0.2
Frijoles at Rio Grande	10/09	F 1	<4	340	3	17	16	<3	<2	3	<3	<10	270	<0.2
		R1												<0.2
Water Quality Standards[c]														
EPA Primary Drinking Water Standard					50		2,000	4	5		100			2
EPA Secondary Drinking Water Standard			100	50-200								1,000	300	
EPA Action Level												1,300		
NM Wildlife Habitat Stream Standard														0.012
NM Livestock Watering Limit				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

Table 5-9. Total Recoverable Trace Metals in Surface Waters for 1996 (μg/L) (Cont.)

Station Name	Date	Code[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Stations														
Rio Grande at Otowi (bank)	10/11	U	1	90	<15	<50	<3	<3	2	<20	390	<3	<6	<50
Rio Grande at Otowi (wdth intgrt)	10/11	U	1	90	<9	19	3	<3	2	<80	382	<3	5	52
Rio Grande at Frijoles (bank)	10/09	F	1	68	<9	<10	<3	<3	3	<20	350	<3	8	<50
Rio Grande at Frijoles (wdth intgrt)	10/09	F	1	110	<9	<30	3	<3	4	<40	430	<3	11	140
Rio Grande at Cochiti	12/24	U	1	122.6	<33	<32	6	<0.08	5	<83	351.8	<3	14.7	<50
			R1	117.7	<30	<20	4	<0.06	3	<30	342.5	<3	14.7	<50
Jemez River	11/14	U	1	26.2	<30	<20	<3	<3	<3	32.7	140	<3	14	<50
Pajarito Plateau														
Guaje Canyon:														
Guaje Canyon	12/12	U	1	35	<30	<20	<3	<3	6	<30	59.4	<3	<20	62.1
Pueblo Canyon:														
Acid Weir	12/10		Insufficient water, sampled volatile organics only											
Pueblo 1	12/10		Insufficient water, sampled volatile organics only											
Pueblo 2	12/10		No Flow											
Pueblo 3	12/10		1	64.3	<30	<20	5	<3	18	<130	106	<3	26	102
DP/Los Alamos Canyon:														
Los Alamos Canyon Reservoir	12/12	U	1	38.9	<30	<20	<3	<3	7	<30	61.1	<3	<8	98.4
DPS-1	07/09	U	1	54	<29	<38	6	<2	<1	<30	74	<2	<13	34
			R1	54	<5	<18	7	<2	<1	<56	74	<2	<10	76
DPS-4	07/09	U	1	16	<50	22	5	<2	1.3	<60	70	<2	<10	34
Sandia Canyon:														
SCS-1	06/04	U	1	33.3	223.1	<18	2	<10	2	<59	70.8	<10	8.1	65.7
			R1	33.3	226	<37	4	<10	3.4	<70	70.3	<10	8.7	121
SCS-2	06/04	U	1	17.8	225	<18	3	<10	3	<59	101	<10	11.6	72.2
SCS-3	06/04	U	1	14.3	217	<18	2	<10	3.1	<59	101	<10	8.7	56.2

Table 5-9. Total Recoverable Trace Metals in Surface Waters for 1996 (μg/L) (Cont.)

Station Name	Date	Code[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Mortandad Canyon:														
Mortandad at GS-1	08/05	U	1	18	380	<60	<3	0.6	1	<59	64.6	0.17	<2	23
			2				<46							
Mortandad at Rio Grande (A-11)	10/07	F	1	43	<9	<50	<3	<3	7	<30	156	<3	10	<50
Cañada del Buey:														
Cañada del Buey			No Flow (6/4/96, 10/1/96, 12/17/96)											
Pajarito Canyon:														
Pajarito Canyon	12/11	U	1	84.7	<9	<10	<3	<3	<2	<20	147.9	<3	<3	50.3
							<3	<3	<2			<3		
Pajarito at Rio Grande	10/07	F	1	3	<9	<10	<3	<3	3	<30	140	<3	12	120
Water Canyon:														
Water Canyon at Beta	11/08	U	1	27	<9	<30	3	<3	<3	<20	88	<3	8	<50
			R1	25	<9	<15	3	<3	<3	<20	82	<3	6.5	<50
Ancho Canyon:														
Ancho at Rio Grande	10/08	F	1	1	<9	<10	<3	<3	3	36	71	<3	6	75
Frijoles Canyon:														
Frijoles at Monument HQ	06/04	U	1	2	<5	<18	1	<10	3	<59	<1	<10	<2	<16
Frijoles at Rio Grande	10/09	F	1	6	<9	<10	<3	<3	2	35	59	<3	4	<50
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							
NM Wildlife Habitat Stream Standard									2					
NM Livestock Watering Limit							100		50				100	25,000
NMWQCC Groundwater Limit				200	1,000	200	50		50					10,000

[a] Codes: U–unfiltered, F–filtered, d–field duplicate, 1–primary analysis, 2–secondary analysis, R1–lab replicate, D1–lab duplicate.
[b] Less than symbol (<) means measurement was below the analytical uncertainty.
[c] Standards given here for comparison only, see Appendix A. Note that New Mexico Wildlife and Groundwater limits are based on dissolved concentrations, while these analyses are of unfiltered samples, thus concentrations may include metals assciated with the suspended sediments.

Table 5-10. Total Recoverable Trace Metals in Runoff Samples for 1996 (μg/L)

Station Name	Date	Code[a]	Flow (cfs)	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Waters (μg/L)															
LA Canyon near LA	08/22	U 1	2.2	<10[b]	10,000	4.8	16	68	<2	<0.7	4	10	<10	5,500	<0.2
		R1													<0.2
LA Canyon near LA	08/22	U 1		<2	13,800	<15	31	139	1	<2	5	10	15	7,900	<0.2
		R1													<0.2
Cañada del Buey at WR	070/8	F 1	46	<2	1,400	<2.4	54	480	<1	<30	<6	<10	<2	720	<0.2
		D1													<3
Ancho Canyon near Bandelier	06/29	F 1	107	<2	7,040	3	225	810	<1	<3	<3	7.7	<13	3,604	<0.2
		R1													<0.2
Suspended Solids (mg/kg)															
Cañada del Buey at WR	07/08	1		<0.25	29,762	2.7	10.5	265	1.95	<0.25	7.36	19.2	17.4	21,822	<0.2
		R1		<0.25	28,511	<0.31	4.73	231	1.73	<0.25	6.29	17.2		19,654	
		D1				<0.31									<0.2
		D2													<0.2
Ancho Canyon near Bandelier	06/29	1		<0.002	19,250	3.65	13.11	189.4	1.55	<3	5.73	16.5	16.8	16,777	0.127
		R1													0.107
		R2													0.101
Water Quality Standards[c]															
EPA Primary Drinking Water Standard						50		2,000	4	5		100			2
EPA Secondary Drinking Water Standard				100	50-200								1,000	300	
EPA Action Level													1,300		
NM Wildlife Habitat Stream Standard															0.012
NM Livestock Watering Limit					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

Table 5-10. Total Recoverable Trace Metals in Runoff Samples for 1996 (μg/L) (Cont.)

Station Name	Date	Code[a]		Flow (cfs)	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Waters (μg/L)															
LA Canyon near LA	08/22	U	1	2.2	120	14	<20	17	1.2	<2	<30	49	0.59	20	48
LA Canyon near LA	08/22	U	1		390	18.1	22	45	2	<2	<59	64	0.43	22	120
Cañada del Buey at WR	07/08	F	1	46	12	<5	<16	<46	<10	<1.4	<73	49	<10	<16	30
			D1												
Ancho Canyon near Bandelier	06/29	F	1	107	135.3	<35	<44	<46	<10	1	<59	46.6	<10	11.2	228.7
Suspended Solids (mg/kg)															
Cañada del Buey at WR	07/08		1		495	<0.625	18	25	<1.24	<0.6	<7.38	49.2	<1.24	28.1	80
			R1		427	<0.62	14.5	21	<1.24		<7.38	43.1	<1.25	23	65
			D1							0.72					
Ancho Canyon near Bandelier	06/29		1		489	<0.625	13.2	21.6	<1.25	0.69	<7.38	40	<1.25	21.3	77.3
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							
NM Wildlife Habitat Stream Standard										2					
NM Livestock Watering Limit								100		50				100	25,000
NMWQCC Groundwater Limit					200	1,000	200	50		50					1,000

[a] Codes: U–unfiltered, F–filtered, d–field duplicate, 1–primary analysis, R1–lab replicate, D1–lab duplicate.
[f] Less than symbol (<) means measurement was below the analytical uncertainty.
[c] Standards given here for comparison only, see Appendix A. Note that New Mexico Wildlife and Groundwater limits are based on dissolved concentrations, but these analyses are of unfiltered samples- thus concentrations may include metals assciated with the suspended sediments.

Table 5-11. Number of Results above the Analytical Limit of Quantitation for Organic Compounds in Surface Waters in 1996

Station Name	Date	Volatile	Semivolatile	PCB	High Explosives	TIC[a]
Number of Compounds Analyzed		59	69	4	14	
Acid Weir	12/11	0				
Pueblo 1	12/10	0				
Pueblo 3	12/10	1	0	0		15
Los Alamos Canyon Reservoir	12/12	0	1	0		5
DPS-1	07/09	1	3[b]			5
SCS-2	12/10	0	1	0		2
Pajarito Canyon	12/11	0	1	0		4
Pajarito at Rio Grande	10/07	0	0	0		2
Water Canyon at Beta	11/08	0	0	0	2	2
Ancho at Rio Grande	10/08	0	0	0	0	
Frijoles at Monument HQ	06/04	0	0	0	2	
Frijoles at Rio Grande	10/09	0		0		
LA Canyon near LA (filtered)	08/22				0	
LA Canyon near LA (unfiltered)	08/22				0	
Cañada del Buey at WR (water)	07/08				0	
Cañada del Buey at WR (suspended solids)	07/08				0	
Ancho Canyon near Bandelier (water)	06/29				0	
Ancho Canyon near Bandelier (suspended solids)	06/29				0	

[a] TIC—Tentatively identified compounds, TICs are run with all volatile and semivolatile analysis, all detected values reported, limit of quantitation not defined.
[b] Semivolitile sample collected on 12/31/96.

Table 5-12. Organics Found in Surface Waters in 1996 above the Limit of Quantitation

Station Name	Date	Analyte	Sample Value (μg/L)	Uncertainty (μg/L)	Analyte[a] Suite
Pueblo 3	12/10	Hexadecanoic acid	24		voa
Los Alamos Canyon Reservoir	12/12	Di-n-butyl phthalate	4	1.2	semivoa
DPS-1	07/09	Acetone	15	4.5	voa
		Benzoic acid	11	3.3	semivoa
		Di-n-butyl phthalate	7	2.1	semivoa
		Di-n-octyl phthalate	8	2.4	semivoa
SCS-2	12/10	Di-n-butyl phthalate	2	0.6	semivoa
Pajarito Canyon	12/11	Di-n-butyl phthalate	2	0.6	semivoa
Water Canyon at Beta	11/08	HMX	4.92	1.48	HE
		RDX	0.76	0.228	HE
Frijoles at Monument HQ	06/04	Dinitrotoluene [2,4-]	3.443	1.329	HE
		Trinitrotoluene [2,4,6-]	1.442	0.433	HE

[a] voa—volatile organics, semivoa—semivolatile organics, HE—high explosives.

Table 5–13. Radiochemical Analysis for Sediments in 1996 (pCi/g)[a]

Station Name[b]	Date	Code[c]	^{3}H	^{90}Sr	^{137}Cs	U (mg/kg)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Regional Stations:												
Rio Chama at Chamita	05/09	1	0.000 (0.001)[d]	0.70 (0.30)	0.06 (0.02)	1.35 (0.14)	0.001 (0.001)	0.002 (0.001)	0.002 (0.001)	1.5 (0.4)	1.4 (0.2)	2.8 (0.3)
	05/09	R1	0.001 (0.000)				0.001 (0.001)	0.002 (0.001)	0.002 (0.002)			
Rio Grande at Embudo	05/09	1	0.001 (0.001)	0.30 (0.20)	0.07 (0.02)	2.03 (0.20)	0.001 (0.001)	0.003 (0.001)	0.003 (0.005)	3.5 (1.6)	2.4 (0.3)	1.7 (0.2)
	05/09	R1								2.9 (1.3)	2.3 (0.3)	
Rio Grande at Otowi (bank)	05/09	1	0.000 (0.001)	−0.10 (0.20)	0.05 (0.02)	1.10 (0.11)	0.001 (0.001)	0.000 (0.000)	0.000 (0.001)	1.5 (0.7)	2.4 (0.3)	1.9 (0.3)
	05/09	R1			0.05 (0.02)							1.3 (0.2)
	10/11	1	0.026 (0.069)	1.80 (0.80)	0.09 (0.03)	4.17 (0.42)	0.001 (0.000)	0.004 (0.001)	0.003 (0.001)	6.3 (1.9)	5.0 (0.6)	3.0 (0.4)
	10/11	D1	0.025 (0.069)	2.50 (0.90)		3.79 (0.38)	0.001 (0.000)	0.004 (0.001)		6.0 (1.8)	5.0 (0.6)	
Rio Grande at Otowi (wdth intgrt)	10/11	1	−0.018 (0.040)	0.40 (0.90)	0.07 (0.02)	1.81 (0.18)	0.000 (0.000)	0.002 (0.001)	0.003 (0.001)	2.8 (0.8)	2.1 (0.2)	2.7 (0.3)
	10/11	R1			0.09 (0.02)							2.6 (0.3)
Rio Grande at Frijoles (bank)	10/09	1	0.008 (0.049)	1.40 (0.50)	0.09 (0.03)	2.89 (0.29)	0.000 (0.000)	0.003 (0.001)	0.003 (0.001)	3.5 (0.9)	2.7 (0.3)	3.0 (0.4)
	10/09	D1		1.60 (0.50)								
Rio Grande at Bernalillo	05/09	1	0.001 (0.001)	0.00 (0.30)	0.02 (0.03)	1.44 (0.14)	0.000 (0.000)	0.003 (0.001)	0.003 (0.005)	2.4 (0.7)	1.4 (0.2)	1.3 (0.2)
	05/09	D1		0.20 (0.30)								
Jemez River	05/09	1	0.001 (0.001)	0.40 (0.20)	0.08 (0.03)	2.61 (0.26)	0.002 (0.001)	0.006 (0.001)	0.005 (0.002)	14.5 (6.6)	4.1 (0.5)	6.6 (0.7)
	05/09	D1				2.70 (0.27)						
Guaje Canyon:												
Guaje at SR–502	03/11	1	IM[e]	0.10 (0.30)	0.06 (0.03)	1.53 (0.15)	0.001 (0.001)	0.004 (0.001)	0.002 (0.001)	1.9 (0.2)	1.6 (0.2)	3.2 (0.4)
Bayo Canyon:												
Bayo at SR–502	03/11	1	0.004 (0.004)	0.30 (0.30)	0.07 (0.03)	0.93 (0.09)	−0.001 (0.001)	0.002 (0.002)	0.003 (0.001)	1.9 (0.3)	0.9 (0.1)	2.8 (0.3)
Acid/Pueblo Canyons:												
Acid Weir	12/10	1	0.103 (0.034)	0.40 (0.30)	0.27 (0.03)	1.38 (0.14)	0.031 (0.003)	5.340 (0.140)	0.531 (0.019)	2.2 (0.6)	0.7 (0.1)	2.7 (0.3)
	12/10	R1		0.70 (0.20)	0.24 (0.03)	1.30 (0.13)	0.044 (0.005)	8.500 (0.400)	0.420 (0.020)			2.5 (0.3)
Pueblo 1	12/10	1	0.056 (0.045)	0.20 (0.40)	0.17 (0.02)	1.44 (0.14)	0.001 (0.001)	0.006 (0.001)	0.004 (0.001)	5.5 (1.2)	3.7 (0.5)	3.3 (0.4)
Pueblo 2	12/10	1	0.072 (0.014)	0.20 (0.20)	0.15 (0.02)	1.53 (0.15)	0.001 (0.001)	0.003 (0.001)	0.002 (0.001)	3.2 (0.6)	2.0 (0.2)	2.7 (0.3)
	12/10	R1								3.4 (0.7)	2.3 (0.3)	
Hamilton Bend Spring	12/24	1	0.002 (0.000)	0.00 (0.20)	0.09 (0.01)	1.70 (0.17)	0.003 (0.001)	0.423 (0.015)	0.013 (0.002)	3.6 (0.8)	2.6 (0.3)	3.3 (0.4)
Pueblo 3	12/10	1	0.010 (0.011)	0.00 (0.20)	0.11 (0.02)	1.69 (0.17)	0.000 (0.000)	0.005 (0.001)	0.008 (0.003)	4.0 (1.1)	1.7 (0.1)	3.0 (0.4)
Pueblo at SR–502	05/07	1	0.234 (0.144)	0.00 (0.30)	0.07 (0.03)	1.81 (0.18)	0.009 (0.002)	0.769 (0.032)	0.034 (0.010)	4.1 (0.7)	1.2 (0.1)	3.3 (0.4)
	05/07	R1		0.10 (0.20)						4.2 (0.9)	1.8 (0.2)	
DP/Los Alamos Canyons:												
Los Alamos at Bridge	05/08	1	IM	0.10 (0.20)	0.11 (0.03)	1.60 (0.16)	0.002 (0.001)	0.003 (0.001)	0.005 (0.005)	2.7 (0.5)	1.6 (0.2)	2.3 (0.3)
Los Alamos at LAO–1	05/08	1	IM	0.10 (0.20)	0.15 (0.04)	1.65 (0.17)	0.001 (0.001)	0.346 (0.013)	0.010 (0.002)	1.9 (0.3)	1.0 (0.1)	2.4 (0.3)
Los Alamos at GS–1	05/08	1	IM	0.10 (0.20)	0.05 (0.02)	1.23 (0.12)	0.000 (0.001)	0.060 (0.005)	0.006 (0.001)	1.3 (0.2)	0.5 (0.1)	1.8 (0.3)
	05/08	R1					0.002 (0.001)	0.054 (0.005)	0.006 (0.013)			
DPS–1	05/08	1	IM	0.20 (0.20)	0.38 (0.06)	0.77 (0.08)	0.005 (0.001)	0.044 (0.004)	0.053 (0.004)	0.9 (0.1)	1.4 (0.2)	2.2 (0.3)
	05/08	D1				0.67 (0.07)						

Table 5-13. Radiochemical Analysis for Sediments in 1996 (pCi/g)[a] (Cont.)

Station Name[b]	Date	Code[c]	^{3}H	^{90}Sr	^{137}Cs	U (mg/kg)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
DP/Los Alamos Canyons (Cont.):												
DPS-4	05/08	1	IM	0.90 (0.20)	3.17 (0.26)	1.35 (0.14)	0.049 (0.003)	0.221 (0.009)	0.460 (0.030)	3.0 (0.4)	4.8 (0.6)	5.3 (0.6)
Los Alamos at LAO-3	05/08	1	IM	0.40 (0.30)	1.19 (0.12)	0.84 (0.08)	0.022 (0.002)	0.124 (0.005)	0.198 (0.009)	1.3 (0.2)	1.6 (0.2)	3.0 (0.4)
	05/08	R1			1.63 (0.16)							3.6 (0.4)
Los Alamos at LAO-4.5	05/08	1	IM	0.20 (0.20)	0.82 (0.09)	0.91 (0.09)	0.011 (0.001)	0.088 (0.004)	0.092 (0.005)	0.8 (0.1)	0.9 (0.1)	2.6 (0.3)
	05/08	D1		0.30 (0.30)	0.75 (0.09)	0.99 (0.10)	0.007 (0.001)	0.122 (0.006)	0.111 (0.006)	1.1 (0.1)	1.2 (0.1)	2.6 (0.3)
Los Alamos at SR-4	05/02	1	0.000 (0.000)	0.10 (0.20)	0.06 (0.02)	1.09 (0.11)	0.001 (0.000)	0.088 (0.004)	0.014 (0.002)	1.2 (0.2)	0.7 (0.1)	2.5 (0.3)
Los Alamos at Totavi	08/15	1	0.008 (0.001)	0.10 (0.40)	0.16 (0.02)	2.97 (0.30)	0.000 (0.001)	0.026 (0.003)	0.004 (0.001)	6.1 (2.2)	5.1 (0.6)	3.8 (0.4)
	08/15	R1				2.78 (0.28)			0.011 (0.002)			
Los Alamos at Otowi	05/02	1	0.000 (0.000)	0.30 (0.20)	1.67 (0.16)	2.91 (0.29)	0.029 (0.003)	0.243 (0.009)	0.340 (0.020)	5.5 (1.2)	4.3 (0.5)	5.9 (0.6)
	05/02	D1		0.90 (0.40)	1.75 (0.17)	2.90 (0.29)	0.032 (0.003)	0.230 (0.010)	0.370 (0.020)	6.1 (1.3)	4.5 (0.5)	5.3 (0.6)
	08/15	1	−0.001 (0.000)	0.20 (0.40)	0.13 (0.02)	1.34 (0.13)	0.001 (0.001)	0.100 (0.006)	0.004 (0.001)	1.8 (0.3)	0.7 (0.1)	3.1 (0.4)
Sandia Canyon:												
Sandia at SR-4	03/11	1	IM	0.10 (0.30)	0.04 (0.02)	1.21 (0.12)	0.000 (0.001)	0.003 (0.001)	0.002 (0.001)	3.2 (0.6)	2.3 (0.3)	1.2 (0.2)
	03/11	R1			0.06 (0.02)							2.4 (0.3)
Mortandad Canyon:												
Mortandad near CMR Building	04/11	1	0.076 (0.009)	0.10 (0.20)	0.07 (0.03)	1.45 (0.15)	0.030 (0.003)	0.008 (0.001)	0.005 (0.002)	10.9 (4.4)	4.3 (0.5)	2.6 (0.3)
	04/11	D1		0.90 (0.20)	0.07 (0.03)	1.81 (0.18)	0.027 (0.003)	0.012 (0.002)	0.006 (0.001)	8.1 (1.7)	4.1 (0.5)	
Mortandad west of GS-1	04/11	1	0.171 (0.026)	0.00 (0.20)	2.30 (0.21)	1.77 (0.18)	0.009 (0.002)	0.205 (0.009)	0.039 (0.002)	17.7 (3.7)	29.4 (3.5)	4.7 (0.5)
	04/11	R1										2.6 (0.3)
Mortandad at GS-1	04/11	1	31.877 (0.392)	0.50 (0.20)	16.10 (1.20)	0.89 (0.09)	6.800 (0.350)	4.850 (0.250)	9.060 (0.280)	54.1 (8.2)	43.4 (5.0)	20.0 (2.0)
Mortandad at MCO-5	04/11	1	0.000 (0.000)	0.80 (0.20)	14.70 (1.10)	1.36 (0.14)	2.220 (0.110)	5.790 (0.280)	7.250 (0.250)	43.1 (6.4)	26.5 (3.1)	16.0 (2.0)
	04/11	R1							8.250 (0.330)			
Mortandad at MCO-7	04/11	1	0.000 (0.000)	0.40 (0.20)	6.06 (0.48)	0.72 (0.07)	1.000 (0.500)	3.220 (0.160)	2.070 (0.100)	30.5 (5.2)	16.9 (2.0)	7.1 (0.7)
	04/11	R1							2.180 (0.110)			
Mortandad at MCO-9	04/11	1	0.000 (0.000)	0.10 (0.40)	0.54 (0.07)	1.03 (0.10)	0.002 (0.002)	0.037 (0.005)	0.016 (0.002)	10.6 (2.1)	8.6 (1.0)	4.4 (0.5)
Mortandad at MCO-13 (A-5)	04/11	1	0.000 (0.000)	−0.10 (0.50)	0.44 (0.06)	1.24 (0.12)	0.002 (0.001)	0.026 (0.002)	0.007 (0.001)	11.0 (2.9)	7.6 (0.9)	3.8 (0.4)
Mortandad A-6	08/15	1	0.002 (0.000)	0.40 (0.40)	0.24 (0.03)	2.12 (0.21)	0.001 (0.000)	0.023 (0.002)	0.004 (0.001)	3.7 (0.9)	5.6 (0.7)	3.5 (0.4)
	08/15	R1		0.40 (0.40)						5.8 (1.9)	2.6 (0.3)	
Mortandad A-7	08/15	1	0.004 (0.000)	0.40 (0.20)	0.20 (0.02)	2.21 (0.22)	0.000 (0.000)	0.008 (0.001)	0.003 (0.001)	8.5 (3.1)	5.9 (0.7)	3.4 (0.4)
	08/15	R1					0.001 (0.001)	0.010 (0.002)				
Mortandad at SR-4 (A-9)	08/15	1	0.005 (0.001)	0.30 (0.20)	0.10 (0.01)	1.85 (0.19)	0.000 (0.001)	0.004 (0.001)	0.002 (0.001)	6.1 (2.6)	3.2 (0.4)	3.4 (0.4)
	08/15	R1			0.08 (0.01)							2.8 (0.3)
Mortandad at Rio Grande (A-11)	10/07	1	IM	0.30 (0.50)	0.06 (0.02)	1.63 (0.16)	0.001 (0.001)	0.002 (0.001)	0.004 (0.002)	2.2 (0.5)	2.6 (0.3)	2.6 (0.3)
	10/07	R1			0.02 (0.04)							2.6 (0.3)
Cañada del Buey:												
Cañada del Buey at SR-4	03/11	1	IM	0.10 (0.20)	0.12 (0.04)	0.84 (0.08)	0.001 (0.001)	0.003 (0.001)	0.000 (0.000)	1.9 (0.3)	1.4 (0.2)	2.8 (0.3)
	03/11	D1		0.00 (0.30)		0.61 (0.06)	0.001 (0.001)	0.003 (0.001)	0.003 (0.001)	2.4 (0.4)	1.2 (0.1)	

Table 5–13. Radiochemical Analysis for Sediments in 1996 (pCi/g)[a] (Cont.)

Station Name[b]	Date	Code[c]	^{3}H	^{90}Sr	^{137}Cs	U (mg/kg)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
TA–54 Area G:												
G–1	03/22	1	0.004 (0.003)	0.10 (0.20)	0.09 (0.03)	0.77 (0.08)	0.001 (0.001)	0.003 (0.001)	0.005 (0.001)	2.4 (0.5)	1.1 (0.1)	2.6 (0.3)
	03/22	D1		0.30 (0.20)			0.000 (0.001)	0.025 (0.003)	0.003 (0.001)			
G–2	03/22	1	0.023 (0.006)	0.30 (0.30)	0.06 (0.02)	1.15 (0.12)	0.000 (0.001)	0.012 (0.003)	0.003 (0.001)	3.9 (0.8)	1.8 (0.2)	2.3 (0.3)
	03/22	R1					0.001 (0.001)	0.003 (0.001)	0.004 (0.002)			
G–3	03/22	1	0.243 (0.070)	0.10 (0.10)	0.20 (0.04)	1.07 (0.11)	0.004 (0.002)	0.030 (0.004)	0.007 (0.003)	3.5 (0.7)	2.4 (0.3)	2.7 (0.3)
	03/22	D1				0.76 (0.08)	0.002 (0.001)	0.012 (0.002)	0.012 (0.002)			
	03/22	R1					0.007 (0.002)	0.013 (0.002)	0.010 (0.002)			
	03/22	R2					0.004 (0.002)	0.021 (0.003)	0.015 (0.002)			
G–4	03/22	1	0.019 (0.006)	0.20 (0.20)	0.26 (0.05)	1.68 (0.17)	0.004 (0.002)	0.018 (0.003)	0.006 (0.001)	5.1 (1.0)	4.0 (0.5)	4.1 (0.5)
	03/22	R1					0.003 (0.001)	0.015 (0.003)	0.003 (0.001)	7.6 (1.8)	4.3 (0.5)	
G–5	03/22	1	0.031 (0.009)	0.20 (0.20)	0.16 (0.04)	1.58 (0.16)	0.021 (0.003)	0.040 (0.005)	0.014 (0.002)	5.3 (1.5)	3.1 (0.4)	3.8 (0.4)
	03/22	R1					0.017 (0.005)	0.043 (0.003)	0.014 (0.004)			
	03/22	R2					0.017 (0.002)	0.039 (0.007)				
G–6	03/22	1	0.038 (0.009)	0.10 (0.20)	0.12 (0.03)	2.55 (0.26)	0.018 (0.003)	0.226 (0.012)	0.035 (0.003)	7.2 (2.1)	2.5 (0.3)	3.2 (0.4)
	03/22	R1					0.012 (0.002)	0.139 (0.007)	0.049 (0.004)			
G–7	03/22	1	0.020 (0.005)	0.00 (0.20)	0.15 (0.03)	0.88 (0.09)	0.243 (0.014)	0.174 (0.011)	0.013 (0.002)	4.0 (0.7)	2.0 (0.2)	2.9 (0.3)
	03/22	R1					0.118 (0.007)	0.105 (0.007)	0.044 (0.006)			
G–8	03/22	1	0.016 (0.005)	0.30 (0.40)	0.38 (0.06)	1.36 (0.14)	0.119 (0.008)	0.150 (0.009)	0.014 (0.002)	4.0 (0.7)	3.2 (0.4)	3.9 (0.4)
	03/22	R1			0.33 (0.05)		0.084 (0.005)	0.063 (0.004)	0.014 (0.004)			3.0 (0.3)
G–9	03/22	1	0.017 (0.005)	0.00 (0.30)	0.18 (0.04)	1.77 (0.18)	0.031 (0.004)	0.040 (0.004)	0.021 (0.003)	4.5 (0.9)	2.0 (0.2)	3.5 (0.4)
	03/22	R1					0.091 (0.005)	0.030 (0.003)	0.013 (0.016)			
Pajarito Canyon:												
Two–mile at SR–501	03/12	1	0.003 (0.014)	0.20 (0.20)	0.28 (0.05)	1.09 (0.11)	0.001 (0.001)	0.007 (0.001)	0.003 (0.001)	3.7 (0.7)	2.5 (0.3)	3.4 (0.4)
Pajarito at SR–501	03/11	1	0.036 (0.063)	0.20 (0.20)	0.08 (0.03)	1.10 (0.11)	0.001 (0.001)	0.006 (0.001)	0.002 (0.001)	3.0 (0.8)	2.3 (0.3)	3.1 (0.4)
	03/11	R1	0.035 (0.063)									
Pajarito at SR–4	03/11	1	0.067 (0.106)	0.00 (0.30)	0.21 (0.05)	1.19 (0.12)	0.001 (0.001)	0.010 (0.001)	0.009 (0.002)	5.0 (1.3)	2.7 (0.3)	–0.1 (0.2)
Potrillo Canyon:												
Potrillo at SR–4	03/11	1	0.006 (0.017)	0.10 (0.30)	0.18 (0.05)	1.22 (0.12)	0.001 (0.001)	0.006 (0.001)	0.002 (0.002)	5.2 (1.1)	3.3 (0.4)	4.8 (0.5)
Fence Canyon:												
Fence at SR–4	03/11	1	0.001 (0.014)	0.30 (0.20)	0.40 (0.07)	1.79 (0.18)	0.001 (0.001)	0.011 (0.001)	0.007 (0.001)	4.8 (0.8)	3.5 (0.4)	6.0 (0.6)
Cañon de Valle:												
Cañon de Valle at SR–501	03/12	1	0.000 (0.003)	0.10 (0.20)	0.13 (0.03)	0.93 (0.09)	0.001 (0.001)	0.003 (0.001)	0.004 (0.001)	2.0 (0.4)	1.4 (0.2)	1.5 (0.2)
Water Canyon:												
Water at SR–501	03/11	1	IM	0.00 (0.20)	0.09 (0.03)	0.65 (0.07)	0.001 (0.001)	0.005 (0.002)	0.003 (0.002)	3.0 (0.5)	2.1 (0.2)	2.8 (0.3)
Water at SR–4	03/11	1	0.009 (0.014)	0.10 (0.30)	0.28 (0.05)	1.84 (0.18)	0.001 (0.001)	0.011 (0.002)	0.004 (0.001)	8.7 (3.0)	5.7 (0.7)	5.2 (0.6)

Table 5–13. Radiochemical Analysis for Sediments in 1996 (pCi/g)[a] (Cont.)

Station Name[b]	Date	Code[c]	^{3}H	^{90}Sr	^{137}Cs	U (mg/kg)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Indio Canyon:												
Indio at SR–4	03/11	1	0.005 (0.009)	0.10 (0.40)	0.16 (0.05)	0.67 (0.07)	0.001 (0.001)	0.007 (0.002)	0.006 (0.003)	1.7 (0.3)	1.5 (0.2)	3.6 (0.4)
Ancho Canyon:												
Ancho at SR–4	03/11	1	IM	0.10 (0.20)	0.07 (0.03)	1.14 (0.11)	0.000 (0.001)	0.002 (0.001)	0.002 (0.001)	3.9 (0.8)	2.3 (0.3)	3.1 (0.4)
Above Ancho Spring	10/08	1	0.003 (0.025)	1.60 (0.50)	0.27 (0.04)	2.94 (0.29)	0.001 (0.000)	0.002 (0.001)	0.003 (0.001)	4.3 (1.9)	4.5 (0.5)	3.5 (0.4)
	10/08	R1							0.004 (0.004)			
Ancho at Rio Grande	10/08	1	0.056 (0.034)	0.50 (0.40)	0.15 (0.03)	1.43 (0.14)	0.001 (0.000)	0.002 (0.001)	0.003 (0.003)	1.4 (1.0)	2.5 (0.3)	2.9 (0.3)
	10/08	R1	0.096 (0.034)				0.000 (0.001)	0.003 (0.001)		11.9 (3.5)	3.3 (0.4)	
Chaquehui Canyon:												
Chaquehui at Rio Grande	10/09	1	–0.030 (0.025)	–0.10 (0.40)	0.06 (0.02)	1.28 (0.13)	0.000 (0.000)	0.002 (0.001)	0.003 (0.001)	6.3 (1.4)	1.4 (0.2)	1.7 (0.2)
TA–49 Area AB:												
AB–1	03/25	1	0.029 (0.037)	0.70 (1.20)	0.51 (0.06)	1.96 (0.20)	0.003 (0.002)	0.023 (0.004)	0.008 (0.002)	7.6 (2.8)	7.4 (0.9)	3.2 (0.4)
AB–2	03/25	1	0.060 (0.047)	0.40 (1.00)	0.31 (0.05)	1.43 (0.14)	0.003 (0.001)	0.076 (0.006)	0.020 (0.003)	7.6 (3.2)	7.2 (0.9)	2.9 (0.3)
	03/25	D1				1.40 (0.14)						
AB–3	03/25	1	0.098 (0.009)	0.30 (0.70)	0.23 (0.04)	1.11 (0.11)	0.029 (0.003)	1.668 (0.058)	0.402 (0.015)	5.7 (2.0)	6.9 (0.8)	2.5 (0.3)
	03/25	R1					0.035 (0.004)	1.727 (0.060)	0.420 (0.300)			
AB–4	03/25	1	0.068 (0.024)	0.50 (1.20)	0.35 (0.05)	1.57 (0.16)	0.003 (0.002)	0.014 (0.003)	0.007 (0.002)	6.0 (1.6)	5.4 (0.6)	3.3 (0.4)
AB–4A	03/25	1	–0.007 (0.086)	–0.90 (2.00)	0.25 (0.04)	1.62 (0.16)	0.003 (0.002)	0.013 (0.002)	0.004 (0.001)	4.6 (2.0)	4.8 (0.6)	2.5 (0.3)
	03/25	R1			0.22 (0.04)							2.7 (0.3)
AB–5	03/25	1	0.006 (0.011)	0.70 (1.10)	0.61 (0.08)	0.95 (0.10)	0.003 (0.002)	0.033 (0.005)	0.013 (0.002)	6.0 (2.0)	6.5 (0.8)	3.1 (0.4)
AB–6	03/25	1	0.002 (0.006)	0.10 (1.90)	0.28 (0.05)	1.42 (0.14)	0.001 (0.001)	0.012 (0.002)	0.007 (0.002)	5.7 (1.5)	3.6 (0.4)	2.6 (0.3)
	03/25	D1		0.60 (0.90)								
AB–7	03/25	1	0.076 (0.013)	0.10 (0.60)	0.13 (0.03)	0.72 (0.07)	–0.002 (0.001)	0.007 (0.003)	–0.002 (0.001)	3.6 (0.7)	2.3 (0.3)	2.1 (0.3)
AB–8	03/25	1	0.001 (0.003)	0.30 (0.70)	0.09 (0.03)	0.84 (0.08)	0.001 (0.001)	0.002 (0.001)	0.003 (0.001)	2.5 (0.5)	1.9 (0.2)	2.5 (0.3)
	03/25	R1								2.9 (0.6)	1.8 (0.2)	
AB–9	03/25	1	0.001 (0.004)	0.90 (1.00)	0.15 (0.04)	1.00 (0.10)	0.000 (0.001)	0.002 (0.001)	0.004 (0.001)	2.6 (0.5)	1.5 (0.2)	2.6 (0.3)
AB–10	03/25	1	0.000 (0.005)	0.50 (0.60)	0.14 (0.03)	0.45 (0.05)	0.000 (0.001)	0.003 (0.001)	0.001 (0.001)	3.2 (0.5)	2.0 (0.2)	1.6 (0.2)
AB–11	03/25	1	0.002 (0.004)	0.60 (0.60)	0.25 (0.05)	0.48 (0.05)	0.000 (0.001)	0.007 (0.002)	0.003 (0.001)	2.2 (0.4)	1.1 (0.1)	2.0 (0.3)
Frijoles Canyon:												
Frijoles at Monument HQ	08/20	1	0.420 (0.062)	0.10 (0.40)	0.12 (0.04)	2.38 (0.24)	0.000 (0.004)	0.004 (0.004)	0.007 (0.002)	0.4 (0.2)	1.3 (0.2)	3.0 (0.4)
	08/20	D1	0.176 (0.060)	0.20 (0.40)	0.11 (0.03)	2.40 (0.24)	0.001 (0.001)	0.004 (0.001)	0.006 (0.002)	0.4 (0.2)	1.4 (0.2)	3.5 (0.4)
Frijoles at Rio Grande	10/09	1	0.487 (0.251)	1.30 (0.50)	0.50 (0.06)	4.55 (0.46)	0.002 (0.001)	0.020 (0.002)	0.009 (0.002)	3.0 (0.7)	7.8 (0.9)	4.7 (0.5)
	10/09	R1				4.41 (0.44)						
Reservoirs on Rio Chama (New Mexico):												
Heron Upper	06/27	1	ND[f]	0.30 (0.20)	0.47 (0.06)	2.57 (0.26)	0.0003 (0.000)[g]	0.0093 (0.001)[g]	0.008 (0.002)	7.5 (3.4)	5.7 (0.7)	3.0 (0.4)
	06/27	R1										2.3 (0.3)
Heron Middle	06/27	1	ND	0.20 (0.30)	0.18 (0.27)	3.06 (0.31)	0.0001 (0.000)	0.0038 (0.000)	0.004 (0.003)	14.0 (6.0)	8.8 (1.1)	3.0 (0.3)

Table 5-13. Radiochemical Analysis for Sediments in 1996 (pCi/g)[a] (Cont.)

Station Name[b]	Date	Code[c]	^{3}H	^{90}Sr	^{137}Cs	U (mg/kg)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Reservoirs on Rio Chama (New Mexico)(Cont.):												
Heron Lower	06/27	1	ND	0.30 (0.20)	0.45 (0.06)	2.26 (0.23)	0.0004 (0.000)	0.0120 (0.000)	0.000 (0.003)	1.8 (0.4)	1.3 (0.2)	2.4 (0.3)
	06/27	D1		0.20 (0.30)	0.53 (0.06)	2.73 (0.27)	0.0005 (0.000)	0.0127 (0.000)	0.009 (0.002)	9.7 (2.7)	6.4 (0.8)	2.4 (0.3)
El Vado Upper	06/26	1	ND	0.20 (0.30)	0.16 (0.03)	2.27 (0.23)	0.0002 (0.000)	0.0053 (0.000)	0.005 (0.001)	9.9 (4.2)	5.8 (0.7)	2.4 (0.3)
	06/26	R1					0.0002 (0.000)	0.0052 (0.000)				
El Vado Middle	06/26	1	ND	0.20 (0.30)	0.11 (0.16)	2.51 (0.25)	0.0001 (0.000)	0.0020 (0.000)	0.003 (0.001)	5.8 (2.6)	4.5 (0.6)	2.1 (0.3)
El Vado Lower	06/26	1	ND	0.40 (0.20)	0.23 (0.04)	2.32 (0.23)	0.0002 (0.000)	0.0067 (0.000)	0.001 (0.002)	11.0 (5.0)	8.7 (1.1)	2.7 (0.3)
Abiquiu Upper	06/25	1	ND	0.10 (0.20)	0.08 (0.13)	1.32 (0.13)	0.0001 (0.000)	0.0011 (0.000)	0.002 (0.001)	2.9 (0.7)	0.9 (0.1)	1.4 (0.2)
	06/25	D1					0.0002 (0.000)	0.0011 (0.000)		1.4 (0.2)	0.9 (0.1)	
Abiquiu Middle	06/28	1	ND	0.50 (0.20)	0.12 (0.03)	2.69 (0.27)	0.0002 (0.000)	0.0038 (0.000)	0.003 (0.003)	7.6 (3.0)	4.6 (0.6)	1.9 (0.3)
	06/28	D1			0.13 (0.03)							
Abiquiu Lower	06/28	1	ND	0.10 (0.20)	0.35 (0.05)	2.23 (0.22)	0.0003 (0.000)	0.0090 (0.001)	0.004 (0.001)	9.8 (3.8)	5.6 (0.7)	2.4 (0.3)
Reservoirs on Rio Grande (Colorado):												
Rio Grande Upper	09/21	1	–0.160 (0.131)	0.20 (0.30)	0.42 (0.04)	3.02 (0.30)	0.0007 (0.000)	0.0165 (0.001)	0.007 (0.002)	7.5 (3.1)	5.5 (0.6)	3.4 (0.4)
	09/21	R1	0.181 (0.133)	0.40 (0.20)		3.07 (0.31)				–1.8 (0.8)	6.4 (0.8)	
Rio Grande Middle	09/21	1	0.048 (0.137)	0.50 (0.30)	0.33 (0.03)	3.08 (0.31)	0.0006 (0.000)	0.0144 (0.000)	0.007 (0.002)	8.5 (1.5)	7.1 (0.8)	3.3 (0.4)
Rio Grande Lower	09/21	1	0.458 (0.158)	0.40 (0.40)	0.49 (0.04)	2.84 (0.28)	ND	ND	0.007 (0.002)	16.4 (6.1)	8.5 (1.0)	2.9 (0.3)
	09/21	D1			0.58 (0.05)				0.007 (0.002)			3.1 (0.4)
Reservoirs on Rio Grande (New Mexico):												
Cochiti Upper	10/16	1	0.000 (0.000)	1.60 (0.60)	0.43 (0.04)	2.86 (0.29)	0.0009 (0.000)	0.0166 (0.001)	0.007 (0.002)	8.1 (5.1)	8.1 (1.0)	3.4 (0.4)
	10/16	R1								9.7 (6.0)	7.9 (1.0)	
Cochiti Middle	10/16	1	0.000 (0.000)	2.70 (0.70)	0.70 (0.06)	3.13 (0.31)	0.0012 (0.000)	0.0238 (0.001)	0.009 (0.002)	16.1 (12.9)	11.4 (1.5)	4.4 (0.5)
Cochiti Lower	10/16	1	0.000 (0.000)	1.30 (0.50)	0.34 (0.03)	2.10 (0.21)	0.0006 (0.000)	0.0138 (0.001)	0.006 (0.001)	8.1 (3.0)	5.5 (0.6)	3.0 (0.4)
	10/16	R1				2.80 (0.28)						
Standardized Comparisons												
Average Detection Limits				1.00	0.05	0.20	0.002[g]	0.002[g]	0.002	1.5	1.5	0.8
Background (x + 2 s)[h]				0.87	0.44	4.40	0.006	0.023	0.090[i]	14.8[i]	12.0[i]	8.2[i]
SAL[j]				4.4	5.1	67	27	24	22			

[a] Except where noted.
[b] Sample sizes: stream channels—100 g; reservoirs—1000 g.
[c] Code: 1—primary analysis, D—lab duplicate, R—lab replicate.
[d] Radioactivity counting uncertainties are shown in parentheses (1 standard deviation); values are less than analytical uncertainties. Values less than 2 standard deviations are considered nondetections.
[e] IM—Insufficient moisture for tritium analysis.
[f] ND—No Data; laboratory analysis not performed.
[g] Limits of Detection for ^{238}Pu and $^{239,240}Pu$ reservoir analyses are 0.0001 pCi/g.
[h] Purtymun, 1987a; upper limit for background.
[i] Preliminary background value for channel sediments from 1974 to 1996 (McLin 1997).
[j] SAL—Screening Action Level; Environmental Restoration, 1997; see text for details.

Table 5-14. Detections of Above-Background Radionuclides in Sediments for 1996

Station Name[a]	Date	Codes[b]	Analyte	Value	Sigma[c]	Units	DL[d]	BG[e]
Acid Weir	12/10	1	^{238}Pu	0.031	0.003	pCi/g	0.005	0.006
	12/10	R1	^{238}Pu	0.044	0.005	pCi/g	0.005	0.006
	12/10	1	^{239}Pu	5.340	0.140	pCi/g	0.005	0.023
	12/10	R1	^{239}Pu	8.500	0.400	pCi/g	0.005	0.023
	12/10	1	^{241}Am	0.531	0.019	pCi/g	0.005	0.090
	12/10	R1	^{241}Am	0.420	0.020	pCi/g	0.005	0.090
Hamilton Bend Spring	12/24	1	^{239}Pu	0.423	0.015	pCi/g	0.005	0.023
Pueblo at SR-502	05/97	1	^{238}Pu	0.009	0.002	pCi/g	0.005	0.006
	05/97	1	^{239}Pu	0.769	0.032	pCi/g	0.005	0.023
Los Alamos at LAO-1	05/08	1	^{239}Pu	0.346	0.013	pCi/g	0.005	0.023
Los Alamos at GS-1	05/08	1	^{239}Pu	0.060	0.005	pCi/g	0.005	0.023
	05/08	R1	^{239}Pu	0.054	0.005	pCi/g	0.005	0.023
DPS-1	05/08	1	^{239}Pu	0.044	0.004	pCi/g	0.005	0.023
DPS-4	05/08	1	^{137}Cs	3.17	0.26	pCi/g	0.05	0.44
	05/08	1	^{238}Pu	0.049	0.003	pCi/g	0.005	0.006
	05/08	1	^{239}Pu	0.221	0.009	pCi/g	0.005	0.023
	05/08	1	^{241}Am	0.460	0.030	pCi/g	0.002	0.090
Los Alamos at LAO-3	05/08	1	^{137}Cs	1.19	0.12	pCi/g	0.05	0.44
	05/08	R1	^{137}Cs	1.63	0.16	pCi/g	0.05	0.44
	05/08	1	^{238}Pu	0.022	0.002	pCi/g	0.005	0.006
	05/08	1	^{239}Pu	0.124	0.005	pCi/g	0.005	0.023
	05/08	1	^{241}Am	0.198	0.009	pCi/g	0.005	0.090
Los Alamos at LAO-4.5	05/08	1	^{137}Cs	0.82	0.09	pCi/g	0.05	0.44
	05/08	D1	^{137}Cs	0.75	0.09	pCi/g	0.05	0.44
	05/08	1	^{238}Pu	0.011	0.001	pCi/g	0.005	0.006
	05/08	D1	^{238}Pu	0.007	0.001	pCi/g	0.005	0.006
	05/08	1	^{239}Pu	0.088	0.004	pCi/g	0.005	0.023
	05/08	D1	^{239}Pu	0.122	0.006	pCi/g	0.005	0.023
	05/08	1	^{241}Am	0.092	0.005	pCi/g	0.005	0.090
	05/08	D1	^{241}Am	0.111	0.006	pCi/g	0.005	0.090
Los Alamos at SR-4	05/02	1	^{239}Pu	0.088	0.004	pCi/g	0.005	0.023
Los Alamos at Totavi	08/15	1	^{239}Pu	0.026	0.003	pCi/g	0.005	0.023
Los Alamos at Otowi	05/02	1	^{137}Cs	1.67	0.16	pCi/g	0.05	0.44
	05/02	D1	^{137}Cs	1.75	0.17	pCi/g	0.05	0.44
	05/02	1	^{238}Pu	0.029	0.003	pCi/g	0.005	0.006
	05/02	D1	^{238}Pu	0.032	0.003	pCi/g	0.005	0.006
	05/02	1	^{239}Pu	0.243	0.009	pCi/g	0.005	0.023
	05/02	D1	^{239}Pu	0.230	0.010	pCi/g	0.005	0.023
	08/15	1	^{239}Pu	0.100	0.006	pCi/g	0.005	0.023
	05/02	1	^{241}Am	0.340	0.020	pCi/g	0.005	0.090
	05/02	D1	^{241}Am	0.370	0.020	pCi/g	0.005	0.090
Mortandad near CMR Building	04/11	1	^{238}Pu	0.030	0.003	pCi/g	0.005	0.006
	04/11	D1	^{238}Pu	0.027	0.003	pCi/g	0.005	0.006
Mortandad west of GS-1	04/11	1	^{137}Cs	2.30	0.21	pCi/g	0.05	0.44
	04/11	1	^{238}Pu	0.009	0.002	pCi/g	0.005	0.006
	04/11	1	^{239}Pu	0.205	0.009	pCi/g	0.005	0.023
	04/11	1	Alpha	17.7	3.7	pCi/g	1.5	14.8
	04/11	1	Beta	29.4	3.5	pCi/g	1.5	12.0

Table 5-14. Detections of Above-Background Radionuclides in Sediments for 1996 (Cont.)

