5. Surface Water, Groundwater, and Sediments

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Highlights from 1997

The 1997 surface water analysis results are consistent with past findings. Environmental surveillance runoff samples are collected using automated samplers; the samplers are actuated when a significant precipitation event causes flow in a drainage crossing the Laboratory's eastern or western boundaries. Ten gross alpha and gross beta values exceeded the DOE Derived Concentration Guide (DCG) values in surface water or runoff samples in 1997. No radionuclides exceeded the DCG, however.

Groundwater sample analysis results from the regional aquifer were consistent with previous years' results. Trace levels of tritium are present in the regional aquifer in a few areas where former or present liquid waste discharges occurred, notably beneath Los Alamos, Pueblo, and Mortandad Canyons. The highest regional aquifer tritium level found in a test well is about 2% of the drinking water standard and poses no health risk according to the US Public Health Service. In 1994, possible strontium-90 detections occurred in a sampling of test wells. However, continued testing shows no detectable levels, suggesting that the 1994 values were not true detections. Nitrate (as nitrogen) levels in a test well beneath Pueblo Canyon continue to be high, but in 1997, were only about half the drinking water standard.

Analytical results for alluvial and intermediate depth groundwater are similar to those of past years. Waters near former or present effluent discharge also show the effects of these discharges; however, radionuclide activities are below DOE dose concentration guidelines for public exposure. Only three measured values (americium-241, plutonium-238, and plutonium-239, -240) exceeded DOE dose concentration guidelines for a DOE-operated drinking water system: these were measured in a shallow canyon bottom well just downstream from the TA-50 Radioactive Liquid Waste Treatment Facility permitted outfall in Mortandad Canyon.

Analytical results from the 1997 sediment samples are consistent with historical data. Radiochemical measurements for the majority of sediment samples collected at locations other than radioactive effluent release areas and waste management areas reflect worldwide fallout levels. As expected, sediment samples from radioactive effluent release areas and waste management areas exceeded worldwide fallout levels for tritium, cesium-137, plutonium, and americium-241, and gross alpha, gross beta, and gross gamma activities. Sediments from three Mortandad Canyon sampling stations continue to show cesium-137 values that exceed screening action levels. Radiochemical analyses of the large 1-kg samples collected in 1997 from Heron, El Vado, Abiquiu, Cochiti, and Rio Grande Reservoirs are similar to those from previous years. These sample results were below atmospheric fallout levels except for some of the Cochiti and Rio Grande Reservoir samples, which showed slightly above-background concentrations for cesium-137 and total uranium.

5. Surface Water, Groundwater, and Sediments

A. Description of Monitoring Program

Studies related to development of groundwater supplies began at Los Alamos 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, 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.

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 (ESP 1981). The use of different means reflect different methods of averaging discrete data collected over a large area. 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 (ESP 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 regional aquifer (at a depth of 180 m [590 ft]) beneath the lower reach of Pueblo Canyon. Except for occasional nitrate values, levels of these constituents are a small fraction of the Environmental Protection Agency (EPA) drinking water standards.

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. 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 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 (RLWTF) at TA-50. The TA-50 facility began operations in 1963. The TA-50 effluents infiltrate into the stream channel and maintain a saturated zone in the alluvium extending about 3.5 km downstream from the outfall. The easternmost extent of saturation is onsite, about 1.6 km west of the Laboratory boundary with the Pueblo of San Ildefonso. In addition to residual radionuclides, the effluent contains nitrate that often causes alluvial groundwater concentrations to exceed the New Mexico groundwater standard of 10 mg per liter (nitrate as nitrogen). The groundwater standard applies because the TA-50 effluent infiltrates into 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 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 downstream to the Laboratory boundary with the Pueblo of San Ildefonso.

The alluvium is less than 1.5 m thick in the upper reach of Mortandad Canyon and thickens to about 23 m at the easternmost extent of saturation. The saturated portion of the alluvium is perched on weathered and unweathered tuff and is generally no more than 3 m 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 per day in the upper reach to about 2 m per day in the lower reach of the canyon (Purtymun 1974 and Purtymun et al., 1983). The high turnover rate for water in the alluvial groundwater prevents accumulation of chemicals from the RLWTF effluent (Purtymun et al., 1977). The top of the regional aquifer is about 290 m below the 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. Saturated alluvium does not extend beyond the facility boundary. Three shallow observation wells were constructed in 1985 as part of a compliance agreement with the State of New Mexico to determine whether TAs 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 groundwater system of limited extent. The thickness of the alluvium ranges from 1.2 to 5 m, but the underlying weathered tuff ranges in thickness from 3.7 to 12 m. In 1992, saturation was found within only a 0.8-km long segment, and only two observation wells have ever contained water (ESP 1994). 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 Plant 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 Plant was completed in late 1992.

B. Surface Water Sampling

1. Introduction

The Laboratory monitors surface waters from regional and Pajarito Plateau stations to evaluate the environmental effects of its operations. No perennial surface water flows extend completely across the Laboratory in any of the canyons. Periodic natural surface runoff occurs in two modes: (1) spring snowmelt runoff that occurs over days to weeks at a low discharge rate and sediment load, and (2) summer runoff from thunderstorms that occurs over hours at a high discharge rate and sediment load. The surface water within the Laboratory is not a source of municipal, industrial, or irrigation water, though 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 protection 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, Livestock Watering and Wildlife Habitat standards. The NMWQCC groundwater standards can also be applied in cases where groundwater outflow may affect stream water quality. Appendix A presents information on these standards.

2. Monitoring Network

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

Regional surface water samples (Figure 5-1) are collected from stations on the Rio Grande, Chama, and the Jemez Rivers. 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 1997, the station on the Rio Grande at Bernalillo was not sampled.

Surface water monitoring stations located on the Pajarito Plateau are shown in Figures 5-2 and 5-3. The stations monitor the water quality effects of past or potential contaminant sources, such as industrial or NPDES-permitted outfalls and the effects of nonpoint sources, including possible soil contamination sites.

3. Radiochemical Analytical Results

The results of radiochemical analyses for surface water samples for 1997 are listed in Tables 5-1 and 5-2. Tables 5-3 and 5-4 contain lists of radionuclides detected in surface water and runoff samples and of possible detections, according to criteria discussed in Section 5.F.4. Because uranium, gross alpha, and gross beta are widespread at detectable levels, only 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 per liter for uranium, 5 pCi per liter for gross alpha, and 20 pCi per liter for gross beta.

Radiochemical values that are greater than 1/25 of the DOE DCGs for Public Dose for Ingestion of Environmental Water (that is, greater than the DOE drinking water system DCGs) are shown in Table 5-5. Gross alpha and gross beta values in this table are greater than their respective EPA drinking water limits, which are higher than the DCG. Note that the DCG value for gross beta is actually the strontium-90 DCG, and the DCG for gross alpha is the plutonium-239, -240 DCG. Ten gross alpha and gross beta values exceeded the DOE public dose DCG values in surface water or runoff samples in 1997. These samples were the surface water samples from Mortandad Canyon at GS-1 and runoff samples from Los Alamos Canyon near Los Alamos, Area G stations G-SWMS-5 and G-SWMS-6, Potrillo Canyon near White Rock, and Cañada del Buey at White Rock. Half of these values are possible detections, owing to their high uncertainty (see Section 5.F.4).

Most of the measurements at or above detection limits are from locations with previously known contamination: the perimeter of Area G, Acid/Pueblo Canyon, DP/Los Alamos Canyon, and Mortandad Canyon. Otherwise, the remainder 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. 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 near TA-54, Area G and in Pueblo, DP/Los Alamos, and Mortandad Canyons are discussed below.

a. Radiochemical Analytical Results for Surface Water. The 1997 samples from the Rio Grande at Otowi and the Rio Grande at Frijoles were collected from the bank; no width-integrated samples were collected. The 1995 and 1996 bank samples from Rio Grande at Otowi showed possible detections of americium-241, and the 1996 sample had possible plutonium-238 and gross beta detections. An additional station (Rio Grande at Otowi Upper) was located farther upstream from the previous station, based on the possibility that the original station was detecting Laboratory-derived radionuclides present in flood deposits upstream of the mouth of Los Alamos Canyon. None of these stations had any radionuclide detections in 1997.

The samples from the Rio Grande at Cochiti and the Jemez River had gross alpha detections at relatively small values. A second sample from Rio Grande at Cochiti had a much lower gross alpha value. Other than low levels of uranium, which are probably of natural origin, no other radionuclides were detected at these two stations so the source of the gross alpha readings is unclear.

Americium-241 was detected 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. The 1997 sample had no radionuclide detections, except for a low level of uranium.

A possible detection of americium-241 occurred at the station Los Alamos at State Road 4. In 1995, there was a possible detection of americium-241 at this location. Plutonium-239, -240 was detected at the stations Los Alamos at State Road 4 and Pueblo at State Road 502. Results are consistent with past detections of plutonium-239, 240 at these locations.

Americium-241 was detected at Water Canyon at Beta below TA-16. There have been no detections of americium-241 at this location in the past**.**

b. Radiochemical Analytical Results for Runoff. Automated samplers were used to collect runoff samples whenever rainfall events caused significant runoff at the Laboratory boundaries. See Section 5.F.1 for a description of the runoff samplers and sampling protocols. In addition to measured data, Table 5-2 gives calculated activities associated with the suspended sediments for cases where both filtered and unfiltered samples were obtained for runoff samples. (See Section 5.F.1 for discussion of filtered and unfiltered samples.) The values were determined by subtracting the filtered results from the unfiltered results, using the total suspended solids measured for the samples. The associated uncertainties were calculated using propagation of errors. This is a method for determining how measurement errors affect the results of a calculation using these measurements. Two samples were snowmelt rather than thunderstorm runoff and have much lower total suspended solids: Los Alamos Canyon at Los Alamos and Pajarito at SR 501. The values for these samples have high uncertainties reflecting the small total suspended solids.