Station Name[a]	Date	Codes[b]	Analyte	Value	Sigma[c]	Units	DL[d]	BG[e]
Mortandad at GS-1	04/11	1	Tritium	31.88	0.39	pCi/g		
	04/11	1	^{137}Cs	16.10	1.20	pCi/g	0.05	0.44
	04/11	1	^{238}Pu	6.800	0.350	pCi/g	0.005	0.006
	04/11	1	^{239}Pu	4.850	0.250	pCi/g	0.005	0.023
	04/11	1	^{241}Am	9.060	0.280	pCi/g	0.005	0.090
	04/11	1	Alpha	54.1	8.2	pCi/g	1.5	14.8
	04/11	1	Beta	43.4	5.0	pCi/g	1.5	12.0
	04/11	1	Gamma	20.0	2.0	pCi/g	0.8	8.2
Mortandad at MCO-5	04/11	1	^{137}Cs	14.70	1.10	pCi/g	0.05	0.44
	04/11	1	^{238}Pu	2.220	0.110	pCi/g	0.005	0.006
	04/11	1	^{239}Pu	5.790	0.280	pCi/g	0.005	0.023
	04/11	1	^{241}Am	7.250	0.250	pCi/g	0.005	0.090
	04/11	R1	^{241}Am	8.250	0.330	pCi/g	0.005	0.090
	04/11	1	Alpha	43.1	6.4	pCi/g	1.5	14.8
	04/11	1	Beta	26.5	3.1	pCi/g	1.5	12.0
	04/11	1	Gamma	16.0	2.0	pCi/g	0.8	8.2
Mortandad at MCO-7	04/11	1	^{137}Cs	6.06	0.48	pCi/g	0.05	0.44
	04/11	1	^{239}Pu	3.220	0.160	pCi/g	0.005	0.023
	04/11	1	^{241}Am	2.070	0.100	pCi/g	0.005	0.090
	04/11	R1	^{241}Am	2.180	0.110	pCi/g	0.005	0.090
	04/11	1	Alpha	30.5	5.2	pCi/g	1.5	14.8
	04/11	1	Beta	16.9	2.0	pCi/g	1.5	12.0
Mortandad at MCO-9	04/11	1	^{137}Cs	0.54	0.07	pCi/g	0.05	0.44
	04/11	1	^{239}Pu	0.037	0.005	pCi/g	0.005	0.023
Mortandad at MCO-13 (A-5)	04/11	1	^{137}Cs	0.44	0.06	pCi/g	0.05	0.44
	04/11	1	^{239}Pu	0.026	0.002	pCi/g	0.005	0.023
Mortandad A-6	08/15	1	^{239}Pu	0.023	0.002	pCi/g	0.005	0.023
G-1	03/22	D1	^{239}Pu	0.025	0.003	pCi/g	0.005	0.023
G-3	03/22	1	^{239}Pu	0.030	0.004	pCi/g	0.005	0.023
G-5	03/22	1	^{238}Pu	0.021	0.003	pCi/g	0.005	0.006
	03/22	R2	^{238}Pu	0.017	0.002	pCi/g	0.005	0.006
	03/22	1	^{239}Pu	0.040	0.005	pCi/g	0.005	0.023
	03/22	R1	^{239}Pu	0.043	0.003	pCi/g	0.005	0.023
	03/22	R2	^{239}Pu	0.039	0.007	pCi/g	0.005	0.023
G-6	03/22	1	^{238}Pu	0.018	0.003	pCi/g	0.005	0.006
	03/22	R1	^{238}Pu	0.012	0.002	pCi/g	0.005	0.006
	03/22	1	^{239}Pu	0.226	0.012	pCi/g	0.005	0.023
	03/22	R1	^{239}Pu	0.139	0.007	pCi/g	0.005	0.023
G-7	03/22	1	^{238}Pu	0.243	0.014	pCi/g	0.005	0.006
	03/22	R1	^{238}Pu	0.118	0.007	pCi/g	0.005	0.006
	03/22	1	^{239}Pu	0.174	0.011	pCi/g	0.005	0.023
	03/22	R1	^{239}Pu	0.105	0.007	pCi/g	0.005	0.023
G-8	03/22	1	^{238}Pu	0.119	0.008	pCi/g	0.005	0.006
	03/22	R1	^{238}Pu	0.084	0.005	pCi/g	0.005	0.006
	03/22	1	^{239}Pu	0.150	0.009	pCi/g	0.005	0.023
	03/22	R1	^{239}Pu	0.063	0.004	pCi/g	0.005	0.023
G-9	03/22	1	^{238}Pu	0.031	0.004	pCi/g	0.005	0.006
	03/22	R1	^{238}Pu	0.091	0.005	pCi/g	0.005	0.006
	03/22	1	^{239}Pu	0.040	0.004	pCi/g	0.005	0.023
	03/22	R1	^{239}Pu	0.030	0.003	pCi/g	0.005	0.023

Table 5-14. Detections of Above-Background Radionuclides in Sediments for 1996 (Cont.)

Station Name[a]	Date	Codes[b]	Analyte	Value	Sigma[c]	Units	DL[d]	BG[e]
AB-1	03/25	1	^{137}Cs	0.51	0.06	pCi/g	0.05	0.44
	03/25	1	^{239}Pu	0.023	0.004	pCi/g	0.005	0.023
AB-2	03/25	1	^{239}Pu	0.076	0.006	pCi/g	0.005	0.023
AB-3	03/25	1	^{238}Pu	0.029	0.003	pCi/g	0.005	0.006
	03/25	R1	^{238}Pu	0.035	0.004	pCi/g	0.005	0.006
	03/25	1	^{239}Pu	1.668	0.058	pCi/g	0.005	0.023
	03/25	R1	^{239}Pu	1.727	0.060	pCi/g	0.005	0.023
	03/25	1	^{241}Am	0.402	0.015	pCi/g	0.005	0.090
AB-5	03/25	1	^{137}Cs	0.61	0.08	pCi/g	0.05	0.44
	03/25	1	^{239}Pu	0.033	0.005	pCi/g	0.005	0.023
Frijoles at Rio Grande	10/09	1	^{137}Cs	0.50	0.06	pCi/g	0.05	0.44
	10/09	1	Total U	4.55	0.46	mg/kg	0.25	4.40
	10/09	R1	Total U	4.41	0.44	mg/kg	0.25	4.40
Cochiti Middle	10/16	1	^{137}Cs	0.70	0.06	pCi/g	0.05	0.44
	10/16	1	^{238}Pu	0.0012	0.0001	pCi/g	0.0001	0.006
	10/16	1	^{239}Pu	0.0238	0.0010	pCi/g	0.0001	0.023

[a]Selection Criteria: (1) Value $\geq$ 4.66*Sigma; (2) Value $\geq$ DL; and (3) Value $\geq$ BG.
[b]Code: 1—primary analysis, D—lab duplicate, R—lab replicate.
[c]Sigma is the analytical counting uncertainity (1 standard deviation).
[d]DL = Detection Limit (average) for analytical method.
[e]BG = Purtymun et al., 1987 and McLin and Lyons 1997; upper limit for background.

Table 5-15. Possible Detections of Above-Background Radionuclides in Sediments for 1996

Station Name[a]	Date	Codes[b]	Analyte	Value	Sigma[c]	Units	DL[d]	BG[e]
Rio Grande at Otowi (bank)	10/11	D1	^{90}Sr	2.5	0.9	pCi/g	1.00	0.87
Rio Grande at Frijoles (bank)	10/09	1	^{90}Sr	1.4	0.5	pCi/g	1.00	0.87
	10/09	D1	^{90}Sr	1.6	0.5	pCi/g	1.00	0.87
Pueblo at SR-502	05/07	1	^{238}Pu	0.009	0.002	pCi/g	0.005	0.006
Mortandad west of GS-1	04/11	1	^{238}Pu	0.009	0.002	pCi/g	0.005	0.006
G-3	03/22	R1	^{238}Pu	0.007	0.002	pCi/g	0.005	0.006
G-5	03/22	R1	^{238}Pu	0.017	0.005	pCi/g	0.005	0.006
Above Ancho Spring	10/08	1	^{90}Sr	1.6	0.5	pCi/g	1.00	0.87
Frijoles at Rio Grande	10/09	1	^{90}Sr	1.3	0.5	pCi/g	1.00	0.87
Rio Grande Lower	09/21	1	Alpha	16.4	6.1	pCi/g	1.5	14.8
Cochiti Upper	10/16	1	^{90}Sr	1.6	0.6	pCi/g	1.00	0.87
Cochiti Middle	10/16	1	^{90}Sr	2.7	0.7	pCi/g	1.00	0.87
Cochiti Lower	10/16	1	^{90}Sr	1.3	0.5	pCi/g	1.00	0.87

[a]Selection Criteria: (1) 2.33*Sigma $\leq$ Value $\leq$ 4.66*Sigma; (2) Value $\geq$ DL; and (3) Value $\geq$ BG.
[b]Code: 1—primary analysis, D—lab duplicate, R—lab replicate.
[c]Sigma is the analytical counting uncertainity (1 standard deviation).
[d]DL = Detection Limit (average) for analytical method.
[e]BG = Purtymun et al., 1987 and McLin and Lyons 1997; upper limit for background.

Table 5-16. Plutonium Analyses of Sediments in Reservoirs on the Rio Chama and Rio Grande

Year[a]	Location[b]	^{238}Pu (fCi/g)	Sigma[c]	^{239,240}Pu (fCi/g)	Sigma[c]	Ratio (^{239,240}Pu/^{238}Pu)
Abiquiu Reservoir (Rio Chama)[d]						
1984	Mean	0.7	0.2	12.7	1.1	18.1
1985	Mean	0.7	0.2	8.8	0.8	12.6
1986	Mean	0.3	0.1	7.5	0.3	25.0
1987	Mean	0.2	0.0	3.7	0.2	18.5
1988	Mean	0.3	0.1	7.4	0.3	24.7
1989	Mean	0.4	0.1	3.7	0.2	9.3
1990	Mean	0.1	0.1	2.6	0.2	26.0
1991	Mean	0.3	0.2	7.2	0.4	24.0
1992	Mean	0.1	0.0	0.8	0.0	8.0
1993	Mean	0.2	0.1	5.1	0.4	25.5
1994	Mean	0.2	0.1	0.5	0.2	2.5
1995[e]	Mean	13.7	1.7	8.0	1.3	0.6
1996	Upper	0.2	0.0	1.1	0.1	5.5
	Middle	0.2	0.0	3.8	0.1	19.0
	Lower	0.3	0.1	9.0	0.9	30.0
1996	Mean	0.2	0.0	4.6	0.4	19.9
1984–96	Mean	0.3	0.1	5.4	0.4	17.8
1984–96	StDev	0.2	0.1	3.5	0.3	8.0
1984–96	Count	12	12	12	12	12
Cochiti Reservoir (Rio Chama)[d]						
1984	Mean[c]	0.7	0.1	19.7	1.1	28.1
1985	Mean	1.6	0.3	24.1	0.8	15.1
1986	Mean	1.3	0.1	21.6	0.3	16.6
1987	Mean	0.8	0.1	17.5	0.2	21.9
1988	Mean	1.7	0.2	12.1	0.3	7.1
1989	Mean	2.5	0.2	49.3	0.2	19.7
1990	Mean	3.2	0.1	17.6	0.2	5.5
1991	Mean	0.2	0.1	4.1	0.4	20.5
1992	Mean	1.9	0.2	13.4	0.0	7.1
1993	Mean	4.1	0.4	30.5	0.4	7.4
1994	Mean	0.4	0.1	9.3	0.4	23.3
1995[e]	Mean	7.6	1.4	12.5	1.8	1.6
1996	Upper	0.9	0.1	16.6	0.5	18.4
	Middle	1.2	0.1	23.8	1.0	19.8
	Lower	0.6	0.1	13.8	0.9	23.0
1996	Mean	0.9	0.1	18.1	0.8	20.1
1984–96	Mean	1.6	0.2	19.8	0.4	16.0
1984–96	StDev	1.2	0.1	11.6	0.3	7.6
1984–96	Count	12	12	12	12	12

[a] Year sampled.
[b] Sample location within reservoir: Upper, Middle, or Lower end; or mean of all three sample locations.
[c] Sigma is the analytical counting uncertainty (1 standard deviation).
[d] Samples were collected June 25, 1996, at Abiquiu Reservoir; and October 16, 1996, at Cochiti Reservoir.
[e] Uncertainties for 1995 data were not within quality control specifications; data not used for long-term statistics.

Table 5-17. RESRAD Input Parameters for Mortandad Canyon Sediments Collected in 1996

Parameter	Value	Comments
Area of Contaminated Zone	10,000 m^2 [a]	RESRAD default value; a larger 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 top most unit being sand (Purtymun et al., 1983) and Table 13.1 in the data handbook (Yu 1993)
Humidity in air	4.8 g/cm^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)
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	8400 m^3/yr	RESRAD default value
Mass loading for inhalation	5.53×10^{-3} g/m^3	Factor used for benchmarking against several codes (Faillace et al., 1993)
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 each year	0.7	Based on 18 h/d (Fresquez et al., 1996)
Fraction of time spent outdoors	0.01	Assumes an industrial scenario where access to site is somewhat limited. (Robinson and Thomas 1991)
Shape factor	1	Corresponds to a contaminated area larger than a circular area of 1200 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)

[a] For each sampling location, the area of the contaminated zone was assumed to be 100 m^2.

Table 5-18. Total Effective Dose Equivalent[a] for Mortandad Canyon (mrem)

Location	1996		1995	
Near CMR Building	0.16	(± 0.032)[b]	0.10	(± 0.14)[b]
West of GS-1	3.3	(± 0.60)[b]	0.17	(± 0.081)[b]
GS-1	24	(± 3.4)[b]	37	(± 5.9)[b]
MCO-5	21	(± 3.2)[b]	19	(± 3.3)[b]
MCO-7	8.8	(± 1.4)[b]	4.3	(± 0.95)[b]
MCO-9	0.78	(± 0.21)[b]	0.62	(± 0.20)[b]
MCO-13 (A-5)	0.65	(± 0.19)[b]	0.43	(± 1.1)[b]
A-6	0.41	(± 0.097)[b]	0.79	(± 1.2)[b]
A-7	0.36	(± 0.072)[b]	0.19	(± 0.10)[b]
A-8		—[c]	0.30	(± 0.15)[b]
SR-4 (A-9)	0.19	(± 0.057)[b]	0.17	(± 0.088)[b]
A-10		—[c]	0.061	(± 0.028)[b]
Rio Grande (A-11)	0.16	(± 0.12)[b]	0.10	(± 0.054)[b]
Average for entire Mortandad Canyon	6.0	(± 22)[b]	6.8	(± 30)[b]

[a] Based on results from RESRAD version 5.61 using input parameters listed in Table 1 and three exposure pathways: ingestion, inhalation, and external.
[b] ±2 sigma in parenthesis; to convert to μSv multiply by 10.
[c] No sample collected at these locations in 1996.

Table 5-19. Maximum Total Effective Dose Equivalent

Location	Average + 2 Sigma (mrem/yr) 1996	1995
Near CMR Building	0.19	0.24
West of GS-1	3.8	0.25
GS-1	27	43
MCO-5	25	22
MCO-7	10	5.3
MCO-9	0.99	0.82
MCO-13 (A-5)	0.84	1.5
A-6	0.51	2.0
A-7	0.43	0.29
A-8	—[a]	0.45
SR-4 (A-9)	0.25	0.26
A-10	—[a]	0.089
Rio Grande (A-11)	0.29	0.15
Average for entire Mortandad Canyon	28	37

[a] No sample collected at these locations in 1996.

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations														
Rio Chama at Chamita	05/09	1	<0.25[d]	1,900	1.07	<0.75	38.00	0.18	<0.25	1.27	2.71	<1.63	3,223	<0.010
	05/09	R1	<0.25	1,700	1.18	<0.80	34.00	0.17	0.33	1.33	2.56	<1.63	3,014	<0.010
	05/09	R2												0.031
Rio Grande at Embudo	05/09	1	<0.25	738	<0.34	<0.75	13.70	<0.12	<0.25	0.88	1.29	<1.60	1,511	<0.010
	05/09	R1												<0.010
	05/09	R2												0.011
Rio Grande at Otowi (bank)	05/09	1	<0.25	<11	0.41	<0.75	<0.12	<0.12	0.31	<0.37	<1.25	<1.63	<6	<0.010
	05/09	R1												<0.010
	10/11	2	<0.40	11,815	4.80	<1.30	227.00	0.68	<0.27	6.20	13.50	9.22	13,110	<0.050
	10/11	R1	<0.40	11,335	4.70	<0.70	223.00	0.65	<0.30	6.30	13.10	8.80	12,975	<0.050
Rio Grande at Otowi (wdth intgrt)	10/11	3	<0.40	3,799	2.00	<3.00	75.00	0.24	<0.30	2.83	6.49	2.24	6,510	<0.050
	10/11	R1												<0.05
Rio Grande at Frijoles (bank)	10/09	1	<0.40	6,112	3.20	<3.00	163.00	0.52	<0.30	4.47	8.65	6.30	9,133	<0.060
	10/09	R1												<0.060
Rio Grande at Bernalillo	05/09	1	<0.25	1,302	1.31	<0.75	35.40	0.10	<0.25	1.24	2.10	3.30	2,803	<0.010
	05/09	R1												<0.010
Jemez River	05/09	1	<0.30	5,404	5.25	1.19	58.50	0.63	0.29	3.90	7.54	4.68	<1,243	<0.010
	05/09	R1												0.010
Guaje Canyon:														
Guaje at SR-502	03/11	1	<0.25	1,680	0.50	<0.75	20.90	<0.12	0.32	2.20	5.44	<1.63	6,600	<0.010
	03/11	R1												<0.010
Bayo Canyon:														
Bayo at SR-502	03/11	1	<0.25	1,520	0.40	<0.74	39.60	<0.12	0.39	1.09	3.56	1.79	3,250	<0.010
	03/11	R1												<0.010
Acid/Pueblo Canyons:														
Acid Weir	12/10	1	<0.40	1,354	1.60	<3.00	25.70	0.23	<0.30	1.56	1.53	2.73	4,602	<0.050
	12/10	R1												<0.050
Pueblo 1	12/10	1	<0.40	1,198	1.10	<3.00	17.26	0.16	<0.30	1.83	1.94	1.72	3,503	<0.050
	12/10	R1												<0.050
Pueblo 2	12/10	1	<0.40	1,476	0.40	<3.00	18.59	<0.15	<0.30	1.23	1.95	1.84	2,345	<0.050
	12/10	R1												<0.050
Hamilton Bend Spring	12/24	1	<0.09	1,638	0.50	<0.54	16.40	0.12	<0.30	<1.30	1.56	1.82	3,053	<0.050
	12/24	R1	<0.09	1,119	<0.40	<0.70	9.99	<0.06	<0.24	0.63	<1.32	4.00	1,875	<0.050

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Acid/Pueblo Canyons (Cont.):														
Pueblo 3	12/10	1	<0.40	1,580	0.40	<3.00	23.47	<0.15	<0.30	1.58	1.71	1.32	2,071	<0.050
	12/10	R1												<0.050
Pueblo at SR-502	05/07	1	3.40	1,930	0.60	<0.80	24.00	<0.12	<0.25	4.60	6.00	3.20	18,600	<0.010
	05/07	R1												<0.010
DP/Los Alamos Canyons:														
Los Alamos at Bridge	05/08	1	<0.25	3,134	1.30	<0.76	40.00	0.34	<0.25	1.80	4.60	5.20	6,170	0.023
	05/08	R1												0.031
	05/08	R2												0.017
Los Alamos at LAO-1	05/08	1	<0.25	2,040	2.30	<0.70	264.00	0.20	<0.25	1.80	3.70	2.40	7,394	0.106
	05/08	R1												0.065
	05/08	R2												0.056
Los Alamos at GS-1	05/08	1	<0.20	1,575	1.00	<0.70	20.00	0.17	<0.24	1.50	3.10	2.70	4,900	0.0200
	05/08	R1	<0.25	1,160	0.90	<0.70	18.00	0.18	<0.25	1.30	3.90	2.50	3,700	<0.010
DPS-1	05/08	1	<0.25	1,370	0.95	<0.74	23.00	0.14	<0.25	2.90	3.70	1.80	3,172	0.022
	05/08	R1												<0.010
DPS-4	05/08	1	<0.25	1,380	0.63	<0.74	14.00	0.17	<0.25	0.87	2.00	1.70	3,476	<0.010
	05/08	R1												0.014
Los Alamos at LAO-3	05/08	1	0.35	776	0.57	<0.75	16.00	<0.13	<0.25	0.80	1.30	2.20	1,600	<0.010
	05/08	R1												<0.010
Los Alamos at LAO-4.5	05/08	1	<0.25	854	0.64	<0.74	11.00	<0.12	<0.25	0.79	1.50	<1.60	2,963	<0.010
	05/08	R1												<0.010
	05/08	2	<0.25	2,320	1.10	<0.75	23.00	0.31	<0.25	1.70	3.60	2.90	5,387	0.016
	05/08	R1												0.011
Los Alamos at SR-4	05/02	1	<0.25	3,020	1.07	<0.75	39.00	0.44	<0.25	1.50	4.10	4.30	4,600	0.036
	05/02	R1												0.046
	05/02	R2												0.039
Los Alamos at Totavi	08/15	1	<0.40	1,268	<0.40	<0.70	17.00	<0.15	<0.30	1.08	1.65	1.46	2,920	0.118
	08/15	R1												<0.100
Los Alamos at Otowi	05/02	1	<0.25	1,000	0.61	<0.75	19.00	0.13	<0.25	1.05	1.90	2.06	2,510	<0.016
	05/02	R1												<0.016
	08/15	2	<0.40	2,465	<0.40	1.45	24.00	<0.15	<0.30	1.47	1.67	1.70	3,057	<0.2000
	08/15	R1												<0.200

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Sandia Canyon:														
Sandia at SR-4	03/11	1	<0.24	2,520	1.10	<0.72	27.00	0.18	0.30	1.07	2.54	<1.56	3,170	
Mortandad Canyon:														
Mortandad near CMR Building	04/11	1	0.53	4,384	1.30	<0.75	48.10	0.54	0.18	2.42	4.50	7.11	7,504	<0.010
	04/11	R1	<0.25	5,945	1.50	<1.09	48.00	0.61	<0.25	2.55	5.76	6.00	8,808	0.016
	04/11	R2												<0.010
Mortandad west of GS-1	04/11	1	<0.25	6,643	2.40	<0.75	93.00	0.45	<0.25	2.97	5.24	8.56	8,219	0.020
	04/11	R1												0.023
	04/11	R2												0.018
Mortandad at GS-1	04/11	1	<0.25	1,830	0.76	<0.75	13.80	0.45	<0.25	1.24	2.63	4.39	5,429	<0.010
	04/11	R1												<0.010
Mortandad at MCO-5	04/11	1	<0.25	848	<0.30	<0.75	9.78	0.23	<0.25	0.91	1.42	2.67	2,085	<0.010
	04/11	R1												<0.010
Mortandad at MCO-7	04/11	1	<0.25	951	0.51	<0.75	11.60	0.24	<0.25	1.59	1.54	<1.63	7,190	<0.010
	04/11	R1												0.010
	04/11	R2												<0.010
Mortandad at MCO-9	04/11	1	<0.25	2,272	1.20	<0.75	43.40	0.48	<0.25	2.21	2.02	3.57	4,481	<0.010
	04/11	R1												<0.010
Mortandad at MCO-13 (A-5)	04/11	1	<0.25	2,029	0.50	<0.75	20.30	0.32	<0.25	1.29	1.89	<1.63	2,810	<0.010
	04/11	R1												<0.010
Mortandad A-6	08/15	1	<0.40	1,584	<0.40	1.70	15.30	<0.15	<0.30	<0.72	0.81	0.99	1,979	<0.010
	08/15	R1	<0.40	1,483	<0.40	<0.70	17.00	<0.15	<0.30	0.92	1.07	1.41	1,745	<0.200
Mortandad A-7	08/15	1	<0.40	2,176	<0.40	<0.70	17.60	<0.15	<0.30	0.92	1.22	1.28	4,890	<0.010
	08/15	R1												<0.010
Mortandad at SR-4 (A-9)	08/15	1	<0.40	5,095	1.10	<0.90	59.00	0.17	<0.30	2.80	3.64	2.10	5,899	<0.200
	08/15	R1												<0.200
Mortandad at Rio Grande (A-11)	10/07	1	<0.40	3,098	1.10	<0.70	51.00	0.26	<0.30	4.31	4.86	3.73	6,972	<0.050
	10/07	R1												<0.050
Cañada del Buey:														
Cañada del Buey at SR-4	03/11	1	<0.24	2,110	0.70	<0.70	25.30	<0.12	0.37	1.81	2.54	0.67	5,020	<0.010
	03/11	R1	<0.25	2,220	0.40	<0.74	27.20	0.15	0.58	1.84	2.55	<1.59	4,745	<0.010

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
TA-54 Area G:														
G-1	03/22	1	<0.25	2,150	1.30	7.67	19.30	0.16	<0.25	0.95	1.59	<1.62	3,767	<0.010
	03/22	R1	<0.25	2,090	0.80	7.27	23.30	0.13	<0.25	0.86	1.65	<1.62	3,775	<0.010
G-2	03/22	1	<0.24	3,920	1.32	2.96	45.70	0.27	<0.24	1.75	3.09	2.42	6,640	<0.010
	03/22	R1												0.012
G-3	03/22	1	<0.25	4,090	1.08	3.03	54.80	0.24	<0.66	2.77	8.51	4.63	6,750	<0.010
	03/22	R1												<0.010
G-4	03/22	1	<0.25	2,485	0.78	3.04	27.50	0.30	0.20	0.88	2.06	1.93	5,000	<0.010
	03/22	R1												0.016
G-5	03/22	1	<0.26	4,920	1.64	3.05	67.90	0.49	0.26	2.20	4.27	2.82	5,960	<0.010
	03/22	R1												0.048
	03/22	R2												0.058
G-6	03/22	1	<0.25	6,620	1.84	2.78	65.70	0.46	<0.25	2.36	5.46	2.51	7,670	0.019
	03/22	R1												<0.010
	03/22	R2												0.016
G-7	03/22	1	<0.25	2,040	0.65	2.29	20.20	<0.12	0.25	0.52	1.39	1.69	3,290	<0.010
	03/22	R1												<0.010
G-8	03/22	1	<0.25	4,680	1.25	2.21	36.60	0.33	0.20	1.47	3.82	2.68	6,260	<0.010
	03/22	R1												<0.010
G-9	03/22	1	<0.25	2,240	0.56	2.85	20.60	<0.12	<0.12	0.73	1.92	<1.60	2,690	<0.010
	03/22	R1												<0.010
	03/22	R2												0.033
Pajarito Canyon:														
Twomile at SR-501	03/12	1	<0.24	2,770	1.20	<0.71	38.10	<0.12	0.50	1.45	2.65	2.35	4,240	<0.010
	03/12	R1												<0.010
Pajarito at SR-501	03/11	1	<0.24	2,650	1.20	<0.70	21.80	<0.12	0.34	2.11	2.94	1.97	5,380	<0.010
	03/11	R1												<0.010
	03/11	1	<0.24	3,300	0.80	<0.71	25.00	0.12	0.46	1.66	3.03	1.50	8,270	0.010
	03/11	R1												0.010
Potrillo Canyon:														
Potrillo at SR-4	03/11	1	<0.24	1,012	0.60	<0.71	15.20	<1.18	0.47	0.65	<1.18	<1.53	1,968	<0.010
	03/11	R1												<0.010

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Fence Canyon:														
Fence at SR-4	03/11	1	<0.24	5,000	1.60	<0.71	67.40	0.27	0.54	2.03	3.13	3.22	5,900	<0.010
	03/11	R1												<0.010
Cañon de Valle:														
Cañon de Valle at SR-501	03/12	1	<0.24	664	0.50	<0.73	13.60	<0.12	<0.24	<0.36	2.04	1.59	2,700	0.010
	03/12	R1												0.010
Water Canyon:														
Water at SR-501	03/11	1	<0.24	2,930	0.40	<0.73	35.20	0.17	<0.24	1.56	2.39	1.66	3,980	0.020
	03/11	R1												0.010
Water at SR-4	03/11	1	<0.25	4,895	1.50	<0.74	79.50	0.56	0.36	1.98	5.62	3.13	5,260	<0.010
	03/11	R1												<0.010
Indio Canyon:														
Indio at SR-4	03/11	1	<2.46	3,460	1.10	<0.74	25.00	0.18	0.42	1.94	3.61	<1.60	7,920	<0.010
	03/11	R1												<0.010
Ancho Canyon:														
Ancho at SR-4	03/11	1	<0.23	2,100	0.60	<0.70	16.10	<0.69	0.36	5.36	9.96	<1.51	26,600	<0.010
	03/11	R1												<0.010
Above Ancho Spring	10/08	1	<0.40	8,417	1.90	<3.00	83.73	0.65	<0.30	4.65	7.55	6.63	10,451	<0.050
	10/08	R1												<0.050
Ancho at Rio Grande	10/08	1	<0.40	2,907	1.80	<0.70	56.70	0.22	<0.30	2.31	4.68	2.17	5,872	<0.050
	10/08	R1												<0.050
Chaquehui Canyon:														
Chaquehui at Rio Grande	10/09	1	<0.40	1,762	1.70	<3.00	23.47	<0.15	<0.30	1.84	2.75	2.97	3,379	<0.050
	10/09	R1												<0.050
TA-49 Area AB:														
AB-1	03/25	1	<0.25	13,761	3.99	<0.75	145.00	<0.13	<0.25	6.93	8.65	9.76	13,153	<0.010
	03/25	R1	<0.25	14,632	3.69	<0.75	41.00	<0.13	<0.25	4.40	9.42	6.77	13,251	<0.010
AB-2	03/25	1	<0.25	10,000	3.85	<0.75	118.00	<0.13	<0.25	7.03	7.34	5.34	12,687	<0.010
	03/25	R1												<0.010
AB-3	03/25	1	<0.25	3,063	1.27	<0.75	45.00	<0.13	<0.25	1.60	2.91	3.15	6,718	<0.010
	03/25	R1												<0.010
AB-4	03/25	1	<0.25	12,985	4.12	<0.75	150.00	<0.13	<0.25	4.40	8.63	5.88	11,742	<0.010
	03/25	R1												<0.010

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
TA-49 Area AB (Cont.):														
AB-4A	03/25	1	<0.25	19,130	3.80	<0.75	156.00	<0.13	<0.25	5.00	12.00	7.38	14,322	<0.010
	03/25	R1												<0.010
AB-5	03/25	1	<0.25	11,541	3.05	<0.75	117.00	<0.13	<0.25	4.30	7.95	5.66	10,055	<0.010
	03/25	R1												<0.010
AB-6	03/25	1	<0.25	6,934	2.80	<0.75	63.40	<0.13	<0.25	3.00	6.56	3.17	8,831	<0.010
	03/25	R1												<0.010
AB-7	03/25	1	<0.25	1,014	0.89	<0.75	29.00	<0.13	<0.25	<0.38	<1.25	2.76	2,009	<0.010
	03/25	R1												<0.010
AB-8	03/25	1	3.53	6,038	2.42	<0.75	50.00	<0.13	<0.25	1.90	4.39	4.09	8,608	<0.010
	03/25	R1												<0.010
AB-9	03/25	1	<0.25	4,669	1.72	<0.75	51.00	<0.13	<0.25	1.61	3.50	2.66	7,532	<0.010
	03/25	R1												<0.010
AB-10	03/25	1	<0.25	2,487	1.48	<0.75	28.70	<0.13	<0.25	<0.38	1.79	1.85	4,346	0.013
	03/25	R1												0.012
	03/25	R2												0.016
AB-11	03/25	1	<0.25	1,883	0.54	<0.75	17.40	<0.13	<0.25	<0.38	1.34	2.65	3,444	<0.010
	03/25	R1												<0.010
Frijoles Canyon:														
Frijoles at Monument HQ	08/20	1	<0.40	14,550	4.00	1.76	126.00	1.16	<0.30	5.28	10.90	8.84	11,920	<0.050
	08/20	R1												<0.050
Frijoles at Rio Grande	10/09	1	<0.40	10,335	2.90	0.86	85.30	0.93	0.22	3.97	8.20	5.89	9,860	<0.050
	10/09	R1												<0.050
Reservoirs on Rio Chama (New Mexico):														
Heron Upper	06/27	1	4.89	17,017	4.80	2.03	139.00	0.85	0.28	7.00	15.30	15.00	20,231	<0.035
	06/27	R1												<0.038
Heron Middle	06/27	1	<0.25	14,224	6.30	<5.50	144.00	0.86	<0.68	9.10	11.80	16.40	20,334	<0.030
	06/27	R1												<0.028
Heron Lower	06/27	1	<0.25	20,465	6.50	6.30	144.00	0.92	0.47	7.50	18.10	16.50	20,588	<0.043
	06/27	D1	<0.25	11,888	5.80	<3.80	115.00	0.69	<0.25	7.40	10.80	12.60	18,055	<0.050
	06/27	R1												<0.040
El Vado Upper	06/26	1	<0.25	10,405	7.30	0.86	122.50	0.78	0.65	8.40	16.50	15.40	17,889	<0.037
	06/26	R1												<0.042

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Reservoirs on Rio Chama (New Mexico) (Cont.):														
El Vado Middle	06/26	1	<0.25	11,956	6.40	<2.70	144.00	0.91	<0.25	10.50	13.60	14.80	24,333	<0.040
	06/26	R1												<0.038
El Vado Lower	06/26	1	<0.25	21,579	9.80	8.72	156.00	1.06	<0.25	9.26	22.10	13.80	23,359	<0.040
	06/26	R1												<0.036
Abiquiu Upper	06/25	1	<0.30	7,318	2.60	4.86	142.00	0.38	2.60	2.80	8.08	3.56	7,460	<0.044
	06/25	R1	<0.25	5,215	2.20	4.10	143.00	0.34	0.51	3.02	6.40	3.87	7,048	<0.040
Abiquiu Middle	06/28	1	<0.25	18,997	4.10	4.62	250.00	1.09	<0.25	9.81	18.00	13.70	20,160	<0.047
	06/28	R1												<0.042
Abiquiu Lower	06/28	1	<0.25	1,150	0.60	<2.48	29.50	<0.13	<0.25	1.45	1.25	<1.63	1,431	<0.042
	06/28	R1												<0.033
Reservoirs on Rio Grande (Colorado):														
Rio Grande Upper	09/21	1	<0.40	13,883	0.01	<0.70	213.30	0.58	0.32	8.65	5.51	11.40	21,568	<0.050
	09/21	R1	<0.40	11,050	0.01	<0.70	194.80	0.58	<0.30	8.11	5.02	10.50	19,945	<0.050
Rio Grande Middle	09/21	1	<0.40	16,386	0.01	<0.70	250.60	0.87	0.34	11.50	5.27	14.30	25,319	<0.050
	09/21	R1												<0.050
Rio Grande Lower	09/21	1	<0.40	16,564	0.01	<0.70	208.00	0.74	0.51	9.00	5.16	14.80	20,315	<0.050
	09/21	R1												<0.050
Reservoirs on Rio Grande (New Mexico):														
Cochiti Upper	10/16	1	<0.40	11,786	0.00	<0.70	208.00	0.82	<0.80	6.41	12.50	11.50	13,026	<0.050
	10/16	R1												<0.050
Cochiti Middle	10/16	1	<0.40	26,532	0.01	<0.70	254.00	1.60	<0.45	12.20	20.00	18.00	21,663	<0.050
	10/16	R1												<0.050
Cochiti Lower	10/16	1	<0.40	4,268	0.00	<0.70	55.40	0.29	<0.30	3.32	7.05	3.15	8,478	<0.050
	10/16	R1												<0.050
Standardized Comparisons														
Average Detection Limits			0.25	11	0.34	0.70	0.12	0.08	0.40	0.50	0.50	0.50	14	0.050
1996 Mean (x)[e]			0.42	5,538	1.72	1.60	68.63	0.35	0.33	3.09	5.27	4.66	7,939	0.031
1996 Standard Deviation (s)[f]			0.66	5,648	1.82	1.62	67.82	0.31	0.25	2.79	4.58	4.32	6,388	0.035
SAL[g]			380	77,000	BG[h]	5,900	5,300	BG	38	4,600	30[i]	2,800	NA[j]	23

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Stations													
Rio Chama at Chamita	05/09	1	58.80	<0.62	<2.25	<5.75	<0.625	<0.17	<7.38	18.00	<0.625	5.97	24
	05/09	R1	57.00	<0.62	<2.25	<5.70	<0.625	<0.17	<7.40	16.60	<0.620	5.78	30
Rio Grande at Embudo	05/09	1	43.00	<0.62	<2.25	<5.75	<0.620	0.18	<7.38	4.65	<0.625	3.11	8
Rio Grande at Otowi (bank)	05/09	1	0.26	<0.62	<2.25	5.75	<0.625	<0.17	<7.38	<0.12	<0.625	<0.25	<2
	10/11	2	321.00	<0.75	10.80	9.70	<0.300	0.70	<3.00	149.00	<0.300	21.00	39
	10/11	R1	322.00	<0.50	12.00	9.50	<0.300	0.50	<3.50	148.00	<0.300	20.70	38
Rio Grande at Otowi (wdth intgrt)	10/11	3	148.00	<0.50	<4.86	3.80	<0.300	0.30	<3.00	28.50	<0.300	14.00	
	10/11	R1											38
Rio Grande at Frijoles (bank)	10/09	1	225.00	<0.50	7.19	7.10	<0.300	<0.70	<3.00	81.94	<0.300	16.01	29
Rio Grande at Bernalillo	05/09	1	80.80	<0.62	2.40	<5.75	<0.625	<0.17	<7.38	14.60	<0.625	5.59	17
Jemez River	05/09	1	205.00	<0.62	7.62	6.79	<0.625	<0.17	<7.38	28.20	<0.625	10.70	24
Guaje Canyon:													
Guaje at SR-502	03/11	1	107.00	<0.63	5.42	<5.72	<1.250	<0.13	<7.37	5.76	<0.600	14.20	21
Bayo Canyon:													
Bayo at SR-502	03/11	1	98.10	<0.62	<6.33	<5.66	<1.230	<0.13	<7.26	4.94	<0.620	5.63	12
Acid/Pueblo Canyons:													
Acid Weir	12/10	1	255.00	<0.50	<1.70	15.30	<0.300	<0.70	<3.00	3.73	<0.300	6.30	38
Pueblo 1	12/10	1	143.00	<0.50	<1.70	20.40	<0.300	<0.70	<3.00	5.97	<0.300	3.99	30
Pueblo 2	12/10	1	100.00	<0.50	<1.70	4.20	<0.300	<0.70	<3.00	2.93	<0.300	3.18	13
Hamilton Bend Spring	12/24	1	101.00	<1.10	<5.70	4.60	<0.300	<1.20	<3.60	3.04	<0.300	3.22	21
	12/24	R1	51.10	<0.66	<2.20	2.60	<0.300	<0.70	<10.50	1.93	<0.300	2.06	12
Pueblo 3	12/10	1	126.50	<0.50	<1.70	6.50	<0.300	<0.70	3.13	3.46	<0.300	2.69	18
Pueblo at SR-502	05/07	1	460.00	3.00	<3.00	5.31	<0.625	<0.20	<7.30	4.30	<0.625	17.00	109
DP/Los Alamos Canyons:													
Los Alamos at Bridge	05/08	1	205.00	<0.62	2.30	15.90	<0.625	<0.44	<7.40	11.00	<0.625	8.90	36
Los Alamos at LAO-1	05/08	1	186.00	<0.62	<2.20	12.90	<0.625	<0.85	<7.40	6.30	<0.625	7.70	43
Los Alamos at GS-1	05/08	1	160.00	<0.62	<2.20	10.90	<0.625	<0.17	<7.30	4.20	<0.625	4.70	23
	05/08	R1	133.00	<0.62	<2.20	11.70	<0.625	<0.17	<7.32	4.10	<0.625	3.80	20
DPS-1	05/08	1	145.00	<0.62	<2.20	20.90	<0.625	<0.29	<7.32	4.70	<0.625	4.20	26
DPS-4	05/08	1	99.00	<0.90	<2.20	9.33	<0.625	<0.80	<7.30	3.00	<0.625	4.20	24
Los Alamos at LAO-3	05/08	1	73.00	<0.62	<2.30	7.75	<0.625	<0.17	<7.40	3.50	<0.625	2.50	18
Los Alamos at LAO-4.5	05/08	1	87.00	<0.62	<2.20	6.67	<0.625	<0.17	<7.20	3.10	<0.625	3.20	20
	05/08	2	180.00	0.60	<2.30	17.00	<0.625	<0.17	<7.40	4.20	<0.625	5.80	42

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
DP/Los Alamos Canyons (Cont.):													
Los Alamos at SR-4	05/02	1	188.00	<0.62	<2.20	17.20	<5.500	0.19	<7.33	8.40	<20.60	5.50	44
Los Alamos at Totavi	08/15	1	62.00	<0.50	<6.00	2.50	<0.300	<0.30	<3.00	4.50	<0.300	5.24	11
Los Alamos at Otowi	05/02	1	68.00	<0.60	<2.20	<5.70	<5.500	<0.17	<7.30	5.50	<20.60	4.40	16
	08/15	2	69.00	<0.50	<2.70	3.10	<0.300	<0.30	<3.00	8.33	<0.300	5.50	13
Sandia Canyon:													
Sandia at SR-4	03/11	1	130.00	<0.60	2.73	<5.52	<1.200	<0.13	<7.10	4.17	8.200	3.29	21
Mortandad Canyon:													
Mortandad near CMR Building	04/11	1	257.00	1.55	6.82	10.70	<5.410	<0.55	<7.38	9.70	<20.60	8.30	109
	04/11	R1	268.00	2.00	5.00	11.10	<5.460	<0.55	<7.38	9.82	<20.60	10.10	103
Mortandad west of GS-1	04/11	1	462.00	<0.62	3.76	25.50	<5.410	<0.55	<7.38	24.70	<20.60	10.30	41
Mortandad at GS-1	04/11	1	246.00	1.65	<2.25	6.30	<5.460	<0.56	<7.38	2.21	<20.60	4.25	32
Mortandad at MCO-5	04/11	1	89.00	<0.62	<2.25	<5.70	<5.460	<0.56	<7.38	1.59	<20.60	1.71	16
Mortandad at MCO-7	04/11	1	160.00	0.89	<2.25	<5.66	<5.410	<0.55	<7.40	1.63	<20.60	5.23	44
Mortandad at MCO-9	04/11	1	242.80	<0.62	<2.25	9.40	<5.460	<0.55	<7.38	6.10	<20.60	4.43	29
Mortandad at MCO-13 (A-5)	04/11	1	113.00	<0.96	<2.25	<5.70	<5.460	<0.55	<7.38	3.00	<20.60	3.35	19
Mortandad A-6	08/15	1	79.70	<1.30	0.90	3.30	<0.300	<0.30	<3.00	2.41	<0.300	2.07	12
	08/15	R1	129.00	<0.50	2.00	5.30	<0.300	<0.30	<3.00	2.50	<0.300	2.30	27
Mortandad A-7	08/15	1	170.00	<0.50	0.90	5.90	<0.300	<0.30	<4.00	2.56	<0.300	3.33	39
Mortandad at SR-4 (A-9)	08/15	1	238.00	<0.50	3.39	6.70	<0.300	<0.30	<3.00	8.88	<0.300	8.99	25
Mortandad at Rio Grande (A-11)	10/07	1	159.00	<0.50	6.40	4.50	<0.300	<0.50	<3.00	11.40	<0.300	13.30	19
Cañada del Buey:													
Cañada del Buey at SR-4	03/11	1	149.00	<0.61	7.72	<5.61	<1.230	<0.13	<7.20	3.20	<0.610	7.60	19
	03/11	R1	196.00	<0.62	4.67	<5.66	<2.460	<0.13	<7.26	3.59	<1.230	6.67	18

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
TA-54 Area G:													
G-1	03/22	1	135.00	<0.62	5.86	4.20	<1.250	<0.13	<7.37	3.76	<0.630	3.95	25
	03/22	R1	132.00	<0.62	2.20	5.60	<1.270	<0.13	<7.37	4.89	<0.600	4.18	22
G-2	03/22	1	199.00	<0.61	3.76	8.50	<1.230	<0.12	<7.19	8.34	<0.610	7.10	31
G-3	03/22	1	211.00	<0.63	4.70	139.00	<1.260	0.18	<7.40	10.40	<0.630	10.20	386
G-4	03/22	1	206.00	<0.54	11.40	12.00	<1.300	<0.13	<7.37	4.14	<0.600	3.97	39
G-5	03/22	1	223.00	<0.64	3.40	10.00	<1.280	0.13	<7.55	12.20	<0.640	7.50	34
G-6	03/22	1	225.00	<0.62	4.71	10.00	<1.230	<0.25	<7.28	15.80	<0.620	10.50	35
G-7	03/22	1	102.00	<0.63	2.26	6.30	<1.260	<0.13	<7.41	3.72	<0.630	3.99	60
G-8	03/22	1	193.00	<0.61	4.18	9.20	<1.230	<0.12	<7.20	7.25	<0.610	6.89	35
G-9	03/22	1	96.50	<0.61	2.95	3.40	<1.230	<0.12	<7.23	3.22	<0.610	3.28	13
Pajarito Canyon:													
Twomile at SR-501	03/12	1	178.00	<0.59	2.97	9.75	<1.200	<0.13	<7.02	8.61	<0.600	5.08	28
Pajarito at SR-501	03/11	1	125.00	<0.59	4.14	<5.50	<1.190	<0.13	<7.02	5.14	<0.600	7.78	20
	03/11	1	192.00	<0.59	4.14	<5.43	<1.180	<0.13	<6.96	3.91	0.650	10.30	31
Potrillo Canyon:													
Potrillo at SR-4	03/11	1	70.10	<0.59	2.12	<5.43	<1.180	<0.13	<6.96	2.19	<0.590	1.82	9
Fence Canyon:													
Fence at SR-4	03/11	1	199.00	<0.59	4.02	5.70	<1.200	<0.13	<7.02	10.30	0.600	6.33	24
Cañon de Valle:													
Cañon de Valle at SR-501	03/12	1	43.10	<0.61	2.18	10.20	<1.220	<0.13	<7.14	3.27	<0.610	4.41	14
Water Canyon:													
Water at SR-501	03/11	1	147.00	<0.61	2.20	<5.57	<1.210	<0.13	<7.14	8.11	<0.610	5.35	18
Water at SR-4	03/11	1	154.00	<0.62	6.32	16.60	<2.490	<0.13	<7.32	12.00	<1.250	4.19	34
Indio Canyon:													
Indio at SR-4	03/11	1	208.00	<0.62	4.58	<5.66	<2.470	<0.13	<7.26	4.90	<1.230	8.48	43
Ancho Canyon:													
Ancho at SR-4	03/11	1	380.00	<0.58	6.95	<5.34	<1.170	<0.13	<6.84	3.06	<0.580	19.90	119
Above Ancho Spring	10/08	1	251.00	<0.50	6.95	9.70	<0.300	<1.00	<3.00	17.70	<0.300	14.30	60
Ancho at Rio Grande	10/08	1	122.00	<0.50	3.36	4.10	<0.300	0.50	<3.00	16.30	<0.300	12.10	18
Chaquehui Canyon:													
Chaquehui at Rio Grande	10/09	1	76.30	<0.50	1.70	2.30	<0.300	<0.70	<3.00	12.70	<0.300	6.71	11

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
TA-49 Area AB:													
AB-1	03/25	1	545.00	<0.63	6.52	19.50	<1.240	0.37	<7.38	23.50	<0.620	18.10	195
	03/25	R1	329.00	<0.63	6.28	16.00	<1.230	0.38	<7.38	22.00	<0.620	1.15	180
AB-2	03/25	1	494.00	<0.63	6.56	15.90	<1.250	0.39	<7.38	21.60	<0.630	22.70	59
								<7.38					
AB-3	03/25	1	133.00	<0.63	<2.25	5.80	<1.240	0.50	<7.38	6.10	<0.620	8.58	65
AB-4	03/25	1	292.00	<0.63	6.00	14.30	<1.230	0.53	<7.38	26.30	<0.610	17.30	24
AB-4A	03/25	1	287.00	<0.63	6.50	16.90	<1.250	0.48	<7.38	32.00	<0.630	21.00	32
AB-5	03/25	1	338.00	<0.63	8.38	13.30	<1.240	0.55	<7.38	24.20	<0.620	12.00	34
AB-6	03/25	1	231.00	<0.63	4.60	8.90	<1.250	0.32	<7.38	10.60	<0.620	14.00	21
AB-7	03/25	1	129.00	<0.63	0.25	4.10	<1.250	0.14	<7.38	3.80	<0.630	2.58	50
AB-8	03/25	1	118.00	<0.63	3.77	9.50	<1.220	0.34	<7.38	8.88	<0.610	9.51	25
AB-9	03/25	1	176.00	<0.63	3.20	6.70	<1.250	0.27	<7.38	9.06	<0.620	6.90	24
AB-10	03/25	1	152.00	<0.63	<2.25	3.50	<1.270	0.22	<7.38	3.68	<0.630	5.00	16
AB-11	03/25	1	86.90	<0.63	<2.25	2.70	<0.620	0.12	<7.38	3.35	<1.230	3.17	15
Frijoles Canyon:													
Frijoles at Monument HQ	08/20	1	640.00	<0.62	5.77	19.70	<0.300	1.10	4.50	40.30	0.300	23.30	66
Frijoles at Rio Grande	10/09	1	413.00	<1.30	6.11	14.90	<0.300	0.80	3.64	29.20	<0.300	16.90	46
Reservoirs on Rio Chama (New Mexico):													
Heron Upper	6/27	1	340.00	<0.62	18.50	15.00	<0.100	0.78	<7.38	36.60		25.00	70
Heron Middle	6/27	1	726.00	<0.62	21.10	14.00	<0.100	0.81	<7.38	78.50		17.20	74
Heron Lower	06/27	1	382.00	<0.63	18.40	17.70	<0.100	1.02	<7.38	45.70		30.00	84
	06/27	D1	339.00	<0.62	15.50	12.60	<0.100	0.88	<7.38	37.70		18.10	58
El Vado Upper	06/26	1	377.00	<0.62	17.60	11.70	<0.100	1.07	<7.38	70.00		30.20	75
El Vado Middle	06/26	1	741.00	<0.62	19.00	11.70	<0.100	0.81	<7.38	53.20		24.60	81
El Vado Lower	06/26	1	674.00	<0.63	21.50	15.90	0.100	1.08	<7.38	74.20		40.00	74
Abiquiu Upper	06/25	1	188.00	<0.63	5.78	5.20	<0.100	0.36	<0.18	52.30		15.10	26
	06/25	R1	194.00	<0.62	6.57	4.90	<0.100	0.32	<7.38	53.30		12.00	27
Abiquiu Middle	06/28	1	597.00	<1.17	19.10	15.40	<0.100	0.69	<0.18	97.00		19.00	62
Abiquiu Lower	06/28	1	63.70	<0.13	3.18	1.40	<0.100	<0.15	<8.85	10.00		<2.00	12

Table 5-20. Total Recoverable Trace Metals in Sediments for 1996 (mg/kg) (Cont.)

Station Name[a,b]	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Reservoirs on Rio Grande (Colorado):													
Rio Grande Upper	9/21	1	440.00	<0.50	13.20	14.00	<0.300	0.00	<3.00	64.50	0.300	40.00	103
	9/21	R1	447.00	<0.50	5.82	12.50	<0.300	<0.00	<3.00	61.10	<0.300	32.90	84
Rio Grande Middle	9/21	1	659.00	<0.50	7.63	15.80	<0.300	0.00	<3.00	59.80	0.300	28.40	86
Rio Grande Lower	9/21	1	420.30	<0.50	5.00	15.00	<0.300	0.00	<3.00	68.90	0.300	28.70	70
Reservoirs on Rio Grande (New Mexico):													
Cochiti Upper	10/16	1	349.00	<0.50	12.00	13.40	<0.300	0.00	<3.00	108.00	<0.300	20.00	44
Cochiti Middle	10/16	1	761.00	<0.50	17.50	22.50	<0.300	0.00	<3.00	139.00	0.300	24.30	66
Cochiti Lower	10/16	1	120.60	<0.12	5.40	6.50	<0.300	0.00	<3.00	26.00	<0.300	17.50	25
Standardized Comparisons													
Average Detection Limits			0.20	0.90	2.00	0.20	0.200	0.30	4.00	0.30	0.200	0.50	1
1996 Mean (x)[e]			227.85	0.67	5.51	10.54	1.195	0.37	6.12	21.89	2.769	10.56	43
1996 Standard Deviation (s)[f]			168.10	0.34	4.82	13.74	1.489	0.29	2.09	31.31	6.256	8.76	47
SAL[g]			3,200	380	1,500	400	31	380	46,000	46,000	5.40	540	23,000

[a] Sample sizes: stream channels—100 g ; reservoirs—1000 g.
[b] Analytical uncertainties are approximately 10% of reported values.
[c] Code: 1—primary analysis, 2—secondary analysis, D—lab duplicate, R—lab replicate.
[d] Actual value is less than (<) listed value.
[e] Mean value of all 1996 sample values; if censored data are present, the < sign was omitted and the reported value was used.
[f] Standard deviation of all 1996 sample values; if censored data are present, the < sign was omitted and the reported value was used.
[g] SAL—Screening Action Level; Environmental Restoration, March 1997 values; see text for details. All units are in mg/kg.
[h] SAL value is less than background; therefore use local background (BG) value for SAL value.
[i] SAL value for hexavalent chromium is listed; SAL value for trivalent or total chromium is 210 mg/kg.
[j] No SAL value has been established for iron.

Table 5-21. Number of Analyses above Analytical Limit of Quantitation for Organic Compounds in Sediment Samples for 1996

Station Name	Date	Code[a]	Volatile[b]	Semivolatile[c]	PCB[d]	HE[e]	TIC[f]
Number of Compounds Analyzed			59	69	4	14	
Regional Stations							
Rio Grande at Otowi (bank)	10/11	1	0	0	0		10
Rio Grande at Frijoles (bank)	10/09	1		0	0		11
Canyons Along SR-4 or SR-502							
Bayo at SR-502	03/11	1				0	0
Pueblo at SR-502	05/07	1				0	0
Los Alamos at SR-4	05/02	1				0	0
Los Alamos at Otowi	05/02	1				0	0
Sandia at SR-4	05/02	1	0	0	0	0	2
Cañada del Buey at SR-4	05/02	1				0	0
Pajarito at SR-4	05/02	1				0	0
Potrillo at SR-4	05/02	1				0	0
Fence at SR-4	05/02	1				0	0
Water at SR-4	05/02	1	0	0	0	0	5
Indio at SR-4	05/02	1				0	0
Ancho at SR-4	05/02	1		0	0	0	1
TA-54 Area G							
G-1	03/22	1		0	0		4
G-2	03/22	1		0	0		0
G-3	03/22	1		0	0		5
G-4	03/22	1		0	0		0
G-5	03/22	1		0	0		0
G-6	03/22	1		0	0		4
G-7	03/22	1		0	0		1
G-8	03/22	1		0	0		2
G-9	03/22	1		0	0		1

[a]Code: 1—primary analysis, D—lab duplicate, R—lab replicate.
[b]Volatile organic compounds.
[c]Semivolatile organic compounds.
[d]Polychlorinated biphenyl compounds.
[e]High explosive compounds.
[f]Tentatively identified compounds.

Table 5-22. Radiochemical Analyses of Groundwater for 1996 (pCi/L[a])

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	U (μg/L)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Main Aquifer												
Test Wells:												
Test Well 1	08/01	u 1	749 (147[c])	−0.3 (.6)	.65 (.44)	2.04 (.21)	−.016 (.005)	.009 (.010)	−.038 (.010)	2.23 (.8)	4.75 (.6)	−37 (50)
Test Well 2	08/21	u 1	161 (136)	−0.1 (.5)	−.98 (.32)	−.01 (.01)	−.003 (.003)	.019 (.011)	−.022 (.009)	−.49 (.12)	1.35 (.18)	−57 (50)
		u R1				−.01 (.01)						
Test Well 3	01/29	u 1	52 (330)	0.5 (.8)	−.23 (.34)	.05 (.06)	.039 (.013)	.008 (.009)	−.014 (.030)	.44 (.26)	3.55 (.5)	243 (60)
		u 2					.039 (.013)	.008 (.009)				
		u R1					.013 (.010)	.005 (.010)	−.004 (.030)			
		u R2					.013 (.010)	.005 (.010)				
	07/03	u 1	544 (74)	0.1 (.3)	−.32 (1.31)	.11 (.01)	.004 (.007)	−.010 (.007)	−.013 (.012)	−.23 (.05)	2.15 (.3)	−87 (50)
		u D1			−2.01 (.80)							
		u R1							−.003 (.016)	−.51 (.12)	1.05 (.2)	−87 (50)
	09/30	u 1	−52 (136)	−0.2 (.4)	.29 (.33)	.33 (.03)	.017 (.012)	.004 (.010)	.011 (.016)	−.43 (.12)	2.25 (.3)	−27 (50)
		u R1	11 (137)									
	11/15	u 1	−336 (139)	−0.7 (.8)	.59 (2.67)	.62 (.06)	.010 (.007)	−.007 (.006)	.045 (.024)	1.13 (.4)	4.05 (.6)	−17 (50)
Test Well 4	01/23	u 1	−253 (178)	0.7 (1.0)	.03 (.41)	.12 (.12)	.004 (.007)	.006 (.009)	.036 (.040)	−.071 (.002)	2.65 (.4)	323 (70)
		u 2					.004 (.007)	.006 (.009)				
		u D1			−.16 (1.56)							
		u D2			−.16 (1.56)							
		u R1								−.057 (.004)	−.6 (.04)	
	07/03	u 1	530 (73)	−1.0 (.2)	−.43 (1.14)	.04 (.01)	.010 (.009)	.004 (.012)	.010 (.018)	−.37 (.07)	3.45 (.4)	−107 (50)
		u 2					−.007 (.001)	−.014 (.005)	−.004 (.014)			
		u D1		−0.5 (.2)		.04 (.01)						
		u R1	−298 (62)				.007 (.009)	−.011 (.001)				
	09/27	u 1	−179 (135)	1.3 (.4)	−.44 (1.12)	.15 (.02)	−.006 (.002)	−.017 (.002)	−.036 (.008)	−.28 (.07)	2.95 (.4)	43 (50)
	11/15	u 1	−278 (139)	−0.1 (.8)	.14 (2.00)	.66 (.07)	−.003 (.005)	.005 (.009)	.050 (.026)	.55 (.2)	4.15 (.6)	−37 (50)
		u R1				.67 (.07)						
Test Well 8	01/29	u 1	−241 (322)	1.2 (.8)	.48 (2.50)	.48 (.05)	−.003 (.006)	−.003 (.009)	.006 (.040)	8.93 (3.2)	12.45 (1.5)	−97 (50)
		u 2					−.003 (.006)	−.003 (.009)				
		u D1				.55 (.06)						
		u R1										−107 (50)
	07/23	u 1	−289 (144)	−0.6 (.2)	−1.87 (.80)	.48 (.05)	−.003 (.008)	.003 (.009)	−.017 (.016)	.11 (.05)	1.15 (.2)	3 (50)
		ud 1	−41 (140)	0.4 (.3)	−1.70 (.80)	.47 (.05)	.017 (.009)	.003 (.009)	.017 (.025)	1.23 (.3)	1.55 (.2)	−27 (50)
		ud 2					.020 (.013)	.033 (.015)	.009 (.016)			
		ud R1										−37 (50)

Table 5-22. Radiochemical Analyses of Groundwater for 1996 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Test Wells (Cont.):												
Test Well 8 (Cont.)	09/30	u 1	−99 (136)	−0.1 (.4)	.21 (.35)	.58 (.06)	.003 (.009)	.019 (.014)	−.020 (.010)	−1.47 (.5)	1.65 (.2)	−47 (50)
		u R1				.58 (.06)	−.004 (.006)	.020 (.012)	−.019 (.011)			
	11/15	u 1	20 (141)	−0.5 (.8)	.89 (.70)	.68 (.07)	.008 (.013)	.000 (.017)	−.008 (.015)	1.33 (.4)	2.05 (.3)	−47 (50)
		u R1					−.003 (.006)	−.007 (.007)	.049 (.024)			
Test Well DT-5A	11/27	u 1	−56 (141)	−0.1 (.3)	−1.87 (.80)	.33 (.03)	−.006 (.006)	.029 (.015)	−.015 (.016)	.71 (.19)	2.37 (.3)	−57 (50)
		u R1				.32 (.03)	.000 (.007)	.003 (.009)	−.041 (.013)			−57 (50)
		u 1										−97 (50)
		u R1										43 (50)
Test Well DT-9	09/18	u 1	−9 (133)	0.0 (.3)	−.40 (.26)	.41 (.04)	.016 (.010)	.016 (.011)	−.025 (.010)	.47 (.14)	.95 (.1)	−7 (50)
		u D1			−.61 (.23)							
		u R1	−267 (131)									
	12/05	u 1	−129 (139)	0.3 (.3)	−1.43 (.80)	.39 (.04)	.003 (.008)	−.001 (.008)	−.011 (.018)	.46 (.1)	1.85 (.3)	−197 (50)
		u 2	−129 (139)									
		u R1		−0.1 (.3)								
Test Well DT-10	09/19	1	170 (135)	1.4 (.5)	.17 (.32)	.57 (.06)	.014 (.012)	.025 (.014)	−.020 (.020)	−1.97 (.5)	7.45 (.9)	−67 (50)
		R1								.81 (.25)	7.95 (.9)	
	12/06	u 1	211 (143)	−0.8 (.6)	−1.27 (.80)	.59 (.06)	−.003 (.004)	.014 (.011)	−.018 (.015)	1.33 (.3)	3.15 (.4)	−157 (50)
		u R1					−.001 (.006)	.022 (.012)	.032 (.026)			−137 (50)
Water Supply Wells:												
O-1	12/17	u 1	−236 (140)	0.3 (.4)	−.79 (.60)	3.16 (.32)	.005 (.009)	−.002 (.009)	.018 (.019)	5.83 (3.2)	2.75 (.5)	−47 (50)
	12/18	u 1	−397 (139)	0.3 (.4)	.03 (1.83)	3.10 (.31)	−.008 (.002)	−.002 (.007)	−.022 (.012)	3.83 (2.2)	2.35 (.5)	−77 (50)
		u R1	−652 (137)									
	12/19	u 1	−347 (140)	0.5 (1.0)	−.51 (1.01)	3.05 (.31)	−.012 (.003)	.006 (.010)	−.008 (.017)	3.83 (2.2)	2.75 (.5)	−97 (50)
		u R1							.002 (.016)			
		1	−724 (137)	−0.1 (.4)	−.45 (1.12)	2.81 (.28)	.001 (.008)	.007 (.010)	−.007 (.015)	7.63 (4.1)	2.85 (.5)	−77 (50)
		1	−66 (136)	0.0 (.4)		1.71 (.17)	.020 (.018)	−.004 (.011)	−.026 (.014)			−7 (50)
		R1	−379 (133)				−.003 (.010)	−.007 (.009)	.032 (.027)			
O-4	12/16	u 1	−506 (138)	0.2 (.4)	−.04 (1.72)	.88 (.09)	.004 (.007)	−.005 (.009)	−.003 (.014)	2.13 (1)	5.45 (.9)	−77 (50)
PM-1	04/25	u 1	−105 (322)	0.2 (.9)	−1.29 (.80)	1.49 (.15)	.006 (.008)	.024 (.013)	−.006 (.016)	.33 (.2)	3.25 (.4)	−47 (50)
PM-2	04/25	u 1	3 (325)	−0.1 (.9)	−1.20 (.80)	.25 (.03)	−.003 (.005)	−.006 (.007)	−.026 (.009)	−.37 (.1)	7.95 (1)	−77 (50)
		u 2					−.005 (.001)	−.012 (.001)	.017 (.019)			
		u R1										−67 (50)
PM-3	04/25	u 1	−270 (317)	−0.1 (.8)	1.84 (.73)	.81 (.08)	−.007 (.003)	.022 (.011)	−.021 (.014)	.13 (.1)	3.15 (.4)	−87 (50)
		u D1	2.6	(.8)								
		u D2	2.6	(.8)								

Table 5-22. Radiochemical Analyses of Groundwater for 1996 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Water Supply Wells (Cont.):												
PM-5	04/25	u 1	−273 (317)	0.1 (.9)	−.40 (.38)	.76 (.08)	.012 (.008)	.001 (.008)	−.023 (.012)	−.37 (.1)	1.55 (.2)	−77 (50)
G-1	09/09	u 1	145 (136)	−0.2 (.2)	−.07 (1.68)	.44 (.05)	−.001 (.006)	−.009 (.006)	.018 (.017)	−.32 (.08)	6.55 (.8)	33 (50)
		u R1	194 (137)									
G-1A	09/08	u 1	−487 (132)	−0.2 (.2)	.53 (.78)	.41 (.04)	.020 (.012)	.009 (.011)	−.017 (.014)	1.03 (.4)	6.15 (.8)	83 (50)
		u R1					−.015 (.010)	.009 (.011)	−.019 (.012)			
		u 1	−236 (134)	−0.4 (.2)	−.26 (1.40)	.41 (.04)	.000 (.010)	.000 (.008)	.022 (.016)	.65 (.26)	6.35 (.8)	13 (50)
		u R1										13 (50)
G-2	04/25	u 1	−371 (314)	−0.3 (.7)	−1.05 (.22)	1.11 (.11)	−.005 (.003)	−.006 (.007)	−.027 (.021)	.53 (.3)	2.55 (.4)	−47 (50)
		u 2					.026 (.012)	.004 (.010)	.064 (.025)			
G-5	04/25	u 1	306 (333)	−0.1 (.7)	−.65 (.81)	1.09 (.11)	.017 (.010)	−.004 (.007)	−.029 (.010)	1.23 (.5)	1.75 (.2)	−87 (50)
		u D1			−1.12 (.10)							
		u R1								−.01 (.2)	1.85 (.3)	
G-6	04/25	u 1	13 (325)	−0.6 (1.0)	−.72 (.70)	.46 (.05)	.007 (.007)	.002 (.008)	.002 (.017)	.63 (.2)	1.65 (.2)	−57 (50)
		u R1	−286 (317)									
		u 1	−230 (318)	−0.1 (.8)	−1.45 (.80)	.42 (.04)	.001 (.005)	−.003 (.006)	−.027 (.016)	.93 (.3)	2.85 (.4)	−47 (50)
		u R1							−.023 (.014)			
Main Aquifer Springs												
White Rock Canyon Group I:												
Sandia Spring	08/29	u 1	244 (137)	3.6 (.3)	2.06 (4.88)	.86 (.09)	−.016 (.006)	.023 (.017)	−.029 (.009)	5.03 (1.7)	6.15 (.7)	−57 (50)
		u D1			−.56 (.96)							
		u R1								9.93 (3)	7.45 (.9)	
Spring 3A	10/07	f 1	56 (136)	−0.4 (.3)	−1.15 (.07)	1.27 (.13)	−.004 (.006)	.007 (.010)	−.019 (.036)	1.03 (.4)	3.85 (.5)	−47 (50)
		f R1					.007 (.007)	.010 (.010)	−.006 (.015)			
Spring 4	10/07	f 1	−205 (134)	0.1 (.3)	−1.90 (.80)	1.15 (.12)	−.002 (.004)	−.009 (.005)	.008 (.017)	.2 (1)	3.35 (.4)	−37 (50)
Spring 4A	10/08	f 1	−157 (134)	0.7 (.3)	1.67 (4.29)	1.04 (.11)	.006 (.009)	.017 (.013)	−.030 (.013)	.9 (.36)	6.55 (.8)	−27 (50)
Ancho Spring	10/08	f 1	−119 (134)	0.8 (.3)	.48 (2.50)	.29 (.03)	.011 (.008)	.008 (.011)	−.008 (.030)	−.34 (.08)	2.15 (.3)	−137 (50)
White Rock Canyon Group II:												
Spring 5A	10/08	f 1	366 (138)	−0.8 (.3)	−.75 (.67)	2.11 (.21)	−.006 (.001)	.007 (.009)	−.014 (.015)	.93 (.5)	3.85 (.5)	−77 (50)
		fd 1	−186 (134)	0.0 (.3)	−.46 (1.10)	1.92 (.19)	−.006 (.003)	−.001 (.011)	−.006 (.040)	.73 (.36)	4.35 (.5)	−57 (50)
		fd 2					.141 (.027)	−.001 (.007)				
Spring 6	10/08	f 1	214 (137)	−0.3 (.3)	−1.56 (.80)	.36 (.04)	−.006 (.004)	−.001 (.007)	−.022 (.010)	.93 (.3)	1.95 (.2)	−117 (50)
		f R1					.004 (.006)	.009 (.010)	−.022 (.010)			

Table 5-22. Radiochemical Analyses of Groundwater for 1996 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
White Rock Canyon Group II (Cont.):												
Spring 8	10/08	f 1	−97 (134)	−0.2 (.3)	−1.65 (.80)	1.43 (.14)	−.003 (.006)	.007 (.011)	−.029 (.012)	2.23 (.9)	3.75 (.5)	−87 (50)
Spring 8B	10/08	f 1	49 (135)	0.9 (.4)	−1.51 (.80)	1.81 (.18)	−.009 (.004)	−.002 (.008)	−.024 (.013)	.63 (.29)	3.85 (.5)	−127 (50)
Spring 9A	10/09	f 1	90 (136)	0.6 (.3)	−.91 (.42)	.25 (.03)	.004 (.008)	−.003 (.009)	−.032 (.010)	−.18 (.03)	2.25 (.3)	−107 (50)
		f R1	−16 (135)			.25 (.03)						
Spring 9B	10/09	f 1	15 (135)	0.4 (.3)	−1.79 (.80)	.17 (.02)	.000 (.007)	−.004 (.008)	.002 (.014)	.3 (.1)	1.45 (.2)	−167 (50)
Doe Spring	10/08	f 1	−363 (132)	1.2 (.4)	−.58 (.92)	.27 (.03)	.007 (.007)	.002 (.008)	.004 (.017)	−1.02 (.31)	2.15 (.3)	−107 (50)
		f R1							−.044 (.000)			
Spring 10	10/09	f 1	54 (136)	−0.7 (.3)	−.47 (1.09)	1.01 (.10)	−.009 (.002)	−.001 (.007)	−.017 (.011)	−.22 (.06)	1.75 (.2)	−67 (50)
		f D1										−97 (50)
White Rock Canyon Group III:												
Spring 1	08/29	u 1	−777 (129)	0.6 (.3)	−.29 (1.35)	1.51 (.15)	.004 (.008)	−.005 (.008)	−.004 (.017)	2.93 (1.1)	2.95 (.4)	−67 (50)
White Rock Canyon Group IV:												
La Mesita Spring	08/14	u 1	638 (78)	−0.1 (.7)	−.33 (.50)	10.01 (1.00)	.035 (.015)	.004 (.010)	−.016 (.014)	14.03 (5.2)	5.95 (.7)	−47 (50)
		u D1			.81 (3.00)							
		u R1								13.63 (5)	7.95 (1)	
Sacred Spring	08/14	u 1	−48 (69)	0.6 (.6)	−1.33 (.79)	.59 (.06)	.002 (.007)	−.007 (.006)	−.006 (.017)	6.03 (2.4)	8.65 (1.1)	−17 (50)
		u R1										−77 (50)
Alluvial Canyon Groundwater Systems												
Acid/Pueblo Canyons:												
APCO-1	10/17	u 1	−141 (136)	0.5 (.4)	−1.19 (.02)	.34 (.04)	−.003 (.005)	.087 (.020)	−.020 (.012)	−3.97 (1.6)	12.05 (1.4)	283 (60)
		u R1	274 (139)			.32 (.03)	.000 (.008)	.066 (.020)	−.015 (.016)			
Cañada del Buey:												
CDBO-6	12/17	u 1	29 (142)	0.2 (.3)	−.62 (.86)	.27 (.03)	−.010 (.002)	−.008 (.008)	.034 (.026)	7.13 (3.5)	11.55 (2)	−87 (50)
DP/Los Alamos Canyons:												
LAO-C	07/10	u 1	−173 (139)	0.3 (.3)	−1.27 (.80)	.14 (.02)	.007 (.012)	.009 (.010)	.061 (.027)	1.13 (.3)	20.75 (2)	−27 (50)
		u R1	−297 (138)									
LAO-0.7	07/29	u 1	46 (141)	0.2 (.3)	2.69 (.85)	.42 (.04)	−.011 (.006)	.304 (.043)	−.024 (.014)	20.93 (9)	23.75 (3)	−87 (50)
		u R1					−.006 (.007)	.248 (.040)	−.023 (.012)			
LAO-1	07/29	u 1	502 (144)	7.1 (.7)	−.32 (1.31)	.17 (.02)	.008 (.011)	.025 (.013)	−.020 (.013)	.73 (.3)	27.75 (3)	43 (50)
		u D1		6.9 (.7)								

Table 5-22. Radiochemical Analyses of Groundwater for 1996 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
DP/Los Alamos Canyons (Cont.):												
LAO-2	11/13	u 1	152 (139)	16.5 (1.8)	.37 (2.33)	.15 (.02)	–.006 (.006)	.017 (.013)	.001 (.016)	.26 (.17)	54.75 (7)	3 (50)
		u R1	–117 (137)			.12 (.01)						–17 (50)
LAO-3A	07/10	u 1	–51 (140)	25.4 (1.9)	.22 (.32)	.30 (.03)	–.006 (.008)	.019 (.014)	–.014 (.020)	1.93 (.7)	112.75 (14)	–37 (50)
		u D1				.29 (.03)						
LAO-4	07/29	u 1	79 (141)	3.1 (.5)	.23 (.32)	.22 (.02)	.011 (.009)	.033 (.014)	–.015 (.013)	.63 (.2)	16.75 (2)	–47 (50)
		u D1			–.22 (1.45)							
		u R1								.57 (.22)	17.75 (2)	
Mortandad Canyon:												
MCO-4B	03/05	u 1	18279 (600)	108.9 (6.8)	–.82 (.54)	4.00 (.40)	.003 (.005)	.051 (.014)	.486 (.110)	25.73 (9.4)	625.75 (76)	133 (50)
		u D1		140.0 (8.8)								
MCO-5	08/09	u 1	22545 (237)	121.9 (8.0)	5.31 (9.75)	6.49 (.65)	.027 (.013)	.028 (.014)	.393 (.050)	111.93 (47)	561.75 (66)	13 (50)
		u R1										–17 (50)
		ud 1	22722 (237)	99.7 (6.6)	4.81 (9.00)	6.47 (.65)	.021 (.013)	.030 (.014)	.423 (.052)	105.93 (47)	597.75 (71)	–47 (50)
		ud R1					.058 (.018)	.019 (.013)	.410 (.051)			
MCO-6	08/06	u 1	24396 (242)	83.2 (5.7)	1.91 (.90)	5.42 (.54)	.004 (.009)	.020 (.013)	.433 (.052)	108.93 (48)	501.75 (59)	–17 (50)
		u D1				5.68 (.57)						
MCO-7	08/06	u 1	18027 (223)	1.9 (.7)	2.56 (5.63)	2.69 (.27)	.009 (.009)	.010 (.011)	.253 (.040)	127.93 (50)	253.75 (29)	–67 (50)
Pajarito Canyon:												
PCO-1	07/30	u 1	577.71 (146)	0.3 (.7)	–1.75 (.79)	.05 (.01)	.013 (.013)	.019 (.014)	.010 (.020)	.72 (.31)	6.85 (.8)	23 (50)
		u D1			–.04 (.29)					–.55 (.19)	7.45 (.9)	
Intermediate Perched Groundwater Systems												
Pueblo/Los Alamos Area Perched System in Conglomerates and Basalt:												
Test Well 1A	08/02	u 1	180 (143)	0.2 (.6)	.33 (.33)	.07 (.01)	–.015 (.007)	–.010 (.008)	–.030 (.029)	–.34 (.06)	5.65 (.7)	–27 (50)
		u R1		0.6 (.7)								
Test Well 2A	08/21	u 1	2253 (150)	0.0 (.4)	–1.57 (.80)	.11 (.01)	.007 (.010)	.024 (.014)	–.013 (.014)	–.97 (.34)	1.15 (.2)	–47 (50)
		u R1					.018 (.011)	.014 (.013)	–.018 (.012)			
Basalt Spring	08/14	u 1	–310 (63)	–0.3 (.5)	–2.50 (.81)	.58 (.06)	.012 (.008)	.138 (.023)	–.032 (.015)	3.53 (1.3)	13.15 (1.6)	–67 (50)
Perched Groundwater System in Volcanics:												
Water Canyon Gallery	12/16	u 1	–417 (139)	–0.2 (.5)	–.68 (.77)	.24 (.03)	–.001 (.007)	.014 (.012)	.021 (.019)	.37 (.1)	2.25 (.3)	–77 (50)

Table 5-22. Radiochemical Analyses of Groundwater for 1996 (pCi/L[a]) (Cont.)

Station Name	Date	Codes[b]	^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	$^{239,240}Pu$	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
Pueblo of San Ildefonso Water Supply Wells:												
LA-1B	08/27	u 1	22 (135)	−0.1 (.3)	1.00 (.76)	.05 (.01)	.011 (.008)	.023 (.012)	.026 (.018)	−1.17 (.4)	.65 (.11)	−67 (50)
		u R1	−269 (133)									−77 (50)
LA-5	08/14	u 1	−75 (69)	0.0 (.5)	−.97 (.33)	1.18 (.12)	.009 (.010)	.034 (.016)	−.024 (.018)	.85 (.33)	2.95 (.4)	−47 (50)
		u R1	361 (75)									
Westside Artesian Well	08/14	u 1	−107 (68)	−0.3 (.5)	−.61 (.86)	19.36 (1.94)	−.010 (.003)	.004 (.008)	−.028 (.013)	25.93 (9.7)	3.25 (.4)	−67 (50)
		u D1				19.54 (1.96)						
Eastside Artesian Well	08/13	u 1	−184 (136)	0.1 (.5)	.16 (.32)	.19 (.02)	.011 (.013)	.001 (.010)	.002 (.017)	−.88 (.38)	−.49 (.03)	−117 (50)
		u R1					.030 (.014)	.001 (.009)	.009 (.040)			
Halladay House Well	08/13	u 1	−190 (136)	0.5 (.6)	−.14 (1.58)	1.26 (.13)	−.015 (.005)	.011 (.010)	−.003 (.017)	.14 (.04)	−.85 (.1)	−67 (50)
		ud 1	−187 (136)	0.7 (.3)	−.40 (.27)	1.37 (.14)	−.014 (.009)	−.002 (.009)	−.020 (.018)	1.23 (.5)	.85 (.1)	−57 (50)
Pajarito Well (Pump 1)	08/13	u 1	−107 (137)	0.1 (.5)	3.81 (7.50)	9.23 (.92)	.024 (.012)	−.000 (.009)	.005 (.016)	15.03 (6.2)	4.35 (.5)	−77 (50)
Don Juan	08/13	u 1	−308 (135)	0.4 (.9)	−.38 (.27)	5.96 (.60)	−.004 (.008)	−.010 (.008)	−.025 (.013)	6.43 (2.8)	2.65 (.3)	−67 (50)
Playhouse Well		u D1			.48 (.41)							
		u R1								11.63 (5.4)	2.25 (.3)	
Otowi House Well	08/13	u 1	98 (138)	0.2 (.5)	1.61 (.76)	2.87 (.29)	−.007 (.010)	−.009 (.008)	−.019 (.016)	2.83 (.9)	4.35 (.5)	−27 (50)
		u D1				2.70 (.27)						
New Community Well	08/13	u 1	−5 (137)	2.7 (.6)	.64 (2.76)	19.64 (1.97)	.012 (.012)	−.009 (.009)	−.039 (.012)	23.93 (11.3)	5.65 (.7)	−7 (50)
		u R1	−154 (136)									−87 (50)
Sanchez House Well	08/13	u 1	−231 (136)	0.1 (.3)	3.22 (6.62)	9.66 (.97)	.026 (.016)	.043 (.018)	−.019 (.017)	10.63 (4.7)	3.65 (.5)	−107 (50)
Limits of Detection			700	3	2	0.1	0.04	0.04	0.04	3	3	
Water Quality Standards[d]												
DOE DCG for Public Dose			2,000,000	1,000	3,000	800	40	30	30	30	1,000	
DOE Drinking Water System DCG			80,000	40	120	30	1.6	1.2	1.2	1.2	40	
EPA Primary Drinking Water Standard			20,000	8		20				15		
EPA Screening Level											50	
NMWQCC Groundwater Limit						5,000						

[a]Except where noted.
[b]Codes: u—unfiltered, f—filtered, d—field duplicate, 1—primary analysis, 2—second analysis, R1—lab replicate, D1—lab duplicate.
[c]Radioactivity counting uncertainties (1 standard deviation) in parentheses. Radioactivity counting uncertainties may be less than analytical method uncertainties.
[d]Standards given here for comparison only, see Appendix A.

Table 5-23. Detections of Radionuclides in Groundwater for 1996

Station Name	Date	Codes[b]		Analyte	Blank Corrected Value	Lab Value	Uncertainty (σ)	Units	Detection Limit
Test Well 1	08/01	u	1	^{3}H	749	951	147	pCi/L	700
Sandia Spring	08/29	u	1	^{90}Sr	3.61	3.7	0.3	pCi/L	3
Spring 5A	10/08	fd	1	^{238}Pu	0.1412	0.1452	0.0272	pCi/L	0.04
La Mesita Spring	08/14	u	1	Alpha	14.03	14.1	5.2	pCi/L	3
		u	R1	Alpha	13.63	13.7	5	pCi/L	3
		u	1	U	10.01	10.02	1	µg/L	0.1
LAO-0.7	07/29	u	1	Alpha	20.93	21	9	pCi/L	3
		u	1	^{239}Pu	0.304	0.316	0.043	pCi/L	0.04
		u	R1	^{239}Pu	0.248	0.26	0.04	pCi/L	0.04
LAO-1	07/29	u	1	^{90}Sr	7.11	7.2	0.7	pCi/L	3
		u	D1	^{90}Sr	6.91	7	0.7	pCi/L	3
LAO-2	11/13	u	1	Beta	54.75	55	7	pCi/L	3
		u	1	^{90}Sr	16.51	16.6	1.8	pCi/L	3
LAO-3A	07/10	u	1	Beta	112.75	113	14	pCi/L	3
		u	1	^{90}Sr	25.41	25.5	1.9	pCi/L	3
LAO-4	07/29	u	1	^{90}Sr	3.11	3.2	0.5	pCi/L	3
MCO-4B	03/05	u	1	Alpha	25.73	25.8	9.4	pCi/L	3
		u	1	Beta	625.75	626	76	pCi/L	3
		u	1	^{3}H	18,279	18,481	600	pCi/L	700
		u	1	^{90}Sr	108.91	109	6.8	pCi/L	3
		u	D1	^{90}Sr	140.01	140.1	8.8	pCi/L	3
MCO-5	08/09	u	1	Alpha	111.93	112	47	pCi/L	3
		u	1	^{241}Am	0.3933	0.4373	0.0497	pCi/L	0.04
		u	1	Beta	561.75	562	66	pCi/L	3
		u	1	^{3}H	22,545	22,747	237	pCi/L	700
		u	1	^{90}Sr	121.91	122	8	pCi/L	3
		u	1	U	6.49	6.5	0.65	µg/L	0.1
		ud	1	Alpha	105.93	106	47	pCi/L	3
		ud	1	^{241}Am	0.4231	0.4671	0.0516	pCi/L	0.04
		ud	R1	^{241}Am	0.41	0.454	0.051	pCi/L	0.04
		ud	1	Beta	597.75	598	71	pCi/L	3
		ud	1	^{3}H	22,722	22,924	237	pCi/L	700
		ud	1	^{90}Sr	99.71	99.8	6.6	pCi/L	3
		ud	1	U	6.47	6.48	0.65	µg/L	0.1

Table 5-23. Detections of Radionuclides in Groundwater for 1996 (Cont.)

Station Name	Date	Codes[b]		Analyte	Blank Corrected Value	Lab Value	Uncertainty (σ)	Units	Detection Limit
MCO-6	08/06	u	1	Alpha	108.93	109	48	pCi/L	3
		u	1	^{241}Am	0.4329	0.4769	0.0519	pCi/L	0.04
		u	1	Beta	501.75	502	59	pCi/L	3
		u	1	^{3}H	24,396	24,598	242	pCi/L	700
		u	1	^{90}Sr	83.21	83.3	5.7	pCi/L	3
		u	1	U	5.42	5.43	0.54	µg/L	0.1
		u	D1	U	5.68	5.69	0.57	µg/L	0.1
MCO-7	08/06	u	1	Alpha	127.93	128	50	pCi/L	3
		u	1	^{241}Am	0.2527	0.2967	0.0399	pCi/L	0.04
		u	1	Beta	253.75	254	29	pCi/L	3
		u	1	^{3}H	18,027	18,229	223	pCi/L	700
Test Well 2A	08/21	u	1	^{3}H	2,253	2,455	150	pCi/L	700
Basalt Spring	08/14	u	1	^{239}Pu	0.1384	0.1504	0.0226	pCi/L	0.04
Westside Artesian Well	08/14	u	1	Alpha	25.93	26	9.7	pCi/L	3
		u	1	U	19.36	19.37	1.94	µg/L	0.1
		u	D1	U	19.54	19.55	1.96	µg/L	0.1
Pajarito Well (Pump 1)	08/13	u	1	Alpha	15.03	15.1	6.2	pCi/L	3
		u	1	U	9.23	9.24	0.92	µg/L	0.1
Don Juan Playhouse Well	08/13	u	R1	Alpha	11.63	11.7	5.4	pCi/L	3
		u	1	U	5.96	5.97	0.6	µg/L	0.1
New Community Well	08/13	u	1	Alpha	23.93	24	11.3	pCi/L	3
		u	1	U	19.64	19.65	1.97	µg/L	0.1
Sanchez House Well	08/13	u	1	Alpha	10.63	10.7	4.7	pCi/L	3
		u	1	U	9.66	9.67	0.97	µg/L	0.1

[a] Detection defined as sample value – avg. blank ≥ 4.66 σ and ≥ detection limit, except values shown for Uranium ≥ 5 µg/L, for Gross Beta ≥ 40 pCi/L, and for Gross Alpha ≥ 10 pCi/L.

[b] Codes: u—unfiltered, f—filtered, d—field duplicate, 1—primary analysis, 2—second analysis, R1—lab replicate, D1—lab duplicate.

Table 5-24. Possible Detections[a] of Radionuclides in Groundwater for 1996

Station Name	Date	Codes[b]		Analyte	Blank Corrected Value	Lab Value	Uncertainty (σ)	Units	Detection Limit
G-2	04/25	u	1	^{241}Am	0.064	0.108	0.025	pCi/L	0.04
APCO-1	10/17	u	1	^{239}Pu	0.087	0.099	0.02	pCi/L	0.04
		u	R1	^{239}Pu	0.066	0.078	0.02	pCi/L	0.04
LAO-0.7	07/29	u	1	^{137}Cs	2.69	3.88	0.85	pCi/L	2
MCO-4B	03/05	u	1	^{241}Am	0.486	0.53	0.11	pCi/L	0.04
		u	1	^{239}Pu	0.051	0.063	0.014	pCi/L	0.04
MCO-5	08/09	ud	R1	^{238}Pu	0.058	0.062	0.018	pCi/L	0.04
Sanchez House Well	08/13	u	1	^{239}Pu	0.0429	0.0549	0.0177	pCi/L	0.04

[a] Possible detection defined as 2.33 σ ≤ (sample value minus avg. blank) ≤ 4.66 σ and (sample value minus avg. blank) ≥ detection limit.

[b] Codes: u—unfiltered, f—filtered, d—field duplicate, 1—primary analysis, 2—second analysis, R1—lab replicate, D1—lab duplicate.

Table 5-25. Total Committed Effective Dose Equivalent (CEDE) from the Ingestion of Two Liters Per Day Drinking Water Collected during 1996

	Total Committed Effective Dose Equivalent[a] (mrem/yr)	
Well or Water System	**1996**	**1995**
Los Alamos & White Rock[b]	0.071 (± 0.048)[c]	0.43 (± 0.12)[c]

[a] Based on DOE dose conversion factors (DOE 1988a).

[b] Doses based on the 2 liter/day maximum consumption rate (EPA 1989) and the percentage wells were pumped to the distribution system.

[c] ±2 sigma in parenthesis; to convert to µSv multiply by 10.

Table 5-26. Trace-Level Tritium Measurements in Regional Aquifer Test Wells during 1996

Station	Date	TU[a]	ΔTU[b]	pCi/L	ΔpCi/L
DT-10	12/04	0.03	0.09	0.10	0.29
DT-5A	11/27	0.16	0.09	0.51	0.29
DT-9	09/18	–0.02	0.09	–0.06	0.29
DT-9	12/05	0.11	0.10	0.35	0.32
TW-3	01/29	4.77	0.16	15.23	0.51
TW-3	07/03	1.87	0.09	5.97	0.29
TW-3	09/30	1.53	0.09	4.89	0.29
TW-3	11/15	0.05	0.09	0.16	0.29
TW-4	01/23	0.32	0.09	1.02	0.29
TW-4	07/03	0.20	0.10	0.64	0.32
TW-4	09/27	0.04	0.10	0.13	0.32
TW-4	11/15	0.06	0.09	0.19	0.29
TW-8	01/29	8.20	0.27	26.18	0.86
TW-8	07/23	1.72	0.11	5.49	0.35
TW-8	09/30	6.09	0.20	19.45	0.64
TW-8	11/15	3.26	0.12	10.41	0.38

[a]The University of Miami detection limit for this set of samples is about 0.3 pCi/L (0.1 tritium unit (TU)).
1TU = 3.193 pCi/kg H_2O ~ 3.193 pCi/L H_2O.

[b]The Δ values represent one standard deviation of the uncertainty of measurement.