Comparison of the results for filtered and unfiltered samples collected at Los Alamos Canyon near Los Alamos on August 5, 1997, show questionable results. The quantities of strontium-90, uranium, plutonium, and americium-241 are quite large in both the filtered and unfiltered samples. In some cases, the filtered values are higher, as shown by negative values in the calculated suspended sediments activities on Table 5-2. The results for the September 20, 1997, sample from this station are more in line with usual measurements, with unfiltered radionuclide activities greatly exceeding those for the filtered sample. Americium-241; cesium-137; plutonium-238; plutonium-239, -240; strontium-90; and gross alpha and gross beta were detected or possibly detected in most of the runoff samples at this station. Sediment screening action levels (see discussion in 5.C.1) in two samples were exceeded by calculated suspended sediment activities for strontium-90 and cesium-137. These observations were consistent with earlier findings for this station.

The DP Canyon near Los Alamos station showed detections of gross beta; americium-241; and plutonium-239, -240. No runoff sample was collected at Ancho Canyon near Bandelier in 1997. This station had high strontium-90 in 1995, and in 1996 high uranium and possible cesium-137.

The runoff sample collected at Cañada del Buey near White Rock had detectable gross beta, and possible detections of gross alpha and plutonium-239, -240. This station had high uranium levels in 1996.

The largest concentrations of uranium in the runoff samples collected in 1997 was 10.8 µg per liter for a TA-54, Area G runoff sample (G-SWMS-5). Americium-241; plutonium-238; plutonium-239, -240; strontium-90; and gross alpha and gross beta were detected or possibly detected in the runoff samples at TA-54, Area G. These radionuclides have previously been detected in sediment samples surrounding TA-54, Area G.

The samples from Potrillo Canyon near White Rock had detections of gross beta and cesium-137, and possible detections of gross alpha and plutonium-239, -240. No previous data are available for this station.

c. Technical Area 50 Discharges. The cumulative discharge of radionuclides from the RLWTF into Mortandad Canyon between 1963 and 1977, and yearly discharge data for 1995 through 1997 are given in Table 5-6. In addition to total annual activity released for 1995 through 1997, Table 5-6 also shows mean annual activities in effluent for each radionuclide, and the ratio of this activity to the DCG. In 1997, the DCG was exceeded for americium-241, plutonium-238, and plutonium-239, -240. For 1997, the effluent nitrate concentration (average value of 69.6 mg per liter, nitrate as nitrogen) exceeded the New Mexico groundwater standard of 10 mg of nitrate as nitrogen per liter of water.

4. Nonradiochemical Analytical Results

a. Major Chemical Constituents. The results of major chemical constituents analyses in surface water and runoff samples for 1997 are listed in Table 5-7. 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 exceeds standards except for some pH measurements below 6.8 and above 8.5. Fluoride values in samples from the Jemez River, DPS-4, SCS-3, Mortandad at GS-1, and Mortandad at Rio Grande were between 50% and 100% of the NMWQCC Groundwater Standard. The nitrate (as nitrogen) value for Mortandad at Rio Grande was about 75% of the NMWQCC Groundwater Standard.

b. Trace Metals. The results of trace metal analyses on surface water and runoff samples for 1997 are listed in Table 5-8. Samples collected for trace metal analysis (with the exception of unfiltered runoff samples) after May 30, 1997, were filtered so that they could be compared to the NMWQCC standards that apply to dissolved constituents. Samples collected for mercury and selenium analysis were unfiltered, as the NMWQCC standards for these analytes apply to total metals content. The levels of trace metals in samples for 1997 are generally consistent with previous observations.

The sample from the middle of Cochiti Reservoir showed levels of beryllium, cadmium, cobalt, and chromium that exceeded drinking water or NMWQCC groundwater limits. The other two reservoirs did not contain these metals. The sample from the Jemez River had arsenic and boron values exceeding drinking water or NMWQCC groundwater limits. 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 wells and springs in the area have high boron, arsenic, and fluoride levels (Goff et al., 1988).

In 1995, a barium concentration of 520 µg per liter was measured in the sample collected at Water Canyon at Beta, compared to a NMWQCC groundwater limit of 1,000 µg per liter. This sample also had an elevated level of nitrate. The sample collected at Water Canyon at Beta in 1996 also contained about 400 µg per liter of barium, higher than normally observed in surface water on the Pajarito Plateau. For 1997, the barium concentration was 322 µg per liter. Analyses confirmed the presence of high explosives (HE) for the Water Canyon at Beta sample in 1996. No HE was detected at Water Canyon at Beta in 1997. In 1997, runoff samples collected at Los Alamos Canyon near Los Alamos contained similarly high levels of barium (242 to 416 µg of barium per liter of water).

The analytical detection limit used for mercury (0.2 µg per liter) is not adequate to determine whether it is present in excess of the New Mexico Wildlife Habitat stream standard of 0.012 µg per liter. In 1997, mercury was not observed above the detection limit at any location with the exception of Mortandad at Rio Grande and Cañada del Buey.

Aluminum, iron, and manganese concentrations exceed EPA secondary drinking water standards at many locations. These results reflect the presence of suspended solids in the water samples. Some of these cases occur with filtered samples. Some of the water samples were unfiltered, so the results are due to naturally occurring constituents (e.g., aluminum, iron, and manganese) of minerals in the suspended solids.

Lead values (80 to 130 µg per liter) above the EPA drinking water action level (15 µg per liter) and the New Mexico Livestock Watering Standard (100 µg per liter) were again found in the runoff samples collected at Los Alamos Canyon near Los Alamos. This station is upstream of State Road 4 in Los Alamos Canyon. Surprisingly, these results came from analyses that were performed on both filtered and unfiltered samples. These samples also showed levels of beryllium, chromium, and vanadium in the range of 50% to 100% of drinking water or NMWQCC groundwater limits. The sample from DP Canyon near Los Alamos had an unfiltered lead concentration of 18 µg per liter.

Measurable selenium concentrations were reported for surface waters in 1997. Typically, selenium has not been detected in surface waters on the Pajarito Plateau. Selenium values exceeded the New Mexico Wildlife Habitat Stream Standard (2 µg per liter) at Guaje Canyon and Frijoles at Monument HQ.

c. Organics. The locations where organics samples were collected in 1997 are summarized in Table 5-9. (See Section 5.F.2.c. for analytical methods and analytes.) Samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Some samples were also analyzed for HE constituents. In 1996, two HE compounds, 2, 4, 6-trinitrotoluene and 2, 4-dinitrotoluene were detected at Frijoles Canyon at Monument Headquarters in Bandelier National Monument. In 1996, two HE compounds were also detected at the stations Water Canyon at Beta. No HE compounds were detected at any stations in 1997.

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 5-4. These measurements were performed 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. If more than one sample was collected in a year, the average value for the year is plotted. Samples collected before 1996 were preserved in the field and filtered through a 0.45-micron filter in the laboratory. Subsequent measurements represented the total (unfiltered) activity. Plutonium values for 1962 to 1966 are for plutonium-239, -240 only. Plutonium-238 was not measured for those years. 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 per liter; all tritium activities exceed the detection limit of 700 pCi per liter except for a sample collected in April 1988. As discussed in Section 5.B.3 and shown on Table 5-5, the 1997 plutonium values from this station exceeded the DOE drinking water DCG but were below the public dose DCG. Tritium values were about half the EPA drinking water MCL in 1997.

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. Sediments from five regional reservoirs and five stream channels are also sampled annually.

There are no federal or state regulatory standards for soil or sediment contaminants that can be used for comparison with the Laboratory's 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 limits for worldwide fallout and for natural background levels of total uranium (Purtymun et al., 1987). McLin and Lyons (1998) developed provisional fallout levels of radioactivity in sediments for tritium, strontium-90, cesium-137, uranium, plutonium, americium-241, and for gross alpha, gross beta, and gross gamma activity for the period 1974 to 1996. The average activity level for each analyte in these samples, plus twice its standard deviation, is an indicator of the approximate upper limit for worldwide fallout or natural background activity. If an individual sample analysis exceeds a background level, we assume that Laboratory contamination is a possible source.

Screening action levels (SALs) are used by the Laboratory's Environmental Restoration Project to identify the presence of contaminants at levels of concern. SALs are screening levels below a level of human health risk. 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.

2. Monitoring Network

Sediment samples are collected from regional stations and from Pajarito Plateau stations near the Laboratory. The information gathered from these stations document conditions in areas potentially affected by Laboratory operations. Regional sediment sampling stations (Figure 5-1) are located within northern New Mexico and southern Colorado at distances up to 200 km from the Laboratory. Samples from regional stations provide a basis for determining background radionuclide concentrations resulting from fallout. Stations on the Pajarito Plateau (Figures 5-5, 5-3, and 5-6) are located within about 4 km from the Laboratory boundary. The majority of the Pajarito Plateau stations are located within the Laboratory boundary.

During 1997, sediment samples were collected from 22 regional and 68 Pajarito Plateau stations. Of the 22 regional samples, 7 are from rivers and 15 are from the upper, middle, and lower portions of 5 regional reservoirs: 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 management areas. 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. Twelve plateau samples were collected on or adjacent to Pueblo of San Ildefonso Pueblo lands.

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 5-3) 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 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 5-6). Another station (AB-4A) was added in 1981 as the surface drainage changed.

3. Radiochemical Analytical Results for Sediments

a. Radiochemical Analytical Results. The results of radiochemical analyses of sediment samples collected during 1997 are listed in Table 5-10. Individual analytes that meet detection criteria and are above background levels are also summarized in Tables 5-11 and 5-12. Results from the 1997 sediment samples are consistent with those from previous years. The majority of the sediment samples collected at locations other than at known radioactive effluent release areas and waste management areas were within background levels that reflect worldwide fallout. All sediments from the regional stream channel stations showed below-background concentrations for sampled radionuclides.

Many sediment samples from known radioactive effluent release areas, including Acid/Pueblo, DP/Los Alamos, and Mortandad Canyons, exceeded worldwide fallout levels for tritium, cesium-137, plutonium, americium-241, gross alpha, gross beta, and gross gamma activities. These levels are consistent with historical data. Within both Los Alamos and Pueblo Canyons, above-background levels of plutonium in sediments are evident for distances greater than 16 km downstream from the major historical sources in Acid and DP Canyons. The contamination extends off site across Pueblo of San Ildefonso lands and reaches the Rio Grande near the Otowi Bridge. Near the sources, plutonium concentrations are 5 to nearly 300 times background (fallout) levels; levels decline downstream by several orders of magnitude. These patterns have been documented for several decades in Laboratory reports.