Table 5-27. Chemical Quality of Groundwater for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Main Aquifer Test Wells:																				
Test Well 1	08/01	u 1	43	52	10.6	3.4	17.8	33	22.1	<5[f]	101	0.41	0.06	5.53	<.01	300	5.6	175	8.1	393
		u R1	44																	
Test Well 2	08/21	u 1	<10	2.1	0.1	2.9	135.4	55.9	19.7	<5	66	0.5	<.02	0.1	<.01	100	2	5.7	7.4	152
		u R1		2	0.1	2.5	135.3			<5	65							5.6		
Test Well 3	07/03	u 1	33	12.3	4	<3.0	10	5.6	3	<5	67	0.49			0.01	110	4	46.4	7.6	
		u R1		12.3	3.9	1.9	10			<5	61									
	09/30	u 1	55	14.7	4.5	1.3	11.4	5.7	<1.0	<5	86	0.47	0.05	0.4	<.01	160	6.4	55.2	7.8	161
		u R1						5.7	<1.0											
	11/15	u 1	84	15.4	5	1.6	11.2	5.2	4.6	<5	80	0.43	<.02	0.73	<.01	200	<1	59.1	8	176
		u R1								<5	79									
Test Well 4	07/03	u 1	<10	9.1	4.7	<2.0	9.3	4.6	<1.0	<5	64	0.18			0.01	70	<1	42	8.4	
	09/27	u 1	<10	9.9	5.1	1.6	10.3	4.8	<1.0	<5	79		0.02		<.01	86	26	45.7	8.6	137
		u R1								<5	75			0.26						
	11/15	u 1	72	10	5.6	1.9	10.1	4.2	2.2	<5	70	0.19	<.02	1.55	<.01	150	2	47.8	7.9	141
		u R1												1.64						
Test Well 8	07/23	u 1	66	12.2	4.2	2.2	9.9	4.6	3.5	<5	61	0.17	0.25	0.2	<.01	130	<1	47.8	7.5	
		u R1													<.01		<1			
		ud 1	66	12.2	4.2	2.2	10	4.6	3.6	<5	65	0.16	<.01	0.23	<.01	140	<1	47.8	7.7	
	09/30	u 1		11.5	3.9	0.8	10.3											44.8		
	11/15	u 1	76	12.7	4.5	<2.2	11.9	4.3	3.6	<5	62	0.16	<.02	0.35	<.01	160	<1	50.1	8	135
		u R1		11.5	4	1.7	10.5											45		
Test Well DT-5A	11/27	u 1	76	9.5	2.8	1.7	12.3	4.1	3.2	<5	52	0.24	<.02	0.4	<.01	150	<1	35	7.9	110
		u R1		9.7	2.9	2.4	12.7								<.01	150	<1	36		
Test Well DT-9	09/18	u 1	72	9.6	2.6	<.3	10	4	4	<5	58	0.29	<.02	0.41	0.01	150	<1	34.8	8	118
		u R1		9.8	2.7	<.3	10.5											35.6		
	12/05	u 1	73	9.3	2.6	<1.0	9.8	4.7	4.2	<5	52	0.3	<.02	0.35	<.01	150	<1	34	8.1	120
		u 2	73					4.7	4.2	<5	52	0.3	<.02	0.35	<.01	150	<1		8.1	120
		u R1		9.1	2.5	<1.0	9.5											33		
Test Well DT-10	09/19	1	67	11.3	3.4	<.6	10.5	4	4	<5	66	0.25	<.02	0.27	0.01	160	<1	42	8.3	132
		R1	67										<.02				<1	0		
	12/06	u 1	67	10.8	3.2	<1.0	9.9	4.7	4	<5	60	0.26	<.02	0.26	<.01	150	<1	40	8.3	130
		u 2	67					4.7	4	<5	60	0.26	<.02	0.26	<.01	150	<1		8.3	130
		u R1	70										<.02		<.01	150				
		u R2	70										<.02		<.01	150				

Table 5-27. Chemical Quality of Groundwater for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Main Aquifer																					
Water Supply Wells:																					
O-1	06/24	u	1		2.3	<.0	0.5	62						0.02	<.04				5.9		
		u	R1											<.02							
	12/17	u	1	32	2.3	0	<1.0	62.5	5.7	5.7	18	140	0.3	<.02	0.35	<.01	160	<1	5.7	9.3	273
		u	R1										0.29								
	12/18	u	1	32	2.5	0.2	<1.0	60.3	5.8	5.8	8	150	0.31	<.02	0.27	<.01	170	13	7.1	9	271
		u	R1											<.02		<.01	170	12			
	12/19	u	1	32	2.4	0.1	<1.0	61	5.8	5.9	17	150	0.31	0.08	0.28	<.01	160	6	6.3	9.1	275
			1	33	2.1	0.1	<1.0	61.2	5.9	6.1	15	150	0.32	<.02	0.34	<.01	160	2	5.7	9.1	270
			1	38	3.5	0.8	<1.0	63.8	6	6	5	144	0.35			<.01	224	17	12	8.7	285
			R1	39	3	0.3	<1.0	63.9					0.37			<.01	218	19	8.7		
O-4	12/16	u	1	91	19	7.7	2.6	18	8	6.6	<5	120	0.31	0.05	0.44	<.01	200	<1	79.2	7.7	242
PM-1	04/25	u	1	78	23.7	5.9	3.3	16.7	6.6	6.1	<5	114	0.24	0.03	0.47	<.01	242	<1	83	7.5	244
PM-2	04/25	u	1	84	12.3	3.9	2.4	13.1	2.7	3.2	<5	51	0.22	0.03	0.28	<.01	136	<1	46	7.2	114
PM-3	04/25	u	1	91	23.4	7.6	3.2	16.3	7	6.3	<5	140	0.3	0.03	0.42	<.01	250	<1	89	7.3	255
PM-5	04/25	u	1	89	11.8	4.6	2.2	11.6	3.6	4	<5	79	0.28	0.03	0.27	<.01	182	<1	48	7.4	153
G-1	09/09	u	1	83	12.3	0.6	<3.8	20.9			<5	82	0.41	<.02	0.49	<.01	180	<1	33	8.5	163
		u	R1									81	0.41	<.02			180				
G-1A	09/08	u	1	72	9.9	0.5	<2.1	28.4			<5	89	0.56	<.02	0.48	<.01	160	1	27	8.6	185
		u	1	72	9.6	0.5	2.2	27.7			<5	88	0.57	<.02	0.48	<.01	180	1.8	26	8.6	186
G-2	04/25	u	1	74	9.4	0.5	2.5	34	3.7	5.1	<5	97	0.84	0.03	0.47	<.01	198	<1	25	8	205
G-5	04/25	u	1	59	16.9	3.6	1.9	10.6	3.8	5.1	<5	72	0.29	0.03	0.64	<.01	142	<1	57	7.8	167
		u	R1	61					3.8	5	<5	81			0.64	<.01					
		u	R2	61					3.8	5	<5	81			0.64	<.01					
G-6	04/25	u	1	54	15.3	2.4	2.3	17.8	3.2	4.1	<5	71	0.27	0.03	0.45	<.01	140	<1	48	7.7	159
		u	R1										0.28								
		u	R2										0.28								
		u	1	54	12.8	2	2.1	16.2	3.2	4.1	<5	118	0.28	0.03	0.39	0.01	136	<1	40	7.8	150
		u	R1		12.9	2.1	2	16.3											40		
		u	R2		12.9	2.1	2	16.3											40		

Table 5-27. Chemical Quality of Groundwater for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Main Aquifer Springs																				
White Rock Canyon Group I:																				
Sandia Spring	08/29	u 1	47	30.4	2.5	4	16.4	4.6	5.5	<5	115	0.55	0.04	0.04	<.01	170	84	85	7.3	239
		u R1	47																	
Spring 3A	10/07	f 1	51	19	1.7	1.9	14	7.4	6.1	<5	77	0.43	0.1	0.94	<.01	140	1.2	<54	8.2	115
Spring 4	10/07	f 1	55	22	4.6	1.6	14	10.2	10.8	<5	78	0.49	<.02	1.63	<.01	190	1.2	73.1	7.6	206
		f R1						9.8	11.5					1.62						
Spring 4A	10/08	f 1	71	17.6	4.3	1.1	11.3	7.9	7.1	<5	81	0.46	0.02	1.02	<.01	160	<1	61.7	8.4	186
		f R1														160				
Ancho Spring	10/08	f 1	76	11.6	3	1	10.1	5.5	4.4	<5	59	0.35	<.02	0.43	<.01	120	<1	41.3	7.8	133
White Rock Canyon Group II:																				
Spring 5A	10/08	f 1	54	25	3	2.3	29	8.3	8.6	<5	107	0.37	<.02	0.58	<.01	230	<1	73.8	7.8	232
		f R1										0.37					<1			
		fd 1	74	20	2.4	1.6	23	6.9	9	<5	107	0.39	<.02	0.5	<.01	200	<1	59.3	7.6	237
		fd R1	74																	
Spring 6	10/08	f 1	75	11.3	3.4	1.1	10.1	5.6	4.4	<5	59	0.35	0.02	0.48	<.01	150	<1	42.2	8	135
Spring 8	10/08	f 1	75	16.3	3.4	1.9	18.4	6.4	8.1	<5	87	0.38	<.02	0.55	<.01	190	<1	54.7	7.3	194
Spring 8B	10/08	f 1	76	18	4	2.1	21.2	6.6	9.4	<5	102	0.4	0.02	0.59	<.01	200	<1	61.4	6.9	228
Spring 9A	10/09	f 1	75	10.6	3.3	0.5	11.7	5.5	3.7	<5	58	0.49	<.02	0.29	<.01	140	<1	40.1	8.3	128
		f R1	75																	
Spring 9B	10/09	f 1	72	0.4	<.3	9.4	<.2	5.5	4.2	<5	42	0.47	<.02	0.13	<.01	130	<1	0	8	117
		f R1														150				
Doe Spring	10/08	f 1	77	13.6	3.6	1.1	12.2	6.2	3.2	<5	77	0.53	0.02	0.07	<.01	150	1.4	49.8	8	150
		f R1								<5	73									
Spring 10	10/09	f 1	72	14.8	3	0.4	10.9	5.5	3.9	<5	82	0.5	<.02	0.6	<.01	150	<1	49.1	8	161
		f R1												0.6						
White Rock Canyon Group III:																				
Spring 1	08/29	u 1	33	15	1.5	<2.8	27.4	4.6	6.2	<5	106	0.53	0.1	0.37	<.01	210	10	44	7.9	214
		u R1										<1.05				210				
White Rock Canyon Springs Group IV:																				
La Mesita Spring	08/14	u 1	30	34	2.2	3.4	24	8.2	14.1	<5	122	0.24	0.07	2.79	<.01	260	21	93	8.3	299
Sacred Spring	08/14	u 1	22	<.4	<.2	<.5	<.3	4.5	5.6	<5	110	0.53	0.05	0.04	<.01	190	20	<1	7	224

Table 5-27. Chemical Quality of Groundwater for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Alluvial Canyon Groundwater Systems																				
Acid/Pueblo Canyons:																				
APCO-1	10/17	u 1	78	20.2	4.9	10.1	60.2	46.7	25.7	<5	120	0.49	4.3	4.6	<.01	300	2.4	70	7.2	480
Cañada del Buey:																				
CDBO-6	07/02	u 1												0.05						
		u R1												0.07						
	09/30	u 1												0.12						
		u 1												0.09						
	12/17	u 1	60	15	3.8	2.1	20.5	10.5	8.7	<5	78	0.2	0.35	0.07	<.01	150	46	53.1	9	218
		u R1	60																	
		u 1												0.11						
CDBO-7	07/02	u 1												<.04						
		u R1												<.04						
	09/30	u 1												0.12						
		u 1												0.09						
DP/Los Alamos Canyons:																				
LAO-C	07/10	u 1	39	17.4	4	4.5	50.6	85	6.9	<5	60	0.15	<.01	<.04	<.01	250	<1	59.8	7	
LAO-0.7	07/29	u 1	38	18.6	3.7	4.6	43.3	76.1	8.3	<5	66	0.18	0.08	<.04	<.01	250	70	61.6	6.5	
LAO-1	07/29	u 1	40	16.9	3.6	4.9	37.5	62	7.6	<5	56	0.26	<.01	0.11	<.01	220	<1	57	6.6	
LAO-2	11/13	u 1	50	19.5	5.2	7	31	45.4	8.4	<5	76	0.69	0.08	0.19	<.01	230	<1	70	6.6	316
		u R1		21.3	5.7	7.9	34.2						0.05	0.18	<.01	220				
LAO-3A	07/10	u 1	52	17	3.6	7.2	29.7	22.6	12.7	<5	77	1.03	0.08	1.1	<.01	220	2	57.4	6.9	
LAO-4	07/29	u 1	45	13	3.6	5.4	27	15.8	9.6	<5	84	0.66	<.01	0.16	<.01	190	<1	47.2	6.7	
		u R1	45									0.69	<.01	0.15		200				
Mortandad Canyon:																				
MCO-4B	03/05	u 1	41	58.5	4.3	24	108	22	24	<5	224	1.34	0.11	36.6	0.01	482	<1	170	8.6	830
		u R1										1.34								
MCO-5	08/09	u 1	37	73.3	7.1	26.3	119	28.8	27.3	<5	250	1.29	0.06	61	<.01	790	5.6	211	7.9	1,070
		ud 1	36	71.2	6.8	25.3	117	29.1	26.7	<5	251	1.26	0.06	62.5	<.01	790	1	205	7.4	1,087
		ud R1															1			
MCO-6	08/06	u 1	34	68.6	7.6	30	116	29.4	26.8	<5	214	1.21	0.08	63	<.01	780	7.6	203	7.4	1,060
MCO-7	08/06	u 1	38	24.2	6.4	16.9	90	19.6	19.3	<5	174	1.5	0.41	27.9	<.01	590	57	86	7.6	289
		u R1										1.49	0.38			610				

Table 5-27. Chemical Quality of Groundwater for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Alluvial Canyon Groundwater Systems (Cont.)																				
Pajarito Canyon:																				
PCO-1	07/30	u 1	39	30.2	8.7	4.2	27.8	30.7	49.7	<5	55	0.14	0.03	0.48	<.01	250	1	111	6.6	322
		u R1		30	8.6	4.8	27.7							0.48				110		
Intermediate Perched Groundwater Systems																				
Pueblo/Los Alamos Canyon:																				
Test Well 1A	08/02	u 1	<10	11.7	4.8	4.6	49.4	41.1	7.3	<5	73	0.66	0.35	<.04	<.01	190	11	50	7.9	284
Test Well 2A	08/21	u 1	30	29	5.5	1.6	17.9	4.6	<1.0	<5	68	0.22	<.02	0.09	<.01	300	7.6	95	7.1	330
Basalt Spring	08/14	u 1	81	20.2	4.9	10	52.2	38.7	20	<5	121	0.47	4.4	1.33	<.01	380	30	70	6.9	411
		u R1									128									
Perched Groundwater System in Volcanics:																				
Water Canyon Gallery	12/16	u 1	46	6.3	3	1.5	5.8	2.9	3.4	<5	42	0.06	<.02	0.26	<.01	80	2	28.1	8	81.4
Pueblo of San Ildefonso Water Supply Wells:																				
LA-1B	08/27	u 1	<10	2	0.1	1.4	137.8	18.4	27	35	277	3.01	<.02	<.04	<.01	380	<1	5.4	9.4	655
LA-5	08/14	u 1	41	19	0.8	<2.6	15.4	5.5	6.5	<5	88	0.49	<.02	0.2	<.01	180	<1	50	8.3	173
		u R1	41										<.02			170				
Westside Artesian Well	08/14	u 1	25	14	0.9	1.7	380	339	81	26	352	5.44	0.12	<.04	<.01	1100	2.8	38	8.5	1,910
		u R1								25	349									
Eastside Artesian Well	08/13	u 1	<10	3.1	0.2	<1.9	79	5.3	17.5	17	181	0.81	<.02	<.04	<.01	210	<1	9	9.4	385
Halladay HouseWell	08/13	u 1	29	4	<.2	<2.2	39	6.2	13.7	<5	84	0.52	<.02	0.75	<.01	130	<1	10	9	208
		u R1	29											0.75						
		ud 1	31	4.2	<.2	<2.3	41	6.1	13.9	<5	80	0.5	<.02	0.55	<.01	110	<1	11	9	207
		ud R1						6.2	13.7											
Pajarito Well (Pump 1)	08/13	u 1	39	56.1	5.7	4.5	300	201	53.5	15	511	0.58	<.02	0.22	<.01	1100	2	162	7.7	1,710
		u R1									512					1100				
Don Juan Playhouse Well	08/13	u 1	27	6.2	0.5	0.5	64	5.3	15.7	<5	133	0.61	<.02	1.97	<.01	180	<1	17	8.9	314
Otowi House Well	08/13	u 1	60	65	5.1	2.8	39	42.1	25.1	10	196	0.39	<.02	0.62	<.01	350	<1	182	7.3	547
New Community Well	08/13	u 1	27	16	1	1.6	77	9.4	30.5	<5	173	0.14	0.1	1.47	<.01	230	<1	44	8.5	436
Sanchez House Well	08/13	u 1	42	27	1.9	2.5	88	50.2	41.9	11	179	1.2	<.02	1.47	<.01	280	<1	75	8.2	573
		u R1											<.02							

Table 5-27. Chemical Quality of Groundwater for 1996 (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-N	CN	TDS[c]	TSS[d]	Hardness as $CaCO_3$	pH[e]	Conductance (µS/cm)
Water Quality Standards[g]																				
EPA Primary Drinking Water Standard									500			4		10	0.2					
EPA Secondary Drinking Water Standard								250	250							500			6.8–8.5	
EPA Health Advisory							20													
NMWQCC Groundwater Limit								250	600			1.6		10	0.2	1,000			6–9	

[a]Except where noted.
[b]Codes: u—unfiltered, f—filtered, d—field duplicate, 1—primary analysis, R1—lab replicate, D—lab duplicate.
[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 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Main Aquifer															
Test Wells:															
Test Well 1	08/01	u	1	<2[b]	<90	<2	62	91	<1	<2	<6	<10	<13	1220	<.2
		u	R1												<.2
Test Well 2	08/21	u	1	13	<500	12	304	20	<2	<7	<8	<30	<10	83	<.2
		u	R1	10	<500	13	304	19	<2	<7	<8	<7	<10	107	<.2
Test Well 3	07/03	u	1	<2	<90	<2	24	34	<1	<2	3.8	<10	<13	1,0700	<.4
		u	R1	<2	<90	<2	38.5	34.6	<1	<2	<3	<10	<15	1,0700	<.4
	09/30	u	1	<4	<50	<2	39	35	<3	<2	6	5	<10	5,850	<.2
		u	R1												<.2
	11/15	u	1	<10	<50	3	24.9	24.5	<2	<7	<8	<7	<10	69.4	<.2
		u	R1												<.2
Test Well 4	07/03	u	1	<2	<90	<2	<6	48	<1	<2	<3	<10	<13	1,250	<.4
		u	R1												<.4
	09/27	u	1	<4	146	<2	<24	68	<3	<2	<6	11	87	5,730	<.2
		u	R1												<.2
	11/15	u	1	<10	<50	2	<20	54.9	<2	<7	<8	<7	33.9	213	<.2
		u	R1												<.2
Test Well 8	07/23	u	1	<2	<90	<2.2	23	7	<1	<2	<3	<10	<13	71	<.1
		u	R1												<.1
		ud	1	<2	<90	<2.2	36	6.5	<1	<14	<3	<10	<13	64	0.078
		ud	R1												0.088
	09/30	u	1	<4	<50	2	18	7	<3	<2	<3	<9	<10	93	<.2
		u	R1												<.2
	11/15	u	1	<10	<500	2	<20	9.9	<2	<7	<8	<7	<10	154.7	<.2
		u	R1	<10	<500	3	<20	9	<2	<7	0.9	<10	33.9	220.6	<.2
Test Well DT-5A	11/27	u	1	<10	<500	3	<20	26.8	<2	<7	21.7	62.9	<10	1,140	<.2
		u	R1	<10	<500	2	<20	26.6	<2	<7	<8	<7	<10	104	<.2

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Main Aquifer															
Test Wells (Cont.):															
Test Well DT-9	09/18	u	1	<4	<190	<2	24	16	<3	<3	<3	<6	<10	<40	<.2
		u	R1	<4	<187	<2	24	16	<3	<3	<11	<3	<10	<40	<.2
	12/05	u	1	<10	<500	<4	25.6	15.3	<2	<7	<8	<7	<10	93.9	<.2
		u	2			<4									<.2
		u	R1	<10	<500	4	<20	14.5	<1	<7	<8	<7	<10	<20	<.2
		u	R2			4									<.2
Test Well DT-10	09/19	u	1	<4	<187	2	22	7	<3	<2	<3	<3	<10	45	<.2
		u	R1												<.2
	12/06	u	1	<10	<500	<4	<20	6.6	<2	<7	<8	<7	<10	138	<.2
		u	2			<4									<.2
		u	R1												<.2
		u	R2												<.2
Water Supply Wells:															
Otowi 1	06/24	u	1	<3	<90	4.3	70	3	<1	<2	<3	<10	70	24,000	<.2
		u	R1												<.2
	12/17	u	1	<10	<500	<4	63.6	32.6	<2	<7	<8	12.8	<10	514	<.5
		u	R1												<.5
	12/18	u	1	<10	543	4	73	17.6	<2	<7	<18	14.4	<10	3,145	<.3
		u	R1												<.3
	12/19	u	1	<10	<500	<4	99.8	21.9	<2	<7	<8	15.3	13.5	3,124	<.2
		u	R1												<.2
		u	1	<10	<500	<4	71.2	7.1	<2	<7	<8	<17	<10	586	<.4
		u	R1												<.4
		u	1	<10	1,000	6	71.2	33.5	<2	<7	<8	16.3	<10	4,483	<.3
		u	R1	<10	<500	6	71.1	30.2	<2	<7	<8	15.3	<10	4,104	<.3
O-4	12/16	u	1	<10	<500	<4	69.1	36.7	<2	<7	<8	<7	83	920.5	<.2
		u	R1												<.2
PM-1	04/25	u	1	2	130	2.9	41	71	<1	<2	3	<10	<13	70	
PM-2	04/25	u	1	11	280	3.7	24	36	1	<2	<3	30	18	<65	
PM-3	04/25	u	1	<2	<110	3.4	49	48	<1	<2	<3	<10	<13	<65	
PM-5	04/25	u	1	<2	140	3.5	16	30	1	<2	<3	<10	<13	<65	

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Main Aquifer														
Water Supply Wells (Cont.):														
G-1	09/09	u 1	53	<500	6	<70	57	<2	<20	<21	<20	<7	47	<.2
		u 2												
		u R1												<.2
G-1A	09/08	u 1	47	<500	14	63	24	<2	<10	<8	<15	<10	240	<.2
		u 2												
		u R1												<.2
		u 1	44	<500	13	60	23	<2	<7	<21	<15	<30	516	<.2
		u 2												
		u R1												<.2
G-2	04/25	u 1	<2	<110	37.8	32	61	1	<2	<3	10	<13	<65	
G-5	04/25	u 1	<2	<110	3	12	13	<1	<2	<3	<10	<13	<65	
G-6	04/25	u 1	<2	110	4.5	22	8	<1	<2	<3	<10	13	<65	
		u 1	3	<110	4.2	19	7	<1	<2	<3	<10	10	<65	
		u R1	<2	<110	4.5	20	8	<1	<2	<3	<10	<13	<65	
		u R2	<2	<110	4.5	20	8	<1	<2	<3	<10	<13	<65	
Main Aquifer Springs														
White Rock Canyon Group I:														
Sandia Spring	08/29	u 1	21	2,490	<4	<120	118	<2	<7	<8	<7	<10	1,480	<.25
		u 2												
		u R1												0.26
Spring 3A	10/07	f 1	<4	<280	4	48	68	<3	7	4	5	10	140	<.2
		f R1												<.2
Spring 4	10/07	f 1	<4	<280	3	32	43	<3	2	<3	<3	<10	<100	<.2
		f R1												<.2
Spring 4A	10/08	f 1	<4	<280	3	31	38	<3	<2	4	4	<10	<100	<.2
		f R1												<.2
Ancho Spring	10/08	f 1	<4	<280	2	32	26	<3	<2	3	3	<10	<100	<.2
		f R1												<.2

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Main Aquifer Springs (Cont.)															
White Rock Canyon Group II:															
Spring 5A	10/08	f	1	<4	<280	4	60	35	<3	<2	<3	3	10	<100	<.2
		f	R1												<.2
		fd	1	<4	<280	2	<12	28	<3	<2	<3	<3	<10	<100	<.2
		fd	R1												<.2
Spring 6	10/08	f	1	<4	<280	3	34	25	<3	<2	<3	3	<10	<100	<.2
		f	R1												<.2
Spring 8	10/08	f	1	<4	<280	3	31	41	<3	2	<3	<3	<10	<100	<.2
		f	R1												<.2
Spring 8B	10/08	f	1	<4	<280	4	38	41	<3	<2	<3	<3	<10	<100	<.2
		f	R1												<.2
Spring 9A	10/09	f	1	<4	<280	2	<12	30	<3	<2	3	<3	<10	<100	<.2
		f	R1												<.2
Spring 9B	10/09	f	1	<4	<280	2	<12	<1	<3	<2	<3	<3	<10	<100	<.2
		f	R1												<.2
Doe Spring	10/08	f	1	4	<280	3	45	19	<3	<2	<3	<3	<10	<100	<.2
		f	R1												<.2
Spring 10	10/09	f	1	4	<280	4	<12	25	<3	<2	3.5	<3	<10	<100	<.2
		f	R1												<.2
White Rock Canyon Group III:															
Spring 1	08/29	u	1	21	1,820	<9	<100	29	<2	<7	<8	<7	<10	970	<.2
		u	R1												0.218
White Rock Canyon Group IV:															
La Mesita Spring	08/14	u	1	<2	5,100	<3	59	157	<1	<2	10	10	<13	5,200	<.2
		u	R1												<.2
Sacred Spring	08/14	u	1	<2	<160	<3	<13	<1	<1	<2	<3	<10	<13	<47	<.2
		u	R1												<.2

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Alluvial Canyon Groundwater															
Acid/Pueblo Canyons:															
APCO-1	10/17	u	1	<4	130	8	234	45	<3	<2	<9	<3	<10	160	<.2
		u	R1												<.2
Cañada del Buey:															
CDBO-6	12/17	u	1	<10	4,747	5	46.5	121.4	<2	<7	<8	<7	<10	2,226	<.4
		u	R1												<.4
DP/Los Alamos Canyons:															
LAO-C	07/10	u	1	<2	418	<2.2	43	63	<1	<2	<10	<10	<13	256	<.24
		u	R1												0.3
LAO-0.7	07/29	u	1	<2	885	<2.2	43	145	<1	<2	7	<10	<20	780	0.17
		u	R1												0.11
LAO-1	07/29	u	1	<2	721	<2.2	42	45	<1	<6	<3	20	<13	377	<.27
		u	R1												<.27
LAO-2	11/13	u	1	<10	<500	3	50	59.2	<2	<7	<8	<7	<10	153	<.2
		u	R1	<10	<500	3	407.5	65.5	<2	<7	<8	<7	<10	170.2	<.2
LAO-3A	07/10	u	1	<2	1,650	2.3	70	50	<1	<9	<3	10	<13	747	0.14
		u	R1												0.174
LAO-4	07/29	u	1	<2	170	<2.2	59	43	<1	<2	<3	<10	<13	110	<.35
		u	R1												<.35
Mortandad Canyon:															
MCO-4B	03/05	u	1	14	220	<30	80	150	<1	<2	<3	10	<13	216	<.2
		u	R1												<.2
MCO-5	08/09	u	1	<2	97	<2	76	192	<1	<5	<3	<10	<13	89	<.2
		u	R1												<.2
		ud	1	<2	<90	2	62	187	<1	<2	<3	<10	<13	<47	<.2
		ud	R1												<.2
MCO-6	080/6	u	1	<2	191	<2	87	220	<1	<2	<3	<10	<13	108	<.2
		u	R1												<.2
MCO-7	08/06	u	1	<2	3,200	3	79	227	<1	<2	<3	<10	<15	1,640	<.2
		u	R1												<.2

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Alluvial Canyon Groundwater (Cont.)															
Pajarito Canyon:															
PCO-1	07/30	u	1	<2	157		58	154	<1	<2	<10	<10	<15	304	<.2
		u	R1	<2	147		<60	155	<1	<2	<10	<10	<13	303	
Intermediate Perched Groundwater															
Pueblo/Los Alamos Canyon:															
Test Well 1A	08/02	u	1	<2	<90	<2	203	41	<1	<2	<3	<10	<13	3,490	<.2
		u	R1												<.2
Test Well 2A	08/21	u	1	<10	<500	<4	97	32	<2	<7	<8	<7	<10	4,330	<.2
		u	2												
		u	R1												0.252
Basalt Spring	08/14	u	1	<2	240	3	260	105	<1	<2	15	<10	13	190	<.2
		u	R1												<.2
Perched Groundwater in Volcanics:															
Water Canyon Gallery	12/16	u	1	<10	1,169	<4	<20	14.7	<2	<7	<8	<7	<10	494	<.2
		u	R1												<.2
Pueblo of San Ildefonso															
Water Supply Wells:															
LA-1B	08/27	u	1	20	<500	11	295	18	<2	<7	<8	<7	<10	69	<.2
		u	R1												<.2
LA-5	08/14	u	1	<2	<160	<3	<51	61	<1	<2	<3	<10	<13	630	<.2
		u	R1												<.2
Westside Artesian Well	08/14	u	1	<2	<160	4	1,650	41	<1	<2	<3	<10	<13	270	<.2
		u	R1												<.2
Eastside Artesian Well	08/13	u	1	<2	<160	6	110	1	<1	<2	<3	10	<13	250	<1
		u	R1												<1

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Pueblo of San Ildefonso															
Water Supply Wells (Cont.):															
Halladay House Well	08/13	u	1	<2	<160	9	59	36	<1	<2	<3	20	<13	<53	<1
		u	R1												<1
		ud	1	<2	<160	11	82	38	<1	<2	4	20	<13	240	<1
		ud	R1												<1
Pajarito Well (Pump 1)	08/13	u	1	<2	<160	7	1,430	84	<1	<2	5	<10	<13	440	<1
		u	R1												<1
Don Juan PlayhouseWell	8/13	u	1	<2	<160	7	97	2	<1	<2	5	10	<13	<53	<1
		u	R1												<1
Otowi House Well	08/13	u	1	<2	<160	<3	74	290	<1	<2	<3	<10	15	100	<1
		u	R1												<1
New Community Well	08/13	u	1	<2	<160	<6	46	14	<1	<2	<3	<10	<13	<53	<1
		u	R1												<1
Sanchez House Well	08/13	u	1	<2	<160	15	230	80	<1	<2	<3	<10	22	220	<1
		u	R1												<1
Water Quality Standards[c]															
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		
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

[a]Codes: u—unfiltered, f—filtered, d—field duplicate, 1—primary analysis, R1—lab replicate, D1—lab 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 Wildlife and Groundwater limits are based on dissolved concentrations, while many of these analyses are of unfiltered samples—thus concentrations may include suspended sediment quantities.

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (µg/L) (Cont.)

Station Name	Date	Codes[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Main Aquifer														
Test Wells:														
Test Well 1	08/01	u	1	66	<5[b]	<18	<100	4.9	1	<117	295	0.23	<17	1,660
		u	2				62							
Test Well 2	08/21	u	1	13	<30	<40	<60	<3	<3	<60	60	<3	<8	<50
		u	2				<3							
		u	R1	15	<30	<20	<60	<3	<3	<30	60	<3		66
		u	R2				<3							
Test Well 3	07/03	u	1	92	<13	<21	<110	<10	<1.2	<59	56.9	<10	<20	790
		u	R1	90.6	<30	<18	<157	<10	<1.2	<59	56	<10	10.1	783
	09/30	u	1	67	<9	<24	11	<3	2	<60	68	<3	4	427
	11/15	u	1	5.4	<30	<20	<3	<3	<3	<30	74.6	<3	14.7	<50
Test Well 4	07/03	u	1	36.7	<59	<74	<46	<10	<1.2	<59	45	<10	<6	1,830
	09/27	u	1	83	<9	16	57	<3	<2	<60	52	<3	<3	1760
	11/15	u	1	26.2	<30	32.3	12	<3	<3	<30	52.5	<3	14.7	1,423
Test Well 8	07/23	u	1	4	720	<29	<46	<1	<1.3	<59	55	<1	<2	184
		ud	1	2.5	183	<18	<120	<1	1.4	<60	55	<1	6.4	190
	09/30	u	1	4	<9	23	5	<3	2	<40	54	<3	6	22
	11/15	u	1	<30	<30	<20	5	<3	<3	<100	63.4	<3	14.7	251
		u	R1	2.8	<30	<20	6	<3	<3	<90	56.4	<3	14.7	318
Test Well DT-5A	11/27	u	1	<30	<30	<20	4	<3	<3	<30	53.7	<3	14.9	392.9
		u	R1	6.3	<30	<20	3	<3	<3	<30	55	<3	14.7	410
Test Well DT-9	09/18	u	1	1	7	<10	6	<3	4	<20	49	<3	5	237
		u	R1	<1	<9	<10	5	<3	<4	<20	50	<3	5	210
	12/05	u	1	<2	<30	<20	4	<3	<3	<30	47.9	<3	<15	281
		u	2						<3					
		u	R1	<2	<30	<20	3	<3	<3	<30	46.4	<3	<30	178
		u	R2						<3					
Test Well DT-10	09/19	u	1	<9	<10	4	<3	2	<20	48	<3	<3	77	
		u	R1											
	12/06	u	1	<2	<30	<20	<3	<3	<3	<30	46.4	<3	<8	59.4
		u	2								<3			

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (µg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Main Aquifer													
Water Supply Wells:													
Otowi 1	06/24	u 1	230	<14	<27	<50	<10	3	<100	10		11	100
	12/17	u 1	35.1	<30	<20	3	<3	6	<30	12.3	<3	19.4	73.8
		u R1											
	12/18	u 1	105	<28	<20	3	<3	12	<30	15.8	<3	26.7	68.2
		u R1											
	12/19	u 1	185.8	<30	<20	<3	<3	<10	<100	14.9	<3	18.7	271.4
		u R1											
		u 1	20.5	<30	<20	<3	<3	9	<30	10.1	<3	18.7	<50
		u R1											
		u 1	300	<30	<20	3	<3	14	<30	26	<3	36.6	172
		u R1	277	<30	<20	<3	<3	5	<30	23.9	<3	43.3	135
O-4	12/16	u 1	8.9	<30	<20	12	<3	10	<30	106.1	<3	10.7	65.4
		u R1											
PM-1	04/25	u 1	1	<5	<18	<46	<44	<1.6	<59	145	<166	10	22
PM-2	04/25	u 1	69	<5	18	<46	<44	2	<59	59	<166	11	54
PM-3	04/25	u 1	<1	<5	<18	<46	<44	<1.6	<59	126	<166	13	24
PM-5	04/25	u 1	1	<5	<18	<46	<44	2.7	<59	58	<170	11	33
G-1	09/09	u 1	<6	<70	<20	<20	<3	<5	<170	98	6	<40	<50
		u 2				9							
G-1A	09/08	u 1	<2	<30	<20	<60	<3	<3	<90	73	<3	<39	<10
		u 2				<3							
		u 1	<6	30	<70	<60	3	<3	34	73	<3	35	<50
		u 2				3							
G-2	04/25	u 1	<1	<5	<18	<46	<40	2.3	<59	77	<166	84	<22
G-5	04/25	u 1	<1	<5	<18	<46	<44	1.7	<60	83	<166	12	<22
G-6	04/25	u 1	<1	<5	<18	<46	<44	<1.6	<59	77	<166	21	28
		u 1	1	<5	<18	<46	<44	<1.6	<59	65	<166	20	<22
		u R1	1	<5	<18	<46	<44	<1.6	<59	65	<166	20	<22
		u R2	1	<5	<18	<46	<44	<1.6	<59	65	<166	20	<22

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Main Aquifer Springs													
White Rock Canyon Group I:													
Sandia Spring	08/29	u 1	194	<30	<20	<60	<3	<3	<30	320	<3	<8	<50
		u 2				<3							
Spring 3A	10/07	f 1	3	<9	10	10.4	<3	3	28	222	<3	12	<50
Spring 4	10/07	f 1	1	<9	10	<3	<3	3	<20	143	<3	9	170
Spring 4A	10/08	f 1	<1	<9	<10	<3	<3	4	<20	95	<3	7	120
Ancho Spring	10/08	f 1	3	<1	<10	<3	<3	3	32	60	<3	7	130
White Rock Canyon Group II:													
Spring 5A	10/08	f 1	2	<9	<10	<3	<3	3	<60	208	<3	15	95
		fd 1	3	<9	<10	<3	<3	3	<40	166	<3	12	<50
Spring 6	10/08	f 1	<1	<9	<10	<3	<3	5	27	60	<3	7	<50
Spring 8	10/08	f 1	26	<9	11	<3	<3	4	<20	104	<3	11	130
Spring 8B	10/08	f 1	5	<9	<10	<3	<3	4	11	127	<3	11	59
Spring 9A	10/09	f 1	<9	1	<10	<3	<3	3	<20	55	<3	7	<50
Spring 9B	10/09	f 1	<1	<9	<10	<3	<3	2	<20	1	<3	<3	<50
Doe Spring	10/08	f 1	1	<9	<10	<3	<3	8	<20	71	<3	10	<50
Spring 10	10/09	f 1	11	4	<10	<3	<3	<3	30	68	<3	10	<50
White Rock Canyon Group III:													
Spring 1	08/29	u 1	23	<60	<20	<60	<3	<3	<30	189	<3	8	<50
		u 2				<3							
White Rock Canyon Group IV:													
La Mesita Spring	08/14	u 1	50	<5	<27	<50	0.6	<2	<59	760	0.05	12	<22
		u 2				3							
Sacred Spring	08/14	u 1	<1	<5	<27	<46	1	<2	<59	1	0.04	6	<22
		u 2				4							

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (µg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Alluvial Canyon Groundwater Systems													
Acid/Pueblo Canyon:													
APCO-1	10/17	u 1	980	<9	10	<3	<3	3	<30	120	<3	7	60
Cañada del Buey:													
CDBO-6	12/17	u 1	28.4	<30	<20	3	<3	5	<30	112.5	<3	14	<50
DP/Los Alamos Canyons:													
LAO-C	07/10	u 1	10.5	89	23	<46	<1	<1.3	<59	116	<1	<2	<16
LAO-0.7	07/29	u 1	788	<80	<18	<46	<1	<1.3	<60	133	<1	6	60
LAO-1	07/29	u 1	2	66	<50	<46	<1	<1.3	<59	121	<1	6	28
LAO-2	11/13	u 1	<3	287	<20	<3	<3	4	<30	140.9	<3	<8	<50
		u R1	<3	320.9	<20	<3	<3	<3	<30	155.3	<3	<8	<50
LAO-3A	07/10	u 1	16	905	<18	<46	<1	<1.3	<59	104	<1	7	25
LAO-4	07/29	u 1	1	157	<45	<46	2	<1.3	<59	87	<1	2	64
Mortandad Canyon:													
MCO-4B	03/05	u 1	7	133	<18	<1	<2	<20	<59	206	<1	3	20
MCO-5	08/09	u 1	4	138	25	<46	1.1	2	<59	307	0.16	<2	47
		u 2				<3							
		ud 1	2	140	<60	<46	0.2	2	<60	297	0.04	<2	22
		ud 2				<3							
MCO-6	08/06	u 1	6.4	116	<18	<46	0.5	1	<59	312	0.04	<2	<16
		u 2				3							
MCO-7	08/06	u 1	29	<90	<24	<46	<.2	1	<59	159	0.05	<15	54
		u 2				3							
Pajarito Canyon:													
PCO-1	07/30	u 1	136	14	<37	<46	0.9		<59	212	0.09	<2	18
		u 2				<3							
		u R1	134	<45	<18	<130	0.4		<59	210	0.06	<2	19

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Intermediate Perched Groundwater Systems														
Pueblo/Los Alamos Canyon:														
Test Well 1A	08/02	u	1	79	15	<30	<46	0.1	2	<59	79	1.1	<2	3,100
		u	2				9							
Test Well 2A	08/21	u	1	202	<30	<180	<90	<3	<3	<180	161	<3	<8	8,050
		u	2				45							
Basalt Spring	08/14	u	1	644	<18	34	<46	0.6	<2	<59	114	0.04	19	<22
		u	2				<3							
Perched Groundwater System in Volcanics:														
Water Canyon Gallery	12/16	u	1	2	<30	<20	<3	<3	4	<30	48.8	<3	<8	<50
Pueblo of San Ildefonso														
Water Supply Wells:														
LA-1B	08/27	u	1	15	<30	<20	<60	<3	<3	<130	60	<3	<8	<50
		u	2				<3							
LA-5	08/14	u	1	36	<5	<27	<46	0.3	<2	<59	210	0.04	17	150
		u	2				<3							
Westside Artesian Well	08/14	u	1	8	57	<27	<46	0.61	<2	<59	340	0.06	10	<22
		u	2				<3							
Eastside Artesian Well	08/13	u	1	5	5	<27	<3	1.6	<2	<59	42	0.12	7	<22
		u	2				<46							
Halladay House Well	08/13	u	1	<1	<5	<27	<46	0.5	<2	<59	120	0.03	32	<20
		u	2				<3							
		ud	1	2	<5	<40	<46	0.59	<2	<59	125	0.04	32	<22
		ud	2				<3							
Pajarito Well (Pump 1)	08/13	u	1	5	7	<27	<46	0.4	<2	<59	1300	0.07	12	35
		u	2				<3							
Don Juan Playhouse Well	08/13	u	1	<1	<5	28	<3	0.9	<2	<59	87	0.06	14	<22
		u	2				<46							
Otowi House Well	08/13	u	1	1	7	<27	<46	0.9	<2	<59	750	0.05	11	110
		u	2				<3							
New Community Well	08/13	u	1	<1	<5	<27	<3	5	2	<59	188	0.9	13	<22
		u	2				<46							
Sanchez House Well	08/13	u	1	3	9	<27	<3	0.37	<2	<59	26.8	0.05	20	23
		u	2				<46							

Table 5-28. Total Recoverable Trace Metals in Groundwater for 1996 (μg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Water Quality Standards[c]													
EPA Primary Drinking Water Standard					100		6	50			2		
EPA Secondary DrinkingWater Standard			50										5,000
EPA Action Level						15							
EPA Health Advisory										25,000–90,000		80–110	
NMWQCC Livestock Watering Standard						100		2				100	25,000
NMWQCC Groundwater Limit			200	1000	200	50		50					10,000

[a] Codes: u—unfiltered, f—filtered, d—field duplicate, 1—primary analysis, R1—lab replicate, D1—lab 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 Wildlife and Groundwater limits are based on dissolved concentrations, while many of these analyses are of unfiltered samples—thus concentrations may include suspended sediment quantities.

Table 5-29. Number of Results above the Analytical Limit of Quantitation for Organic Compounds in Groundwater for 1996

		Type of Organic Compound				
Station	**Date**	**Volatile**	**Semivolatile**	**PCB[a]**	**HE[b]**	**TIC[c]**
Number of Compounds Analyzed		59	69	4	14	
Test Well DT-5A	11/27	1	0	0	0	1
Test Well DT-9	09/18	0	0	0	0	0
	12/05	0	0	0	0	2
Test Well DT-10	09/19	0	0	0	0	0
	12/06	0	0	0	0	3
Sandia Spring	08/29	0	0	0		0
Spring 3A	10/07	0	0	0		4
Spring 4	10/07	0	0	0	0	3
Spring 4A	10/08	0	0	0	0	2
Ancho Spring	10/08	0	0	0	0	0
Spring 5A	10/08	0	0	0	0	2
Spring 6	10/08	0	0	0	0	1
Spring 8	10/08	0	0	0	0	6
Spring 8B	10/08	0	0	0	0	2
Spring 9	10/09				0	0
Spring 9A	10/09	0	0	0	0	2
Spring 9B	10/09	0	0	0	0	2
Doe Spring	10/08	0	0	0	0	2
Spring 10	10/09	0	0	0	0	2
Spring 1	08/29	1	0	0	0	0
La Mesita Spring	08/14	0	0	0		0
Sacred Spring	08/14	0	0	0		0
LA-1B	08/27	0	0	0		0
LA-5	08/14	0	0	0		0
Eastside Artesian Well	08/13	0	0	0		0
Halladay House Well	08/13	0	0	0		0
Halladay House Well Dup.	08/13	0	0	0		0
Pajarito Well (Pump 1)	08/13	0	0	0		0
Don Juan Playhouse Well	08/13	0	0	0		3
Otowi House Well	08/13	1	0	0		0

[a]Polychlorinated biphenyl.
[b]High explosives.
[c]Tentatively identified compounds (see text).

Table 5-30. Results above the Analytical Limit of Quantitation for Organic Compounds in Groundwater for 1996

Station	Date	Analyte	Value	Uncertainty	Units	Suite
Test Well DT-5A	11/27	Toluene	9	2.7	µg/L	voa
Spring 1	08/29	Butanone [2-]	23	6.9	µg/L	voa
Otowi House Well	08/13	Trichloroethane [1,1,1-]	23	6.9	µg/L	voa

Table 5-31. Total Committed Effective Dose Equivalent from the Ingestion of Two Liters Per Day Drinking Water Collected at the Pueblo of San Ildefonso during 1996.

	Total Committed Effective Dose Equivalent[a] (mrem/yr)	
Well or Water System	**1996**	**1995**
San Ildefonso Pueblo		
Westside Artesian	2.7 (± 0.83)[b]	3.9 (± 1.5)[b]
Halladay House	0.26 (± 0.40)[b]	1.4 (± 0.67)[b]
Pajarito Pump 1	1.5 (± 1.1)[b]	1.6 (± 0.67)[b]
Otowi House	0.47 (± 0.41)[b]	0.82 (± 0.52)[b]
New Community	3.1 (± 1.0)[b]	3.7 (± 1.7)[b]
Sanchez House	1.6 (± 1.1)[b]	1.8 (± 1.0)[b]

[a]CEDE for consumption of water collected from San Ildefonso are based on dose conversion factors listed in FGR#11 (EPA1988).
[b]±2 sigma in parenthesis; to convert to µSv multiply by 10.

Table 5-32. Quality Assurance Sample Results for Radiochemical Analysis in 1996 (pCi/L[a])

Station Name	Date	Codes[b]		^{3}H	^{90}Sr	^{137}Cs	U (µg/L)	^{238}Pu	^{239,240}Pu	^{241}Am	Gross Alpha	Gross Beta	Gross Gamma
DI Blank	01/23	1	W	−98 ± 178	0.5 ± 0.8	0.4 ± 0.7	0.02 ± 0.04	−0.003 ± 0.002	0.023 ± 0.010	0.100 ± 0.050	0.2 ± 0.3	0.7 ± 0.1	410 ± 60
		2	W					−0.003 ± 0.002	0.023 ± 0.010				
		D1	W		0.6 ± 0.9								
		R1	W	98 ± 321									
DI Blank	04/24	1	W	246 ± 326	0.9 ± 0.8	1.0 ± 1.5	0.00 ± 0.01	0.012 ± 0.007	0.003 ± 0.006	0.044 ± 0.017	−0.1 ± 0.0	0.1 ± 0.0	20 ± 50
DI Blank	08/09	1	W	462 ± 144	0.2 ± 0.6	1.2 ± 1.8	0.02 ± 0.00	−0.010 ± 0.010	0.002 ± 0.008	0.027 ± 0.018	−0.1 ± 0.0	0.2 ± 0.0	60 ± 50
		R1	W	555 ± 144									
DI Blank	08/14	1	W	406 ± 73	−0.2 ± 0.5	−0.1 ± 0.8	0.03 ± 0.00	0.011 ± 0.009	−0.003 ± 0.006	0.043 ± 0.020	−0.1 ± 0.0	0.3 ± 0.0	80 ± 50
		R1	W					0.003 ± 0.005	0.012 ± 0.008	0.007 ± 0.015			
DI Blank	08/29	1	W	24 ± 134	0.6 ± 0.5	0.7 ± 1.1	0.00 ± 0.01	0.009 ± 0.007	0.018 ± 0.009	0.048 ± 0.015	−0.2 ± 0.0	−0.2 ± 0.3	70 ± 50
DI Blank	09/08	1	W	437 ± 137	−0.5 ± 0.2	2.6 ± 0.9	0.00 ± 0.01	0.022 ± 0.016	0.011 ± 0.014	0.069 ± 0.036	−0.1 ± 0.0	0.7 ± 0.1	110 ± 50
		R1	W				0.00 ± 0.01						
DI Blank	10/10	1	W	105 ± 134	−1.2 ± 0.4	1.0 ± 0.4	0.00 ± 0.00	−0.002 ± 0.006	0.030 ± 0.013	0.028 ± 0.016	−0.2 ± 0.0	0.0 ± 0.0	150 ± 50
DI Blank	12/12	1	W	−218 ± 139	−0.1 ± 0.4	2.6 ± 0.5	0.00 ± 0.00	0.005 ± 0.006	0.005 ± 0.006	0.032 ± 0.014	1.0 ± 0.3	0.1 ± 0.0	40 ± 50
Average Blank value				202	0.0	1.2	0.00	0.004	0.012	0.044	0.0	0.2	118
Standard Deviation				260	0.7	1.0	0.01	0.009	0.011	0.027	0.4	0.3	125
Spiked Sample	12/17	1	W	−143 ± 139	17.1 ± 1.1	6.8 ± 1.1	0.00 ± 0.00	0.328 ± 0.038	0.441 ± 0.045	0.423 ± 0.049	3.5 ± 0.5	50.5 ± 5.7	40 ± 50
Spike values					20.0			0.400	0.400	0.400			

[a]Except where noted.

[b]Codes: 1—primary analysis, 2—secondary analysis, R1—lab replicate, D1—lab duplicate.

J. Figures

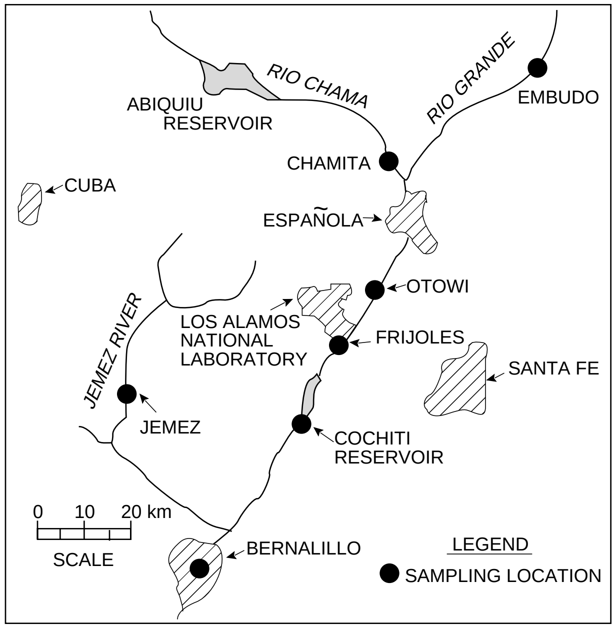


Figure 5-1. Regional surface water and sediment sampling locations.

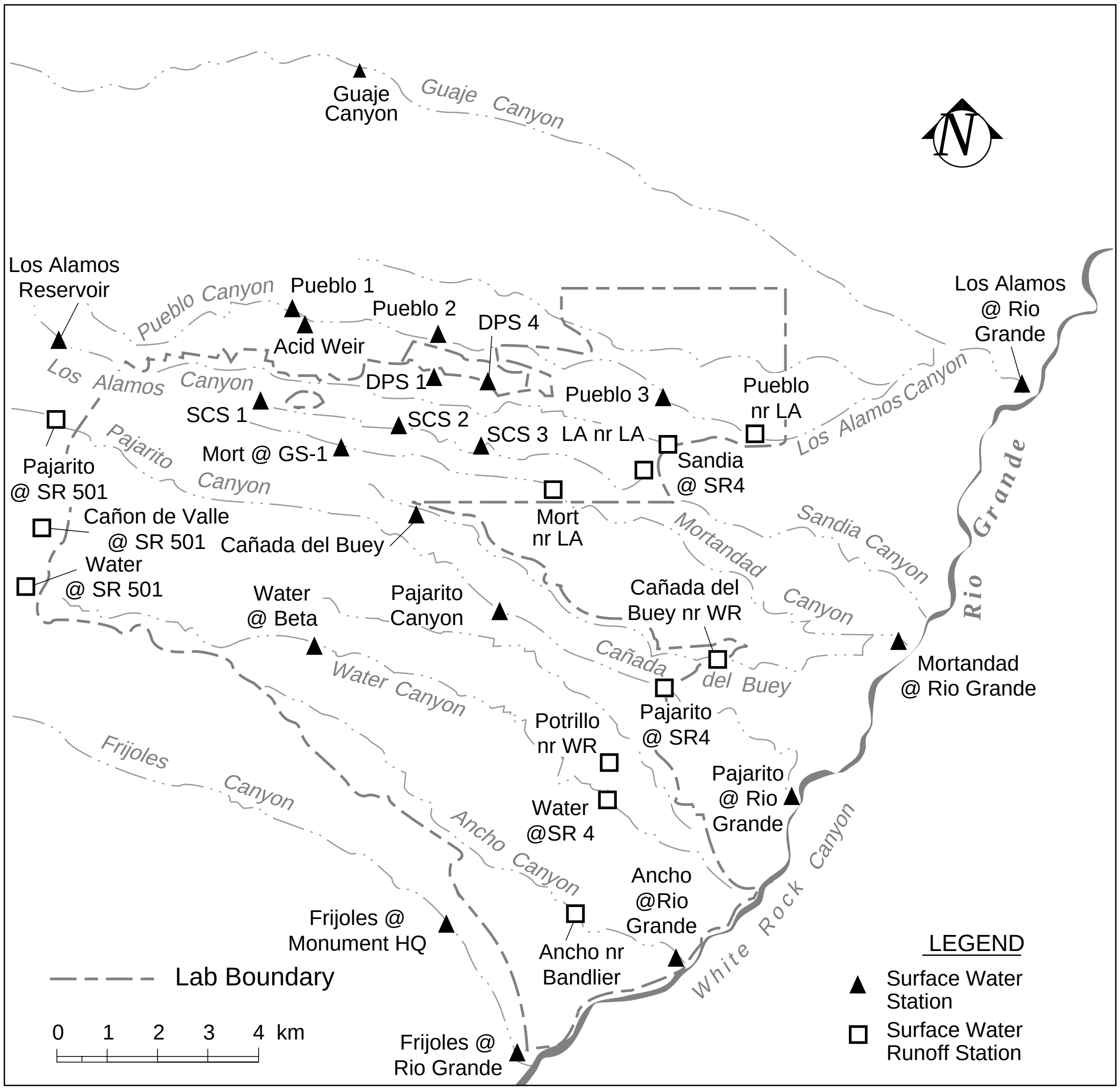


Figure 5-2. Surface water sampling locations in the vicinity of Los Alamos National Laboratory.

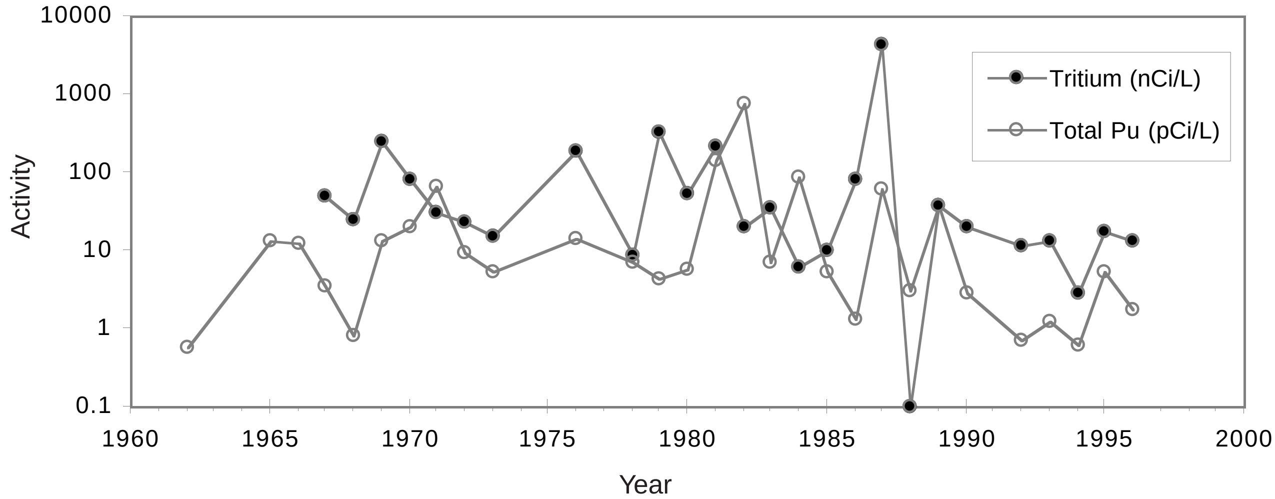


Figure 5-3. Tritium and plutonium activity at Mortandad Canyon at Gaging Station 1.

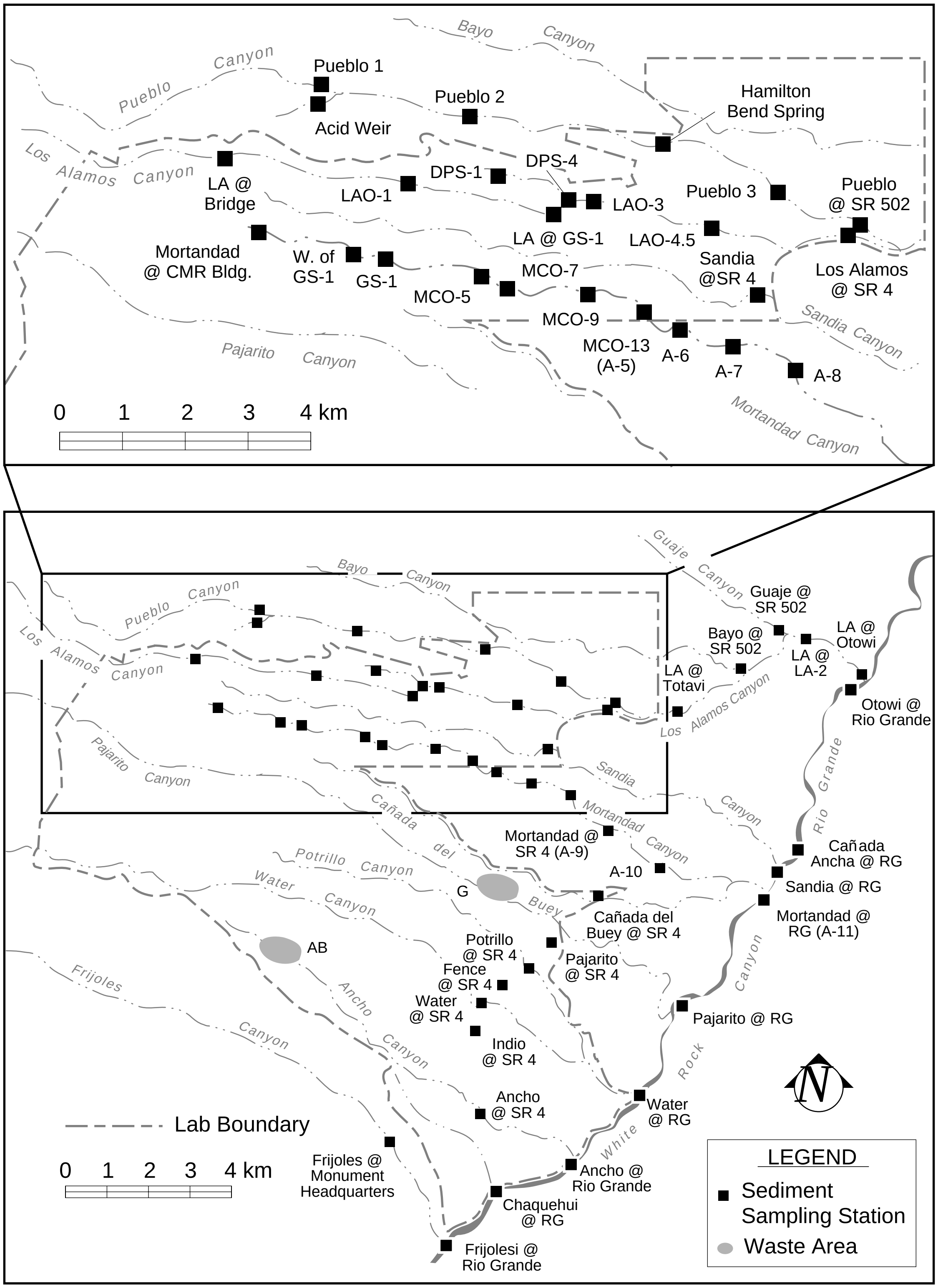
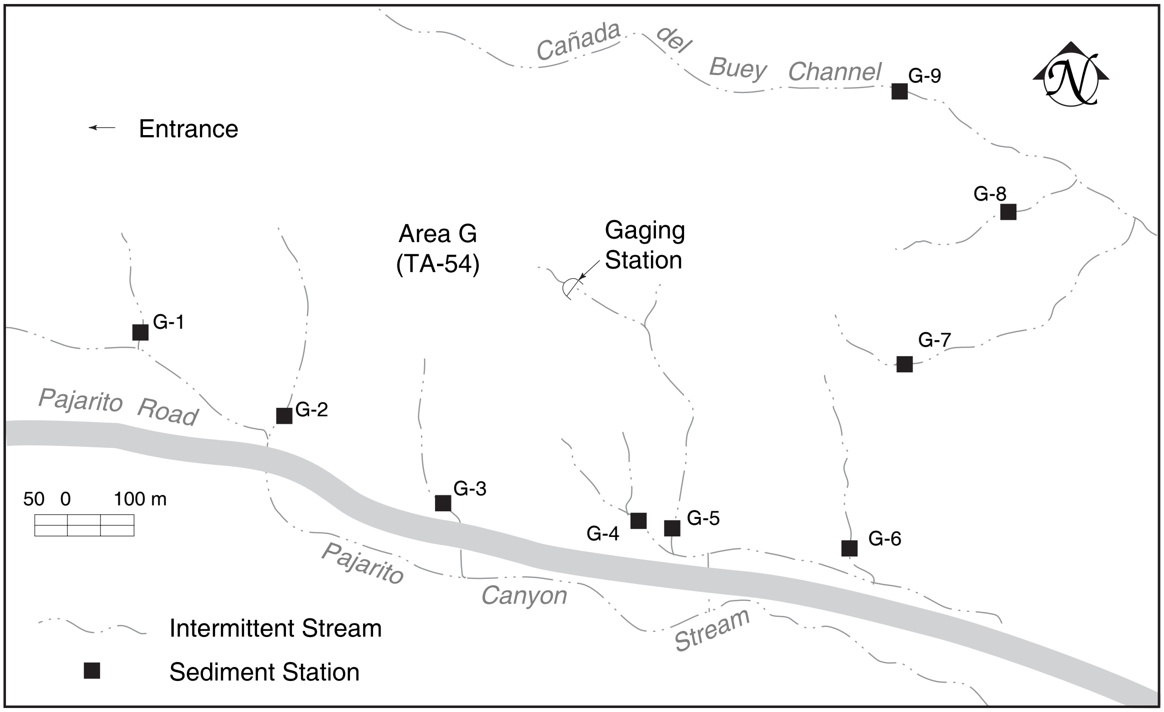


Figure 5-4. Sediment sampling stations on the Pajarito Plateau near Los Alamos National Laboratory. Solid waste management areas with multiple sampling locations are shown in Figure 5-5.



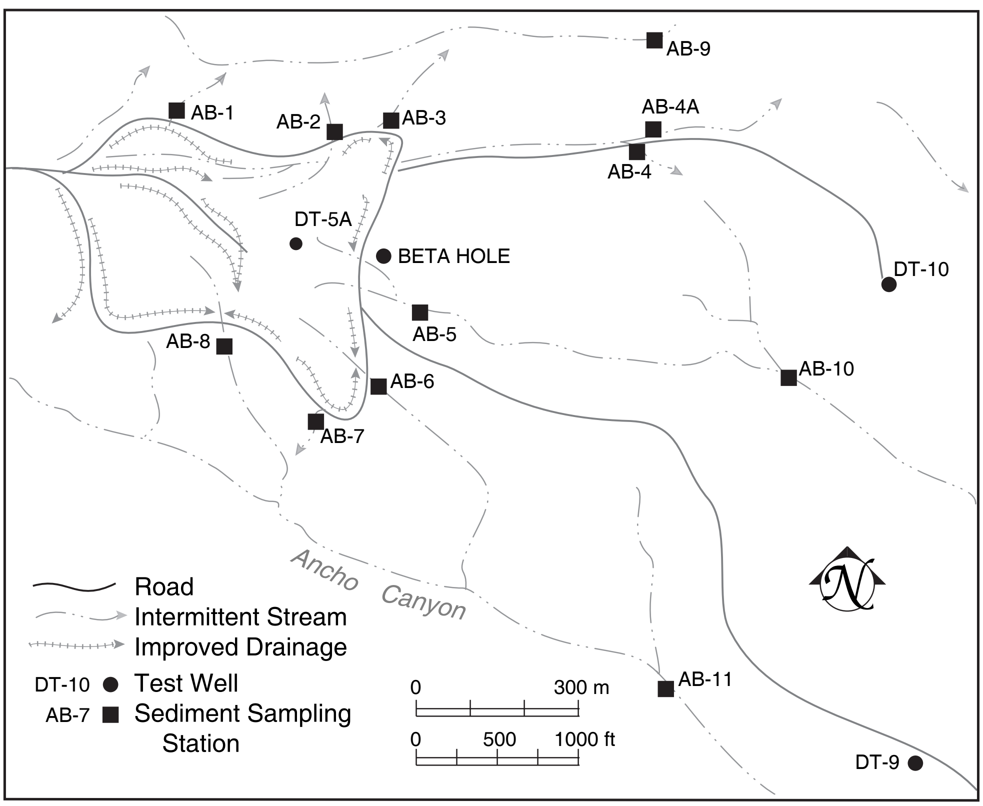
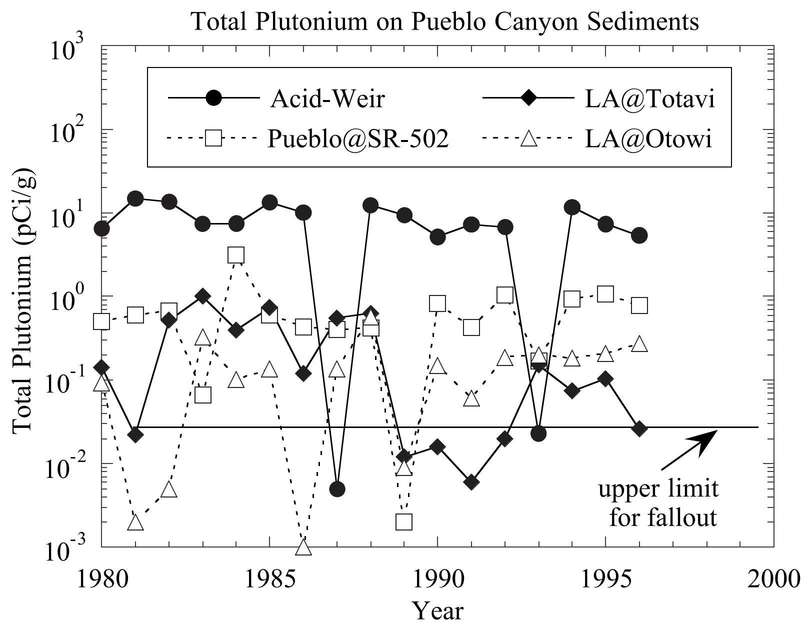


Figure 5-5. Sediment sampling stations at solid waste management areas.
a. Sampling stations at TA-54, Area G.
b. Sediment stations at TA-49, Area AB



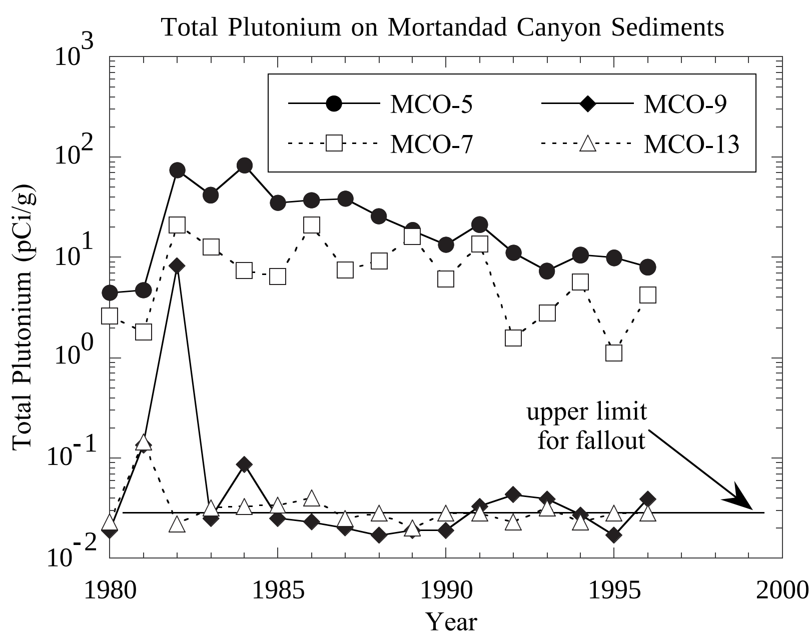


Figure 5-6. Total plutonium activity in Pueblo (top) and Mortandad (bottom) Canyon channel sediments.

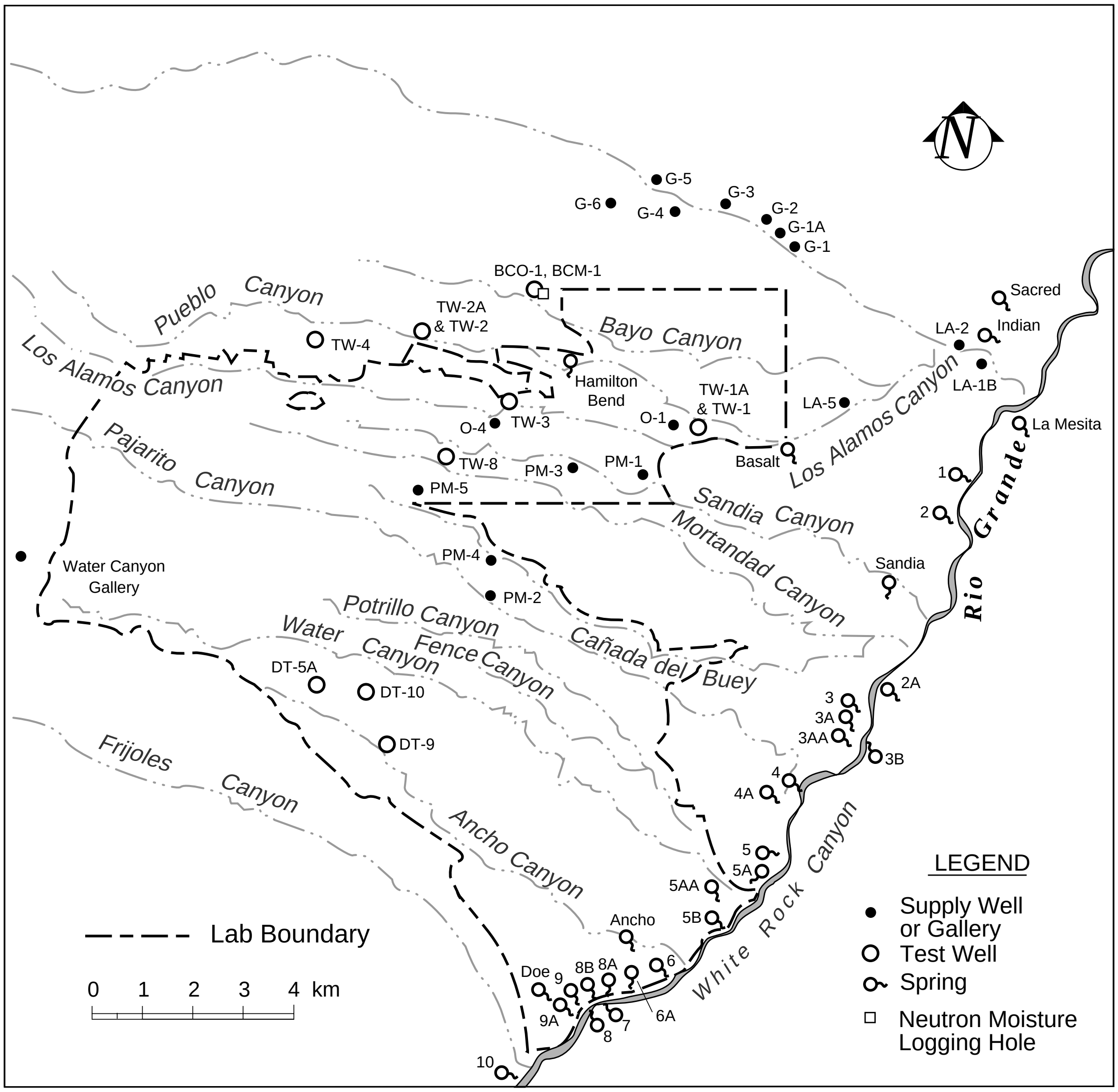


Figure 5-7. Springs and deep and intermediate wells used for groundwater sampling.

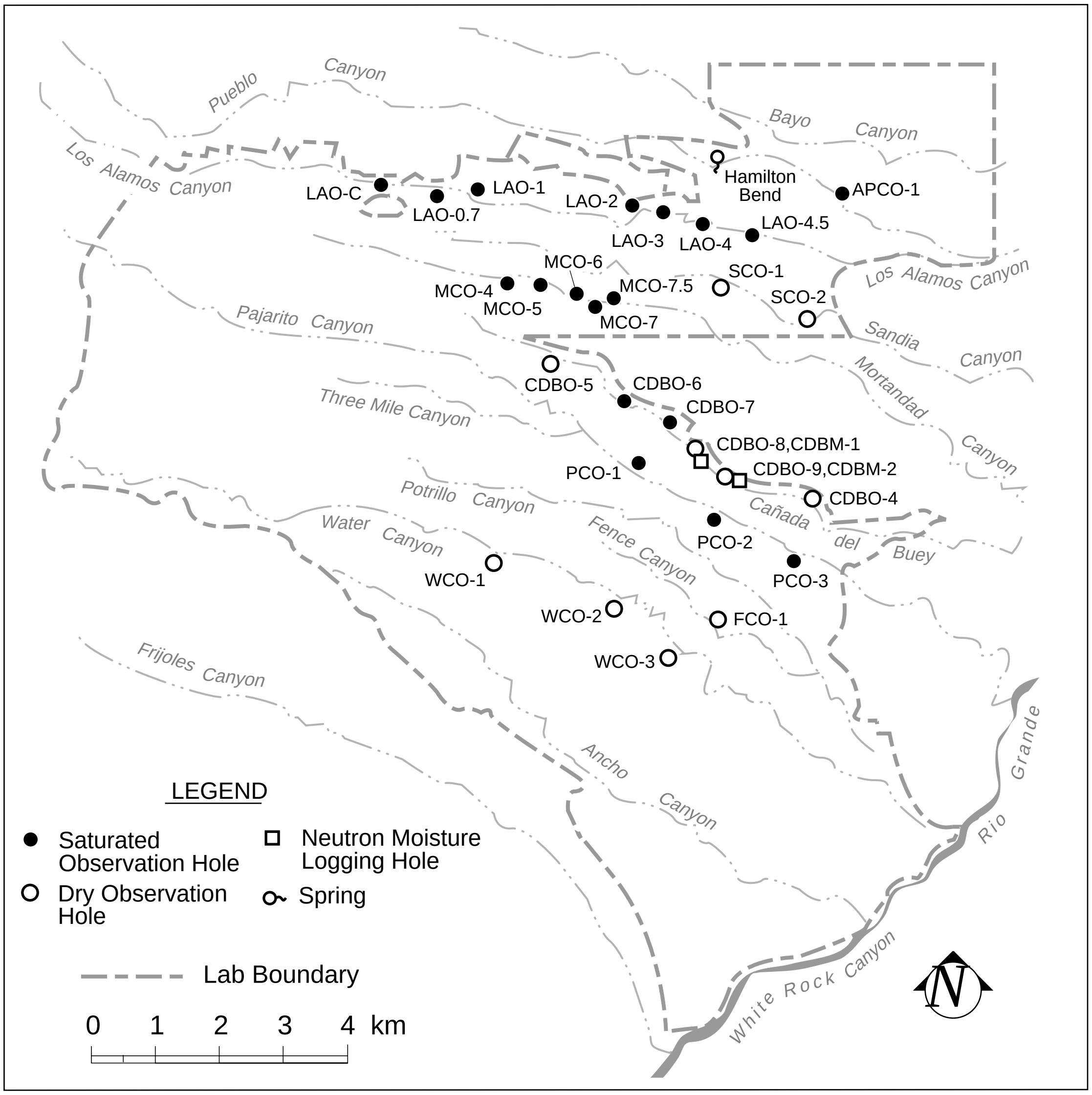


Figure 5-8. Observation wells and springs used for alluvial groundwater sampling and shallow neutron moisture holes.

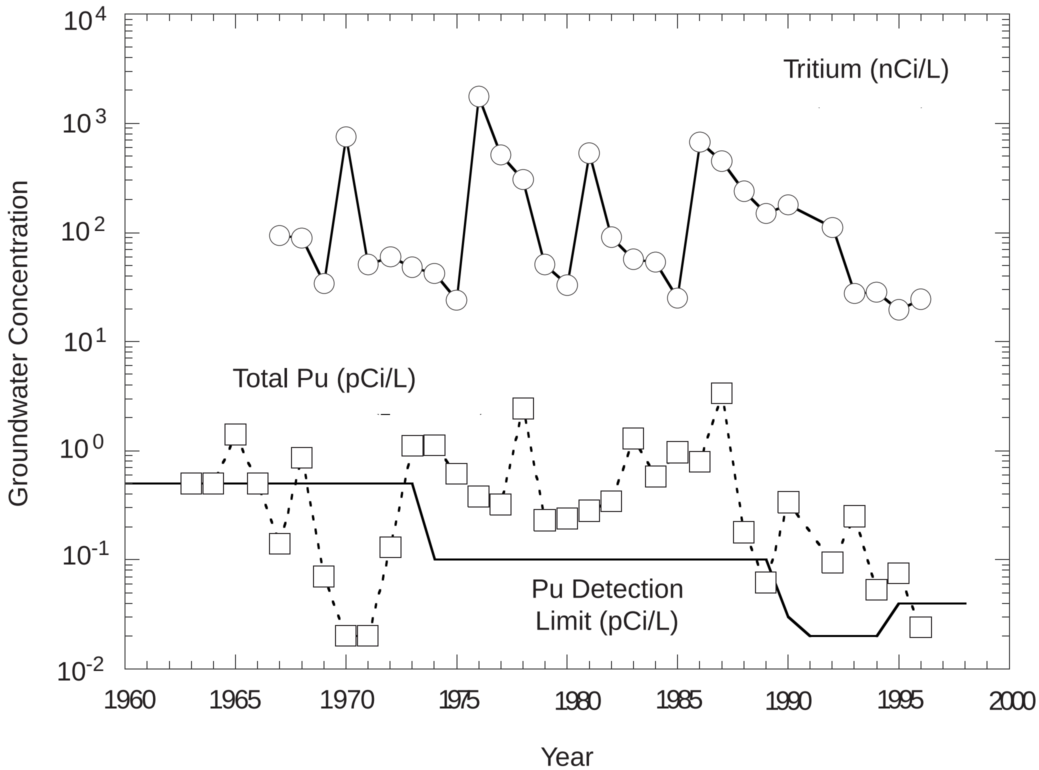


Figure 5-9. Tritium and plutonium concentrations in water samples from Mortandad Canyon Alluvial Observation Well MCO-6.

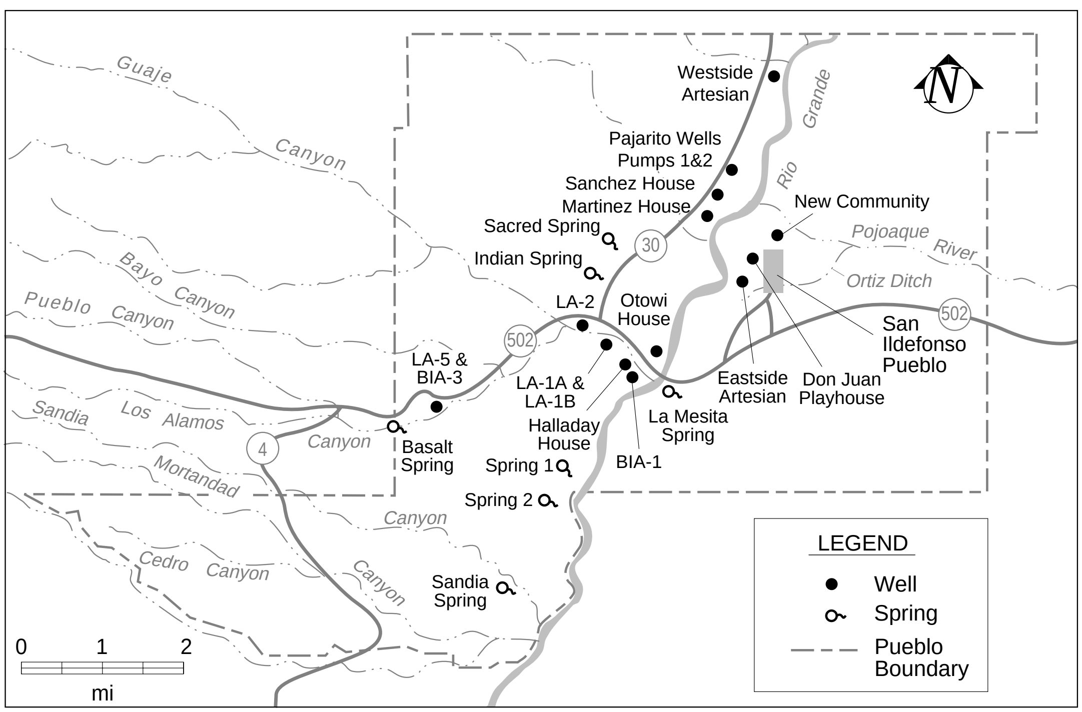


Figure 5-10. Springs and groundwater stations on or adjacent to the Pueblo of San Ildefonso land.

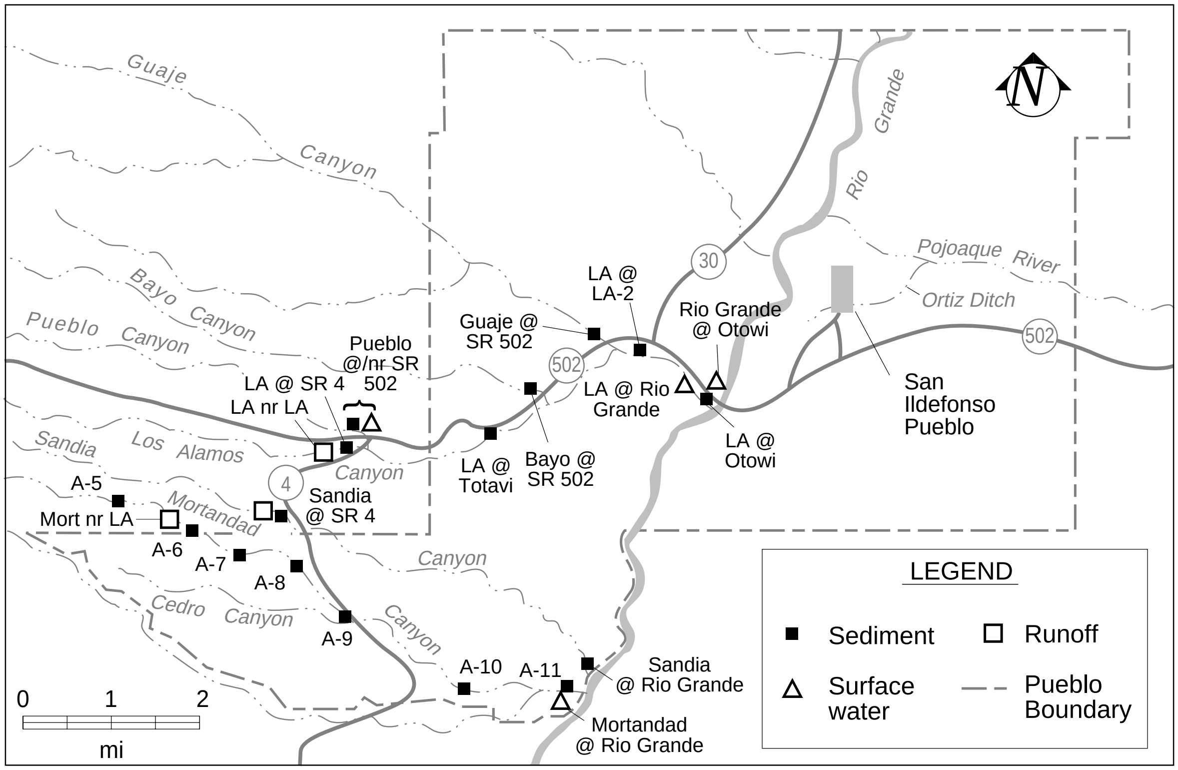


Figure 5-11. Sediment and surface water stations on or adjacent to the Pueblo of San Ildefonso land.

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6. Soil, Foodstuffs, and Associated Biota Monitoring

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Highlights from 1996

Soil Surveillance Program. *Soil samples were collected from 12 on-site (Los Alamos National Laboratory [LANL or the Laboratory]) and 10 perimeter areas around the Laboratory, analyzed for radiological and nonradiological constituents, and compared to regional (background) locations—radionuclides in soils collected from regional background areas are due to natural and/or to worldwide fallout. In general, most radionuclide concentrations in on-site and perimeter areas were within regional statistical reference levels (RSRLs) (i.e., the upper limit background concentration from data averaged from 1974 to 1994) and were far below LANL screening action levels (SALs). Trend analyses show that most radionuclides in soils from on-site and perimeter areas have been decreasing over time. These trends were especially apparent (i.e., significant at p <0.05) for tritium and uranium in soils from on-site areas. Soils were also analyzed for trace and heavy metals, and most metals were within RSRLs and were well below LANL SALs.*

Foodstuffs and Associated Biota Surveillance Program. *Foodstuffs (milk, eggs, fruits, vegetables, honey, elk, deer, fish, herbal tea, and domestic livestock) were collected either from Laboratory and/or surrounding perimeter areas (including several Native American pueblo communities), to determine the impact of LANL operations on the human food chain. Most samples of foodstuffs from Laboratory and/or perimeter locations showed no radioactivity distinguishable from that attributable to natural sources and/or to worldwide fallout. Similarly, most heavy metal elements in produce from Laboratory and perimeter areas were within regional background concentrations.*

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A. Soil Monitoring

1. Introduction

A soil sampling and analysis program provides the most direct means of determining the concentration, inventory, and distribution of radionuclides and radioactivity around nuclear facilities (DOE 1991). This program is mandated by Department of Energy (DOE) Orders 5400.1 and 5400.5. Soil provides an integrating medium that can account for contaminants released to the atmosphere, either directly in gaseous effluents (e.g., air stack emissions) or indirectly from resuspension of on-site contamination (e.g., fugitive dust from solid waste management units [SWMUs]). Subsequently, the knowledge gained from a soil radiological sampling program is critical for providing information about potential pathways (e.g., soil ingestion, food crops, resuspension into the air, and contamination of groundwater) that may result in a radiation dose to humans (Fresquez et al., 1996a). This program evaluates radionuclide, radioactivity, and nonradionuclides (heavy metals) in soils collected from on-site (Los Alamos National Laboratory—LANL or the Laboratory), around the perimeter of the Laboratory, and regional (background) locations. On-site and perimeter areas are compared to regional background areas—these background areas are distant from the Laboratory, and their radionuclide and non-radionuclide contents are due to naturally occurring elements and/or to worldwide fallout.

2. Monitoring Network

Soil surface samples are collected from mesa tops that are relatively level, open, and undisturbed areas at regional (background) locations (6 sites), perimeter (10 sites), and LANL (12 sites) (Figure 6-1). LANL and perimeter areas are compared to soils collected from regional background locations where radionuclides, radioactivity, and heavy metals are due to natural and/or to worldwide fallout events.

a. Off-Site Regional (Background) Stations. The regional background stations for soils are located in northern New Mexico surrounding the Laboratory: Rio Chama, Rio Embudo, Cochiti Pueblo, Bernalillo, Jemez Pueblo, and Santa Cruz Lake. All are over 15 km (9 mi) from the Laboratory (DOE 1991) and are beyond the range of potential influence from normal Laboratory operations.

b. Off-Site Perimeter Stations. Ten soil sampling stations are located within 4 km (2.5 mi) of the Laboratory. These stations are located to reflect the soil conditions of the inhabited areas to the north (Los Alamos townsite area—four stations) and east (White Rock area and Pueblo of San Ildefonso 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.

c. On-Site Stations. Soil samples from 12 on-site stations are collected. Areas sampled at LANL are not from SWMUs—any discernible site at which solid and/or liquid wastes have been routinely and systematically released (e.g., waste tanks, septic tanks, sumps, firing sites, burn pits, sumps, material disposal areas [such as TA-54, Area G, at LANL], and waste-water outfalls) (ESP 1995). Instead, the majority of on-site soil-sampling stations are located close to, and downwind from major facilities and/or operations at LANL in an effort to assess radionuclide, radioactivity, and heavy metals in soils that may have been contaminated as a result of air stack emissions and fugitive dust (e.g., the resuspension of dust from SWMUs).

3. Sampling Procedures, Data Management, and Quality Assurance

Collection of samples for chemical and radiochemical analyses follow a set procedure to ensure proper sample collection, documentation, submittal for chemical analyses, and posting of analytical results. Stations and samples are assigned a unique identifier to provide chain-of-custody control during the transfer of samples from the time of collection through analysis and reporting. All quality assurance/quality control (QA/QC) protocols, chemical analysis, and data handling, validation and tabulation can be found in the operating procedure (OP) entitled, “Soil Sampling for the Soil Monitoring Program,” LANL-ESH-20-SF-OP-007, RO, 1997.

4. Radiochemical Analytical Results

Table 6-1 shows data from soils collected in 1996. Most radionuclide concentrations and radioactivity in soils collected from on-site and perimeter stations were within the long-term regional statistical reference level (RSRL). The RSRL is the average background concentration plus twice the standard deviation of the mean from data collected over a 21-yr period; data from 1974 through 1994 from regional background stations were used to establish the approximate upper limit background concentration for worldwide fallout of tritium, strontium-90; cesium-137; americium-241; plutonium-238; and plutonium-239, -240; and total uranium (Fresquez et al., 1996a). Some total uranium and plutonium-239, -240 values in some perimeter and on-site stations were above the RSRL but were far below LANL screening action levels (SALs). LANL SALs, developed by the Environmental Restoration Project at the Laboratory, are used to identify the presence of contaminants of concern and are derived from a risk assessment pathway using a 10-mrem/yr dose.

5. Nonradiochemical Analytical Results

Soils were also analyzed for trace and heavy metals. These data will be used to establish a database and are meaningful from a Laboratory operation/effects standpoint. The results of the 1996 soil sampling program can be found in Table 6-2.

Most concentrations of heavy metals measured in soils collected from perimeter and on-site areas were within RSRLs, and in fact, were within the range of metals normally encountered in the Los Alamos area (Ferenbaugh et al., 1990) and the continental United States (Shacklette and Boerngen 1984).

6. Total Effective Dose Equivalent from Living in Areas Where Soils Were Collected in 1996

A residential scenario (Fresquez et al., 1996a) was used in a computer model, RESRAD (version 5.61), to estimate the effective dose equivalent (EDE) from external radiation and the committed effective dose equivalent (CEDE) from internally deposited radiation (Yu et al., 1995). The EDE and CEDE are added together to provide an estimate of the total effective dose equivalent (TEDE). Table 6-3 presents a summary of this TEDE, based on the mean radioisotope concentrations, for a person living in the region, around the perimeter of the Laboratory, and on Laboratory property. The maximum TEDEs (i.e., the TEDE plus 2 sigma using the maximum consumption rate for fruits and vegetables) for samples collected during 1996 from the region, from the Laboratory’s perimeter, and from on-site locations are 4.2 mrem, 5.1 mrem, and 4.2 mrem, respectively. The maximum net positive TEDE for the soils collected in 1996 after subtraction of soils collected from regional background locations show 0.78 mrem (<0.8% of the DOE public dose limit [PDL]) for perimeter soils, and 0.77 mrem (<0.8% of the DOE PDL) for on-site soils. The radionuclides that contributed more than 5% to these maximum net positive TEDEs are cesium-137, plutonium-239, and uranium for perimeter soils; and cesium-137 and uranium for on-site soils.

7. Long-Term Trends

All soils collected from on-site and perimeter stations during 1974 through 1994 were subjected to a Mann-Kendal test for trend analysis (Fresquez et al., 1996a). Most radionuclides and radioactivity detected in LANL and perimeter soils, with the exception of plutonium-238 (increased at ≈96% of the sites) and gross alpha activity (increased at half of the sites), exhibited generally decreasing trends over time.

Activities of tritium, cesium-137, plutonium-239, and concentrations of uranium showed significantly decreasing ($p < 0.05$) trends over time in many soils collected from on-site and perimeter areas. Their decrease may be due in part to reductions in Laboratory operations, air stack emissions, and to better engineering controls employed by the Laboratory (ESP 1995), but is probably a result of (1) the cessation of above-ground nuclear weapons testing in the early 1960s, (2) weather conditions (wind, water erosion, and leaching), and (3) radioactive decay (half-life) (Rogowski and Tamura 1965, Wicker and Schultz 1982). Tritium, which has a half-life of about 12 years, exhibited the greatest decrease in activity over the 21 years in almost all of the soil sites studied, including regional locations.

Plutonium-238 and gross alpha activity generally increased over time in most on-site, perimeter, and even in regional background sites—all sites, however, were far from being statistically significant ($p < 0.05$). The source of most plutonium-238 detected in the environment is from nuclear weapons testing in the atmosphere (Klement 1965) and from the reentry burn-up of satellites containing a plutonium-238 power source (Perkins and Thomas 1980). Only a few gross alpha readings and a few gross beta readings showed significantly increasing trends ($p < 0.05$) over time. In these cases, however, the measurement period was both early and very short (1978 to 1981).

B. Foodstuffs and Associated Biota Monitoring

1. Introduction

There are many agriculturally important products that are grown and/or are harvested in the area surrounding LANL—and the ingestion of foodstuffs constitutes a critical pathway by which radionuclides can be transferred to humans (Wicker and Schultz 1982). Samples of milk, eggs, produce, fish, honey, herbal teas, domestic cattle, and elk and deer are collected annually from Laboratory and surrounding communities to determine the impact of Laboratory operations on the human food chain (Figure 6-2). This program is mandated by DOE Orders 5400.1 and 5400.5. The two main objectives of the Foodstuffs Monitoring Program are to (1) determine and compare radioactive and heavy metals constituents in foodstuffs between on-site LANL and perimeter areas with regional areas; and (2) calculate a maximum CEDE to surrounding area residents (e.g., Los Alamos townsite, White Rock/Pajarito Acres, the Pueblo of San Ildefonso, and Cochiti Pueblo) who may consume such foodstuffs.

2. Produce

a. Monitoring Network. Fruits, vegetables, and grains are collected each year from on-site (Laboratory), perimeter (Los Alamos townsite and White Rock/Pajarito Acres), and off-site regional (background) locations (Figure 6-2). Samples of produce are also collected from the Pueblos of Cochiti and San Ildefonso, which are located in the general vicinity of LANL. Produce from areas within and around the perimeter of LANL are compared to produce collected from regional (background) gardens more than 16 km (10 mi) from the Laboratory; these areas are located around the Española, Santa Fe, and Jemez areas. The regional sampling locations are sufficiently distant from the Laboratory to be unaffected by airborne emissions.

b. Sampling Procedures, Data Management, and Quality Assurance. Produce samples are collected from local gardens within and around the perimeter of the Laboratory in the summer and fall of each year (Salazar 1984). All QA/QC protocols, chemical analysis, and data handling, validation, and tabulation can be found in the OP entitled, "Produce Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-001, RO, 1997.

c. Radiochemical Analytical Results. Concentrations of radionuclides in produce collected from on-site, perimeter, and off-site regional (background) locations during the 1996 growing season can be found in Table 6-4. Most radionuclide concentrations in fruits and vegetables collected from on-site and perimeter areas were less than the RSRL. Strontium-90 concentrations, on the other hand, at most sites were higher than the RSRLs, although most values were not considered detectable values (individual results were lower than two times the counting uncertainty). The causes of the higher concentrations of strontium-90 in produce samples collected from Los Alamos townsite, Cochiti Pueblo, Pueblo of San Ildefonso, and LANL sites, as compared to background are not completely known, but may be a reflection of analytical discrepancies and/or incomplete washing procedures rather than contamination effects by Laboratory operations.

d. Dose Equivalents to Individuals from Ingestion of Produce. Table 6-5 presents the summary of the CEDE from the ingestion of produce collected during the growing season in 1996, and for a comparison, the results for the 1995 growing season. The maximum annual CEDE (i.e., the total CEDE plus 2 sigma) using the maximum consumption rate of 160 kg/yr (352 lb/yr) for produce is 3.3 mrem from the on-site sample, but the maximum annual CEDE for the regional background (Española, Santa Fe, and Jemez Pueblo) sample is 0.93 mrem. The maximum net positive CEDE from consuming produce collected from Cochiti Pueblo, White Rock, Los Alamos townsite, and the Pueblo of San Ildefonso is 0.086 mrem (<0.1% of the DOE PDL), 0.019 mrem (<0.02% of the DOE PDL), 0.77 mrem (<0.8% of the DOE PDL), and 2.2 mrem (2.2% of the DOE PDL), respectively. The radionuclides contributing more than 5% to this maximum net positive CEDE are natural uranium and plutonium-239 for the Cochiti Pueblo samples; plutonium-239 and americium-241 for the White Rock samples; and strontium-90, natural uranium, plutonium-239, and americium-241 for the Los Alamos townsite and the Pueblo of San Ildefonso samples. Because ingestion of produce collected on-site is not considered to be a significant pathway because of the small amount of edible material and the limited access to these foodstuffs, calculation of a total net positive CEDE and comparison to the DOE PDL is not appropriate. There is no significant difference ($p < 0.05$) between produce samples collected from background, perimeter, or on-site locations; and there is no significant difference ($p < 0.05$) between the 1995 and the 1996 CEDE.

e. Nonradiochemical Analytical Results. Most trace and heavy metal elements, particularly silver, arsenic, beryllium, cadmium, mercury, antimony, selenium, and thallium in produce from on-site, perimeter, and regional locations were below the limit of detection (Table 6-6). In those cases where produce samples contained some metals above the limit of detection (e.g., barium, chromium, nickel, and lead), only a few samples exceeded the RSRL. Lead, for example, was higher in concentration in two samples collected from the White Rock/Pajarito Acres area.

3. Honey

a. Monitoring Network. Beehives located within perimeter areas—Los Alamos townsite and White Rock/Pajarito Acres—are sampled on an annual basis for honey (Figure 6-2). Honey from these hives is compared to honey collected from regional background hives located in northern New Mexico (Fresquez et al., 1996b).

b. Sampling Procedures, Data Management, and Quality Assurance. Honey is collected by a professional (contract) bee keeper. All QA/QC protocols, chemical analysis, and data handling, validation, and tabulation can be found in the OP entitled, "Honey Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-004, RO, 1997.

c. Radiochemical Analytical Results. Results of the analysis of honey collected during the 1996 season are presented in Table 6-7. Most radionuclide concentrations in honey collected from perimeter hives were below RSRLs. A few radionuclides, principally actinium-228, cobalt-60, potassium-40, and strontium-90 observed in Los Alamos townsite and White Rock/Pajarito Acres samples, were in concentrations just above the RSRL; most levels, however, were small as compared to background.

d. Dose Equivalents to Individuals from Ingestion of Honey. Table 6-8 presents the summary of the CEDE from the ingestion of honey collected in 1996. The maximum CEDE (i.e., the CEDE plus 2 sigma) using the maximum consumption rate of 5 kg/yr (11 lb/yr) for all honey samples collected in 1996 is 0.075 mrem for the consumption of honey collected from around the Laboratory. The maximum net positive CEDE from consuming honey from Los Alamos townsite and White Rock and honey collected at a regional background station (i.e., San Pedro), using the maximum consumption rate, is 0.036 mrem (<0.04% of the DOE PDL) and 0.0030 mrem (<0.004% of the DOE PDL), respectively. The radionuclides that contributed more than 5% are potassium-40 for honey collected in Los Alamos; and strontium-90, cesium-137, and total uranium for honey collected in White Rock.