Within Mortandad Canyon, the largest plutonium concentrations in sediments (more than 100 times background) are found between the point where TA-50 RLWTF effluent enters the drainage (GS-1) and the sediment traps (MCO-7), an approximately 3-km distance. Radionuclide levels near or slightly exceeding fallout levels are found downstream of the sediment traps, extending to the Laboratory/Pueblo of San Ildefonso boundary station A-6.

In 1997, sediment samples from GS-1, MCO-5, and MCO-7 in Mortandad Canyon showed cesium-137 concentrations that were up to four times greater than the SAL value. Median values since 1980 for cesium-137 at these stations range up to six times greater than the SAL value. Cesium-137 levels at these stations have declined by factors of 5 to 35 since the early 1980s because of lower cesium-137 discharges from the RLWTF at TA-50. During 1997, no other sediment samples showed any values that exceeded respective SAL values, although reported values from stations GS-1, MCO-5, and MCO-7 were between 31% and 94% of the SAL values for tritium, plutonium, and americium-241. These radionuclide levels decrease rapidly in the downstream direction. The levels are consistent with historical data that reflect TA-50 effluent discharges into Mortandad Canyon since 1963.

At TA-54, Area G, a number of stations exceeded background levels for cesium-137 and plutonium. At TA-49, Area AB, a number of sediment stations showed above-background values for tritium, cesium-137, plutonium, and americium-241. The reported values are consistent with earlier observations from these stations.

Several of the Pajarito Plateau stations that are outside radioactive effluent and solid waste management areas showed slightly above-background radioactivity values. These stations included Chaquehui at Rio Grande (tritium), Fence at State Road 4 (plutonium-238), Frijoles at Monument Headquarters (uranium), and Pajarito at State Road 4 (plutonium-239, -240 and uranium). These 1997 values are within the range of historical results obtained for these sites during the 1980s and 1990s. The sources of the above-background levels have not been determined. At the Chaquehui at Rio Grande station, however, it appears that Laboratory activities may be responsible for anomalous levels of tritium found in moisture distilled from the sediment. Similar tritium levels were detected near this station in the early 1990s during sampling by both the Environmental Surveillance Program and the ER Project. The pattern and persistence of the higher-than-background levels of tritium support a hypothesis of a subsurface source of tritium at this location, possibly arising from tritium disposal activities at nearby TA-33.

Results of the radiochemical analyses of the 1-kg samples collected in 1997 from Heron, El Vado, Abiquiu, Cochiti, and Rio Grande Reservoirs are similar to those from previous years. All of these sample results were below background levels except for some samples from Cochiti and Rio Grande Reservoirs. The samples from the Rio Grande Upper, Rio Grande Middle, and Cochiti Lower stations showed above-background levels for cesium-137. Sediments from the Cochiti Middle and Cochiti Lower stations showed above-background values for total uranium. Historical values for cesium and uranium at these stations have exceeded reported background levels on several occasions. The Rio Grande Reservoir results reflect natural variations in fallout and background concentration levels for radionuclides in sediments, as it is far removed from Laboratory influences. The elevated levels of cesium-137 and uranium from Cochiti Reservoir may reflect a combination of atmospheric fallout contributions or natural conditions and Laboratory activities. There is a known abundance of natural uranium in soils and rocks near the reservoir. In previous studies, the isotopic atom ratio of uranium-235 to uranium-238 in Cochiti Reservoir bottom-feeding fish and in lake sediments were consistent with naturally occurring uranium (that is, 0.0072) (Fresquez et al., 1995, Gallaher 1997). There was no indication of the refined forms of uranium (enriched or depleted in uranium-235) used in Laboratory research.

Plutonium deposition by atmospheric fallout in the Rio Grande Basin is not uniform but varies with differences in weather, altitude, erosion, and sediment transport conditions. Summary data from reservoir sediment plutonium analyses are shown in a long-term context in Table 5-13. Abiquiu Reservoir historically has had some of the lowest plutonium concentration ranges and isotopic ratios observed, while Cochiti and Rio Grande Reservoirs have had some of the highest. The other sampled reservoirs tend to fall between these two extremes. The data show that mean plutonium concentration levels are higher in Cochiti Reservoir than in Abiquiu Reservoir. The results of the reservoir analyses may be interpreted in conjunction with previous studies (Purtymun et al., 1990; Graf, 1993; Fresquez et al., 1994, 1995; Gallaher, 1997; and McLin and Lyons, 1998), which provide a regional context for reservoir sediments. Before 1963, between 2 and 12 grams of plutonium were released from the Laboratory into the Acid/Pueblo/Los Alamos Canyon watershed. A small but unquantified portion of this plutonium, along with trace amounts of strontium-90 and cesium-137, has been carried across Pueblo of San Ildefonso lands into the Rio Grande. These Laboratory-contaminated sediments have commingled with fallout-contaminated sediments carried by the Rio Grande and have accumulated in Cochiti Reservoir since its construction in 1973. Between 50% and 90% of the plutonium in Cochiti Reservoir sediments probably has originated from atmospheric fallout, while the remainder may be associated with Laboratory sources. However, strontium-90, cesium-137, plutonium-238, and plutonium-239, -240 in Cochiti Reservoir sediments have not entered the food chain (nongame fish) at levels significantly higher than in Heron, El Vado, or Abiquiu Reservoirs**.**

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 1997 are presented in Table 5-14. Sediments from the Mortandad A-10 and G-8 stations showed elevated mercury levels at 4.0 and 4.3 mg per kilogram, respectively. The reason for these elevated mercury levels is not understood. Historically, mercury levels much above the detection limit have not been found in sediment samples collected at A-10 and G-8 nor in general for the Environmental Surveillance Program's Pajarito Plateau stations. However, some Environmental Restoration Project samples have shown higher mercury levels, so a Laboratory source is possible. None of the other results show any significant accumulations of metals, and results are comparable to previously collected data.

b. Organic Analyses. Beginning in 1993, sediments have been analyzed for VOCs, SVOCs, and PCB. No samples were analyzed for VOCs in 1997. Some sediment samples also have been analyzed for HE constituents since 1995. Samples from only a portion of the sediment stations are analyzed each year for organics; in 1997 only about one-seventh of the stations were analyzed. The sampled stations are listed in Table 5-15. The analytical results showed that there were no SVOCs, PCBs, or HE constituents detected above the limit of quantitation (LOQ) in any of the sediment samples collected during 1997.

5. Long-Term Trends

The concentrations of radionuclides in sediments from Acid, Pueblo, and lower Los Alamos Canyons have been relatively constant at each station since 1980, with some yearly variability. The total plutonium concentrations (plutonium-238 plus plutonium-239, -240) observed since 1980 in sediments at four indicator locations are shown in Figure 5-7.

Figure 5-7 also depicts total plutonium concentrations at four stations in Mortandad Canyon from 1980 to 1997. 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. The plutonium concentrations upstream of the sediment traps have declined by approximately a factor of 10 since the 1980s, presumably due to decreased radioactivity in the RLWTF discharges. Below the sediment traps, plutonium concentrations have remained relatively constant: the levels are more than 100 times lower than above the traps, and are close to atmospheric fallout levels.

Available data indicate that a small but measurable amount of Laboratory-derived plutonium is present in Mortandad Canyon sediments at the Pueblo of San Ildefonso boundary, possibly extending downstream to near State Road 4. Analysis of sediments collected at the boundary station Mortandad A-6 in 1997 showed cesium-137; total uranium; plutonium-239, -240; and gross beta activity that exceed background levels. Above-background plutonium-239, -240 concentrations also were detected at this station in 4 of the previous 10 years.

A special study that utilized low-detection-limit thermal ionization mass spectrometry to analyze plutonium and uranium in sediments (Gallaher et al., 1997) indicates that off-site migration of Laboratory-derived plutonium has occurred in Mortandad Canyon. Evidence of Laboratory-derived plutonium extends for a distance of approximately 1.5 miles beyond the Laboratory boundary to near State Road 4. There remains considerable uncertainty, however, about the timing and means of contaminant movement in this part of the canyon. There has been no observed stream flow at the boundary since hydrologic studies began in Mortandad Canyon in 1961. Moreover, there have been no recorded flows at the boundary since continuous stream gaging measurements began in 1995 (Shaull et al., 1996a, 1996b, 1998). These observations suggest that if any contaminants have reached Pueblo of San Ildefonso lands, transport by storm water was probably before 1960 and thus before the initial discharges from the TA-50 RLWTF-permitted outfall. Wind, vehicles, or foot traffic could also have carried contaminated dust, soils, and sediments downstream.

D. Groundwater Sampling

1. Introduction

Groundwater resource management and protection efforts at the Laboratory are focused on the regional (or main) 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 1988). This program 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 1995 (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 regional 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 public dose limit (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 regional 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, although these latter standards are only directly applicable to the public water supply. The supply wells in the regional 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 Watering Stream Standards and Wildlife Habitat 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 regional (or main) aquifer, perched alluvial groundwater in the canyons, and localized intermediate-depth perched groundwater systems. The sampling locations for the regional aquifer and the intermediate-depth perched groundwater systems are shown in Figure 5-8. The sampling locations for the canyon alluvial perched groundwater systems are shown in Figure 5-9. The springs and wells are described by Purtymun (1995).

Sampling locations for the regional aquifer include test wells, supply wells, and springs. Eight deep test wells, completed within the regional 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 regional aquifer, and the casings are not cemented, which would seal off surface infiltration along the boreholes.

Samples are collected from 13 deep water supply wells in 3 well fields that produce water for the Laboratory and community. The well fields include the off-site Guaje Well Field and the on-site Pajarito and Otowi Well Fields. The Guaje Well Field, located northeast of the Laboratory, contains seven wells, six of which had significant production during 1997. The five wells of the Pajarito Well Field are located in Sandia and Pajarito Canyons and on mesa tops between those canyons. Two wells comprise the Otowi Well Field, located in Los Alamos and Pueblo Canyons; no production from Otowi-1 occurred in 1997. Additional regional 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 regional aquifer (Purtymun et al., 1980). As such, the springs serve to detect possible discharge of contaminated groundwater from beneath the Laboratory into the Rio Grande. Based on their chemistry, the springs in White Rock Canyon are divided into 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 or from 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 discharges 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 mostly dry since their installation in 1989. All but two of the wells in Cañada del Buey are generally dry.

As a condition of Module 8, Section C of the Laboratory's HSWA permit, the Laboratory installed several alluvial wells (or, in some cases, boreholes). This work was completed in 1990 according to EPA's RCRA guidelines (Purtymun and Stoker 1990, Stoker 1990, ESP 1992). Some of the wells were drilled near existing wells in order to compare observations with older wells. Because these wells are of more modern construction, during 1997 they were substituted for the older wells in the monitoring network. These RCRA wells included:

- three wells in Los Alamos Canyon (LAO-3A, LAO-4.5C, and LAO-6A),
- three wells in Mortandad Canyon (MCO-4B, MCO-6B, and MCO-7A).

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, where this perched water is sampled. During the winter of 1996–97, a falling tree broke the connecting pipe, and the water now flows down Water Canyon.

3. Radiochemical Analytical Results for Groundwater

The results of radiochemical analyses of groundwater samples for 1997 are listed in Table 5-16. Tables 5-17 and 5-18 contain lists of radionuclides detected in water samples and of possible radionuclide detections, according to criteria discussed in Section 5.F. Because uranium, gross alpha, and gross beta are common 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 5µg per liter for uranium, 5µg per liter for gross alpha, and 20 pCi per liter for gross beta. Discussion of the results will address the regional aquifer, the canyon alluvial groundwater, and the intermediate perched groundwater system.

Radiochemical values that are greater than 1/25 of the DOE DCGs for Public Dose for Ingestion of Environmental Water (that is, greater than the DOE drinking water system DCGs) are shown in Table 5-19. Gross alpha and gross beta values in this table are greater than their respective EPA drinking water limits. Note that the DCG value for gross beta is actually the strontium-90 DCG, and the DCG for gross alpha is the plutonium-239, -240 DCG. Two gross alpha values exceeded half the DOE public dose DCG values, at CDBO-7 and MCO-7.5 (the CDBO-7 value was 168% of the DCG). These values are possible detections rather than detections, owing to their high uncertainties. Aside from CDBO-7 and LAO-3A, values on the table are from alluvial wells in Mortandad Canyon. MCO-3 results for plutonium-238; plutonium-239, -240; and americium-241 were more than 40% of the DCG. The gross beta results for all wells in Mortandad Canyon were about 10% of the DCG except MCO-7A, which was lower.

a. Radiochemical Constituents in the Regional Aquifer. For samples from wells or springs in the regional 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. In addition, most of the results were near or below the detection limits of the analytical methods used. The exceptions are discussed below. The main exception was uranium found in springs and wells on Pueblo of San Ildefonso land. Since dissolved uranium is a common constituent of groundwater (Hem 1989), only occurrences close to the proposed EPA MCL of 20 µg per liter 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. The chemical analysis of strontium-90 is difficult, and the sensitivity of the method is near to the EPA MCL. 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). The wells were sampled four times during 1996, with no radionuclides detected, except naturally occurring uranium and trace levels of tritium. TW-8 was not sampled in 1997 because of a pump problem. No strontium-90 was detected in the other two wells during 1997.

Water supply well G-1 showed a possible strontium detection in 1997. No other radiological or nonradiological parameters were elevated. The value of 5.19 ± 1.39 pCi per liter was slightly larger than the detection limit of 3 pCi per liter but the uncertainty is sufficiently large to make detection uncertain. In 1995, water supply well G-1A had a strontium-90 detection of 3.9 ± 0.7 pCi per liter. This value is just above the strontium-90 detection limit of 3 pCi per liter. Another 1995 analysis of the same sample gave a result of 7.4 ± 3.5 pCi per liter. Due to the very high uncertainty for that analysis, that result did not qualify as a detection or as a possible detection. Analysis of the 1996 and 1997 samples indicate no trace of strontium-90 in samples from G-1A.

Strontium-90 was detected in Sandia Spring during 1996, but none was apparent in 1997.

La Mesita Spring has a significant uranium concentration of 12.1 µg per liter. 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 still below the proposed EPA primary drinking water MCL of 20 µg per liter. The spring also has a high gross alpha value of about 12.8 pCi per liter, near the EPA primary drinking water standard of 15 pCi per liter. The EPA standard applies to gross alpha not arising from radon and uranium, however.

b. Tritium Sampling of Test Wells. Three test wells, DT-5A, DT-9, and DT-10, were sampled for trace levels of tritium in 1997. This section discusses the trace-level tritium analyses done by the University of Miami Tritium Laboratory.

Tritium is a naturally occurring isotope of hydrogen. Tritium is produced in the atmosphere by cosmic rays and in rocks by decay of naturally occurring radioactive elements. Tritium is also produced by nuclear reactors and as part of the development and testing of nuclear weapons. Because tritium is an isotope of hydrogen, tritium commonly occurs in nature as part of a water molecule. Before atmospheric testing of nuclear weapons began, tritium levels in northern New Mexico precipitation were about 20 pCi per liter (Adams 1995). This is 5 to 10 times higher than the tritium level detected in the Los Alamos public water supply wells. By the mid-1960s, tritium in atmospheric water in northern New Mexico reached a peak level of about 6,500 pCi per liter. At present, atmospheric levels in northern New Mexico are about 30 pCi per liter, and those in the Los Alamos vicinity range from 20 to 450 pCi per liter (Adams 1995).

Because tritium often occurs as part of a water molecule, the rate of infiltration of tritium into the earth is the same as the infiltration rate of water. Other radionuclides such as plutonium-238 or strontium-90 infiltrate at a much slower rate, if at all; the progress of these radionuclides is either halted or significantly slowed by the chemical processes of adsorption (adherence to the surfaces of soil particles, for example) or precipitation (the formation of solid chemical phases).

Tritium has a half-life of 12.43 years. This relatively short half-life combined with low naturally occurring levels of tritium means that groundwater isolated from the surface should have a very low tritium activity. Groundwater that contains between 16 and 65 pCi per liter of tritium most likely shows the effects of recent recharge, that is, recharge within the last four decades (Blake 1995). Groundwater with a tritium activity below about 1.6 pCi per liter is probably old and isolated from surface recharge. The age of such groundwater is more than 3,000 years, but there may be large dating uncertainties associated with small tritium activities. Groundwater with a tritium activity greater than 1,000 pCi per liter and collected after 1990 can only be the result of contamination (Blake 1995).

All of the tritium results determined by the trace-level method for the regional aquifer wells at TA-49 are shown in Table 5-20. These low tritium levels suggest that the regional aquifer water tapped by these wells is isolated from surface recharge.

c. Radiochemical Constituents in Alluvial Groundwater. Except for a possible detection of gross alpha activity in CDBO-7, none of the radionuclide activities in alluvial groundwater are above the DOE DCGs for Public Dose for Ingestion of Environmental Water. Except for americium-241; plutonium-238; and plutonium-239, -240, values in samples from MCO-3 in Mortandad Canyon and gross alpha and gross beta values in Table 5-19, none of the radionuclide activities exceeds 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 per liter. Plutonium-239, -240 was detected in LAO-0.7 (and has been every year since 1993) and was possibly detected at LAO-1. Strontium-90 was possibly detected at LAO-1 and LAO-4. LAO-2 and LAO-3A showed gross beta activities approaching or exceeding the drinking water screening level of 50 pCi per liter.

The alluvial groundwater samples from Mortandad Canyon showed levels of radionuclides within the ranges observed previously. Tritium; strontium-90; cesium-137; plutonium-238; plutonium-239, -240; americium-241; gross alpha; gross beta; and gross gamma are either detected or possibly detected in many of the wells. The radionuclide levels are in general highest at well MCO-3, which is nearest to the TA-50 RLWTF outfall, and are lower further down the canyon. Values in MCO-3 are similar to those in surface water station Mortandad at GS-1 located a short distance upstream. The levels of tritium, strontium-90, 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, except at MCO-3.

Cañada del Buey well CDBO-7 had possible detections of gross alpha, gross beta, and strontium-90. The uncertainties for all of these measurements were quite high, however. Pueblo Canyon well APCO-1 had a plutonium-239, -240 level above the detection limit from 1994 through 1996. No plutonium-239, -240 was detected in this well in 1997. Only one well in Pajarito Canyon (PCO-1) was sampled in 1997 because wells PCO-2 and PCO-3 were dry, or their pumps were inoperable.

d. 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 groundwater 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. Tritium was not detected in TW-2A in 1997, for the first year since 1991. Tritium levels in that well have averaged at about 2,590 pCi per liter from 1992 through 1996. Neither TW-1A nor TW-2A had detectable plutonium-239, -240 levels, in contrast to 1995. Basalt Spring again showed detectable plutonium-239, -240, as well as gross beta. 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 1997 are listed in Table 5-21, and results of total recoverable metal analyses are listed in Table 5-22.

a. Nonradiochemical Constituents in the Regional Aquifer. With the following exceptions, values for all parameters measured in the water supply wells were within drinking water limits. Note that separate samples are collected to determine regulatory compliance for the public water supply system, and that these samples were all in compliance for 1997.

The pH values in wells G-2 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. The analytical laboratory reported values in PM-1 for pH of 1.7 and electrical conductance of 12,000 µS per centimeter. These values are clearly in error and compare with field values for PM-1 of 7.8 for pH and 270 µS per centimeter for electrical conductance.

Otowi-1 had high aluminum, iron, and manganese values. These values probably reflect the high total suspended solids in the well, which had not been completely prepared as a water supply well.