Because analyses of several more radionuclides were requested in 1996 as compared to previous years, a direct comparison of these results with previous years cannot be made. However, the 1996 results of analyses for tritium, strontium-90, cesium-137, uranium, plutonium-238, plutonium-239, and americium-241 (the radionuclides requested in 1995) show the annual CEDE for the maximum consumption rate for samples collected from the background sample, White Rock, and Los Alamos townsite to be 0.0028 (±0.011), 0.0029 (±0.0012), and 0.0045 (±0.030) mrem, respectively. These dose equivalents can be directly compared with the previous year. The confidence intervals for the 1995 data set and this 1996 modified data set overlap, indicating that there is no difference between the 1995 and the 1996 calculated CEDEs for these sampling locations.

4. Eggs

a. Monitoring Network. Fresh eggs are collected from free-range chickens from the Los Alamos townsite area and from the Pueblo of San Ildefonso. These eggs are compared to eggs produced from free-range chickens located in the Española area.

b. Sampling Procedures, Data Management, and Quality Assurance. Approximately 24 medium sized eggs from Los Alamos townsite, Pueblo of San Ildefonso, and Española (background) were collected directly from the farmer, transported in Styrofoam containers to the Laboratory, and submitted to CST-9 for the analysis of tritium; total uranium; strontium-90; plutonium-238; plutonium-239, -240; americium-241; and cesium-137. All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the OP entitled, "Egg Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-006, RO, 1997.

c. Radiochemical Analytical Results. Results of radionuclide concentrations detected in eggs collected from Los Alamos townsite and the Pueblo of San Ildefonso, as they compare to eggs collected from the Española area can be found in Table 6-9. Most radionuclide values in eggs collected from Los Alamos townsite and the Pueblo of San Ildefonso were less than the RSRLs. Although the cesium-137 activity in eggs collected from Los Alamos townsite was greater than the RSRL, the level was not considered a detectable hit because the concentration was lower than the counting uncertainty; and is, therefore, of no concern.

d. Dose Equivalents to Individuals from Ingestion of Eggs. Table 6-10 presents the summary of the CEDE from the ingestion of eggs collected near the Pueblo of San Ildefonso, Los Alamos townsite, and a regional background location near Española in 1996. The maximum annual CEDE (i.e., the total CEDE plus 2 sigma) using the maximum consumption rate of 20 kg/yr (55 g/day) for eggs collected at Los Alamos townsite is 0.15 mrem. The maximum net positive CEDE for eggs collected from the Pueblo of San Ildefonso and from Los Alamos townsite and the regional background location is 0.002 mrem (<0.002% of the DOE PDL) and 0.12 mrem, respectively. Cesium-137 contributed greater than 99% of these dose equivalents. Because cesium-137 was not "detected" in any of the egg samples (i.e., the reported counting uncertainty is larger than the concentration measured), the contribution of this radionuclide to the maximum net positive dose appears to be from natural variability within the data set as a result of measuring low concentrations (i.e., near the detection limits of the instruments). There is no statistical difference ($p < 0.05$) between the maximum CEDE (i.e., average CEDE + 2 sigma) calculated for eggs collected from the Pueblo of San Ildefonso, Los Alamos townsite, and the regional background in the Española area.

5. Milk

a. Monitoring Network. There are no milk production facilities within 15 km (9 mi) of the Laboratory—the closest working dairy, located in the Pojoaque Valley, is approximately 40 km (24 mi) away. However, because milk is considered one of the most important and universally consumed foodstuffs, the analysis of milk may yield information as to the deposition of small amounts of radionuclides over a relatively large area. Accordingly, various radionuclides in milk from the Pojoaque Valley dairy were analyzed and compared to milk collected from a dairy (regional background location) located in Albuquerque.

b. Sampling Procedures, Data Management, and Quality Assurance. Milk is collected directly from the dairies in the Pojoaque Valley and from Albuquerque and submitted to CST-9 in the original containers for the analysis of tritium; uranium; strontium-90; plutonium-238; plutonium-239, -240; iodine-131; and cesium-137. All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the OP entitled, "Milk/Tea Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-005, RO, 1997.

c. Radiochemical Analytical Results. The results of the radiochemical analysis performed on milk collected from the Pojoaque Valley and Albuquerque (background) during 1996 are summarized in Table 6-11. Most radionuclide concentrations in milk collected from the Pojoaque Valley, with the exception of total uranium, were less than

RSRLs and were similar to those obtained in previous years. Milk collected from both Pojoaque Valley and Albuquerque dairies contained detectable uranium concentrations; however, this fact was not unexpected because uranium is a natural element in all soils, and the degree to which it is found in milk depends on many factors, including the geology, mineralogy, vegetation, and meteorological (wind and rain) conditions of the area (Wicker and Schultz 1982).

d. Dose Equivalents to Individuals from Ingestion of Milk. Table 6-12 presents the summary of the CEDE from the ingestion of milk collected from the Pojoaque Valley for 1996. The results from 1994 and 1995 are also presented for comparison. The maximum CEDE (i.e., the CEDE plus 2 sigma) using the maximum consumption rate of 0.5 L/day for milk is 0.70 mrem from the regional background sample (Albuquerque). The maximum net positive CEDE from consuming milk from the Pojoaque Valley and from the regional background location is 0.083 mrem (<0.09% of the DOE PDL). The radionuclides contributing more than 5% to this total net positive difference are strontium-90 and uranium. There is no significant difference ($p < 0.05$) between the maximum CEDE (i.e., average CEDE + 2 sigma) calculated for milk samples collected from the Pojoaque Valley and the regional background. The confidence intervals for these data sets overlap, indicating that there is no difference between the 1994, 1995, and 1996 CEDEs.

6. Fish

a. Monitoring Network. Fish are collected annually upstream and downstream of the Laboratory (Figure 6-2). Cochiti Reservoir, a 10,690-acre flood and sediment control project, is located on the Rio Grande approximately five miles downstream from the Laboratory. Radionuclides in fish collected from Cochiti Reservoir are compared to fish collected from background reservoirs. Abiquiu, Heron, and El Vado Reservoirs are located on the Rio Chama, upstream from the confluence of the Rio Grande and intermittent streams that cross Laboratory lands (Fresquez et al., 1994a).

Two types of fish are collected: game (surface-feeders) and nongame (bottom-feeders). Game fish include Rainbow Trout (*Salmo gairdneri*), Brown Trout (*Salmo trutta*), Kokanee Salmon (*Oncorhynchus nerka*), Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieui*), White Crappie (*Pomixis annularis*), and Walleye (*Stizostedion vitreum*). Nongame fish include the White Sucker (*Catostomus commersone*), Channel Catfish (*Ictalurus penctatus*), Carp (*Cyprinus carpio*), and Carp Sucker (*Carpiodes carpio*).

b. Sampling Procedures, Data Management, and Quality Assurance. Fish are collected by hook and line, trot line, or gill nets (Salazar 1984). All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the OP entitled, "Fish Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-002, RO, 1997.

c. Radiochemical Analytical Results. Concentration of radionuclides in game and nongame fish collected upstream and downstream of the Laboratory are presented in Table 6-13. In general, the concentrations of most radionuclides in game and nongame fish collected from Cochiti Reservoir before and after the Dome Fire were less than the RSRL from similar fish collected from Abiquiu, Heron, and El Vado Reservoirs. Uranium in fish from Cochiti Reservoir is from naturally occurring sources. The isotopic ratio of uranium-235 to uranium-238 in Cochiti Reservoir bottom-feeding fish collected during 1993 (1.25 × 1,013 atoms uranium-235/ash g to 1.74 × 1,015 atoms uranium-238/ash g) and 1994 (1.20 × 1,013 atoms uranium-235/ash g to 1.65 × 1015 atoms uranium-238/ash g), for example, were consistent with naturally occurring uranium (i.e., 0.0072 ratio) (Efurd 1993). In other words, there was no evidence of depleted uranium in fish samples collected from Cochiti Reservoir in past years. Depleted uranium, a by-product of uranium enrichment processes, has been used in dynamic weapons testing at LANL firing sites since the mid-1940s. Also, there was no evidence of uranium-236; this isotope does not occur in nature and is indicative of the presence of man-made uranium. These results compare well with radionuclide contents in crappie, trout, and salmon from comparable (background) reservoirs and lakes in Colorado (Wicker et al., 1972, Nelson and Wicker 1969).

d. Dose Equivalents to Individuals from Ingestion of Fish. Table 6-14 presents the summary of the CEDE from the ingestion of fish collected from upstream (Abiquiu, Heron, and El Vado Reservoirs) and downstream (Cochiti Reservoir) of the Laboratory before and after the 1996 Dome Fire. The maximum CEDE (i.e., the CEDE plus 2 sigma) using the maximum consumption rate of 21 kg/yr (46 lb/yr) for fish collected before the fire is 0.21 mrem from the Cochiti Reservoir bottom feeders, and the maximum CEDE for fish collected after the fire is 0.17 mrem. The maximum net positive CEDE for consuming fish from the

Cochiti Reservoir before the fire using the maximum consumption rate and subtracting the background from upstream of the Laboratory, is 0.12 mrem (<0.13% of the DOE PDL) for the bottom feeders and 0.052 mrem (<0.06% of the DOE PDL) for the higher level feeders. The maximum net positive CEDE for consuming fish from the Cochiti Reservoir after the 1996 Dome Fire using the maximum consumption rate and subtracting the background from upstream of the Laboratory, is 0.083 mrem (<0.09% of the DOE PDL) for the bottom feeders and 0.030 mrem (<0.04% of the DOE PDL) for the higher level feeders. The radionuclides contributing more than 5% to the maximum net positive CEDEs for samples collected before the Dome Fire are strontium-90, uranium, and americium-241 for bottom feeders and strontium-90, uranium, and plutonium-239 for the higher level feeders. The radionuclides contributing more than 5% to the total maximum net positive CEDEs for samples collected after the Dome Fire are strontium-90, uranium, and americium-241 for bottom feeders and strontium-90, cesium-137, uranium, plutonium-238, and americium-241 for the higher level feeders.

There is no significant difference ($p < 0.05$) between the maximum CEDE (i.e., average CEDE + 2 sigma) calculated for fish collected from upstream of the Laboratory and from Cochiti Reservoir before or after the Dome Fire. There is no significant difference ($p < 0.05$) between the 1995 CEDE and the 1996 CEDE calculated for the fish collected.

e. Long-Term Data Evaluation of Naturally Occurring Uranium in Surface- and Bottom-Feeding Fish Upstream and Downstream of the Laboratory. Fresquez et al., (1994a) 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 in game and nongame fish collected from Cochiti Reservoir were not significantly different in fish collected from reservoirs upstream of the Laboratory. Total uranium was the only radionuclide that was found to be significantly higher in both game and nongame fish from Cochiti Reservoir as compared to fish from Abiquiu, Heron, and El Vado Reservoirs. Uranium concentrations in fish collected from Cochiti Reservoir, however, significantly ($p < 0.05$) decreased from 1981 to 1993, and no evidence of depleted uranium was found in fish samples collected from Cochiti Reservoir in 1993. Based on the average concentration of radionuclides over the years, the net positive CEDE from consuming 21 kg/yr (46 lb/yr) of game fish and nongame fish from Cochiti Reservoir after natural background has been subtracted was 0.005 and 0.009 mrem/yr, respectively. The highest dose was <0.01% of the DOE PDL (Fresquez and Armstrong 1996).

f. Nonradiological Analytical Results. The mean levels of all heavy metals in bottom-feeding fish collected from Cochiti Reservoir on June 3, 1996 (pre-Dome Fire) were within the RSRL (Table 6-15). In addition, all of these metals, particularly beryllium, mercury, and lead, were similar to values reported from 1991 to 1995. Mercury concentrations in fish occurring in lakes and reservoirs in New Mexico have been of significant concern to the public for several years. However, based on five years of data, mercury concentrations in fish upstream of LANL have been consistently higher, albeit slightly, than mercury concentrations downstream of the Laboratory.

Although some heavy metals, particularly silver, barium, beryllium, cadmium, chromium, and thallium in fish collected from Cochiti Reservoir on August 8, 1996, after the Dome Fire, were higher in concentrations than metals in fish collected upstream of LANL, they were less than the RSRL. The higher concentrations of these metals in fish from Cochiti Reservoir were probably a result of the fire on Forest Service and Bandelier National Park lands.

7. Game Animals (Elk and Deer)

a. Monitoring Network. Road kills of elk and deer are collected on an annual basis from within Laboratory boundaries, and the meat and bone are analyzed for various radionuclides. Three elk and five deer were collected during 1995 and 1996. These data, from meat and bone samples, were compared to radionuclide concentrations in meat and bone samples from elk and deer collected from regional background locations (Fresquez et al., 1994b).

b. Sampling Procedures, Data Management, and Quality Assurance. Elk and deer meat and bone tissue are collected from fresh road kills around the Laboratory. Background samples are collected from the New Mexico Department of Game and Fish during this same period of time. All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the OP entitled, “Game Animal Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-003, RO, 1997.

c. Radiochemical Analytical Results. Results of road kill elk and deer collected during 1995 and 1996 can be found in Tables 6-16 and 6-17.

Most radionuclides in muscle and bone tissue of deer collected from LANL lands were less than RSRLs. Activities of cesium-137 and americium-241 in muscle and activities of tritium, strontium-90, and plutonium-238 in bone in some deer samples, however, were greater than the RSRL. And, three out of the five deer bone samples collected from LANL lands contained higher strontium-90 levels than background.

Most radionuclides, with the exception of total uranium, in muscle and bone tissue of elk collected within LANL lands were less than the RSRL. Only one sample, a leg bone sample from a cow elk collected on the Pueblo of San Ildefonso at State Road 4, contained detectable (where the analytical result was higher than two sigma) and higher concentrations of total uranium. The value was greater than the RSRL.

d. Dose Equivalents to Individuals from Ingestion of Game Animals. Table 6-18 presents the summary of the CEDE from the ingestion of elk collected during 1996. Because there were no regional background elk collected in 1994 or 1995 (ESP 1996), the 1993 data are also presented as a comparison (Fresquez et al., 1994b). The maximum annual CEDE (i.e., the total CEDE plus 2 sigma) using the maximum consumption rate of 5.7 kg (13 lb) for elk bone and 23 kg/yr (50 lb) for elk muscle collected on-site in 1996 is 2.2 mrem and 0.042 mrem, respectively. For the regional sample, the maximum annual CEDE is 0.80 mrem for the consumption of elk bone and 0.044 mrem for the consumption of elk muscle. The maximum net positive CEDE from consuming bone and muscle from elk collected on-site and elk collected off-site in 1996 is 1.4 mrem (1.4% of the DOE PDL) for bone and 0.011 mrem (0.011% of the DOE PDL) for muscle. The radionuclides that contributed more than 5% to this maximum net positive dose is strontium-90 for bone and muscle. There is no significant difference ($p < 0.05$) between the maximum CEDE (i.e., average CEDE + 2 sigma) calculated in 1995 and 1996 or from 1996 on-site or off-site locations.

Table 6-19 presents the summary of the CEDE from the ingestion of deer collected during 1996. The maximum annual CEDE (i.e., the total CEDE plus 2 sigma) using the maximum consumption rate of 4.8 kg/yr (11 lb/yr) for deer bone and 23 kg/yr (50 lb/yr) for deer muscle collected on-site in 1996 is 3.7 mrem and 0.16 mrem, respectively. For the regional sample, the maximum annual CEDE is 0.4 mrem for the consumption of deer bone and 0.05 mrem for the consumption of deer muscle. The maximum net positive CEDE from consuming bone and muscle from deer collected on-site and deer collected off-site in 1996 is 3.3 mrem (<3.5% of the DOE PDL) for bone and 0.13 mrem (<0.15% of the DOE PDL) for muscle. The radionuclides that contributed more than 5% to this total net positive dose is strontium-90 for bone and cesium-137 for muscle.

8. Domestic Animals.

a. Monitoring Network. Free-ranging cattle owned by residents of the Pueblo of San Ildefonso graze the boundaries of LANL on a regular basis and are offered by the Pueblo for sampling and analysis.

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the OP entitled, "Game Animal Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-003, RO, 1997.

c. Radiochemical Analytical Results. Radionuclide concentrations in muscle and bone tissue of a domestic free-range steer collected from the Pueblo of San Ildefonso lands during the 1996 year can be found in Table 6-20. Results are compared to background elk samples—elk and cattle are both free-ranging grazers—collected during the same year. In general, most radionuclides, with the exception of total uranium, in muscle and bone tissue of a steer collected from the Pueblo of San Ildefonso were less than the RSRL. Total uranium in bone tissue, however, was detected at two times the levels commonly encountered in bone tissue of elk.

d. Dose Equivalents to Individuals from Ingestion of Domestic Animals. Table 6-21 presents the summary of the CEDE from the ingestion of a free-range steer collected from the Pueblo of San Ildefonso during 1996. Because this was the first year that a steer was sampled, there are no background samples with which to compare the 1996 results. In order to compare this CEDE to a background value, elk collected from the region from 1991 to the present were used. The maximum CEDE (i.e., the CEDE plus 2 sigma) using the maximum consumption rate of 110 kg/yr (243 lb/yr) for muscle and 275 kg/yr (61 lb/yr) for bone for steer collected from the Pueblo of San Ildefonso in 1996 is 2.3 mrem for the consumption of bone tissue and 0.17 mrem for the consumption of muscle tissue. The maximum net positive CEDE from consuming steer bone and muscle collected from Pueblo of San Ildefonso land, after the subtraction of elk CEDE from regional background, is 0.23 mrem

(<0.3% of the DOE PDL) and 0.057 mrem (<0.06% of the DOE PDL), respectively. The radionuclides that contributed more than 5% to this total maximum net positive dose are cesium-137, uranium, and americium-241 for bone; and strontium-90, uranium, and plutonium-239 for muscle. There is no significant difference (p <0.05) between the maximum CEDE (i.e., average CEDE + 2 sigma) calculated for steer tissues collected from the Pueblo of San Ildefonso and elk tissue collected at regional background locations in 1996.

9. Herbs/Tea

a. Monitoring Network. Navajo Tea (Cota) was collected from three perimeter areas surrounding the Laboratory: Los Alamos townsite on the north, White Rock on the southeast, and Pueblo of San Ildefonso lands on the east. Tea was collected from the Española area as a background value.

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the OP entitled, "Milk/Tea Sampling and Processing for the Foodstuffs Monitoring Program," LANL-ESH-20-SF-OP-005, RO, 1997.

c. Radiochemical Analytical Results. Results of the tea collected during the 1996 year can be found in Table 6-22. Tea collected from Los Alamos townsite, White Rock/Pajarito Acres, and the Pueblo of San Ildefonso contained detectable levels (where the analytical result was higher than two sigma) of plutonium-238, plutonium-239, and total uranium. These were greater than the RSRL. All other radionuclides were within background values.

d. Dose Equivalents to Individuals from Ingestion of Herbal Tea. Table 6-23 presents the summary of the CEDE from the ingestion of Navajo tea (Cota) collected in 1996. The maximum CEDE (i.e., the CEDE plus 2 sigma) using the maximum consumption rate of 1.5 L/day for all tea samples collected in 1996 is 1.9 mrem for the consumption of tea collected in the Pueblo of San Ildefonso. The maximum net positive CEDE from consuming tea from Los Alamos townsite, White Rock/Pajarito Acres, and the Pueblo of San Ildefonso and tea collected at a regional background station, using the maximum consumption rate, is 0.24 mrem (<0.3% of the DOE PDL), 0.27 mrem (<0.3% of the DOE PDL), and 0.92 mrem (<1.0% of the DOE PDL), respectively. The radionuclides that contributed more than 5% to these maximum net positive CEDEs are strontium-90, uranium, plutonium-238 and plutonium-239 for tea collected in Los Alamos; cesium-137, plutonium-238, and plutonium-239 for tea collected in White Rock, and cesium-137, uranium, and plutonium-238 for tea collected at the Pueblo of San Ildefonso. There is no significant difference (p <0.05) between the maximum CEDE calculated for consuming tea from the sampling locations.

C. Special Studies, Including Long-Term Data Evaluations

1. Radionuclide Concentrations in Soils and Produce from Native American Pueblo Gardens in the Vicinity of Los Alamos National Laboratory

Radionuclide (tritium, strontium-90, cesium-137, plutonium-238, plutonium-239, and total uranium) concentrations were determined in soils and produce collected from gardens in the Pueblos of Cochiti, Jemez, Taos, and San Ildefonso. All radionuclides in soils from Pueblo areas were within or just above RSRL (natural and/or worldwide fallout). Similarly, the average levels of radionuclides in produce collected from gardens in the Pueblos of Cochiti, Jemez, Taos, and San Ildefonso were not significantly different in produce collected from regional (background) locations. The CEDE from consuming 160 kg (352 lb) of produce from the Pueblos of Cochiti, Jemez, Taos, and San Ildefonso, after the background value has been subtracted, was 0.036 (±0.016), 0.072 (±0.051), 0.012 (±0.027), and 0.110 (±0.102) mrem/yr, respectively. The highest calculated dose, based on the mean + 2 std dev (95% confidence level), was 0.314 mrem/yr; this was <0.4% of the International Commission on Radiological Protection (ICRP) permissible dose limit for members of the public (Fresquez et al., 1996c).

2. Radionuclide Concentrations in Elk and Deer from Los Alamos National Laboratory (1992–1995)

Rocky Mountain elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) are common inhabitants of LANL lands. Many of these animals forage over areas at LANL that may contain radioactivity above natural and/or worldwide fallout levels. A study was conducted to determine (1) radionuclide contents (tritium, cesium-137, strontium-90, plutonium-238, plutonium-239, americium-241, and total uranium) in muscle and bone from elk and deer collected from road kills on LANL lands from 1992 through 1995; and (2) the CEDE and the corresponding risk of excess cancer fatalities to people who consume meat and bone from these animals.

In general, most radionuclide concentrations in muscle and bone from elk and deer collected from LANL lands were either at less than detectable levels (where the analytical result was smaller than two counting uncertainties) or within upper limit background concentrations (the background mean + 2 std dev). Based on the long-term average, most radionuclides in muscle tissue from elk collected from LANL lands, with the exception of plutonium-239, were not significantly different ($p < 0.05$) from radionuclide concentrations in muscle from elk collected from background locations. Similarly, most radionuclides, with the exception of total uranium, were not significantly higher in bone from LANL elk as compared to bone from background elk. No significant differences resulted in any of the radionuclides measured in muscle and bone collected from LANL deer as compared to background deer. Overall, the maximum total net positive CEDE—based on the average concentration plus two standard deviations of all radionuclides measured over the years after the subtraction of background values—from the consumption of 51 lb of muscle and 13 lb of bone from LANL elk and deer were as follows: elk muscle = 0.029 mrem/yr, elk bone = 0.149 mrem/yr, deer muscle = 0.182 mrem/yr, and deer bone = 0.742 mrem/yr. All maximum total net positive CEDEs were well below the ICRP permissible dose limit of 100 mrem/yr from all pathways, and the highest CEDE (0.742 mrem/yr from deer bone) corresponds to a risk of excess cancer fatalities of 3.7×10^{-7} (<0.4 in a million). This risk was far below the EPA limit guideline of 10^{-4} (Fresquez et al., 1996d).

3. Radionuclides in Bees and Honey within and around Los Alamos National Laboratory

Honeybees are effective monitors of environmental pollution. LANL, in fact, has maintained a network of honeybee colonies within and around LANL for 17 years (1979 through 1995); the objectives for maintaining this honeybee network were to (1) determine the bioavailability of certain radionuclides in the environment with respect to LANL operations (tritium, cobalt-57, cobalt-60, europium-152, potassium-40, beryllium-7, sodium-22, manganese-54, rubidium-83, cesium-137, plutonium-238, plutonium-239, strontium-90, americium-241, and total uranium) and (2) estimate the CEDE and the corresponding risk of excess cancer fatalities to people who may consume honey from hives located around the perimeter of the Laboratory (Los Alamos and White Rock/Pajarito Acres). All other radionuclides, with the exception of tritium, in honey collected from perimeter hives around LANL were not significantly different from background. Overall, the maximum total net positive CEDE—based on the average concentration plus two std dev of all the radionuclides measured over the years after the subtraction of background values—from consuming 11 lb of honey 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 ICRP permissible dose limit of 100 mrem/yr from all pathways and corresponds to a risk of excess cancer fatality of 1.6×10^{-8} (0.016 in a million)—far below the EPA's limit guideline of 10^{-4} (Fresquez et al., 1997a).

4. Radionuclide Concentrations in Pinto Beans, Sweet Corn, and Zucchini Squash Grown in Los Alamos Canyon at Los Alamos National Laboratory

Pinto beans (*Phaselous vulgaris*, var. Idaho 111), sweet corn (*Zea mays*, var. early sunglow), and zucchini squash (*Cucurbita pepo*, var. black beauty) were grown in a randomized complete block field/pot experiment at a site within Los Alamos Canyon at LANL. That site contained the highest levels of surface gross gamma radioactivity within that canyon bottom. Soils, as well as washed edible and nonedible (washed) crop tissues, were analyzed for various radionuclides (tritium, cesium-137, strontium-90, plutonium-238, plutonium-239, americium-241, total uranium, gross alpha, gross beta, and gross gamma) and heavy metals (arsenic, mercury, antimony, cadmium, chromium, lead, and zinc). Most radionuclides, with the exception of tritium and total uranium, in soil from Los Alamos Canyon were detected in significantly higher concentrations ($p < 0.01$) than in soil collected from regional background locations. Similarly, most radionuclides in edible crop portions of beans, squash, and corn were detected in significantly higher concentrations than regional background. Soil to plant concentration ratios for radionuclides and heavy metals in edible and nonedible crop tissues from Los Alamos Canyon were calculated. All heavy metals in soils, as well as edible and nonedible crop tissues grown in soils from Los Alamos Canyon, were within regional background concentrations. Overall, the maximum net positive CEDE—the CEDE plus two sigma for each radioisotope minus background and then all positive doses summed—to a hypothetical 50-year resident who ingested 160 kg [352 lb] of beans, corn, and squash from the region used in this study in equal proportions, was 74 mrem/yr. This dose was below the ICRP permissible dose limit of 100 mrem/yr from all pathways; however, the addition of other internal and external exposure route factors may increase the overall dose over the PDL. The risk of an excess cancer fatality, based on 74 mrem/yr, was 3.7×10^{-5} (37 in a million); which is below the EPA's limit guideline of 10^{-4} (Fresquez et al., 1997b).

5. Sampling of Perimeter Surface Soils at Technical Area 54, Area G

During fiscal year (FY) 1996, 41 surface soil samples were collected from the perimeter of TA-54, Area G. Fewer samples were taken in FY96 than in previous years, and the locations sampled depended on historical data collected at Area G between FY93 and FY95. The locations for the FY96 surface soil samples were chosen on the basis that these were sites that could best indicate whether contaminants, under the influence of surface water runoff, were moving outside the TA-54, Area G perimeter. Each sampling point was located in an obvious (but small) drainage channel just outside the perimeter fence. These sampling locations were thus biased to best determine movement of contaminated soil being carried by surface water runoff from within the confines of Area G to beyond the Area G fence (Conrad 1997). The radioactive constituents measured in these surface soil samples included americium-241, cesium-137, isotopic plutonium, and tritium.

The analytical results of the surface soil sampling indicate that some perimeter soils at Area G continue to be elevated above background levels for tritium and plutonium. The most elevated concentrations of tritium in soils are prevalent in locations that are adjacent to the active tritium disposal shafts, and next to a series of inactive tritium shafts and the transuranic (TRU) waste storage pads. Isotopic plutonium and americium-241 activity are slightly elevated in perimeter surface soils located adjacent to the TRU pads. Cesium-137 is uniformly distributed in the perimeter soils. The perimeter soil samples were not analyzed for total uranium, but previous years' uranium data have show a uniform distribution in surface soils with no evidence of elevated levels over background.

No gross changes in radioactivity in surface soil samples were observed, and the samples collected in FY96 contain radioactivity similar to samples collected in FY95. No new locations where surface soils were elevated with radioactivity were defined by sampling. These findings are consistent with analogous measurements taken in FY93, FY94, and FY95. The Area G perimeter surface soil data indicate that very little radioactivity is moving outside of Area G under the influence of surface water runoff (Conrad 1997).

6. Dual Axis Radiographic Test Facility Mitigation Action Plan Activities

Elk are being collared in the vicinity of the Dual Axis Radiographic Test (DARHT) facility to effectively evaluate their current use of that area. Global positioning system (GPS) radio collars are put on elk in an attempt to gather data. These data are necessary to make clearer decisions associated with Laboratory projects that may affect elk, whether in a positive or negative manner. The data gathered and analyzed pertain primarily to habitat, water, and terrain use. This information aids in developing management strategies that can be used to alleviate the concerns associated with the DARHT project. The study objectives are to assess seasonal and daily activity use by elk of the DARHT project area to evaluate potential short and long term impacts of DARHT.

Information on large predators using the DARHT project area is also being collected. The study objectives are to determine the presence or absence of large predators (mountain lion, black bear) in the project area, and, if present, assess use of the project area by these species.

Collection and analysis of small mammal tissues is done to identify radionuclides present and monitor concentration amounts over time to obtain a trend analysis. The collection and sampling of small mammals in the vicinity of DARHT before operation of the facility provides a baseline of contaminant concentrations that can be compared to postoperational activities to determine if release of contaminants occurs. The information is used to identify radionuclide presence within surface and subsurface soils in adjacent canyons and to quantitatively estimate the amount of radionuclide uptake at the sampling locations by sampling carcasses of burrowing nocturnal small mammals.

In Chapter 2 of this report, there is a general description of the DARHT Mitigation Action Plan.

7. Environment, Safety, and Health Technology Development and Evaluation Applications Research Study

In 1996, ESH-20 initiated a research project involving the use of an advanced radiotelemetry system on elk studies at LANL. Project objectives included testing a new telemetry system, addressing important questions in contaminant transport and radionuclide concentrations in animals, providing information about elk and deer populations in the area, and providing data on animal diseases. Error rates were determined for a GPS collar associated with varying vegetation types and terrain types that can be applied to locational fixes of animals following deployment of the collars in an applied field study. The error rates were calculated to be less than traditional telemetry devices and thus provides a more effective tool for wildlife studies. Habitat use patterns, water source use patterns, and movements based on human-induced barriers were identified. The GPS data were successfully interfaced with the geographical information system (GIS) to further advance the applications of the technology.

8. National Institutes of Health Hantavirus Grant

Beginning in 1994, the National Institutes of Health, through a collaborative research effort with the University of New Mexico School of Medicine, has funded the ESH-20 Biology Team to study the Sin Nombre hantavirus. Data are collected on small mammal populations, animal health, climatology, and food source use and availability at two locations in the Four Corners area. The objectives of this study are testing for correlations between population densities and concentrations of hantavirus; testing for correlations between ecological parameters, climatological conditions, and food source use or availability and concentrations of hantavirus; and determining seroprevalence rates in various species of rodents. The results of this study have shown a steady decrease in seroprevalence rates of infected animals.

In addition, monitoring of seroprevalence of hantavirus in rodent populations is occurring in Los Alamos County. The deer mouse was the most commonly captured species at all locations except one site where voles (*Microtus* spp.) were the most commonly captured species. Other species sampled included: harvest mice (*Reithrodontomys megalotis*), woodrats (*Neotoma* spp.), shrews (*Sorex* spp.), white-footed mice (*Peromyscus leucopus*), piñon mice (*Peromyscus trueii*), and brush mice (*Peromyscus boylii*). Results of the testing from 1993 to 1996 identified a total overall seroprevalence rate among deer mice of approximately 5.5%, 4.2%, 0%, and 0%, respectively. Several other species tested positive for the hantavirus, but it is uncertain if it is the Sin Nombre virus. Further studies will be necessary to quantify seroprevalence rates in those species. Testing has shown that seroprevalence rates for Los Alamos County were much lower than elsewhere in the region.

9. Technical Area 54, Area G, Enhanced Surveillance Activities—Small Mammal Contaminant Study

Small mammals were sampled at two waste burial sites at TA-54, Area G, and a control site within the proposed Area G expansion area. The purpose of these 1996 activities was to identify radionuclides that are present within surface and subsurface soils at waste burial sites, to compare the amount of radionuclide uptake by small mammals at waste burial sites to a control site, and to identify the primary mode of contamination to small mammals, either through surface contact, ingestion, or inhalation. Three composite samples of approximately five animals per sample were collected at each site. Pelts and carcasses of each animal were separated and analyzed independently. Samples were analyzed for americium-241, strontium-90, plutonium-238, plutonium-239, total uranium, cesium-137, and tritium. Significantly higher (parametric t-test at $p < 0.05$) levels of total uranium, americium-241, plutonium-238, and plutonium-239 were detected in pelts as compared to the carcasses of small mammals at TA-54. Concentrations of other measured radionuclides in carcasses were nearly equal to or exceeded the mean concentrations in the pelts. Because of low capture rates at each site, no statistical analysis could be conducted to compare sites.

10. Fire Hazard Modeling

As a result of the La Mesa Fire in 1977 and the Dome Fire in 1996, ESH-20 initiated an ongoing effort to evaluate the potential for catastrophic wildland fires to occur in populated areas that are adjacent to LANL. The first step in this process is to inventory fuel levels in forests and woodlands on the Pajarito Plateau. This was done at 39 environmental surveillance plots, and the results are being used as inputs into fire behavior models. The outputs of these analyses will be used to prioritize areas and suggest methods for reducing the threats to populated areas from catastrophic fire.

The preliminary results of this inventory indicate that the greatest threat of catastrophic fire is in areas at higher elevations that are predominated by ponderosa pine forests and mixed conifer forests. Woodlands at lower elevations are less threatened by severe fires. ESH-20 is collaborating with the Los Alamos County Fire Department, the US Forest Service, and other emergency organizations to implement strategies for reducing the fire hazard near potentially affected residential and business districts.

11. Integration of a Custom FORTRAN Code and the Geographic Information System for Conducting a Spatially Dynamic Risk Assessment of Federally Protected Species

The Endangered Species Act of 1973 requires that the Department of Energy protect listed species at facilities such as the Los Alamos National Laboratory.

A preliminary risk assessment of the Mexican spotted owl (*Strix occidentalis lucida*) (Gallegos et al., 1997a), the American peregrine falcon (*Falco peregrinus*) (Gallegos et al., 1997b), and the bald eagle *(Haliaeetus leucocephalus*) was performed using a custom FORTRAN model, ECORSK5, and the geographic information system. Estimated doses from soil ingestion and food consumption contaminant pathways were compared against toxicity reference values to generate hazard indices that included a measure of cumulative effects from multiple contaminants (radionuclides, metals, and organic chemicals). The soil ingestion contaminant exposure pathway included a bioaccumulation component, and the food consumption contaminant pathway included a biomagnification component. Simulated foraging within scalable home ranges was weighted exponentially based on distance from randomly selected simulated nest sites. Other model variables included occupancy weighting, toxicity reference value adjustment, and home range sloping. Hazard indices for the most realistic foraging scenarios assessed were 0.73 (±0.23), 1.16 (±1.0) and 0.015 (±0.004) for the owl, falcon, and eagle, respectively. Hazard indices values below 1.0 were considered to be indicative of no unacceptable risk and generally require no further assessment. Information on risk by specific geographical location was generated for use in management of contaminated areas, species habitat, facility siting, and/or facility operations in order to maintain risk from contaminants at acceptably low levels.

Table 6.1. Radiochemical Analyses of Soils Collected in 1996

Location	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	Total Uranium (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)
Off-Site Regional (Background) Stations:										
Rio Chama	0.4 (0.8)[a]	0.6 (0.4)	0.41 (0.12)	2.43 (0.48)	0.003 (0.004)	0.016 (0.006)	0.007 (0.004)	4.8 (4.0)	5.5 (1.4)	2.4 (0.6)
Embudo	0.3 (0.8)	0.4 (0.4)	0.40 (0.12)	1.91 (0.38)	0.002 (0.002)	0.014 (0.004)	0.005 (0.004)	5.4 (4.2)	5.7 (1.4)	2.6 (0.6)
Santa Cruz	0.3 (0.8)	–0.1 (0.6)[b]	0.11 (0.08)	2.18 (0.44)	0.001 (0.002)	0.008 (0.004)	0.004 (0.002)	5.3 (7.4)	5.8 (1.6)	2.8 (0.6)
Cochiti	0.2 (0.8)	0.3 (0.4)	0.26 (0.10)	1.88 (0.38)	0.001 (0.002)	0.006 (0.004)	0.005 (0.006)	2.6 (1.6)	3.8 (1.0)	2.3 (0.6)
Bernalillo	0.5 (0.8)	0.1 (0.4)	0.17 (0.08)	2.35 (0.48)	0.004 (0.004)	0.005 (0.004)	0.006 (0.004)	3.3 (3.6)	4.9 (1.2)	2.2 (0.6)
Jemez	0.5 (0.8)	0.1 (0.4)	0.26 (0.24)	3.18 (0.64)	0.002 (0.002)	0.012 (0.004)	0.006 (0.002)	5.0 (5.4)	4.3 (1.0)	3.8 (0.8)
Mean (±2SD)	0.4 (0.2)	0.2 (0.5)	0.27 (0.24)	2.32 (0.95)	0.002 (0.002)	0.010 (0.009)	0.006 (0.002)	4.4 (2.3)	5.0 (1.6)	2.7 (1.2)
RSRL[c]	6.34	0.82	1.13	4.05	0.008	0.028	0.208	35.3	13.6	7.3
SAL[d]	1,900[e]	4.4	5.1	29	27	24	22	NA[f]	NA	NA
Off-Site Perimeter Stations:										
Otowi	1.2 (0.8)	0.0 (0.4)	0.22 (0.08)	1.92 (0.38)	0.000 (0.002)	0.018 (0.006)	0.005 (0.002)	4.3 (3.6)	4.1 (1.0)	2.4 (0.6)
TA-8 (GT Site)	0.0 (0.8)	0.6 (0.4)	0.51 (0.16)	2.74 (0.54)	0.002 (0.002)	0.025 (0.004)	0.011 (0.004)	7.9 (5.2)	6.9 (1.6)	3.5 (0.8)
Near TA-49 (BNP)	0.3 (0.8)	0.2 (0.6)	0.58 (0.18)	4.44 (0.88)	0.000 (0.002)	0.022 (0.004)	0.008 (0.004)	7.0 (4.2)	7.8 (1.8)	3.7 (0.8)
East Airport	0.7 (0.8)	0.1 (0.4)	0.17 (0.10)	3.55 (0.72)	0.002 (0.002)	0.023 (0.004)	0.007 (0.004)	5.1 (2.0)	5.1 (1.2)	3.6 (0.8)
West Airport	0.5 (0.8)	0.3 (0.8)	0.33 (0.12)	4.13 (0.82)	0.004 (0.002)	0.275 (0.020)	0.048 (0.008)	2.9 (2.4)	8.0 (2.0)	3.5 (0.8)
North Mesa	0.4 (0.8)	0.6 (0.4)	0.47 (0.16)	3.91 (0.78)	0.002 (0.002)	0.026 (0.004)	0.010 (0.004)	7.8 (5.4)	5.6 (1.4)	4.0 (0.8)
Sportsman's Club	0.3 (0.8)	0.2 (0.6)	0.73 (0.20)	4.25 (0.86)	0.001 (0.002)	0.041 (0.006)	0.012 (0.100)	6.7 (3.0)	6.7 (1.6)	3.7 (0.8)
Tsankawi/ PM-1	0.6 (0.8)	0.1 (0.6)	0.25 (0.12)	4.36 (0.88)	0.001 (0.002)	0.009 (0.002)	0.008 (0.004)	7.4 (4.2)	4.8 (1.2)	4.6 (1.0)
White Rock (East)	0.3 (0.8)	0.3 (0.6)	0.23 (0.10)	2.77 (0.56)	0.001 (0.002)	0.007 (0.002)	0.004 (0.002)	6.3 (5.8)	5.6 (1.4)	3.5 (0.8)
San Ildefonso	0.6 (0.8)	0.1 (0.6)	0.25 (0.08)	2.36 (0.48)	0.002 (0.002)	0.015 (0.004)	0.006 (0.002)	–0.2 (0.0)	3.8 (0.8)	3.4 (0.8)
Mean (±2SD)	0.5 (0.6)	0.3 (0.4)	0.37 (0.37)	3.44 (1.84)	0.002 (0.002)	0.046 (0.162)	0.012 (0.026)	5.5 (5.2)	5.8 (2.9)	3.6 (1.1)
On-Site Stations:										
TA-16 (S-Site)	0.5 (0.8)	0.3 (0.4)	0.68 (0.18)	5.13 (1.02)	0.001 (0.002)	0.025 (0.004)	0.010 (0.004)	7.1 (4.6)	7.2 (1.8)	3.9 (0.8)
TA-21 (DP-Site)	0.7 (0.8)	0.1 (0.4)	0.08 (0.06)	2.55 (0.52)	0.004 (0.004)	0.015 (0.006)	0.007 (0.008)	6.5 (5.2)	5.5 (1.4)	2.9 (0.6)
Near TA-33	1.1 (0.8)	0.2 (0.4)	0.71 (0.18)	3.17 (0.64)	0.001 (0.002)	0.011 (0.002)	0.010 (0.004)	6.4 (4.4)	6.9 (1.6)	3.4 (0.8)
TA-50	0.8 (0.8)	0.2 (0.6)	0.25 (0.10)	3.64 (0.72)	0.004 (0.002)	0.097 (0.010)	0.019 (0.004)	4.5 (1.8)	3.9 (1.0)	3.2 (0.8)
TA-51	0.5 (0.8)	0.3 (0.4)	0.31 (0.10)	3.22 (0.64)	0.001 (0.002)	0.012 (0.004)	0.005 (0.002)	4.4 (2.4)	3.2 (0.8)	3.1 (0.8)
West of TA-53	0.5 (0.8)	0.3 (0.4)	0.19 (0.10)	3.26 (0.66)	0.001 (0.002)	0.026 (0.008)	0.004 (0.006)	7.0 (3.8)	5.2 (1.2)	3.1 (0.8)
East of TA-53	0.9 (0.8)	0.3 (0.4)	0.40 (0.12)	2.49 (0.50)	0.002 (0.002)	0.025 (0.006)	0.007 (0.002)	6.6 (3.0)	4.7 (1.2)	3.3 (0.8)
East of TA-54	2.8 (0.8)	0.3 (0.4)	0.45 (0.14)	2.44 (0.48)	0.004 (0.002)	0.053 (0.008)	0.016 (0.010)	2.4 (1.0)	2.5 (0.6)	3.8 (0.8)
Potrillo Drive/ TA-36	0.5 (0.8)	0.3 (0.4)	0.34 (0.10)	2.62 (0.52)	0.001 (0.002)	0.015 (0.004)	0.005 (0.002)	4.6 (2.0)	4.3 (1.0)	2.8 (0.6)
Near Test Well DT-9	0.4 (0.8)	0.0 (0.6)	0.42 (0.12)	2.63 (0.52)	0.002 (0.002)	0.013 (0.004)	0.008 (0.004)	3.4 (1.2)	3.1 (0.8)	3.3 (0.8)
R-Site Road East	0.6 (0.8)	0.5 (0.6)	0.34 (0.10)	4.42 (0.88)	0.000 (0.002)	0.012 (0.004)	0.003 (0.002)	4.5 (1.8)	4.4 (1.0)	2.9 (0.6)
Two-Mile Mesa	0.4 (0.8)	0.2 (0.4)	0.46 (0.14)	3.71 (0.74)	0.001 (0.002)	0.017 (0.004)	0.007 (0.004)	3.9 (2.2)	4.0 (1.0)	3.0 (0.8)
Mean (±2SD)	0.8 (1.3)	0.3 (0.2)	0.39 (0.36)	3.27 (1.68)	0.002 (0.003)	0.027 (0.050)	0.008 (0.010)	5.1 (3.1)	4.6 (2.9)	3.2 (0.7)

[a](±2 counting uncertainty); values are the uncertainty of the analytical result at the 95% 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) from Fresquez et al. (1996a).
[d]SAL (Los Alamos National Laboratory Screening Action Level) from Fresquez et al. (1996a).
[e]Equivalent to the SAL of 260 pCi/dry g soil at 12% moisture.
[f] NA = not applicable.

Table 6.2. Total Recoverable Trace and Heavy Metals (μg/g dry) in Soils Collected in 1996[a,b]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb[c]	Se	Tl[c]
Off-Site Regional (Background) Stations:												
Rio Chama	0.13	2.3	60.3	0.32	0.13	7.43	0.03	5.23	11.60		0.4	
Embudo	0.13	1.7	103.0	0.46	0.13	8.59	0.03	6.87	7.21		0.3	
Santa Cruz	0.13	4.6	194.0	0.77	0.13	12.00	0.03	9.10	13.90		0.5	
Cochiti	0.13	3.0	103.0	0.43	0.13	6.55	0.03	5.59	8.32		0.4	
Bernalillo	0.13	4.1	145.0	0.55	0.13	7.78	0.03	7.99	10.90		0.4	
Jemez	0.13	5.7	108.6	0.46	0.13	6.93	0.03	5.52	6.96		0.5	
Mean(±2SD)	0.13 (0.0)	3.3 (3.1)	116 (84.8)	0.49 (0.28)	0.13 (0.0)	8.24 (3.63)	0.03 (0.0)	6.57 (2.96)	9.44 (5.42)		0.4 (0.2)	
RSRL[d]	2.09	6.04	194	0.74	0.20	14.8	0.02	10.9	14.40		0.6	
SAL[e]	400	6	5,600	0.9	80	400	24	1,600	500		400	
Off-Site Perimeter Stations:												
Otowi	0.13	1.8	97.0	0.435	0.13	8.37	0.03	5.69	7.20		0.3	
TA-8 (GT Site)	0.13	2.0	118.3	0.511	0.13	5.49	0.05	4.13	11.50		0.5	
TA-49 (BNP)	0.13	3.2	129.0	0.693	0.13	7.49	0.05	4.32	11.90		0.3	
East Airport	0.13	2.4	83.0	0.738	0.13	10.6	0.03	5.74	12.40		0.4	
West Airport	0.13	2.3	110.0	0.616	0.71	8.41	0.03	6.96	23.40		0.2	
North Mesa	0.13	2.9	99.1	0.655	0.13	10.0	0.03	5.52	11.70		0.4	
Sportsman's Club	0.13	3.9	91.5	0.515	0.13	7.79	0.03	4.28	10.10		0.4	
Tsankawi/ PM-1	0.13	2.1	64.4	0.906	0.13	5.41	0.03	3.82	15.50		0.5	
White Rock (East)	0.13	3.4	122.0	1.100	0.13	9.79	0.03	6.49	16.05		0.4	
San Ildefonso	0.13	1.7	41.7	0.471	0.13	4.36	0.03	2.85	7.28		0.2	
Mean (±2SD)	0.13 (0.0)	2.7 (1.5)	95.4 (57.5)	0.689 (0.409)	0.19 (0.39)	7.70 (4.47)	0.03 (0.02)	4.90 (2.7)	13.31 (9.20)		0.4 (0.2)	
On-Site Stations:												
TA-16 (S-Site)	0.13	1.6	187.0	0.825	0.13	5.72	0.03	4.45	9.31		0.4	
TA-21 (DP-Site)	0.13	3.1	100.0	0.827	0.13	4.41	0.03	6.18	38.90		0.3	
Near TA-33	0.13	2.4	101.0	0.818	0.13	9.58	0.03	7.99	15.00		0.3	
TA-50	0.13	2.1	77.1	0.470	0.13	4.03	0.03	3.86	10.30		0.3	
TA-51	0.13	3.2	111.0	0.606	0.13	6.96	0.03	5.32	13.70		0.3	
West of TA-53	0.13	2.7	96.0	0.651	0.13	8.12	0.03	6.39	11.10		0.4	
East of TA-53	0.13	2.1	46.8	0.452	0.13	3.95	0.03	2.88	10.00		0.3	
East of TA-54	0.13	1.6	47.2	0.520	0.13	3.46	0.03	2.63	8.85		0.1	
Potrillo Drive/ TA-36	0.13	2.5	73.6	0.463	0.13	5.95	0.02	5.34	9.32		0.5	
Near Test Well DT-9	0.13	2.1	118.0	0.873	0.13	7.57	0.03	6.40	10.10		0.4	
R-Site Road	0.13	3.1	135.5	0.869	0.13	10.01	0.03	5.46	12.00		0.5	
Two-Mile Mesa	0.13	4.2	47.3	0.499	0.13	3.38	0.03	1.98	8.95		0.4	
Mean (±2SD)	0.13 (0.0)	2.6 (1.5)	95.0 (82.3)	0.656 (0.349)	0.13 (0.0)	6.10 (4.70)	0.03 (0.01)	4.91 (3.59)	13.13 (16.68)		0.4 (0.2)	

[a] Analysis by EPA Method 3051 for total recoverable metals.
[b] All less-than values were reduced by one-half concentration. (Gilbert 1987).
[c] Sb and Tl were not analyzed in FY96.
[d] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) from Fresquez et al. (1996a).
[e] SAL (Los Alamos National Laboratory Screening Action Level).

Table 6-3. Total Effective Dose Equivalent (TEDE) from Living on Soils Collected in 1996

Total Effective Dose Equivalent[a] (mrem/yr)	
	Maximum Consumption[b]
Regional (Background)	1.6 (±2.6)[c]
Perimeter	2.4 (±2.7)[c]
On Site	2.4 (±1.8)[c]
1974–1996 Regional	2.4 (±3.6)[c]

[a] Based on RESRAD version 5.61 and residential scenario [Fresquez et al., 1996a].
[b] Maximum consumption rate is 160 kg/yr (352 lbs/yr) for fruits and vegetables (NRC 1977) and 44 g/yr for soil (Fresquez et al., 1996a).
[c] ±2 sigma in parenthesis; to convert to μSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-4. Radionuclides in Produce Collected from Off-Site, Perimeter, and On-Site Areas during the 1996 Growing Season[a]

	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/dry g)	^{239,240}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/g dry)
Off-Site Regional (Background) Stations							
Española/Santa Fe/Jemez:							
cucumbers	0.22 (0.28)[b]	50.5 (151.6)	66.7 (26.6)	2.7 (2.7)	4.0 (10.6)	25.3 (21.3)	70.5 (45.2)
tomatoes	0.36 (0.28)	–9.0 (48.0)[c]	0.0 (20.0)	1.0 (2.0)	0.4 (8.0)	14.0 (14.0)	10.0 (12.0)
corn	0.23 (0.28)	–9.6 (30.7)	6.4 (12.8)	1.3 (1.3)	–1.3 (3.8)	9.0 (7.7)	12.2 (10.2)
corn	–0.07 (0.28)	58.9 (175.4)	12.8 (12.8)	2.6 (1.3)	–3.8 (1.3)	4.5 (9.0)	16.6 (16.6)
corn	0.43 (0.28)	–22.4 (30.7)	38.4 (12.8)	3.8 (1.3)	1.3 (5.1)	3.8 (5.1)	3.8 (11.5)
cucumbers	0.18 (0.28)	46.6 (138.3)	66.5 (26.6)	10.6 (2.7)	–8.0 (2.7)	10.6 (13.3)	4.0 (21.3)
tomatoes	–0.27 (0.27)	–12.0 (48.0)	20.0 (40.0)	2.0 (2.0)	3.0 (8.0)	12.0 (14.0)	6.0 (18.0)
pinto bean	0.11 (0.14)	7.5 (11.0)	65.0 (10.0)	2.5 (0.5)	–0.5 (0.2)	1.0 (1.0)	7.0 (3.0)
squash	–0.30 (0.1)	43.5 (66.0)	15.0 (30.0)	6.0 (1.5)	–7.2 (2.7)	2.7 (3.6)	28.5 (10.5)
squash	–0.20 (0.1)	107.0 (27.0)	40.0 (30.0)	7.0 (1.0)	2.0 (4.0)	19.0 (8.0)	21.0 (10.0)
squash	–0.50 (0.1)	–31.2 (28.8)	36.0 (24.0)	6.0 (1.2)	5.0 (4.0)	10.0 (5.0)	18.0 (7.2)
squash	0.50 (0.1)	64.8 (97.2)	36.0 (24.0)	7.2 (1.2)	13.2 (7.7)	16.5 (8.8)	40.8 (28.8)
corn	–0.21 (0.14)	8.7 (3.0)	15.0 (12.0)	1.2 (0.3)	–0.3 (1.2)	1.2 (1.8)	9.0 (3.9)
corn	–0.24 (0.14)	13.8 (4.0)	14.0 (6.0)	0.8 (0.2)	0.3 (1.5)	5.7 (2.7)	3.2 (1.4)
corn	0.32 (0.14)	5.1 (7.5)	3.0 (6.0)	0.9 (0.3)	6.0 (2.7)	6.3 (2.4)	7.5 (2.7)
corn	0.49 (0.14)	11.1 (16.8)	33.0 (6.0)	0.9 (0.3)	5.1 (4.5)	–0.9 (1.5)	–3.3 (8.1)
Mean (±2 SD)	0.07 (0.64)[d]	20.8 (74.9)	29.2 (44.5)	3.5 (5.9)	1.2 (10.3)	8.8 (14.5)	15.9 (36.3)
RSRL[e]	16.9	690	75.6	38.2	35.4	67.9	52.2
Off-Site Perimeter Stations							
Los Alamos:							
squash	0.51 (0.28)	104.8 (55.0)	91.7 (26.2)	2.6 (2.6)	5.2 (13.1)	15.7 (18.3)	79.9 (55.0)
peaches	–0.32 (0.27)	–3.8 (36.5)	7.6 (15.2)	1.5 (1.5)	0.8 (4.6)	1.5 (6.1)	–1.5 (7.6)
tomatoes	0.01 (0.27)	24.0 (74.0)	10.0 (20.0)	1.0 (2.0)	–6.0 (10.0)	14.0 (18.0)	2.0 (24.0)
apples	0.05 (0.28)	–6.5 (17.3)	57.6 (21.6)	1.4 (0.7)	1.4 (5.8)	9.0 (7.9)	–1.1 (17.3)
squash	–0.18 (0.27)	95.6 (55.0)	52.4 (26.2)	2.6 (2.6)	5.2 (10.5)	7.9 (13.1)	13.1 (26.2)
lettuce	0.14 (0.28)	37.5 (115.0)	525.0 (100.0)	95.0 (20.0)	–2.5 (25.0)	195.0 (90.0)	587.5 (225.0)
squash	0.22 (0.28)	107.4 (52.4)	144.1 (26.2)	2.6 (2.6)	–2.6 (13.1)	28.8 (26.2)	369.4 (99.6)
Mean (±2 SD)	0.06 (0.54)	51.3 (100.9)	126.9 (363.6)	15.2 (70.4)	0.2 (8.4)	38.8 (138.8)	149.9 (469.7)

Table 6-4. Radionuclides in Produce Collected from Off-Site, Perimeter, and On-Site Areas during the 1996 Growing Season[a] (Cont.)

	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/dry g)	^{239,240}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/g dry)
White Rock/Pajarito Acres:							
green beans	0.01 (0.28)	24.2 (15.6)	31.2 (31.2)	2.3 (1.6)	–3.9 (1.6)	1.6 (4.7)	58.5 (25.0)
squash	0.38 (0.28)	23.6 (70.7)	26.2 (52.4)	6.6 (2.6)	–5.2 (15.7)	24.9 (31.4)	56.3 (41.9)
squash	–0.12 (0.28)	34.1 (104.8)	39.3 (26.2)	3.9 (2.6)	–3.9 (2.6)	22.3 (21.0)	31.4 (23.6)
corn	0.30 (0.28)	12.2 (37.1)	0.0 (12.8)	2.6 (1.3)	–1.3 (3.8)	10.9 (9.0)	5.1 (12.8)
tomatoes	0.51 (0.28)	–12.0 (48.0)	10.0 (20.0)	1.0 (2.0)	2.0 (10.0)	15.0 (14.0)	26.0 (22.0)
green beans	0.25 (0.28)	6.2 (18.7)	7.8 (15.6)	2.3 (1.6)	0.3 (7.8)	6.2 (9.4)	20.3 (14.0)
tomatoes	–0.07 (0.28)	33.0 (20.0)	0.0 (20.0)	2.0 (2.0)	6.0 (8.0)	5.0 (8.0)	9.0 (10.0)
Mean (±2SD)	0.18 (0.48)	17.3 (32.9)	16.4 (31.5)	3.0 (3.6)	–0.9 (7.9)	12.3 (17.8)	29.5 (42.2)
Cochiti:							
cucumbers	0.32 (0.28)	27.9 (82.46)	305.9 (106.4)	78.5 (16.0)	9.3 (16.0)	13.3 (21.3)	57.2 (37.2)
squash	0.57 (0.29)	52.4 (157.2)	131.0 (183.4)	3.9 (2.6)	1.3 (5.2)	10.5 (13.1)	7.9 (36.7)
squash	0.58 (0.29)	65.5 (196.5)	–104.8 (104.8)	5.2 (2.6)	–7.9 (26.2)	24.9 (36.7)	23.6 (26.2)
tomatoes	0.26 (0.28)	3.0 (8.0)	190.0 (360.0)	2.0 (2.0)	3.0 (6.0)	18.0 (12.0)	20.0 (14.0)
green beans	0.46 (0.28)	12.5 (9.36)	156.0 (171.6)	3.1 (1.6)	1.6 (10.9)	22.6 (18.7)	27.3 (13.7)
corn	0.52 (0.28)	9.0 (26.88)	–19.2 (25.6)	2.6 (1.3)	1.9 (6.4)	5.8 (9.0)	41.0 (21.8)
Mean (±2SD)	0.45 (0.27)	28.4 (50.8)	109.8 (296.9)	15.9 (61.4)	1.5 (11.0)	15.9 (14.6)	29.5 (34.6)
Pueblo of San Ildefonso:							
parsley	0.35 (0.28)	48.4 (24.2)	242.0 (110.0)	27.5 (6.6)	15.4 (13.2)	86.9 (26.4)	72.6 (35.2)
cucumbers	–0.25 (0.27)	75.8 (228.96)	133.0 (160.0)	5.3 (2.7)	0.0 (10.6)	12.0 (13.3)	22.6 (21.3)
squash	0.45 (0.28)	128.4 (55.02)	170.3 (183.4)	9.2 (2.6)	3.9 (10.5)	2.6 (10.5)	27.3 (21.3)
tomatoes	0.17 (0.28)	65.0 (32.0)	10.0 (100.0)	2.0 (2.0)	–2.0 (10.0)	27.0 (20.0)	4.0 (20.0)
corn	–0.06 (0.28)	–3.2 (30.72)	115.2 (294.4)	1.3 (1.3)	2.6 (3.8)	3.2 (5.1)	6.4 (6.4)
lettuce	0.03 (0.28)	115.0 (350.0)	400.0 (250.0)	1.0 (0.5)	17.5 (25.0)	25.0 (35.0)	10.0 (20.0)
green beans	0.50 (0.28)	24.2 (71.76)	101.4 (62.4)	3.1 (1.6)	1.6 (9.4)	7.8 (9.4)	9.4 (12.5)
Mean (±2SD)	0.17 (0.56)	64.8 (93.9)	167.4 (248.6)	7.1 (18.9)	5.6 (15.4)	23.5 (59.2)	21.8 (48.0)

Table 6-4. Radionuclides in Produce Collected from Off-Site, Perimeter, and On-Site Areas during the 1996 Growing Season[a] (Cont.)

	^{3}H (pCi/mL)	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/dry g)	^{239,240}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/g dry)
On-Site Stations							
LANL:							
apples	1.77 (0.30)	2.5 (2.88)	–7.2 (7.2)	0.4 (0.7)	1.1 (3.6)	4.3 (5.0)	16.9 (8.6)
peaches	0.31 (0.28)	2.3 (6.08)	38.0 (30.4)	2.3 (1.5)	0.8 (6.1)	17.5 (13.7)	27.4 (13.7)
peaches	2.61 (0.31)	36.5 (16.72)	7.6 (15.2)	1.5 (1.5)	1.5 (7.6)	–0.8 (7.6)	1.5 (7.6)
necterines	0.19 (0.28)	–1.6 (37.44)	15.6 (15.6)	0.8 (1.6)	–7.8 (78.0)	0.0 (39.0)	76.4 (48.4)
pears	0.38 (0.28)	–3.4 (14.88)	–6.2 (6.2)	0.9 (0.6)	0.0 (1.9)	1.9 (2.5)	25.1 (11.8)
crab apples	0.68 (0.29)	–4.4 (19.2)	612.0 (1016.0)	1.2 (0.8)	0.8 (2.4)	1.6 (2.4)	14.8 (8.8)
Mean (±2SD)	0.99 (1.96)	5.3 (31.1)	110.0 (493.0)	1.2 (1.3)	–0.6 (7.1)	4.1 (13.6)	27.0 (51.7)

[a] There are no concentration guides for produce; however, all mean radionuclide contents in produce collected from LANL, with the exception of ^{3}H, and perimeter areas were not significantly higher from regional background using a nonparametric Wilcoxon Rank Sum test at the 0.05 probability level (Gilbert 1987).

[b] (±2 counting uncertainty); values are the uncertainty in the analytical results at the 95% confidence level.

[c] See Appendix B, for an explanation of the presence of negative values.

[d] (±2 standard deviation).

[e] Regional Statistical Reference Level; this is the upper-limit background concentration [mean + 2 std dev] from 1981 to 1994 data.

Table 6-5. Total Committed Effective Dose Equivalent and Maximum Annual CEDE[a] from the Ingestion of Produce Collected during 1995 and 1996

	1996		1995	
Background	CEDE (mrem)	Max CEDE (mrem)	CEDE (mrem)	Max CEDE (mrem)
Española, Santa Fe, Jemez				
# of Produce Samples	16		6	
Maximum Consumption[b]	0.19 (±0.74)[c]	0.93	0.38 (±0.86)[c]	1.2
Off-Site:				
Cochiti Pueblo				
# of Produce Samples	6		5	
Maximum Consumption[b]	0.24 (±0.56)[c]	0.80	0.20 (±0.45)[c]	0.65
White Rock/Pajarito Acres				
# of Produce Samples	7		6	
Maximum Consumption[b]	0.77 (±0.15)[c]	0.22	0.078 (±0.18)[c]	0.26
Los Alamos Townsite				
# of Produce Samples	7		6	
Maximum Consumption[b]	0.38 (±1.3)[c]	1.7	0.12 (±0.23)[c]	0.35
Pueblo of San Ildefonso				
# of Produce Samples	7		5	
Maximum Consumption[b]	0.81 (±2.3)[c]	3.2	0.31 (±0.54)[c]	0.85
On-Site:[d]				
# of Produce Samples	6		5	
Maximum Consumption[b]	0.61 (±2.7)[c]	3.3	0.54 (±1.6)[c]	2.2

[a] Based on DOE dose conversion factors (DOE 1988); maximum annual CEDE is the average CEDE + 2 sigma.
[b] Maximum consumption rate for produce is 160 kg/yr [NRC 1977].
[c] ±2 sigma of the data in parenthesis; to convert to μSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.
[d] Calculations presented here are for comparison purposes only. Produce grown on-site is not available for consumption.

Table 6-6. Total Recoverable Trace and Heavy Metals (μg/g dry) in Produce Collected in 1996[a]

	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl
Off-Site Regional (Background) Stations												
Española/Santa Fe/Jemez:												
cucumber	0.27[b]	1.10	18.40	0.06[b]	0.12[b]	0.48	0.05[b]	2.45	1.3	0.15[b]	0.2	0.15[b]
tomato	0.27[b]	0.10[b]	3.72	0.06[b]	0.32	4.35	0.05[b]	28.60	7.8	0.15[b]	0.1[b]	0.15[b]
corn	0.27[b]	0.10[b]	1.08	0.06[b]	0.12[b]	0.13[b]	0.05[b]	6.18	21.5	0.15[b]	0.1[b]	0.15[b]
corn	0.27[b]	0.10[b]	0.40	0.06[b]	0.12[b]	0.13[b]	0.05[b]	6.86	25.7	0.15[b]	0.1[b]	0.15[b]
corn	0.58	0.10[b]	0.35	0.06[b]	0.12[b]	0.13[b]	0.05[b]	4.02	26.4	0.15[b]	0.3	0.15[b]
cucumber	0.27[b]	0.10[b]	12.30	0.06[b]	0.12[b]	0.26	0.05[b]	0.36[b]	2.1	0.15[b]	0.4	0.15[b]
tomato	0.27[b]	0.10[b]	12.70	0.06[b]	0.12[b]	4.03	0.05[b]	20.60	3.6	0.15[b]	0.3	0.15[b]
Mean	0.31	0.24	6.99	0.06	0.15	1.36	0.05	9.87	12.6	0.15	0.2	0.15
(±2 std dev)	(0.23)	(0.76)	(14.70)	(0.00)	(0.15)	(3.88)	(0.00)	(21.11)	(22.9)	(0.00)	(0.2)	0.00
RSRL[c]	1.38	0.66	27.43	0.53	0.46	3.98	0.06	23.50	22.0	0.18	0.3	0.20
Off-Site Perimeter Stations												
Los Alamos Townsite:												
squash	0.27[b]	0.10[b]	13.70	0.06[b]	0.12[b]	0.52	0.05[b]	1.37	1.1	0.15[b]	0.1[b]	0.15[b]
peach	0.58	0.10[b]	1.91	0.06[b]	0.12[b]	1.51	0.05[b]	5.09	2.8	0.15[b]	0.1[b]	0.15[b]
tomato	0.27[b]	0.10[b]	3.28	0.06[b]	0.12[b]	2.06	0.05[b]	17.00	1.9	0.40	0.1[b]	0.15[b]
apple	0.27[b]	0.10[b]	2.27	0.06[b]	0.12[b]	0.50	0.05[b]	2.76	3.3	0.15[b]	0.1[b]	0.15[b]
squash	0.27[b]	0.10[b]	9.75	0.06[b]	0.13[b]	0.38	0.05[b]	7.50	0.6	0.15[b]	0.3	0.15[b]
lettuce	0.27[b]	0.10[b]	27.70	0.06[b]	0.12[b]	0.63	0.05[b]	1.36	1.4	0.15[b]	0.4	0.15[b]
squash	0.56	0.10[b]	12.80	0.06[b]	0.12[b]	0.13[b]	0.05[b]	2.49	1.8	0.15[b]	0.2	0.15[b]
Mean	0.36	0.10	10.20	0.06	0.12	0.82	0.05	5.37	1.8	0.19	0.2	0.15
(±2 std dev)	(0.29)	(0.00)	(18.35)	(0.00)	(0.01)	(1.39)	(0.00)	(11.17)	(1.9)	(0.19)	(0.2)	(0.00)
White Rock /Pajarito Acres:												
green bean	0.27[b]	0.10[b]	16.10	0.06[b]	0.12[b]	0.13[b]	0.05[b]	2.36	6.3	0.15[b]	0.2	0.15[b]
squash	0.27[b]	0.10[b]	10.00	0.06[b]	0.12[b]	0.13[b]	0.05[b]	3.66	1.6	0.15[b]	0.3	0.15[b]
squash	0.56	0.10[b]	7.10	0.06[b]	0.12[b]	0.33	0.05[b]	1.88	1.1	0.15[b]	0.4	0.15[b]
corn	0.27[b]	0.10[b]	0.26	0.06[b]	0.12[b]	0.37	0.05[b]	6.26	48.0	0.40	0.1[b]	0.15[b]
tomato	0.27[b]	0.10[b]	4.59	0.06[b]	0.12[b]	3.09	0.05[b]	16.30	32.7	0.15[b]	0.1[b]	0.15[b]
green bean	0.27[b]	0.10[b]	14.20	0.06[b]	0.12[b]	0.13[b]	0.05[b]	3.58	2.2	0.15[b]	0.2	0.15[b]
tomato	0.27[b]	0.10[b]	2.25	0.06[b]	0.12[b]	0.54	0.05[b]	3.93	5.1	0.15[b]	0.2	0.15[b]
Mean	0.31	0.10	7.79	0.06	0.12	0.67	0.05	5.42	13.9	0.19	0.2	0.15
(±2 std dev)	(0.22)	(0.00)	(11.92)	(0.00)	(0.00)	(2.15)	(0.00)	(10.00)	(37.4)	(0.19)	(0.2)	(0.00)

Table 6-6. Total Recoverable Trace and Heavy Metals (µg/g dry) in Produce Collected in 1996[a] (Cont.)

	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl
Cochiti/Peña Blanca/Santo Domingo:												
cucumber	0.16[b]	0.10[b]	7.40	0.06[b]	0.12[b]	0.23	0.05[b]	0.36[b]	2.9	0.15[b]	0.2	0.15[b]
squash	0.16[b]	0.10[b]	3.97	0.06[b]	0.12[b]	0.44	0.05[b]	0.36[b]	1.8	0.15[b]	0.3	0.15[b]
squash	0.16[b]	0.10[b]	3.55	0.06[b]	0.12[b]	0.78	0.05[b]	0.36[b]	1.3	0.15[b]	0.1[b]	0.15[b]
tomato	0.16[b]	0.10[b]	5.97	0.06[b]	0.12[b]	1.79	0.10	13.00	1.1	0.15[b]	0.1[b]	0.15[b]
green bean	0.16[b]	0.10[b]	8.22	0.06[b]	0.12[b]	0.17	0.05[b]	0.36[b]	4.4	0.15[b]	0.2	0.15[b]
corn	0.16[b]	0.10[b]	0.40	0.06[b]	0.12[b]	0.17	0.05[b]	0.36[b]	9.0	0.15[b]	0.4	0.15[b]
Mean	0.16	0.10	4.92	0.06	0.12	0.60	0.06	2.47	3.4	0.15	0.2	0.15
(±2 std dev)	(0.00)	(0.00)	(5.75)	(0.00)	(0.00)	(1.26)	(0.04)	(10.32)	(6.0)	(0.00)	(0.2)	(0.00)
Pueblo of San Ildefonso:												
parsley	0.16[b]	0.15[b]	29.90	0.06[b]	0.12[b]	0.08[b]	0.05[b]	0.36[b]	2.1	0.15[b]	0.3	0.15[b]
cucumber	0.16[b]	0.15[b]	18.10	0.06[b]	0.12[b]	0.08[b]	0.05[b]	0.36[b]	1.0	0.15[b]	0.3	0.15[b]
squash	0.16[b]	0.15[b]	8.70	0.06[b]	0.12[b]	0.23	0.05[b]	0.36[b]	1.5	0.15[b]	0.1[b]	0.15[b]
tomato	0.16[b]	0.15[b]	5.30	0.06[b]	0.12[b]	0.40	0.05[b]	1.50	2.4	0.15[b]	0.3	0.15[b]
corn	0.16[b]	0.40	0.82	0.06[b]	0.12[b]	0.08[b]	0.10	3.60	27.1	0.15[b]	0.7	0.15[b]
Mean	0.16	0.20	12.56	0.06	0.12	0.17	0.06	1.24	6.8	0.15	0.3	0.15
(±2 std dev)	(0.00)	(0.22)	(23.17)	(0.00)	(0.00)	(0.28)	(0.04)	(2.82)	(22.7)	(0.00)	(0.4)	(0.00)
On-Site Stations												
LANL:												
apple	0.16[b]	0.10[b]	3.33	0.06[b]	0.12[b]	0.08[b]	0.10	0.36[b]	6.2	0.15[b]	0.1[b]	0.15[b]
peach	0.16[b]	0.10[b]	2.49	0.06[b]	0.12[b]	0.22	0.05[b]	0.36[b]	4.3	0.15[b]	0.2	0.15[b]
peach	0.16[b]	0.10[b]	6.28	0.06[b]	0.12[b]	0.08[b]	0.05[b]	0.85	2.9	0.15[b]	0.1[b]	0.15[b]
nectarine	0.16[b]	0.50	4.82	0.06[b]	0.12[b]	0.08[b]	0.05[b]	1.43	4.4	0.15[b]	0.1[b]	0.15[b]
pear	0.16[b]	0.10[b]	6.58	0.06[b]	0.12[b]	0.08[b]	0.05[b]	1.03	11.6	0.15[b]	0.1[b]	0.15[b]
crab apple	0.16[b]	0.10[b]	16.70	0.06[b]	0.12[b]	0.08[b]	0.10	1.10	12.6	0.15[b]	0.3	0.15[b]
Mean	0.16	0.17	6.70	0.06	0.12	0.10	0.07	0.86	7.0	0.15	0.2	0.15
(±2 std dev)	(0.00)	(0.33)	(10.31)	(0.00)	(0.00)	(0.11)	(0.05)	(0.85)	(8.2)	(0.00)	(0.2)	(0.00)

[a] Analysis by EPA Method 3051 for total recoverable metals.
[b] Less than values were converted to one-half the concentration. (Gilbert 1987).
[c] Regional Statistical Reference Level; this is the upper limit background concentration (mean + 2 std dev) from 1994, 1995, and 1996 data.

Table 6-7. Radionuclides in Honey Collected from Off-Site Perimeter and Regional (Background) Beehives during 1996

	Perimeter					
Radioisotope	Los Alamos Spruce St.	Los Alamos 42nd St.	Los Alamos Arizona St.	White Rock/Pajarito Acres	Regional (Background)	RSRL[e]
^{3}H (pCi/mL)[a]	0.03 (0.28)[b]	0.41 (0.28)	1.27 (0.38)	0.01 (0.26)	0.16 (0.30)	5.25
^{228}Ac (pCi/L)	8.4 (25.2)	26.0 (13.0)	1.72 (5.16)	34.9 (15.8)	15.1 (8.8)	23.90
^{57}Co (pCi/L)	–1.1 (1.52)[c]	–0.16 (1.52)	–0.16 (1.52)	0.46 (1.4)	2.5 (1.12)	154.68
^{58}Co (pCi/L)	–1.88 (1.52)	10.2 (30.6)	–4.6 (1.52)	–1.94 (1.52)	–1.66 (1.52)	–0.14
^{60}Co (pCi/L)	8.58 (4.16)	5.24 (3.0)	12.3 (5.2)	4.18 (2.64)	0.36 (1.08)	2.66
^{152}Eu (pCi/L)[d]						9.69
^{40}K (pCi/L)	524.0 (144.0)	922.0 (220.0)	960.0 (228.0)	499.0 (140.0)	499.0 (140.0)	740.00
^{7}Be (pCi/L)	64.1 (33.6)	48.8 (30.0)	70.0 (210.0)	49.4 (28.4)	53.3 (30.6)	887.27
^{214}Bi (pCi/L)	–4.8 (1.52)	–5.8 (1.52)	–3.4 (1.52)	–2.6 (1.52)	–4.8 (1.52)	–3.28
^{22}Na (pCi/L)[d]						70.12
^{54}Mn (pCi/L)	1.6 (0.0)	–0.02 (0.0)	1.74 (1.48)	–0.1 (0.0)	0.86 (0.0)	89.28
^{83}Rb (pCi/L)[d]						248.32
^{137}Cs (pCi/L)	4.8 (14.4)	–0.14 (1.6)	1.12 (3.36)	4.2 (12.6)	3.0 (9.0)	305.28
^{238}Pu (pCi/L)	0.001 (0.008)	–0.005 (0.022)	–0.004 (0.004)	0.004 (0.012)	0.042 (0.028)	0.07
^{239}Pu (pCi/L)	0.027 (0.022)	0.002 (0.012)	0.011 (0.018)	0.023 (0.020)	0.019 (0.020)	0.12
^{212}Pb (pCi/L)	5.66 (2.84)	–1.1 (0.0)	–1.22 (0.0)	–0.18 (0.0)	3.82 (2.16)	5.98
^{214}Pb (pCi/L)	2.0 (6.0)	–2.4 (1.52)	0.14 (0.44)	–1.86 (1.52)	0.58 (1.72)	2.30
^{241}Am (pCi/L)	0.004 (0.019)	0.044 (0.034)	0.025 (0.075)	0.016 (0.026)	0.019 (0.025)	0.05
^{90}Sr (pCi/L)	3.9 (2.8)	5.3 (3.0)	8.2 (3.8)	5.9 (5.8)	1.8 (4.4)	5.04
^{208}Tl (pCi/L)	–0.22 (0.0)	0.98 (0.0)	4.6 (0.0)	5.14 (2.64)	2.34 (1.68)	4.02
^{tot}U (µg/L)	1.13 (0.22)	0.27 (0.06)	0.41 (0.08)	0.92 (0.18)	0.49 (0.10)	4.99

[a] pCi/mL of honey moisture; honey contains approximately 18% water and has a density of 1,860 g/L.
[b] (±2 counting uncertainty); values are the uncertainty in the analytical result at the 95% confidence level.
[c] See Appendix B for an explanation of the presence of negative values.
[d] Lost in analysis.
[e] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) from Fresquez et al., 1996b.

Table 6-8. Total Committed Effective Dose Equivalent from the Ingestion of Honey Collected during 1996

Committed Effective Dose Equivalent[a] (mrem/yr)	
Background	**1996[b]**
# of Honey Samples	1
Maximum Consumption[c]	0.028 (±0.011)
Perimeter	
White Rock:	
# of Honey Samples	1
Maximum Consumption[c]	0.029 (±0.012)[d]
Los Alamos Townsite:	
# of Honey Samples	1
Maximum Consumption[c]	0.045 (±0.030)[d]

[a] Based on DOE dose conversion factors (DOE 1988).
[b] Analyses for 1996 included several radionuclides that were not requested in 1995. These numbers are not directly comparable to previous years.
[c] The maximum consumption rate for honey is 5 kg/yr (11 lb/yr).
[d] ±2 sigma in parenthesis; to convert to µSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-9. Radionuclides in Eggs Collected in 1996

Radionuclide	Pueblo of San Ildefonso[a]		Los Alamos[a] Townsite		Española (Background)		RSRL[b]
^{238}Pu (pCi/L)[c]	0.002	(0.012)[d]	0.001	(0.008)	0.040	(0.022)	0.07
^{239}Pu (pCi/L)	–0.001[e]	(0.002)[e]	0.029	(0.018)	0.035	(0.022)	0.069
^{90}Sr (pCi/L)	0.0	(3.6)	2.1	(2.4)	1.6	(2.8)	3.2
Total U (µg/L)	0.07	(0.02)	0.06	(0.02)	0.05	(0.02)	0.06
Tritium (pCi/mL)	–0.5	(0.6)	0.2	(1.0)	–0.5	(0.6)	0.07
^{137}Cs (pCi/L)	3.8	(11.4)	38.0	(114.0)	3.1	(9.4)	9.04
^{241}Am (pCi/L)	0.012	(0.014)	0.020	(0.026)	0.026	(0.024)	0.05

[a] Most radionuclides in the Pueblo of San Ildefonso and Los Alamos townsite eggs, with the exception of uranium, were not detectable (where the analytical result was greater than two times the counting uncertainty) and higher than the RSRL.
[b] Regional Statistical Reference Level; this is the upper limit background concentration (mean + 2 counting uncertainties) based on 1995 to 1996 data.
[c] One liter (1L) is equal to approximately two dozen eggs (24 eggs) and the density of eggs is around 1,135 g/L.
[d] (±2 counting uncertainties); values are the uncertainty in the analytical results at the 95% confidence level.
[e] See Appendix B for an explanation of the presence of negative numbers.

Table 6-10. Total Committed Effective Dose Equivalent from the Ingestion of Eggs Collected during 1996

	Committed Effective Dose Equivalent (mrem/yr)[a]		
	Pueblo of San Ildefonso	Los Alamos Townsite	Regional Background
Maximum Consumption[b]	0.0040 (±0.021) [c]	0.043 (±0.11) [c]	0.014 (±0.021) [c]

[a] Based on DOE dose conversion factors (DOE 1988).
[b] The maximum consumption rate for eggs is 5 kg/yr or 55 g/day.
[c] ±2 sigma in parenthesis; to convert to µSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-11. Radionuclides in Milk Collected in 1996

Radionuclide	Pojoaque Valley		Albuquerque (Background)		RSRL[a]
^{238}Pu (pCi/L)	0.000	(0.004)[b]	0.002	(0.004)	0.012
^{239}Pu (pCi/L)	0.001	(0.002)	0.005	(0.006)	0.010
^{90}Sr (pCi/L)	1.300	(0.6)	0.400	(0.6)	8
Total U (µg/L)	1.560	(0.32)	0.750	(0.16)	0.94
Tritium (pCi/mL)	0.000	(0.8)	–0.300	(0.8)	0.1
^{137}Cs (pCi/L)	12.000	(8)	14.000	(10)	21
^{131}I (pCi/L)	0.700	(2.2)	3.800	(11.4)	15.0

[a] Regional Statistical Reference Level; this is the upper limit background (mean + 2 std dev) from 1994–1996 data.
[b] (±2 counting uncertainties); values are the uncertainty in the analytical results at the 95% confidence level.
[c] See Appendix B for an explanation of the presence of negative numbers.

Table 6-12. Total Committed Effective Dose Equivalent from the Ingestion of Milk

	Committed Effective Dose Equivalent (mrem)[b]		
	1994	1995	1996
Pojoaque Valley[b]	0.14 (±0.49)[c]	0.26 (±0.50)[c]	0.31 (±0.21)[c]
Albuquerque Background[b]	0.20 (±0.55)[c]	0.48 (±0.40)[c]	0.32 (±0.38)[c]

[a] Based on DOE dose conversion factors (DOE 1988).
[b] Maximum annual consumption rate for milk is 199 kg/yr (0.5 L/day) (EPA 1984).
[c] ±2 sigma of the data in parenthesis; to convert to µSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-13. Radionuclides in Game (Surface-Feeding) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory during 1996

	^{3}H[a] pCi/mL	^{90}Sr 10^{-2} pCi/g dry	^{137}Cs 10^{-2} pCi/g dry	Total Uranium ng/g dry	^{238}Pu 10^{-5} pCig /dry	^{239}Pu 10^{-5} pCi/g dry	^{241}Am 10^{-5} pCi/g dry
Game Fish/Surface Feeders							
Upstream (Abiquiu, Heron, and El Vado):							
trout/walleye	0.65 (0.29)	1.21 (2.42)	1.94 (0.73)	2.42 (0.48)	1.21 (4.84)	0.00 (2.42)	–2.42[b] (2.42)
crappie	0.32 (0.28)	1.21 (2.42)	0.97 (0.48)	3.63 (0.73)	1.21 (2.42)	1.21 (2.42)	7.26 (9.68)
crappie	0.16 (0.28)	3.63 (2.42)	0.61 (0.24)	3.63 (0.73)	0.00 (2.42)	12.1 (0.00)	4.84 (7.26)
crappie	0.55 (0.29)	6.05 (4.84)	0.97 (0.48)	3.63 (0.73)	0.00 (4.84)	2.42 (4.84)	24.2 (24.2)
bass	0.30 (0.28)	2.42 (4.84)	0.61 (0.24)	3.63 (0.73)	4.84 (4.84)	2.42 (4.84)	12.1 (0.00)
Mean (±2 std dev)	0.40 (0.40)	2.90 (4.05)	1.02 (1.09)	3.39 (1.08)	1.45 (3.98)	3.63 (9.68)	9.20 (19.78)
RSRL	0.20	17.00	27.70	6.50	23.6	28.3	28.90
Downstream (Cochiti):							
Pre Dome Fire (6-3-96)							
bass	0.22 (0.28)	3.63 (4.84)	1.94 (0.48)	4.84 (0.97)	–1.21 (2.42)	6.05 (7.26)	6.05 (7.26)
bass	LIA	13.31 (12.1)	1.94 (0.73)	6.05 (2.42)	–2.42 (2.42)	3.63 (4.84)	–2.42 (2.42)
crappie	LIA	4.84 (2.42)	1.94 (5.81)	7.26 (2.42)	1.21 (4.84)	12.1 (0.00)	18.15 (12.1)
crappie	LIA	6.05 (14.52)	2.30 (0.73)	6.05 (2.42)	3.63 (4.84)	2.42 (7.26)	6.05 (7.26)
pike	LIA	1.21 (2.42)	1.33 (0.48)	3.63 (0.73)	–1.21 (4.84)	24.2 (0.00)	24.2 (24.2)
pike	0.16 (0.28)	1.21 (4.84)	1.44 (4.60)	3.63 (0.73)	1.21 (2.42)	12.1 (0.00)	9.68 (7.26)
pike	0.04 (0.28)	0.00 (4.84)	1.57 (0.73)	3.63 (0.73)	4.84 (4.84)	2.42 (4.84)	4.84 (7.26)
Mean (±2 std dev)	0.14 (0.18)	4.32 (9.04)	1.78 (0.68)	5.01 (2.94)	0.86 (5.36)	8.99 (15.80)	9.51 (17.86)
Post Dome Fire (8-8-96)							
bass	–0.00 (0.28)	1.21 (14.52)	1.94 (1.45)	6.05 (2.42)	13.3 (26.6)	7.3 (16.9)	26.62 (41.14)
bass	0.84 (0.29)	4.84 (16.94)	2.54 (1.93)	6.05 (2.42)	0.00 (2.4)	0.0 (4.8)	20.57 (19.36)
bass	–0.32 (0.27)	4.84 (14.52)	1.45 (1.45)	7.26 (2.42)	0.00 (2.4)	0.0 (2.4)	8.47 (14.52)
bass	–0.03 (0.28)	3.63 (12.1)	2.30 (1.69)	6.05 (2.42)	1.20 (4.8)	2.4 (4.8)	10.89 (9.68)
bluegill	–0.02 (0.28)	6.05 (12.1)	1.82 (5.32)	9.68 (2.42)	1.20 (4.8)	10.9 (7.3)	36.30 (21.78)
walleye	0.05 (0.28)	–1.21 (12.1)	2.42 (1.93)	2.42 (0.48)	–1.20 (2.4)	2.4 (4.8)	10.89 (14.52)
Mean (±2 std dev)	0.09 (0.78)	3.23 (5.45)	2.08 (0.83)	6.25 (4.70)	2.42 (10.8)	3.8 (8.7)	18.96 (21.95)

Table 6-13. Radionuclides in Game (Surface-Feeding) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory during 1996 (Cont.)

	^{3}H pCi/mL	^{90}Sr 10^{-2} pCi/g dry	^{137}Cs 10^{-2} pCi/g dry	Total Uranium ng/g dry	^{238}Pu 10^{-5} pCig /dry	^{239}Pu 10^{-5} pCi/g dry	^{241}Am 10^{-5} pCi/g dry
Nongame Fish/Bottom Feeders							
Upstream (Abiquiu, Heron, and El Vado):							
sucker	0.09 (0.28)	2.85 (3.80)	1.14 (0.38)	2.85 (0.57)	3.80 (5.70)	9.50 (0.00)	0.00 (0.00)
sucker	0.58 (0.29)	4.75 (3.80)	0.48 (0.38)	3.80 (0.76)	0.95 (3.80)	0.95 (3.80)	9.50 (0.00)
carp sucker	–0.06 (0.28)	3.80 (3.80)	–0.48 (1.52)	6.65 (1.90)	0.00 (3.80)	9.50 (0.00)	0.00 (0.00)
carp sucker	0.26 (0.28)	5.70 (3.80)	1.52 (0.57)	9.50 (1.90)	1.90 (3.80)	1.90 (3.80)	9.50 (0.00)
catfish	–0.20 (0.28)	1.90 (1.90)	1.33 (0.57)	12.35 (1.90)	–0.95 (1.90)	0.95 (3.80)	9.50 (0.00)
catfish	0.18 (0.28)	0.95 (3.80)	1.14 (3.23)	9.50 (1.90)	9.50 (0.00)	–0.95 (0.00)	9.50 (0.00)
Mean (±2 std dev)	0.14 (0.54)	3.33 (3.56)	0.86 (1.48)	7.44 (7.35)	2.53 (7.57)	3.64 (9.26)	6.33 (9.81)
RSRL	0.20	13.20	26.90	16.20	9.80	19.20	16.14
Downstream (Cochiti):							
Pre Dome Fire (6-3-96)							
carp	0.43 (0.28)	11.4 (1.90)	1.43 (0.57)	24.70 (5.70)	9.50 (0.00)	4.75 (3.80)	7.60 (7.60)
carp	0.16 (0.28)	2.85 (1.90)	1.62 (4.94)	3.80 (0.76)	1.90 (3.80)	9.50 (0.00)	–0.95 (1.90)
catfish	0.35 (0.28)	0.00 (1.90)	1.52 (0.57)	5.70 (1.90)	2.85 (5.70)	9.50 (0.00)	57.00 (19.00)
catfish	0.80 (0.29)	2.85 (1.90)	1.05 (0.38)	14.25 (3.80)	9.50 (19.00)	19.00 (19.00)	8.55 (7.60)
Mean (±2 std dev)	0.44 (0.54)	4.28 (9.87)	1.41 (0.50)	12.11 (19.08)	5.94 (8.26)	10.69 (11.95)	18.05 (52.63)

Table 6-13. Radionuclides in Game (Surface-Feeding) and Nongame (Bottom-Feeding) Fish Upstream and Downstream of Los Alamos National Laboratory during 1996 (Cont.)

	^{3}H pCi/mL	^{90}Sr 10^{-2} pCi/g dry	^{137}Cs 10^{-2} pCi/g dry	Total Uranium ng/g dry	^{238}Pu 10^{-5} pCig /dry	^{239}Pu 10^{-5} pCi/g dry	^{241}Am 10^{-5} pCi/g dry
Downstream (Cochiti) (Cont.):							
Post Dome Fire (8-8-96)							
catfish	–0.09 (0.28)	2.85 (9.5)	2.47 (1.52)	12.35 (1.90)	1.0 (3.8)	3.8 (5.7)	8.55 (7.6)
catfish	0.24 (0.28)	0.00 (49.4)	1.14 (0.76)	8.55 (1.90)	–1.0 (1.9)	2.9 (3.8)	18.05 (13.3)
catfish	–0.25 (0.28)	2.85 (28.5)	2.47 (1.71)	11.40 (1.90)	–4.8 (3.8)	6.7 (7.6)	5.7 (19.0)
carp	–0.07 (0.28)	8.55 (34.2)	1.05 (0.95)	14.25 (3.80)	0.0 (0.8)	–1.0 (1.9)	6.65 (5.7)
carp	–0.28 (0.28)	14.25 (30.4)	0.48 (1.33)	20.90 (38.00)	1.0 (3.8)	1.0 (3.8)	11.4 (9.5)
carp sucker	–0.44 (0.41)	2.85 (13.3)	0.67 (0.76)	2.85 (1.90)	1.9 (5.7)	2.9 (5.7)	2.85 (5.7)
Mean (±2 std dev)	–0.15 (0.47)	5.23 (10.46)	1.38 (1.76)	11.72 (12.00)	–0.3 (4.8)	2.7 (5.2)	8.87 (10.66)

[a] mL of tissue moisture.
[b] See Appendix B for an explanation of the presence of negative values.
[c] (±2 counting uncertainty); values are the uncertainty in the analytical results at the 95% confidence level.
[d] (±2 standard deviation).
[e] Regional Statistical Reference Level; this is the upper-limit background concentration (mean + 2 std dev) from Fresquez et al. (1994a).
[f] Detectable value (where the analytical result was higher than two times the counting uncertainty) and higher than the RSRL.

Table 6-14. Total Committed Effective Dose Equivalent from the Ingestion of Fish from Upstream and Downstream of the Laboratory for 1996

	Committed Effective Dose Equivalent (mrem/yr)[a]		
		Downstream (Cochiti)	
	Upstream (Abiquiu, Heron, El Vado)	Pre-Dome Fire	Post-Dome Fire
Bottom Feeders:			
# Fish Samples	6	7	6
Maximum Consumption[b]	0.042 (±0.051)[c]	0.067 (±0.14)[c]	0.064 (±0.11)[c]
Higher Level Feeders:			
# Fish Samples	5	6	4
Maximum Consumption[b]	0.034 (±0.050)[c]	0.049 (±0.085)[c]	0.049 (±0.065)[c]

[a] Based on DOE dose conversion factors (DOE 1988).
[b] The maximum consumption rate for fish is 21 kg/yr (46 lb/yr).
[c] ±2 sigma of the data in parenthesis; to convert to μSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-15. Mean (±2 std dev) Total Recoverable Trace and Heavy Metals in Bottom-Feeding Fish (μg/g wet) Collected in 1996

		Cochiti Reservoir		
Element	Abiquiu/Heron/El Vado Reservoirs (Background)[a]	Pre-Dome Fire (6-3-96)[a]	Post-Dome Fire (8-8-96)[b]	RSRL[c]
Ag	0.125 (0.00)	0.065 (0.11)	0.468 (0.17)	1.2
As	0.25 (0.00)	0.25 (0.00)	0.05 (0.07)	0.4
Ba	0.063 (0.00)	0.033 (0.06)	0.115 (0.04)	1.2
Be	0.053 (0.05)	0.033 (0.06)	0.348 (0.12)	1.3
Cd	0.105 (0.09)	0.055 (0.09)	0.233 (0.08)	0.3
Cr	0.625 (0.00)	0.324 (0.55)	9.624 (14.82)	1.5
Cu	0.815 (0.00)	0.421 (0.72)	1.978 (4.17)	1.4
Hg	0.342 (0.20)	0.208 (0.20)	0.287 (0.53)	0.4
Ni	1.125 (0.00)	0.582 (0.99)	1.162 (0.42)	1.5
Pb	1.25 (0.00)	1.25 (0.00)	0.05 (0.00)	4.0
Sb	1.25 (0.00)	1.25 (0.00)	0.05 (0.00)	2.1
Se	0.275 (0.00)	0.275 (0.00)	0.243 (0.23)	0.4
Tl	1.25 (0.00)	1.25 (0.00)	8.13 (2.85)	2.1
Zn	5.78 (3.35)	5.840 (2.05)	8.92 (11.19)	6.6

[a] The average of five bottom-feeding fish (mostly catfish, suckers, and carp).
[b] The average of six bottom-feeding fish (mostly catfish, suckers, and carp).
[c] Regional Statistical Reference Level; this is the upper limit background concentration (mean + 2 std dev) from 1991 through 1996.

Table 6-16. Radionuclides in Muscle and Bone Tissues of Elk Collected from On-Site (LANL) and Off-Site (Background) Areas during 1995 and 1996

Location/Date/Sample	^{3}H (pCi/mL)[a]	Total U (ng/dry g)[a]	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/dry g)	^{238}Pu (10^{-5} pCi/dry g)	^{239}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/dry g)
Muscle:							
LANL Elk							
TA-16/State Road 4/12-18-95/Bull	0.30 (0.60)	0.90 (0.20)	26.7 (13.2)	4.1 (16.4)	0.0 (3.3)	0.0 (3.3)	4.1 (3.3)
San Ildefonso/ State Road 4/6-18-96/Cow	0.30 (0.28)	0.10 (0.02)	11.2 (3.2)	–35.0 (16.0)	0.8 (2.4)	1.6 (1.6)	5.6 (5.6)
TA-16/State Road 501/6-25-96/Cow	0.14 (0.28)	0.10 (0.02)	8.8 (2.4)	–14.0 (8.0)	–0.8 (0.3)	2.0 (2.4)	2.0 (2.4)
Mean ±2 std dev	0.25 (0.18)	0.36 (0.92)	15.6 (19.4)	–15.0 (39.1)	0.0 (1.6)	1.2 (2.1)	3.9 (3.6)
Background Elk							
Chama, NM/1-9-96/Bull	0.30 (0.60)	0.50 (0.10)	48.4 (18.4)	4.0 (16.4)	0.0 (3.3)	0.0 (3.3)	4.1 (3.3)
RSRL[a]	0.90	3.06	577.9	3.9	0.0	0.0	7.4
Leg Bone:							
LANL Elk							
TA-16/State Road 4/12-18-95	0.30 (0.60)	0.50 (0.10)	5.3 (21.2)	2,173 (318)	53.0 (42.4)	0.0 (42.4)	53.0 (106.0)
San Ildefonso/ State Road 4/6-18-96/Cow	–0.04 (0.27)	5.30 (1.06)	–5.3 (254.4)	3,964 (636)	21.2 (42.4)	58.3 (63.6)	95.4 (116.6)
TA-16/State Road 501/6-25-96/Cow	0.15 (0.28)	1.10 (0.20)	–5.3 (254.4)	2,215 (318)	15.9 (31.8)	10.6 (21.2)	26.5 (137.8)
Mean ±2 std dev	0.14 (0.34)	2.3 (5.23)	–1.8 (12.24)	2,784 (2,044)	30.0 (40.1)	23.0 (62.1)	58.3 (69.5)
Background Elk							
Chama, NM/1-9-96/Bull	–0.40 (0.60)	0.40 (0.10)	30.1 (86.0)	1505 (172)	86.0 (86.0)	0.0 (34.4)	43.0 (34.4)
RSRL[a]	0.20	4.90	261.7	3477	120.6	80.0	77.4

[a] Regional Statistical Reference Level; this is the upper limit background concentration (mean + 2 std dev) from long-term data.