The lead level in PM-2 was 19 µg per liter, compared to the EPA action level of 15 µg per liter. For well G-2, the arsenic level was about 70% of the standard of 50 µg per liter and was similar to previous measurements. The vanadium levels in wells G-1A and G-2 are just below the EPA health advisory range of 80 to 110 µg per liter.

The test wells in the regional 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 again had a nitrate value of 5.5 mg per liter, below the EPA primary drinking water standard of 10 mg per liter (nitrate as nitrogen). This test well has shown nitrate levels in the range of about 5 to 20 mg per liter (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.

In 1996, the sample from TW-2 had values of sodium, chloride, sulfate, arsenic, and boron that were about 10 times the usual ranges for these values. Results for these analytes from the 1997 sample were in line with values previously found for this well.

Levels of trace metals that approach water quality standards in some of the test wells are believed to be associated with turbidity of samples or 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 regional 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 and 1997, lead levels exceeded the EPA action level in TW-1, 2, 3, and 4. In 1996, TW-1 and TW-4 had lead levels above the 15 µg per liter EPA action level. 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).

Samples collected for metals analysis from most of the White Rock Canyon springs were filtered in 1997. In recent years, samples from a few springs in White Rock Canyon showed aluminum, iron, and manganese levels that exceed NMWQCC Livestock Watering and Wildlife Watering Standards or EPA 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 1997 samples from Sandia Spring were unfiltered and showed levels of aluminum, iron, and manganese that approached standards for drinking water systems. Of the filtered spring samples, Springs 5 and 7 had silver levels two to three times above the drinking water MCL. Such silver values have never been observed at these locations and may be an analytical artifact.

b. Nonradiochemical Constituents in Alluvial Groundwater. The groundwater in Pueblo, Los Alamos, and Mortandad Canyons receives effluents. The canyon bottom alluvial groundwater showed the effects of those effluents in that values of some constituents were elevated above natural levels. Mortandad Canyon alluvial groundwater samples exceeded or approached the NMWQCC Groundwater Standards for fluoride and nitrate (nitrate as nitrogen). The nitrate source is nitric acid used in plutonium processing at TA-55 that enters the TA-50 waste stream. Improvements to the TA-50, RLWTF treatment process are planned during 1998, so that the effluent will not exceed water quality standards in the future. Mortandad Canyon alluvial groundwater is also high in sodium. Nitrate in Pueblo Canyon well APCO-1 was about 60% of the EPA primary drinking water standard of 10 mg per liter (nitrate as nitrogen).

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. Notable 1997 metals values were lead in CDBO-6 and MCO-3, and of molybdenum in LAO-2 and LAO-3A.

c. Nonradiochemical Constituents in Intermediate-Depth Perched Groundwater. In 1997, 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-1A had levels of iron, manganese, and zinc approaching or exceeding water quality standards. Again, the detection of these metals in TW-1A probably reflects either suspended sediments or the flaking of metals from pump hardware and the well casing rather than the existence of dissolved metals in the groundwater. TW-1A had a fluoride concentration that was about 60% of the NMWQCC Groundwater Standard. The pH in TW-1A was above the EPA secondary drinking water range of 8.5. 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 1997. The stations sampled are listed in Table 5-23. Samples were analyzed for VOCs, SVOCs, and PCBs. Test wells at TA-49 and most springs were analyzed for HE constituents.

HE constituents were detected in Ancho Spring during 1995 sampling, but not in 1996 or 1997 samples. This spring is below the explosives testing sites in the southern portion of the Laboratory. Most of the possible organic detections reported by the Organic Analysis Group were rejected because the compounds were either detected in method blanks (introduced during laboratory analysis) or detected in trip blanks.

The only organic detection not rejected was a PCB, Arochlor 1260, found at 0.77 µg per liter in TW-4. The limit of quantitation for this PCB is 0.5 µg per liter. PCBs have not previously been found in this well, and no source is immediately apparent.

5. Long-Term Trends

a. Regional Aquifer. The long-term trends of the water quality in the regional 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 regional 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 regional 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. Detection of lead in the regional 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 regional 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., 1998).

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 RLWTF at TA-50) are depicted in Figure 5-10. 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 per liter 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 outfall 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 (MOU) with the Pueblo and the Bureau of Indian Affairs in 1987 to conduct environmental sampling on pueblo land. This section deals with hydrologic and sediment sampling. The groundwater, surface water, and sediment stations sampled on the Pueblo of San Ildefonso are shown in Figures 5-11 and 5-12. Aside from stations listed in the accompanying tables, the MOU 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, 5-5, and 5-8, and the results of analyses are discussed in previous sections.

1. Groundwater

Radiochemical analyses of the 1997 groundwater samples are shown in Table 5-16. Tables 5-17 and 5-18 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 common 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 per liter for uranium, 5 pCi per liter for gross alpha, and 20 pCi per liter for gross beta.

Most of the groundwater stations (wells and springs) listed in the MOU are discussed in Section 5.D. 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 near or much greater than the proposed MCL of 20 µg per liter are prevalent in well water throughout the Pojoaque area, which includes the Pueblo of San Ildefonso. The high gross alpha readings for these wells are related to uranium occurrence.

In 1997, there were no detections of radionuclides other than uranium in Pueblo of San Ildefonso water supply wells. 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 so that it is uncertain whether or not detection has occurred. At these measurement levels, 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 was also a high value 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 limits of precision of the laboratory analyses at these extremely low measurement 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. Again, in 1997 there were no detections of radionuclides other than uranium in any Pueblo of San Ildefonso water supply wells.

The New Community well had a uranium concentration exceeding the proposed EPA primary drinking water standard of 20 µg per liter. Uranium concentrations at the Pajarito Pump 1, Don Juan Playhouse, 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 Don Juan Playhouse, Otowi House, and New Community wells were below the EPA primary drinking water standard of 15 pCi per liter. This standard applies to gross alpha from radionuclides other than radon and uranium. Except for the Otowi House well, the gross alpha levels are apparently attributable to the presence of uranium.

The chemical quality of the groundwater, shown in Table 5-21, is consistent with previous observations. The sample from the Pajarito Pump 1 well exceeded the drinking water standard for total dissolved solids; this level is similar to those previously measured.

The fluoride values for some wells are near (Eastside Artesian and Sanchez House) or greatly exceed (LA-1B) the NMWQCC Groundwater Standard of 1.6 mg per liter, again similar to previous values. Several of the wells (Eastside Artesian, Halladay House, LA-1B, and Don Juan Playhouse) 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 per liter (nitrate as nitrogen).

Many of the wells have sodium values significantly above the EPA health advisory limit of 20 mg per liter. The values from Pajarito Pump 1, LA-1B, Sanchez House, and Eastside Artesian wells are especially high.

Trace metal analyses are shown in Table 5-22. The boron value in Pajarito Pump 1 was nearly twice the NMWQCC groundwater limit of 750 µg per liter. This value was similar to those of past years. The only other trace metal occurrence of note was antimony that was detected in the Pajarito Pump 1 well. The uncertainty for this measurement was almost as large as the reported values, so the result is questionable.

2. Sediments

Sediments from Pueblo of San Ildefonso lands in Mortandad Canyon were collected in 1997 from five permanent sampling stations, shown in Figure 5-12.

The results of these and other sediment analyses are shown in Tables 5-10 through 5-12 and Table 5-14. Related information is presented in Section 5.C. Results are comparable to sediment data collected from these same stations in previous years; exceptions are discussed below.

Analyses of sediments collected at station Mortandad A-6 in 1997 showed cesium-137; total uranium; plutonium-239, -240; and gross beta activity levels that exceeded background. However, samples from other sediment stations downstream of Mortandad A-6 showed only atmospheric fallout levels for all radionuclides.

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

Analytical results from the sediment sampling locations in Guaje, Bayo, and Sandia Canyons are within the range of values expected from worldwide fallout. These findings are consistent with previous measurements. Sediment samples collected from the Pueblo of San Ildefonso in 1997 were also analyzed for trace metals, as reported in Table 5-14. These results, which are all within the general ranges found in geologic materials from Pajarito Plateau, suggest natural origins for all trace metals (Longmire et al., 1996).

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

1. Sampling

The Draft Quality Assurance Project Plan (ESH-18 1996) is the basic document covering sampling procedures and quality assurance (QA). More focused guidance is provided in formal procedures developed to address sampling 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. Samples are submitted to the Chemical Science and Technology (CST) analytical laboratory. Detailed analytical methods are published in Gautier (1995). Samples are submitted using blind sample numbers to prevent possible bias that might occur if the analyst knows the sampled location.

Beginning in 1996, samples collected for radionuclide and metals analyses at the White Rock Canyon Springs were filtered in the field. 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 soils. The “F/UF” column on the tables of analytical results shows a “UF” for unfiltered samples and an “F” for samples filtered through a 0.45 micron filter.

Beginning May 30, 1997, surface water samples collected for metals analyses were filtered in the field. This procedural change was initiated to make the analytical results comparable with the NMWQCC standards. These standards are typically for dissolved concentrations, except for mercury and selenium, for which New Mexico standards are based on total concentrations. Mercury and selenium were not filtered in the field and were analyzed to determine total concentration.

Runoff was collected using automated samplers located at recently installed gaging stations (Shaull et al., 1998). The contents of bottles collected by the automated sampler were first transferred to a churn splitter, which agitates the samples to ensure that they are well mixed and that the sediments are suspended. If the automated sampler collected adequate water, two sets of samples were submitted to the analytical laboratory. One set was unfiltered and preserved for total concentration analysis, while the other set was submitted unfiltered and unpreserved. The analytical laboratory filtered the latter samples, preserved them, and routed them to the appropriate analyst. If insufficient water was available, only unfiltered samples were analyzed to determine total concentrations.

2. Analytical Procedures

a. Metals and Major Chemical Constituents. Metals and major chemical constituents are analyzed using EPA SW-846 methods. Filtering in the laboratory 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, the analytical laboratory has not filtered water samples submitted for metals analyses, with the exception of runoff samples as mentioned above.

b. Radionuclides. Radiochemical analysis is performed using the methods as updated in Gautier

(1995). Sediment samples are screened through a number 12 US standard testing sieve before digestion. The sieve meets ASTM E-11 specifications and screens out materials larger than 1.7 mm. Ten-gram samples are analyzed from stream channels; 1,000-g samples are analyzed from reservoirs. With larger sample volumes, there is a 10-fold improvement in detection limits of plutonium-238 and plutonium-239, -240 for reservoir samples.