Table 6-17. Radionuclides in Muscle and Bone Tissues of Deer Collected from On-Site (LANL) and Off-Site (Background) Areas during 1995 and 1996

Location/Date/Sample	^{3}H (pCi/mL)[a]	Total U (ng/dry g)[a]	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/dry g)	^{238}Pu (10^{-5} pCi/dry g)	^{239}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/dry g)
Muscle:							
LANL Deer							
TA-16/State Road 4/8-7-95/Doe	0.00 (0.60)	0.36 (0.10)	18.5 (10.8)	4.5 (27.0)	0.0 (3.6)	4.5 (3.6)	—
TA-8/State Road 501/9-25-95/Buck	0.50 (0.60)	0.50 (0.10)	459.0 (90.0)	4.5 (27.0)	0.0 (3.6)	0.0 (3.6)	4.5 (3.6)
TA-21/State Road 502/10-17-95/Doe	0.80 (0.60)	0.63 (0.10)	10.4 (7.2)	0.0 (18.0)	4.5 (9.0)	0.0 (3.6)	4.5 (3.6)
TA-16/State Road 501/6-25-96/Doe	0.35 (0.28)	0.80 (0.20)	17.6 (6.4)	4.0 (16.0)	1.2 (2.4)	2.8 (3.2)	–1.2[b] (0.8)
TA-55/Pajarito Road/8-14-96/Buck	0.13 (0.27)	1.20 (0.24)	25.6 (8.0)	–24.4 (16.0)	0.2 (1.6)	0.8 (1.6)	1.2 (2.4)
Mean ±2 std dev	0.36 (0.63)	0.70 (0.65)	106.2 (394.6)	–2.3 (25.0)	1.2 (3.8)	1.6 (4.0)	2.3 (5.6)
Background Deer							
Cuba, NM/2-12-96/Doe	–0.10 (1.00)	0.50 (0.10)	21.2 (11.2)	0.0 (16.0)	0.0 (3.2)	0.0 (3.2)	0.0 (8.0)
El Vado, NM/3-19-96/Buck	0.40 (0.60)	1.00 (0.20)	15.5 (10.0)	20.0 (60.0)	–5.0 (2.0)	10.0 (10.0)	0.0 (4.0)
Mean ±2 std dev	0.15 (0.71)	0.75 (0.71)	18.4 (8.1)	10.0 (28.3)	–2.5 (7.1)	5.0 (14.1)	0.0 (0.0)
RSRL[a]	0.86	1.46	26.4	38.3	4.6	19.1	0.0
Leg Bone:							
LANL Deer							
TA-16/State Road 4/8-7-95/Doe	0.10 (0.60)	0.90 (0.90)	9.2 (9.2)	1,610 (276)	0.0 (92.0)	0.0 (36.8)	—
TA-8/State Road 501/9-25-95/Buck	0.30 (0.60)	1.30 (0.30)	8.5 (8.5)	1,399 (254)	127.2 (84.8)	0.0 (33.9)	254.4 (84.8)
TA-21/State Road 502/10-17-95/Doe	1.00 (0.60)	1.30 (0.30)	0.0 (206.0)	2,193 (258)	215.0 (86.0)	0.0 (34.4)	43.0 (34.4)
TA-16/State Road 501/6-25-96/Doe	–0.34 (0.27)	0.43 (0.09)	21.5 (34.4)	430 (172.0)	17.2 (25.8)	12.9 (25.8)	60.2 (68.8)
TA-55/Pajarito Road/8-14-96/Buck	0.12 (0.27)	0.86 (0.17)	12.9 (34.4)	8,824 (946)	30.1 (34.4)	8.6 (17.2)	60.2 (51.6)
Mean ±2std dev	0.24 (0.98)	0.96 (0.73)	10.4 (15.6)	3,212 (7,621)	77.9 (182.4)	4.3 (12.2)	104.5 (200.6)

Table 6-17. Radionuclides in Muscle and Bone Tissues of Deer Collected from On-Site (LANL) and Off-Site (Background) Areas during 1995 and 1996 (Cont.)

Location/Date/Sample	^{3}H (pCi/mL)[a]	Total U (ng/dry g)[a]	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/dry g)	^{238}Pu (10^{-5} pCi/dry g)	^{239}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/dry g)
Background Deer							
Cuba, NM/2-12-96/Doe	–0.20 (1.20)	0.40 (0.40)	0.0 (206.4)	989 (172)	0.0 (34.4)	0.0 (34.4)	43.0 (86.0)
El Vado, NM/3-19-96/Buck	0.30 (0.60)	1.30 (0.30)	–8.6 (206.4)	946 (258)	0.0 (2.0)	0.0 (34.4)	43.0 (34.4)
Mean ±2 std dev	0.05 (0.71)	0.85 (1.27)	–4.3 (12.2)	968 (61)	0.0 (0.0)	0.0 (0.0)	43.0 (0.0)
RSRL[a]	0.76	2.12	7.9	1029	0.0	0.0	43

[a]Regional Statistical Reference Level; this is the upper limit background concentration (mean + 2 std dev) from long-term data.
[b]See Appendix B for an explanation of the presence of negative numbers.

Table 6-18. Total Committed Effective Dose Equivalent and Maximum Annual CEDE from the Ingestion of Elk Muscle and Bone

	Total Committed Effective Dose Equivalent (mrem/yr)[a]					
	1996		1994/1995		1993	
# Collected	3		4		3	
Muscle[b]:						
On Site	0.0061	(±0.036)[d]	0.017	(±0.031)[d]	0.028	(±0.057)[d]
Off Site	0.021	(±0.023)[d]	—[c]		0.068	(±0.014)[d]
Bone[b]:						
On Site	1.3	(±0.94)[d]	0.82	(±0.52)[d]	0.35	(±0.42)[d]
Off Site	0.6	(±0.11)[d]	—[c]		0.81	(±0.95)[d]

	Maximum Annual CEDE (mrem)[a]		
	1996	1994/1995	1993
Muscle[b]:			
On Site	0.042	0.048	0.11
Off Site	0.044	—[c]	0.082
Bone[b]:			
On Site	2.2	1.3	0.99
Off Site	0.80	—[c]	1.8

[a] Based on DOE dose conversion factors (DOE 1988).
[b] Maximum consumption rate of 23 kg muscle and 5.7 kg bone per year is based on the meat consumption rate (NRC 1977) and the weight distribution of deer tissue groups (Meadows and Hakonson 1982).
[c] No off-site elk samples were collected in 1994/1995.
[d] ±2 sigma of the data in parenthesis; to convert to µSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-19. Total Committed Effective Dose Equivalent and Maximum Annual CEDE from the Ingestion of Deer Collected during 1996

	Total Committed Effective Dose Equivalent (mrem/yr)[a]			
	On-Site		**Off-Site**	
Muscle[b]	0.031	(±0.13)[c]	0.017	(±0.033)[c]
Bone[b]	1.1	(±2.6)[c]	0.37	(±0.025)[c]

	Maximum Annual Committed Effective Dose Equivalent (mrem)[a]	
	On-Site	**Off-Site**
Muscle[b]	0.16	0.05
Bone[b]	3.7	0.40

[a] Based on DOE dose conversion factors (DOE 1988).
[b] The maximum consumption rate of 23 kg/yr muscle and 4.8 kg/yr bone per year are based on the meat consumption rate (NRC 1977) and the weight distribution of deer tissue groups (Meadows and Hakonson 1982).
[c] ±2 sigma of the data in parenthesis; to convert to µSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-20. Radionuclides in Muscle and Bone of a Free-Ranging Steer Collected from the Pueblo of San Ildefonso Lands in 1996

Tissue/Location	^{3}H (pCi/mL)[a]	Total U (ng/dry g)[a]	^{137}Cs (10^{-3} pCi/dry g)	^{90}Sr (10^{-3} pCi/dry g)	^{238}Pu (10^{-5} pCi/dry g)	^{239}Pu (10^{-5} pCi/dry g)	^{241}Am (10^{-5} pCi/dry g)
Muscle:							
San Ildefonso	–0.40 (0.60)[b]	1.48 (0.30)	14.4 (6.7)	11.1 (14.8)	0.0 (3.0)	7.4 (7.4)	3.7 (3.0)
Elk (Background)[c]	0.30 (0.60)	0.50 (0.10)	48.4 (18.4)	4.0 (16.4)	0.0 (3.3)	0.0 (3.3)	4.1 (3.3)
RSRL[d]	0.90	3.06	577.9	3.9	0.0	0.0	7.4
Leg Bone:							
San Ildefonso	–0.20 (0.60)	10.00 (2.00)	30.0 (90.0)	300.0 (200.0)	50.0 (40.0)	0.0 (40.0)	0.0 (40.0)
Elk (Background)	–0.40 (0.60)	0.40 (0.10)	30.1 (86.0)	1,505.0 (172.0)	86.0 (86.0)	0.0 (34.0)	43.0 (34.4)
RSRL	0.20	4.90	261.7	3,477.0	120.6	80.0	77.4

[a] pCi/mL of tissue moisture; the average dry/wet ratio for domestic cow muscle and bone was 0.27 and 0.72, respectively.
[b] (±2 counting uncertainty); values are the uncertainty in the analytical results at the 95% confidence level.
[c] Background from a Rocky Mountain elk collected in 1996; the dry/wet ratio for muscle and bone was 0.24 and 0.58, respectively.
[d] Regional Statistical Reference Level; this is the upper limit background concentration (mean + 2 std dev) from elk collected from 1991 to present.

Table 6-21. Committed Effective Dose Equivalent from the Ingestion of Steer Muscle and Bone Collected during 1996

	Committed Effective Dose Equivalent (mrem/yr)[a]			
	Pueblo of San Ildefonso		Regional Background (Elk)[b]	
Muscle:				
Maximum Consumption Rate[c]	0.081	(±0.085)[d]	0.086	(±0.18)[d]
Bone:				
Maximum Consumption Rate[c]	0.87	(±1.4)[e]	3.2	(±1.0)[d]

[a] Based on DOE dose conversion factors (DOE 1988).

[b] There were no background samples available for steer. Regional background for elk was used for background.

[c] The maximum consumption rate for steer muscle is 110 kg/yr and for steer bone is 275 kg/yr (NRC 1977) (Meadows and Hakonson 1982).

[d] ±2 sigma of the data in parenthesis; to convert to μSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

Table 6-22. Radionuclides in Navajo Tea (Cota) Collected from Regional and Perimeter Locations in 1996

	^{3}H (pCi/mL)	^{90}Sr (pCi/L)	^{238}Pu (pCi/L)	^{239}Pu (pCi/L)	^{137}Cs (pCi/L)	^{tot}U (μg/L)	^{241}Am (pCi/L)
Off-Site Regional:							
Española	–0.22 (0.27)[a,b]	0.3 (0.8)	0.000 (0.004)	–0.001 (0.005)	13.5 (11.0)	0.32 (0.06)	0.180 (0.160)
RSRL	0.05	1.1	0.004	0.004	24.5	0.38	0.34
Off-Site Perimeter:							
Pueblo of San Ildefonso	–0.11 (0.27)	0.4 (0.8)	0.018 (0.010)	0.011 (0.010)	17.6 (35.2)	0.75 (0.16)	0.015 (0.058)
Los Alamos Townsite	–0.64 (0.26)	1.8 (0.8)	0.012 (0.007)	0.012 (0.007)	7.6 (15.2)	0.89 (0.18)	0.150 (0.100)
White Rock/Pajarito Acres	0.09 (0.27)	0.1 (0.8)	0.027 (0.013)	0.020 (0.012)	17.1 (11.6)	0.44 (0.08)	0.052 (0.056)

[a] See Appendix B for an explanation of the presence of negative numbers.
[b] (±2 counting uncertainty).

Table 6-23. Total Committed Effective Dose Equivalent from the Ingestion of Navajo (Cota) Tea Collected during 1996

Total Committed Effective Dose Equivalent (mrem/yr)[a]	
	Max Consumption[b]
Background	0.87 (±0.79)[c]
White Rock	0.75 (±0.59)[c]
Los Alamos	0.84 (±0.78)[c]
San Ildefonso	0.68 (±1.2)[c]

[a] Based on DOE dose conversion factors (DOE 1988).
[b] The maximum consumption rate for tea is 0.5 L/day.
[c] ±2 sigma in parenthesis; to convert to µSv, multiply by 10; values greater than 2 sigma show high variability and present questionable results.

E. Figures

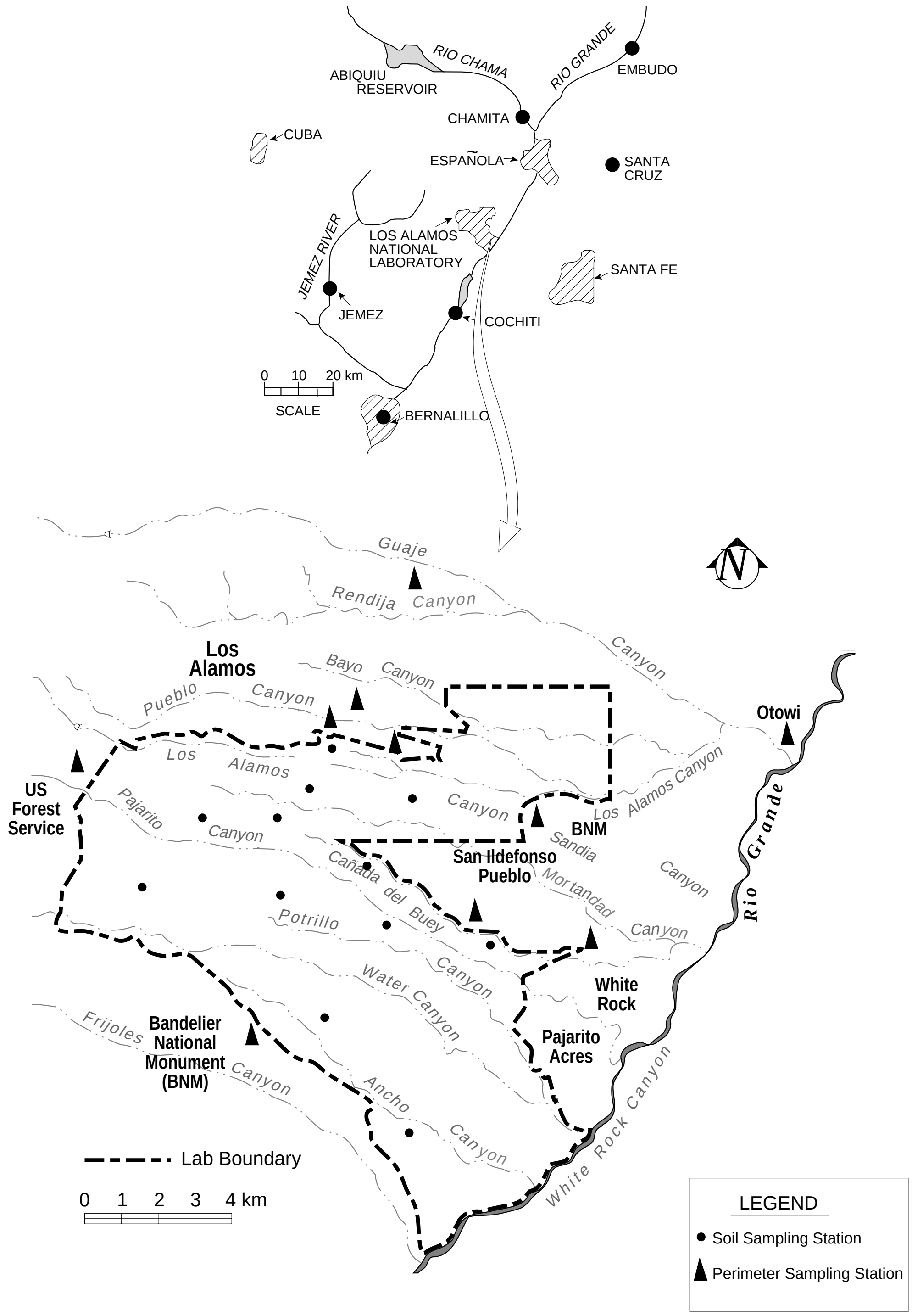

Figure 6-1. Off-site regional (top) and perimeter and on-site (bottom) Laboratory soil sampling locations.

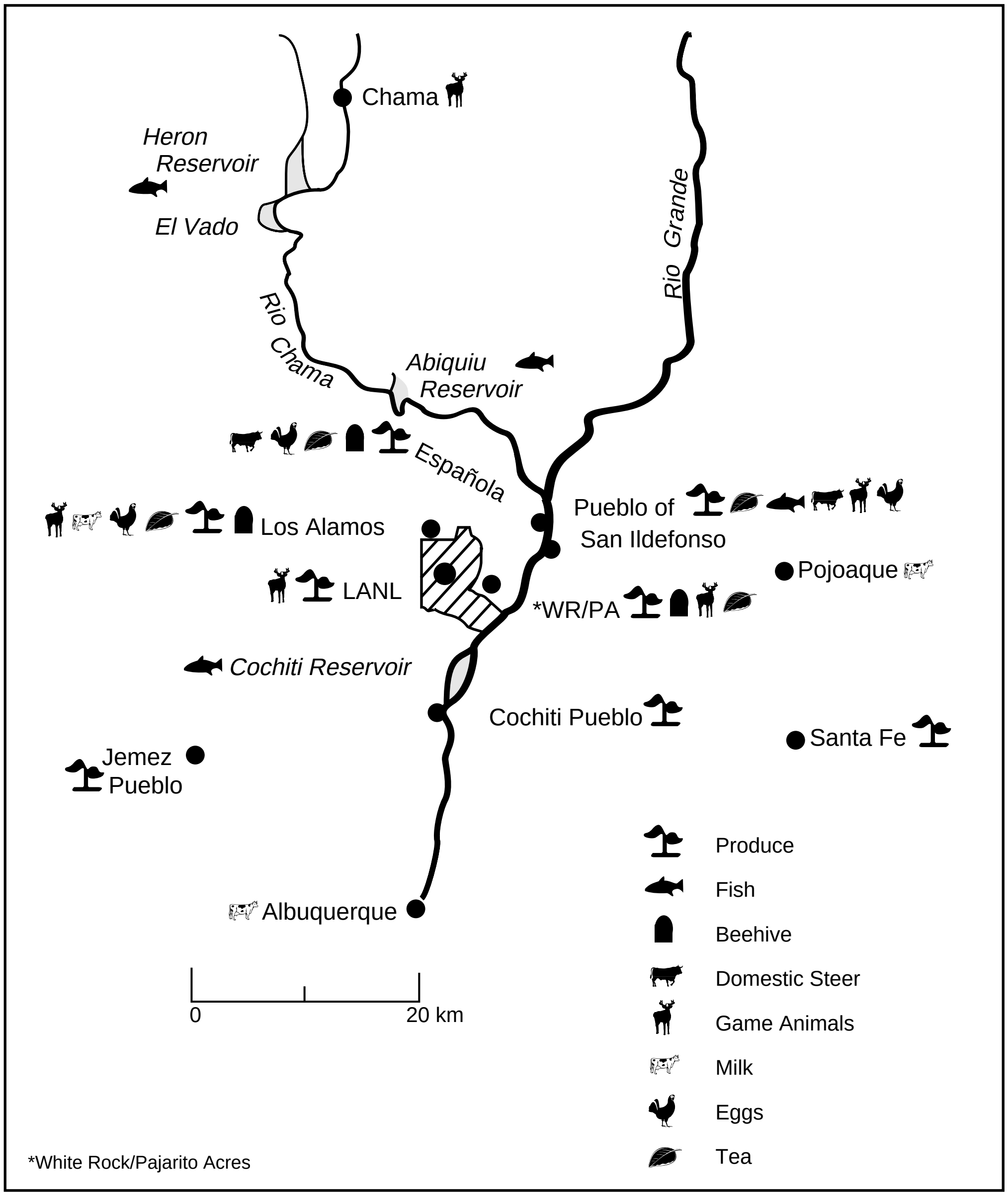

Figure 6-2. Produce, fish, milk, eggs, tea, domestic and game animals, and beehive sampling locations. (Map denotes general locations only.)

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Standards for Environmental Contaminants

Throughout this report, concentrations of radioactive and chemical constituents in air and water samples are compared with pertinent standards and guidelines in regulations of federal and state agencies. No comparable standards for soils, sediments, and 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;" and 5484.1, "Environmental Radiation Protection, Safety, and Health Protection Information Reporting Requirements," Chap. III, "Effluent and Environmental Monitoring Program Requirements."

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 adopted by DOE 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/yr. The PDLs and the DOE dose factors are based on recommendations of the ICRP and the National Council on Radiation Protection and Measurements· (ICRP 1988 and 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 and water in uncontrolled areas measured by the Laboratory's environmental surveillance program are compared with DOE's derived air concentrations (DACs) and derived concentration guides (DCGs), respectively (Table A-2) (DOE 1990). These guides represent the smallest estimated concentrations in water or air, taken in continuously for a period of 50 years, that will result in annual EDEs equal to the PDL of 100 mrem in the fiftieth year of exposure.

In addition to the 100 mrem/yr effective dose PDL, exposures from the air pathway are also limited by the Environmental Protection Agency's (EPA's) standard of 10 mrem/yr EDE (EPA 1989a). To demonstrate compliance with these standards, doses from the air pathway are compared directly with the EPA dose limits.

Nonradioactive Air Quality Standards. Federal and state ambient air quality standards for nonradioactive pollutants are shown in Table A-3. New Mexico nonradiological standards are generally more stringent than national standards.

National Pollutant Discharge Elimination System. Table A-4 presents a summary of these outfalls and the types of monitoring required under National Pollutant Discharge Elimination System (NPDES). Table A-5 presents NPDES monitoring limits.

Drinking Water Standards. For chemical constituents in drinking water, regulations and standards are issued by 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/L. Gross alpha activity (including radium-226, but excluding radon and uranium) may not exceed 15 pCi/L.

A screening level of 5 pCi/L 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 (TableA-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/yr, 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/yr. 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 New Mexico Health and Environment Improvement Division's New Mexico 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 stan-dards can also be applied in cases where groundwater discharges may affect stream water quality.

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 (PDL) for External and Internal Exposures

	EDE[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, 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 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 DOE Order 5480.11.

[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/yr.

[d]This level is from EPA's regulations issued under the Clean Air Act (40 CFR 61, Subpart H).

[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 in Uncontrolled Areas (pCi/L)	DCGs for Drinking Water Systems (pCi/L)	Class[b]	DACs (μCi/mL) Uncontrolled Areas	DACs (μCi/mL) Controlled Areas
^{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	Y	4×10^{-8}	8×10^{-6}
^{89}Sr	2×10^{-5}	20,000	800	Y	3×10^{-10}	6×10^{-8}
^{90}Sr[b]	1×10^{-6}	1,000	40	Y	9×10^{-12}	2×10^{-9}
^{137}Cs	1×10^{0}	3,000	120	D	4×10^{-10}	7×10^{-8}
^{234}U	5×10^{-2}	500	20	Y	9×10^{-14}	2×10^{-11}
^{235}U	5×10^{-2}	600	24	Y	1×10^{-13}	2×10^{-11}
^{238}U	5×10^{-2}	600	24	Y	1×10^{-13}	2×10^{-11}
^{238}Pu	1×10^{-3}	40	1.6	W	3×10^{-14}	3×10^{-12}
^{239}Pu[b]	1×10^{-3}	30	1.2	W	2×10^{-14}	2×10^{-12}
^{240}Pu	1×10^{-3}	30	1.2	W	2×10^{-14}	2×10^{-12}
^{241}Am	1×10^{-3}	30	1.2	W	2×10^{-14}	2×10^{-12}

[a]Guides for uncontrolled areas are based on DOE's PDL for the general public (DOE 1990); those for controlled areas are based on occupational RPSs for DOE Order 5480.11. 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).

[c]Tritium in the HTO form.

Table A-3. National and New Mexico Ambient Air Quality Standards

Pollutant	Averaging Time	Unit	New Mexico Standard	Federal Standards Primary	Federal Standards Secondary
Sulfur dioxide	Annual arithmetic mean	ppm	0.02	0.03	
	24 hours[a]	ppm	0.10	0.14	
	3 hours[a]	ppm			0.5
Total suspended particulate matter	Annual geometric mean	μg/m^3	60		
	30 days	μg/m^3	90		
	7 days	μg/m^3	110		
	24 hours[a]	μg/m^3	150		
PM_{10}[b]	Annual arithmetic mean	μg/m^3		50	50
	24 hours	μg/m^3		150	150
Carbon monoxide	8 hours[a]	ppm	8.7	9	
	1 hour[a]	ppm	13.1	35	
Ozone	1 hour[c]	ppm		0.12	0.12
Nitrogen dioxide	Annual arithmetic mean	ppm	0.05	0.053	0.053
	24 hours[a]	ppm	0.10		
Lead	Calendar quarter	μg/m^3		1.5	1.5
Hydrogen sulfide	1 hour	ppm	0.01		
Total reduced sulfur	1/2 hour	ppm	0.003		

[a] Maximum concentration, not to be exceeded more than once per year.
[b] Particles <10 μm in diameter.
[c] The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations is above the limit of ≤1.

Table A-4. Types of Discharges and Limits Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary Outfall Discharges

Discharge Category	Permit Parameter		Daily Average		Daily Maximum	
13S TA-46 SWSC Plant	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	org/100 mL	500	org/100 mL
	pH		6.0-9.0		6.0-9.0	
	Flow[e]		Report		Report	
05S TA-21 Sanitary Treatment Plant	BOD	concentration	30	mg/L	45	mg/L
		loading limit	0.5	lb/day	N/A	
	TSS	concentration	30	mg/L	45	mg/L
		loading limit	0.5	lb/day	N/A	
	COD[f]		125	mg/L	125	mg/L
			2.1	lb/day	N/A	
	Fecal coliform bacteria[d]		500	org/100 mL	500	org/100 mL
	pH		6.0-9.0		6.0-9.0	
	Flow[e]		Report		Report	

[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]Chemical oxygen demand.

NOTE: Sampling frequency for these sanitary outfalls varies from 1/week to once every 3 months, depending on the parameter.

Table A-5. Limits Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Industrial Outfall Discharges

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
001 Power Plant	1	Monthly	TSS[a]	30	100	mg/L
			Free available CL_2	0.2	0.5	mg/L
			pH	6.0-9.0	6.0-9.0	
02A Boiler Blowdown	2	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	
03A Treated Cooling Water	26	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	
04A Noncontact Cooling Water	32	Every 3 months	pH	6.0–9.0	6.0–9.0	
			Total residual CL_2	Report[b]	Report	mg/L
051 Radioactive Liquid Waste Treatment Facility (TA-50)	1	Variable: weekly to monthly	COD[c]	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[d]	1.0	1.0	mg/L
			Total Ni[b]	Report	Report	mg/L
			Total N[b]	Report	Report	mg/L
			NO_3-NO_2[b]	Report	Report	mg/L
			Ammonia (as N)[b]	Report	Report	mg/L
			pH	6.0-9.0	6.0-9.0	
			COD	125	125	mg/L
			^{226}Ra and ^{228}Ra	30.0	30.0	pCi/L
05A High Explosive	12	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	
06A Photo Wastewater	12	Every 3 months	Total Ag	0.5	1.0	mg/L
			pH	6.0-9.0	6.0-9.0	

Table A-5. Limits Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Industrial Outfall Discharges (Cont.)

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
All Outfall Categories: Annual Water Quality Parameters	88	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[e]	3,000,000	3,000,000	pCi/L

[a]Total suspended solids.
[b]Concentrations are reported to EPA but are not subject to limits.
[c]Chemical oxygen demand.
[d]Total toxic organics.
[e]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[a]
Gross beta & photon	4 mrem/yr[a]
^{226}Ra & ^{228}Ra	5 pCi/L[a]
U	20 µg/L[a]
Radon	300 pCi/L[a]
	Screening Level
Gross alpha	5 pCi/L[a]
Gross beta	50 pCi/L[a]
Inorganic Chemical:	
Primary Standards	**Maximum Contaminant Level (mg/L)**
Asbestos	7 million fibers/L (longer than 10 µm)
As	0.05[a]
Ba	2
Be	0.004
Cd	0.005
CN	0.2
Cr	0.1
F	4.0
Hg	0.002
Ni	0.1
NO_3 (as N)	10
NO_2 (as N)	1
SO_4	500[a]
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]Proposed.

Table A-7. Livestock Watering Standards

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

Table A-8. Wildlife Habitat Stream Standards

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/l for total recoverable selenium and of 0.012 µg/l 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/L nor ammonia in excess of levels which 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 percent 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.

Table A-9. Organic Analytical Methods

Test	SW-846 Method	Extraction Water	Extraction Sediments	Number of Analytes
Volatiles	8260A	E0730	E0720	59
Semivolatiles	8270B[a]	E0530	E0510	69
PCB[b]	8080A, 8081	E0430	E0410	4
HE[c]	8330			14

[a] Direct injection used for method 8270B.
[b] PCB = polychlorinated biphenyls.
[c] HE = high-explosive.

Table A-10. Volatile Organic Compounds

	Limit of Quantitation	
Analytes	Water (μg/L)	Sediments (mg/kg)
Acetone	25	0.025
Benzene	5	0.005
Bromobenzene	5	0.005
Bromochloromethane	5	0.005
Bromodichloromethane	5	0.005
Bromoform	5	0.005
Bromomethane	10	0.01
Butanone [2-]	25	0.025
Butylbenzene [n-]	5	0.005
Butylbenzene [sec-]	5	0.005
Butylbenzene [tert-]	5	0.005
Carbon disulfide	5	0.005
Carbon tetrachloride	5	0.005
Chlorobenzene	5	0.005
Chlorodibromomethane	5	0.005
Chloroethane	10	0.01
Chloroform	5	0.005
Chloromethane	10	0.01
Chlorotoluene [o-]	5	0.005
Chlorotoluene [p-]	5	0.005
Dibromo-3-chloropropane [1,2]	10	0.01
Dibromoethane [1,2-]	5	0.005
Dibromomethane	5	0.005
Dichlorobenzene [o-] (1,2)	5	0.005
Dichlorobenzene [m-] (1,3)	5	0.005
Dichlorobenzene [p-] (1,4)	5	0.005
Dichlorodifluoromethane	10	0.01

Table A-10. Volatile Organic Compounds (Cont.)

	Limit of Quantitation	
Analytes	**Water (μg/L)**	**Sediments (mg/kg)**
Dichloroethane [1,1-]	5	0.005
Dichloroethane [1,2-]	5	0.005
Dichloroethene [1,1-]	5	0.005
Dichloroethene [trans-1,2-]	5	0.005
Dichloroethylene [cis-1,2-]	5	0.005
Dichloropropane [1,2-]	5	0.005
Dichloropropane [1,3-]	5	0.005
Dichloropropane [2,2-]	5	0.005
Dichloropropene [1,1-]	5	0.005
Dichloropropene [cis-1,3-]	5	0.005
Dichloropropene [trans-1,3-]	5	0.005
Ethylbenzene	5	0.005
Hexanone [2-]	20	0.02
Isopropylbenzene	5	0.005
Isopropyltoluene [4-]	5	0.005
Methyl iodide	5	0.005
Methyl-2-pentanone [4-]	20	0.02
Methylene chloride	5	0.005
Propylbenzene	5	0.005
Styrene	5	0.005
Tetrachloroethane [1,1,1,2-]	5	0.005
Tetrachloroethane [1,1,2,2-]	5	0.005
Tetrachloroethylene	5	0.005
Toluene	5	0.005
Trichloroethane [1,1,1-]	5	0.005
Trichloroethane [1,1,2-]	5	0.005
Trichloroethene	5	0.005
Trichlorofluoromethane	5	0.005
Trichloropropane [1,2,3]	5	0.005
Trimethylbenzene [1,2,4-]	5	0.005
Trimethylbenzene [1,3,5-]	5	0.005
Vinyl chloride	10	0.01
Xylenes (o + m + p) [Mixed-]	5	0.005

Table A-11. Semivolatile Organic Compounds

Analytes	Limit of Quantitation Water (μg/L)	Limit of Quantitation Sediments (mg/kg)
Acenaphthylene	10	0.33
Aniline	10	0.33
Anthracene	10	0.33
Azobenzene	10	0.33
Benzidine [m-]	50	1.65
Benzo[a]anthracene	10	0.33
Benzo[a]pyrene	10	0.33
Benzo[b]fluoranthene	10	0.33
Benzo[g,h,i]perylene	10	0.33
Benzo[k]fluoranthene	10	0.33
Benzoic acid	50	1.65
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	0.33
Bromophenylphenyl ether [4-]	10	0.33
Butyl benzyl phthalate	10	0.33
Chloro-3-methylphenol [4-]	10	0.33
Chloroaniline [4-]	10	0.33
Chloronaphthalene [2-]	10	0.33
Chlorophenol [o-]	10	0.33
Chlorophenylphenyl ether [4-]	10	0.33
Chrysene	10	0.33
Di-n-butyl phthalate	10	0.33
Di-n-octyl phthalate	10	0.33
Dibenzo[a,h]anthracene	10	0.33
Dibenzofuran	10	0.33
Dichlorobenzene (1,2) [o-]	10	0.33
Dichlorobenzene (1,3) [m-]	10	0.33
Dichlorobenzene (1,4) [p-]	10	0.33
Dichlorobenzidine [3,3'-]	20	0.66
Dichlorophenol [2,4-]	10	0.33
Diethyl phthalate	10	0.33
Dimethyl phthalate	10	0.33
Dimethylphenol [2,4-]	10	0.33
Dinitrophenol [2,4-]	50	1.65
Dinitrotoluene [2,4-]	10	0.33
Dinitrotoluene [2,6-]	10	0.33
Fluoranthene	10	0.33
Fluorene	10	0.33
Hexachlorobenzene	10	0.33
Hexachlorobutadiene	50	1.65
Hexachlorocyclopentadiene	10	0.33
Hexachloroethane	10	0.33
Indeno[1,2,3-cd]pyrene	10	0.33
Isophorone	10	0.33

Table A-11. Semivolatile Organic Compounds (Cont.)

Analytes	Limit of Quantitation Water (µg/L)	Limit of Quantitation Sediments (mg/kg)
Methyl-4,6-dinitrophenol [2-]	50	1.65
Methylnaphthalene [2-]	10	0.33
Methylphenol [2-]	10	0.33
Methylphenol [4-]	10	0.33
Naphthalene	10	0.33
Nitroaniline [2-]	20	0.66
Nitroaniline [3-]	20	0.66
Nitroaniline [4-]	20	0.66
Nitrobenzene	10	0.33
Nitrophenol [2-]	10	0.33
Nitrophenol [4-]	50	1.65
Nitrosodi-n-propylamine [N-]	10	0.33
Nitrosodimethylamine [N-]	10	0.33
Nitrosodiphenylamine [N-]	10	0.33
Pentachlorophenol	50	1.65
Phenanthrene	10	0.33
Phenol	10	0.33
Picoline [2-]	10	0.33
Pyrene	50	1.65
Pyridine	10	0.33
Trichlorobenzene [1,2,4-]	10	0.33
Trichlorophenol [2,4,5-]	10	0.33
Trichlorophenol [2,4,6-]	10	0.33

Table A-12. Polychlorinated Biphenyls Analytes

	Detection Limits	
Analytes	**Water (μg/L)**	**Sediments (mg/kg)**
Aroclor [Mixed-]	0.05	0.06
Aroclor 1242	0.05	0.06
Aroclor 1254	0.05	0.06
Aroclor 1260	0.05	0.06

Table A-13. High Explosives Analytes

	Limit of Quantitation	
Analytes	**Water (μg/L)**	**Sediments (mg/kg)**
HMX	0.21	2.20
RDX	0.27	1.00
1,3,5-TNB	0.042	0.25
1,3-DNB	0.032	0.25
Tetryl	0.24	0.65
Nitrobenzene	0.13	0.26
2,4,6-TNT	0.068	0.25
4-A-2,6-DNT	0.046	0.25
2-A-4,6-DNT	0.046	0.25
2,6-DNT	0.085	0.25
2,4-DNT	0.085	0.25
2-NT	0.10	0.25
4-NT	0.12	0.25
3-NT	0.13	0.25

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).

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).

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 become 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 sutracted 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:

$$s = \sqrt{\frac{\sum_{i=1}^{N} \left(\bar{c} - c_i\right)^2}{(N-1)}},$$

where

ci = sample i

$\bar{c}$ = mean of samples from a given station or group, and

N = number of samples comprising a station or group.

This value is reported as the uncertainty 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 (km2)	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
gal.	gallon
in.	inch
kg	kilogram
kg/h	kilogram per hour
L	liter
lb	pound
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

Table B-3. Common Measurement Abbreviations and Measurement Symbols (Cont.)

sq ft (ft^2)	square feet
μR	microroentgen
mCi	millicurie
mR	milliroentgen
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)
R	roentgen
std dev or σ	standard deviation
s.u.	standard unit
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 Labortories report BNWL-B-368 (September 1975).

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 ft^2 of leased space for training, support, architectural engineering design, and unclassified research and development in the Los Alamos townsite and White Rock. The publicly accessible Community Reading Room and the Bradbury Science Museum are also located in the Los Alamos townsite.

TA-2, Omega Site: Omega West Reactor, an 8-MW nuclear research reactor, is located here. It was placed into a safe shutdown condition in 1993. It is currently being removed from the nuclear facilities list and will be transferred to the institution for placement into the decontamination and decommissioning (D&D) program during 1997.

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, and 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. A Van de Graaff accelerator was put on shutdown status in 1994.

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 proposed site for DARHT (the dual-axis radiographic hydrotest facility) whose major feature is its intense high-resolution, dual-machine radiographic capability. This site is also used for the investigation of weapons functioning and systems behavior in nonnuclear tests, principally through electronic recordings.

TA-16, S Site: Investigations at this site include development, engineering design, prototype manufacture, and environmental testing of nuclear weapons 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 about half of the facility has been demolished. The programs conducted at DP West, primarily in inorganic and biochemistry, are being relocated during 1997 and the remainder of the site 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 and Center for Human Genome Studies: This site is adjacent to the Los Alamos Medical Center in the townsite. 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 will house research in inorganic and materials chemistry. The Sanitary Wastewater System Consolidation project 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 Bandalier 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 studied at this site.

TA-52, Reactor Development Site: A wide variety of theoretical and computational activities related to nuclear reactor performance and safety are done at this site.

TA-53, Los Alamos Neutron Scattering Center: The Los Alamos Neutron Science Center (LANSCE), including the LANSCE linear proton accelerator, the Manuel Lujan Jr. Neutron Scattering Center (MLNSC), and a medical isotope production facility are located at this TA. Also located at TA-53 are the Accelerator Production of Tritium (APT) Project Office, including the Low-Energy Demonstration Accelerator (LEDA), 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 managing 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.

AT-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, and similar experiments are being planned.

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, Inc.

TA-64: This is the site of the Central Guard Facility and headquarters for the Laboratory Hazard 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.

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.
AEC	Atomic Energy Commission**.** A federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian applications. It was abolished by the Energy Reorganization Act of 1974 and was succeeded by the Energy Research and Development Administration (now part of the US Department of Energy (DOE) and the US Nuclear Regulatory Commission [NRC]).
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.
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.
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.
absorbed dose	The energy imparted to matter by ionizing radiation per unit mass of irradiated material. (The unit of absorbed dose is the rad.)
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, food-stuffs, 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.
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 (subsurface water). 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 ($1/2 \times 1/2$), after three half-lives, one-eighth ($1/2 \times 1/2 \times 1/2$), 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.

- long-lived isotope - 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).
- short-lived isotope - 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).

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 Maximum 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 prior to 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 Clean Air Act; they set limits for such pollutants as beryllium and radionuclides.

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.

PCBs Polychlorinated biphenyls. A family of organic compounds used since 1926 in electric transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCBs are extremely persistent in the environment because they do not break down into new and less harmful chemicals. PCBs are stored in the fatty tissues of humans and animals through the bioaccumulation process. EPA banned the use of PCBs, 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 The unit of population dose that expresses the sum of radiation exposures received by a population. For example, two persons, each with a 0.5 rem exposure, receive 1 person-rem, and 500 people, each with an exposure of 0.002 rem, also receive 1 person-rem.

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 due to a threat to health [see contamination]).

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.

R Roentgen. The roentgen is a unit for measuring exposure. It is defined only for the effect on air and applies only to gamma and x-rays in air. It does not relate biological effects of radiation to the human body.

1 roentgen = 1,000 milliroentgen (mR)

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.

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) due to the different types of radiation.

rem = rad x 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 potassium-40; 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.

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.

uranium **Isotopic Abundance (atom %)**

	^{234}U	^{235}U	^{238}U
depleted	≤0.0055	<0.72	>99.2745
natural	0.0055	0.72	99.2745
enriched	≥0.0055	>0.72	<99.2745

Total uranium is the chemical abundance of uranium in the sample, regardless of its isotopic composition.

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.

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
BEIR	biological effects of ionizing radiation
BOD	biochemical/biological oxygen demand
Btu	British thermal unit
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAS	Connected Action Statement
CCNS	Concerned Citizens for Nuclear Safety
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIO	Community Involvement Office (LANL)
CMR	Chemistry and Metallurgy Research (LANL building)
CO	compliance order
COC	chain-of-custody
COD	chemical oxygen demand
CQI	continuous quality improvement
CST	Chemical Sciences and Technology (LANL division)
CST-3	Analytical Services Group (LANL)
CST-13	Radioisotopes and Industrial Wastewater Science Group (LANL)
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
EEU	ecological exposure unit
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
FY	fiscal year
GWPMPP	Groundwater Protection Management Program Plan
HAZWOPER	hazardous waste operations (training class)
HE	high-explosive
HMPT	Hazardous Materials Packaging and Transportation
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
JCI	Johnson Controls, Inc.
JENV	JCI Environmental Laboratory
LAAO	Los Alamos Area Office (DOE)
LANSCE	Los Alamos Neutron Science Center
LANSCENET	LANSCE Network—TA-53 (for air monitoring)
LANL	Los Alamos National Laboratory (or the Laboratory)
LEDA	Low-Energy Demonstration Accelerator
LLW	low-level radioactive waste
LLMW	low-level mixed waste
LOQ	limit of quantitation
MAP	Mitigation Action Plan
MCL	maximum contaminant level
MDA	material disposal area
MEI	maximum exposed individual
NAGPRA	Native American Grave Protection and Repatriation Act
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
NMED	New Mexico Environment Department
NMEIB	New Mexico Environmental Improvement Board
NMWQCA	New Mexico Water Quality Control Act
NMWQCC	New Mexico Water Quality Control Commission
NOD	Notice of Deficiency
NON	Notice of Noncompliance
NPDES	National Pollutant Discharge Elimination System
NRC	US Nuclear Regulatory Commission
OB/OD	open burning/open detonation
ODS	ozone depleting substance
O&G	oil and grease
OHL	Occupational Health Laboratory (LANL)
OSHA	Occupational Safety and Health Act/Administration
PCB	polychlorinated biphenyl
PDL	public dose limit
PHERMEX	Pulsed high-energy radiographic machine emitting x-rays
ppb	parts per billion
ppm	parts per million
PWA	Process Waste Assessment
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
RCRA	Resource Conservation and Recovery Act
RD&D	research, development, and demonstration
RLWTF	Radioactive Liquid Waste Treatment Facility (LANL)
RSRL	regional statistical reference level
SAL	screening action level
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Officer (New Mexico)
SLD	Scientific Laboratory Division (New Mexico)
SOC	synthetic organic compound
SPCC	Spill Prevention Control and Countermeasures
SVOC	semivolatile organic compound
SWA	Solid Waste Act
SWPP	Storm Water Prevention Plan
SWMR	solid waste management regulations
SWMU	solid waste management unit
SWSC	Sanitary Wastewater Systems Consolidation

Acronyms and Abbreviations

TA	Technical Area
TDS	total dissolved solids
TEDE	total effective dose equivalent
TIC	tentatively identified compound
TLD	thermoluminescent dosimeter
TLDNET	thermoluminescent dosimeter network
TRI	toxic chemical release inventory
TRU	transuranic waste
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTHM	trihalomethane
TWISP	Transuranic Waste Inspectable Storage Project
UC	University of California
USGS	United States Geological Survey
UST	underground storage tank
VAP	vaporous activation products
VOC	volatile organic compound
WASTENET	Waste Management Areas Network
WM	Waste Management (LANL)
WSC	Waste Stream Characterization
WQCC	Water Quality Control Commission
WWW	World Wide Web

Elemental and Chemical Nomenclature

Actinium	Ac	Molybdenum	Mo
Aluminum	Al	Neodymium	Nd
Americium	Am	Neon	Ne
Argon	Ar	Neptunium	Np
Antimony	Sb	Nickel	Ni
Arsenic	As	Niobium	Nb
Astatine	At	Nitrate (as Nitrogen)	NO_3-N
Barium	Ba	Nitrite (as Nitrogen)	NO_2-N
Berkelium	Bk	Nitrogen	N
Beryllium	Be	Nitrogen dioxide	NO_2
Bicarbonate	HCO_3	Nobelium	No
Bismuth	Bi	Osmium	Os
Boron	B	Oxygen	O
Bromine	Br	Palladium	Pd
Cadmium	Cd	Phosphaeus	P
Calcium	Ca	Phosphate (as Phosphous)	PO_4-P
Californium	Cf	Platinum	Pt
Carbon	C	Plutonium	Pu
Cerium	Ce	Polonium	Po
Cesium	Cs	Potassium	K
Chlorine	Cl	Praseodymium	Pr
Chromium	Cr	Promethium	Pm
Cobalt	Co	Protactinium	Pa
Copper	Cu	Radium	Ra
Curium	Cm	Radon	Rn
Cyanide	CN	Rhenium	Re
Carbonate	CO_3	Rhodium	Rh
Dysprosium	Dy	Rubidium	Rb
Einsteinium	Es	Ruthenium	Ru
Erbium	Er	Samarium	Sm
Europium	Eu	Scandium	Sc
Fermium	Fm	Selenium	Se
Fluorine	F	Silicon	Si
Francium	Fr	Silver	Ag
Gadolinium	Gd	Sodium	Na
Gallium	Ga	Stronium	Sr
Germanium	Ge	Sulfate	SO_4
Gold	Au	Sulfite	SO_3
Hafnium	Hf	Sulfur	S
Helium	He	Tantalum	Ta
Holmium	Ho	Technetium	Tc
Hydrogen	H	Tellurium	Te
Hydrogen oxide	H_2O	Terbium	Tb
Indium	In	Thallium	Tl
Iodine	I	Thorium	Th
Iridium	Ir	Thulium	Tm
Iron	Fe	Tin	Sn
Krypton	Kr	Titanium	Ti
Lanthanum	La	Tritiated water	HTO
Lawrencium	Lr (Lw)	Tritium	^3H
Lead	Pb	Tungsten	W
Lithium	Li	Uranium	U
Lithium fluoride	LiF	Vanadium	V
Lutetium	Lu	Xenon	Xe
Magnesium	Mg	Ytterbium	Yb
Manganese	Mn	Yttrium	Y
Mendelevium	Md	Zinc	Zn
Mercury	Hg	Zirconium	Zr

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