Water samples for radiochemical analyses are preserved with nitric acid in the field to a pH of 2 or less. Beginning in 1997 a separate, unpreserved sample was collected for tritium analysis. Before 1996, the analytical laboratory filtered water samples before digesting. Samples collected in 1996 and after are preserved in the field as before but not filtered by the analytical laboratory. At the analytical laboratory, both water and sediment samples are completely digested in a mixture of nitric and hydrofluoric acids.

When especially precise 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 in Tritium Laboratory (1996).

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 are less than the detection limit and the negative values are included in the analytical results.

c. Organics. Organics are analyzed 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 VOC samples are preserved with hydrochloric acid. A trip blank always accompanies the VOC sample.

3. Data Management and Quality Assurance

a. Data Management. CST transfers the data to ESH-18 both electronically and as a hard copy. Samples submitted to CST for analyses before April 11, 1997, went through the Datatrieve System. The electronic data were transferred weekly to the Facility for Information Management, Analysis, and Display (FIMAD). The data were screened by FIMAD and stored in an Oracle database table. Data were extracted from the FIMAD Oracle table and transferred to ESH-18 through a Microsoft Access interface using ODBC drivers.

In April of 1997, CST installed a new SQL Laboratory Information Management System. Samples submitted after April 11, 1997, went through this system. A data retrieval query was created to generate a table of ESH-18 data every week. The complete data set is recreated and downloaded to ESH-18 personal computers every week. The sample location name, the sample barcode number, and the field data are stored in a separate table on ESH-18 personal computers. This table provides the link for associating a blind sample barcode number with a location name.

b. Quality Assurance. Each analytical batch (20 samples or less) contains at least one blank, one matrix spike, and a duplicate as dictated by SW-846 protocols. These samples are provided by CST and submitted along with environmental surveillance samples. ESH-18 also submits blanks, spikes, and duplicate water samples. The analytical results of the blanks and spikes are presented in Tables 5-24 and 5-25. The analytical results for the duplicates are presented on the analytical result tables.

Deionized water (DI) blanks and spiked samples are submitted as regular samples, without any indication that they are QC samples. They go through the same analysis process as the regular field samples. The DI blanks and spiked samples are measured with the same background contributions from reagents and biases as the regular samples and give an estimate of background and systematic analytical errors. The DI blank sample values are used to correct the radiochemical sample analyses results by subtracting the average of the blanks from each of the reported sample values. The original analytical value for radiochemical results may be recovered by adding the average blank value found in Table 5-24 to the values reported in the analytical result tables.

Results in Table 5-24 suggest a high bias in the americium-241 analyses. The average concentration of americium-241 in the DI blanks (0.051 pCi per liter) was above the detection limit. The likely cause for higher than expected concentrations for americium-241 is the plutonium-242 tracer that is added to the sample to determine plutonium recovery. There is a small amount of plutonium-241 in this tracer. Plutonium-241 decays to americium-241 by beta decay, resulting in additional americium-241 in the samples.

A high analytical bias is also suggested for several other analytes. Last year CST analysts believed that the high bias in tritium might be due to the nitric acid preservative. All tritium samples were submitted unpreserved in 1997 and a similar high bias is still suggested.

A high bias, on the order of one-half of the detection limit, is also apparent in the plutonium-238 and plutonium-239, 240 DI blank results. Ideally, these values should be zero.

The concentrations reported in Table 5-24 for the spiked samples are the concentrations after subtraction of the average blank values. There is good agreement between the analytical results and the spiked concentrations after blank correction.

Taylor (1987) suggests a method for evaluating detection limits based on the analytical results for spiked samples. The standard deviation of the average spiked sample result can be used as a measure of the one sigma analytical uncertainty. Results of this analysis are presented in the last line on Table 5-24. Detection limits calculated using this method are at least twice the values that the analytical laboratory reports.

The ratio of the standard deviation of the blank values and the laboratory detection limit is calculated in Table 5-24. Since the detection limits are based on 4.66 times the uncertainty, the standard deviation should be about 22% of the detection limits. The relatively higher standard deviations reported suggest that sample values near the detection limit are not very precise. Both these points emphasize that detection limits are subject to uncertainty and should not be considered an absolute indicator of the presence or absence of an analyte.

Analytical concentrations for DI blanks submitted for trace metals were generally reported as less-than-detection limits. Spiked samples for metals analyses contained four metals. There was generally good agreement between spike concentrations and the analytical results. Standard deviations associated with the average values for the DI blanks and spiked samples are generally significantly less than the reported concentrations, suggesting relatively precise measurements. Mercury concentrations were consistently low at about 40% of the spiked value; we are investigating potential solutions.

4. Determination of Radiochemical Detections

Analytical uncertainties are reported in the tables presenting radiochemical analytical results. The CST analyst for each radiological measurement reports these uncertainties, which are specific to each sample measurement. One standard deviation (one sigma) counting uncertainty is typically reported. Through 1995, the uncertainties reported for tritium in the tables were described in surveillance reports as representing one standard deviation (one sigma). Communications with CST show that this value was reported incorrectly. For tritium results, the value reported as the one-sigma uncertainty through 1995 should have been labeled a three-sigma uncertainty. Since 1996, one-sigma uncertainties have been reported for tritium.

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. In deriving the detection limits CST included the average uncertainties associated with the entire analytical method. Sources of error considered include average counting uncertainties, sample preparation effects, digestion, dilutions, gravimetric and pipetting uncertainties, and spike recoveries.

To identify Laboratory impacts as early as possible, it is important to determine when a contaminant is present in an area where it has not previously been identified. 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 either the limit of detection (LOD) (Keith 1991 and Taylor 1987) or the critical level, L_C (Currie 1968). 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.

The reliable detection limit (RDL) (Keith 1991) (or the L_D [Currie 1968]) is the level at which 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 that originating from cosmic rays or from bedrock. 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 (sigma) and the RDL or L_D is 4.66 sigma.

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

The Surface Water, Sediments, and Groundwater sections of this chapter contain tables identifying two groups of radionuclide detections. Possible detections are defined as being above the detection limit and greater than 2.33 times the uncertainty (sigma) but less than 4.66 sigma. This defines the set of measurements above the critical level but below the RDL. A large data set of values near the detection limit will contain about 1 false positive for every 20 observations. Detections are defined as being above the detection limit and greater than 4.66 sigma, that is, the RDL. These tables are presented to focus on cases where radionuclides were detected. For sediments, detections in either category are also above background levels determined for fallout, or natural background levels in the case of uranium.

G. Unplanned Releases

All unplanned releases were of radioactive and nonradioactive liquid and 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 9 of the 18 unplanned releases that occurred in 1997. It is anticipated that the rest of the unplanned release investigations will be closed when NMED-DOE/OB personnel become available for inspections.

1. Radioactive Liquid Materials

There were no unplanned radioactive liquid releases in 1997.

2. Nonradioactive Liquid Materials

There were 18 unplanned releases of nonradioactive liquid in 1997. The following is a summary of these discharges.

- Five unplanned releases of noncontact cooling water and treated cooling water.
- Four releases of sanitary sewage from the Laboratory’s TA-46, SWSC Plant’s collection system.
- Four releases of diesel from vehicles, equipment, and an old underground storage tank being removed for salvage.
- One release of dielectric oil which occurred while moving an old transformer.
- Three releases of potable water which impacted ER Project solid waste management unit sites.
- One release of drilling water/mud to a watercourse.

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 1997, total water production from 14 wells in the Guaje, Pajarito, and Otowi municipal well fields and Los Alamos Reservoir was 4.88 million m^3. This total production amounts to 71.3% of the total water right of 6.84 million m^3 that is available to DOE under its permit. The Otowi-1 well did not contribute to water supply during 1997 because of operational NPDES discharge restrictions. The drilling of four new replacement wells in the Guaje well field began during 1997. 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 1997” (McLin et al., 1998).

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 groundwater located throughout the facility. These data are automatically recorded at hourly intervals using calibrated pressure transducers. Water level data are presented in the Laboratory report entitled “Water Supply at Los Alamos during 1997” (McLin et al., 1998), which summarizes the locations, start and end dates for data collection, and final water levels recorded during 1997.

3. Surface Water Data at Los Alamos National Laboratory: 1997 Water Year

Surface water discharge data were collected from 19 stream-gaging stations that cover most of the Laboratory. The data, published in the report "Surface Water Data at Los Alamos National Laboratory: 1997 Water Year" (Shaull et al., 1998), show less runoff than do data for the 1996 water year. Water chemistry data from larger storm events occurring at some stations are also published in that report.

The 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.

4. Hydrogeologic Investigations at Los Alamos National Laboratory

Groundwater contained within the regional aquifer beneath LANL is used for both public water supply by Los Alamos County and for industrial applications by the Laboratory. Recently, the Laboratory issued the "Hydrogeologic Workplan," (LANL 1996b) which describes activities proposed to be performed to further characterize the hydrogeologic setting and to enhance the Laboratory's groundwater monitoring program. The workplan was issued as a result of the Laboratory's own commitment to the protection of the groundwater resource and to issues raised by the NMED. The DOE Oversight Bureau reviewed a draft version of the workplan and submitted written recommendations regarding well location, well design, and scheduling.

During the fall of 1997, the Laboratory began implementation of the workplan by drilling test well R-9, a regional-aquifer well located in Los Alamos Canyon near the Laboratory's eastern boundary at State Road 4. Well R-9 is designed to provide geologic, hydrogeologic, and water quality data from shallow and intermediate saturated zones, as well as the regional aquifer. Before drilling R-9, the last regional aquifer test well was drilled in 1960.

Laboratory investigators expected R-9 to encounter an intermediate perched aquifer at approximately 238 ft within the basalt. However, as work progressed, three intermediate saturated zones were encountered: one at approximately 180 ft, another at 270 ft, and a third at 579 ft. Samples from each groundwater zone were collected by the Laboratory and the DOE Oversight Bureau. Preliminary Laboratory analyses showed tritium slightly above background levels in both the 180-ft and 270-ft intermediate saturated zones. Following several attempts, the intermediate saturated zones were successfully sealed off from the lower regional aquifer to prevent cross-contamination between saturated zones. The occurrence of the third saturated zone at 579 ft was an additional, unexpected event. This deep saturated zone was originally assumed to be the upper portion of the regional aquifer. After discovering only 2 ft of saturation, drilling continued for another 100 ft, to a depth of 680 ft, resulting only in dry bedrock and no regional water table. Currently, the drilling is expected to continue until the regional water table is encountered. Water quality and hydrogeologic data collected from all the intermediate saturated zones will be evaluated to decide if additional intermediate saturated zone wells are needed in the vicinity of R-9.

Currently, R-9 is projected to penetrate the regional water table in gravels of the Puye Formation, somewhere deeper than 680 ft below land surface, where it will be completed and developed. Following well completion, the upper 50 ft of saturation within the regional aquifer will be monitored and sampled by the Laboratory and the DOE Oversight Bureau.

Table 5-1. Radiochemical Analysis of Surface Waters for 1997 (pCi/L[a])

Station Name	Date	Code[b]		^{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 Chama at Chamita	10/07	1	UF	138	–670[c,d]	0.7	1.5	–0.71	0.17	1.43	0.15	–0.015	0.006	0.007	0.012	0.030	0.019	1.7	0.4	3.1	0.3	52	48
Rio Grande at Embudo	10/07	1	UF	–212	640	0.1	1.6	–0.36	0.17	1.43	0.15	–0.019	0.010	–0.016	0.009	–0.048	0.010	1.0	0.3	2.7	0.3	14	48
Rio Grande at Otowi Upper (bank)	12/01	1	UF	298	690	0.1	1.1	–0.15	1.00	2.24	0.23	0.010	0.013	–0.004	0.011	0.017	0.020	1.3	1.7	2.6	1.8	79	49
Rio Grande at Otowi (bank)	12/01	1	UF	–22	670	0.1	1.2	0.59	0.42	2.36	0.24	0.000	0.011	0.017	0.013	0.029	0.021	0.9	1.7	2.5	1.8	24	49
Rio Grande at Frijoles (bank)	09/30	1	UF	–162	660	–1.3	2.5	–0.43	0.59	0.97	0.10	–0.031	0.005	–0.006	0.012	–0.035	0.014	3.1	4.5	5.5	2.1	15	49
Rio Grande at Cochiti	10/07	1	UF	248	670	1.8	2.2	0.59	0.32	1.69	0.17	0.043	0.020	0.005	0.015	–0.043	0.011	10.9	1.7	16.9	1.2	47	48
Rio Grande at Cochiti	10/07	1	UF	–22	660	0.3	2.0	–0.44	0.18	0.97	0.10	–0.018	0.011	–0.008	0.010	–0.029	0.011	3.8	0.6	3.9	0.4	19	48
Cochiti Lower	10/29	1	UF	288	690	0.7	1.3	–0.44	0.57	1.35	0.14	–0.024	0.007	–0.009	0.010	–0.001	0.013	1.6	3.1	4.0	1.9	5	48
Cochiti Middle	10/29	1	UF	188	690	1.1	1.2	–0.38	0.67	1.21	0.12	–0.029	0.005	–0.012	0.010	–0.012	0.027	2.0	6.5	2.8	1.8	–8	48
Cochiti Upper	10/29	1	UF	48	680	1.6	1.8	–0.76	0.09	1.33	0.14	–0.019	0.011	–0.007	0.013	–0.028	0.011	1.0	3.1	2.1	1.7	–14	48
Jemez River	10/07	1	UF	–52	650	2.9	2.1	1.20	0.42	0.94	0.10	0.007	0.014	–0.002	0.012	–0.036	0.014	7.0	1.2	14.1	1.1	18	48
Pajarito Plateau																							
Guaje Canyon:																							
Guaje Canyon	11/18	1	UF	–72	650	–0.2	1.4	–0.49	0.50	0.09	0.01	–0.014	0.006	0.016	0.011	–0.018	0.010	1.0	4.8	2.1	1.7	17	49
Pueblo Canyon:																							
Acid Weir	06/02	1	UF	130	190	7.9	3.8	0.85	2.50	0.32	0.04	0.089	0.023	2.585	0.157	0.207	0.035	4.4	1.3	27.0	4.0	20	48
Pueblo 1	06/02	1	UF	264	214	0.3	1.5	–0.55	0.40	0.03	0.01	0.002	0.015	–0.021	0.013	–0.042	0.014	0.8	0.4	1.9	0.7	–14	48
Pueblo 3	06/12	1	UF	–130	156	1.5	1.5	–0.96	0.80	0.42	0.05	–0.009	0.009	0.063	0.019	0.022	0.020	–0.4	0.3	13.6	1.9	–49	47
Pueblo at SR 502	06/12	1	UF	–281	652	0.5	1.5	–0.78	0.07	0.20	0.02	–0.015	0.007	0.179	0.028	0.049	0.024	0.9	3.1	14.1	5.1	–21	48
DP/Los Alamos Canyon:																							
Los Alamos Canyon Reservoir	12/01	1	UF	–172	670	0.0	1.4	0.90	0.39	0.14	0.02	–0.027	0.005	–0.012	0.008	0.005	0.025	–0.3	0.9	1.4	1.6	5	49
DPS-1	06/02	1	UF	–97	90	142.1	9.5	–0.75	0.10	0.39	0.04	–0.034	0.018	0.026	0.020	–0.010	0.015	–3.4	0.7	285.0	38.0	–6	48
DPS-4	06/10	1	UF	29	202	41.9	4.1	1.04	0.41	0.15	0.02	–0.006	0.009	0.056	0.017	0.087	0.028	0.8	0.2	81.0	11.0	–4	48
Los Alamos at Upper GS	12/18	1	UF	178	670	0.6	1.5	–0.70	0.18	0.28	0.03	–0.035	0.007	0.011	0.012	–0.028	0.013	0.4	2.1	5.9	2.1	–28	48
Los Alamos at SR 4	04/29	1	UF	54	199	1.9	1.6	0.24	0.26	0.11	0.01	0.000	0.014	0.159	0.031	0.119	0.033	1.9	0.8	3.4	0.9	20	48
Los Alamos at Rio Grande	05/19	1	UF	–192	–198	0.9	1.7	1.31	0.48	1.58	0.16	–0.001	0.012	0.022	0.015	0.002	0.024	–0.6	2.4	1.1	0.6	36	47
Sandia Canyon:																							
SCS-1	06/12	1	UF	356	216	0.7	2.0	–1.05	0.80	0.24	0.03	0.000	0.010	–0.003	0.011	–0.036	0.017	0.3	1.2	13.0	5.0	–40	48
SCS-2	06/12	1	UF	–27	207	0.4	1.9	–0.64	0.27	0.47	0.05	–0.021	0.008	–0.024	0.009	–0.022	0.017	3.2	3.2	6.7	3.7	–50	47
SCS-3	06/03	1	UF	–59	148	–0.1	1.2	–1.24	0.80	0.55	0.06	–0.027	0.008	0.013	0.014	–0.003	0.015	0.2	0.3	15.0	3.0	–24	48
Mortandad Canyon:																							
Mortandad at GS-1	06/03	1	UF	9,095	424	9.5	3.5	33.28	3.80	0.50	0.05	5.984	0.306	4.705	0.249	11.219	0.554	49.8	9.0	69.0	10.0	–6	48
Mortandad at GS-1	06/03	1	UF	8,797	417	10.5	2.2	32.58	3.70	0.53	0.06	7.011	0.355	6.167	0.318	12.101	0.589	39.8	8.0	69.0	10.0	–4	48
Mortandad at Rio Grande (A-11)	09/11	1	UF	–192	660	1.4	1.6	0.40	1.83	0.53	0.06	0.006	0.013	0.004	0.012	–0.007	0.018	0.4	2.0	5.9	2.1	19	48
Cañada del Buey:																							
Cañada del Buey	05/22	1	UF	–168	194	0.9	1.4	–0.51	0.47	0.53	0.06	0.016	0.020	0.002	0.015	–0.029	0.020	–0.7	1.1	2.7	0.8	42	47
Pajarito Canyon:																							
Pajarito at Rio Grande	09/29	1	UF	–372	650	–0.9	2.4	–0.43	0.59	1.02	0.11	–0.007	0.010	–0.005	0.012	0.028	0.020	1.5	3.1	2.0	1.7	–26	48

Table 5-1. Radiochemical Analysis of Surface Waters for 1997 (pCi/L[a]) (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	
Water Canyon:																							
Water Canyon at Beta	06/23	1	UF	–93	182	–0.3	2.3	–0.11	1.07	0.12	0.02	–0.017	0.021	0.002	0.018	0.289	0.045	0.3	1.4	4.4	1.9	–9	48
Ancho Canyon:																							
Ancho at Rio Grande	09/29	1	UF	28	680	–0.6	1.2	–0.48	0.19	0.20	0.02	–0.012	0.011	0.017	0.014	0.019	0.021	0.5	2.8	1.3	1.6	6	49
Frijoles Canyon:																							
Frijoles at Monument HQ	11/18	1	UF	–232	640	0.7	1.2	0.62	2.17	0.10	0.01	0.011	0.011	–0.006	0.009	–0.007	0.010	0.9	5.9	1.4	1.6	46	49
Frijoles at Rio Grande	09/30	1	UF	–342	650	–0.2	1.1	–0.61	0.32	0.13	0.02	–0.015	0.011	0.012	0.015	–0.051	0.012	0.2	0.9	1.7	1.7	–4	49
Detection Limits				700		3		4		0.1		0.04		0.04		0.04		3		3		120	
Water Quality Standards[e]																							
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													

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[a] Except where noted.

[b] Codes: UF–unfiltered, F–filtered, 1–primary analysis, 2–secondary analysis, R1–lab replicate, D1–lab duplicate.

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

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

[e] Standards given here for comparison only, see Appendix A.

Table 5-2. Radiochemical Analysis of Runoff Water Samples in 1997

Station Name	Date	Codes[b]		Flow (cfs)	^{3}H		^{90}Sr		^{137}Cs		U (μg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Water Samples (pCi/L[a])																								
DP Canyon near LA	08/05	1	UF	5	338	690	–0.2[d]	1.1	1.51	0.50	0.51	0.05	0.023	0.014	0.210	0.033	0.671	0.064	2.6	1.5	49.0	4.0	–69	47
LA Canyon near LA	06/07	1	UF	36	–71	178	8.1	2.0	5.29	0.97	4.16	0.42	0.255	0.043	2.387	0.159	2.702	0.205	258.8	86.0	247.0	37.0	–39	47
LA Canyon near LA	06/07	1	UF	36	–77	167	7.6	1.8	9.58	1.30	4.54	0.46	0.223	0.029	2.208	0.106	5.016	0.308	113.8	52.0	147.0	38.0	–57	47
LA Canyon near LA	08/05	1	F	5.2			12.8	2.6	2.07	4.33	0.25	0.03	0.105	0.027	0.990	0.083	1.309	0.110	16.8	5.0	40.0	4.0	40	48
LA Canyon near LA	08/05	1	UF	5.2	–432	640	25.0	2.7	–0.32	0.76	1.29	0.13	0.140	0.031	1.684	0.122	2.081	0.141	13.8	5.0	33.0	4.0	–27	47
LA Canyon near LA	08/22	1	UF	171	168	680	3.1	0.8	42.28	4.70	6.58	0.66	0.151	0.045	1.285	0.123	10.288	0.503	640.8	168.0	1,637.0	289.0	66	48
LA Canyon near LA	09/20	1	F	40			5.1	2.0	–0.93	0.36	0.01	0.01	–0.006	0.009	0.028	0.014	0.034	0.020	0.1	3.0	12.0	2.0	6	48
LA Canyon near LA	09/20	1	UF	40	–22	660	7.2	1.8	18.88	2.40	4.34	0.44	0.541	0.077	5.459	0.336	7.570	0.443	175.8	5.0	336.0	5.0	12	48
Los Alamos Canyon at LA	03/26	1	F	1.6	127	203	0.7	0.6	–0.32	0.76	0.04	0.01	–0.008	0.010	–0.016	0.009	–0.016	0.016	0.6	0.4	1.1	0.6	6	48
Los Alamos Canyon at LA	03/26	1	UF	1.6	20	190	0.5	0.7	–0.39	0.64	0.10	0.01	–0.043	0.002	–0.028	0.008	–0.005	0.044	1.2	0.6	2.3	0.7	–26	47
Cañada del Buey at WR	08/02	1	UF	3.2	–52	670	2.7	0.8	3.24	0.74	4.30	0.43	0.015	0.019	0.108	0.034	0.017	0.024	233.8	76.0	616.0	105.0	48	48
Pajarito at SR 501	03/25	1	F	0.28	328	219	0.6	0.4	–0.19	0.33	0.13	0.02	–0.015	0.009	–0.008	0.012	0.022	0.021	2.3	0.8	1.7	0.6	–29	47
Pajarito at SR 501	03/25	1	UF	0.28	–93	145	0.8	0.5	3.18	6.00	0.10	0.01	–0.027	0.005	–0.014	0.008	–0.024	0.030	2.1	0.8	1.6	0.6	–45	47
Potrillo Canyon near WR	08/17	1	UF	3.3			2.7	0.9	5.11	0.97	4.64	0.47	–0.027	0.020	0.218	0.049	0.038	0.030	187.8	45.0	343.0	46.0	66	48
Area G Runoff																								
G-SWMS-4	07/21	1	UF	0.12	–111	182	2.1	1.6	0.74	2.33	2.35	0.24	0.143	0.036	2.994	0.199	–0.034	0.020	0.3	1.8	5.9	2.1	25	48
G-SWMS-4	07/21	1	UF	0.12	86	196	0.5	1.6	–1.19	0.36	0.42	0.05	0.060	0.028	0.653	0.071	–0.026	0.014	6.8	2.8	21.0	3.0	–46	47
G-SWMS-5	08/04	1	UF	4.6	498	700	11.5	4.1	–0.25	0.27	10.78	1.08	0.297	0.040	0.704	0.065	0.379	0.120	131.8	4.4	120.0	4.2	118	48
G-SWMS-6	10/21	1	UF	0.36	–152	670	1.8	0.9	1.47	0.49	3.87	0.39	0.325	0.047	2.094	0.142	0.933	0.089	336.8	87.0	425.0	60.0	9	48
Detection Limits					700		3		4		0.1		0.04		0.04		0.04		3		3		120	
Water Quality Standards[e]																								
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													

Table 5-2. Radiochemical Analysis of Runoff Water Samples in 1997 (Cont.)

Station Name	Date	Codes[b]	TSS (mg/L)	Flows (cfs)	^{90}Sr		^{137}Cs		U (mg/kg)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
Calculated activities and uncertainties for suspended sediments in water samples (pCi/g[a])																						
LA Canyon near LA	08/05	1	1,233	5.2	9.9	3.1	–1.94	3.58	0.84	0.11	0.028	0.034	0.563	0.120	0.626	0.145	–2.4	5.7	–5.7	4.6	–54	55
LA Canyon near LA	09/20	1	3,794	40	0.6	0.7	5.22	0.64	1.14	0.12	0.144	0.020	1.431	0.089	1.986	0.118	46.3	1.5	85.4	1.4	2	18
LA Canyon at LA	03/26	1	21	1.6	–7.6	45.1	–3.33	47.32	2.86	0.67	–1.638	0.477	–0.600	0.570	0.510	2.230	31.0	35.7	57.1	43.9	–1,510	3,199
Pajarito at SR 501	03/25	1	4	0.28	47.5	160	842.5	1,661.1	–7.50	5.73	–2.95	2.71	–1.58	3.76	–11.35	9.19	–50.0	282.8	–25.0	212.1	–3,800	16,741
Sediment Comparisons																						
Background (x + 2s)[f]					0.9		0.44		4.40		0.006		0.023		0.090[g]		14.8[g]		12.0[g]		8.2[g]	
SAL[h]					5.9		4.0		95		20		18		17							

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[a] Except where noted.

[b] Codes: UF–unfiltered, F–filtered, 1–primary analysis, 2–secondary analysis, R1–lab replicate, D1–lab duplicate.

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

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

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

[f] Purtymun, 1987a; upper limit for background.

[g] Preliminary background value for channel sediments from 1974–1996 (McLin 1997).

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

Table 5-3. Detections of Radionuclides in Surface Waters and Runoff Samples for 1997[a]

Station Name	Date	Code[b]	Analyte	Lab Value	Uncertainty	Units	Detection Limit
Runoff							
Cañada del Buey at WR	08/02	1 UF	Beta	616.0	105.0	pCi/L	3
DP Canyon near LA	08/05	1 UF	^{241}Am	0.671	0.064	pCi/L	0.04
DP Canyon near LA	08/05	1 UF	Beta	49.0	4.0	pCi/L	3
DP Canyon near LA	08/05	1 UF	^{239,240}Pu	0.210	0.033	pCi/L	0.04
G-SWMS-4	07/21	1 UF	Beta	21.0	3.0	pCi/L	3
G-SWMS-4	07/21	1 UF	^{239,240}Pu	0.653	0.071	pCi/L	0.04
G-SWMS-4	07/21	1 UF	^{239,240}Pu	2.994	0.199	pCi/L	0.04
G-SWMS-5	08/04	1 UF	Alpha	131.8	4.4	pCi/L	3
G-SWMS-5	08/04	1 UF	Beta	120.0	4.2	pCi/L	3
G-SWMS-5	08/04	1 UF	^{238}Pu	0.297	0.040	pCi/L	0.04
G-SWMS-5	08/04	1 UF	^{239,240}Pu	0.704	0.065	pCi/L	0.04
G-SWMS-5	08/04	1 UF	U	10.78	1.08	µg/L	0.1
G-SWMS-6	10/21	1 UF	^{241}Am	0.933	0.089	pCi/L	0.04
G-SWMS-6	10/21	1 UF	Beta	425.0	60.0	pCi/L	3
G-SWMS-6	10/21	1 UF	^{238}Pu	0.325	0.047	pCi/L	0.04
G-SWMS-6	10/21	1 UF	^{239,240}Pu	2.094	0.142	pCi/L	0.04
LA Canyon near LA	06/07	1 F	^{241}Am	2.702	0.205	pCi/L	0.04
LA Canyon near LA	06/07	1 F	Beta	247.0	37.0	pCi/L	3
LA Canyon near LA	06/07	1 F	^{137}Cs	5.29	0.97	pCi/L	4
LA Canyon near LA	06/07	1 F	^{238}Pu	0.255	0.043	pCi/L	0.04
LA Canyon near LA	06/07	1 F	^{239,240}Pu	2.387	0.159	pCi/L	0.04
LA Canyon near LA	06/07	1 UF	^{241}Am	5.016	0.308	pCi/L	0.04
LA Canyon near LA	06/07	1 UF	^{137}Cs	9.58	1.30	pCi/L	4
LA Canyon near LA	06/07	1 UF	^{238}Pu	0.223	0.029	pCi/L	0.04
LA Canyon near LA	06/07	1 UF	^{239,240}Pu	2.208	0.106	pCi/L	0.04
LA Canyon near LA	08/05	1 F	^{241}Am	1.309	0.110	pCi/L	0.04
LA Canyon near LA	08/05	1 F	Beta	40.0	4.0	pCi/L	3
LA Canyon near LA	08/05	1 F	^{239,240}Pu	0.990	0.083	pCi/L	0.04
LA Canyon near LA	08/05	1 F	^{90}Sr	12.8	2.6	pCi/L	3
LA Canyon near LA	08/05	1 UF	^{241}Am	2.081	0.141	pCi/L	0.04
LA Canyon near LA	08/05	1 UF	Beta	33.0	4.0	pCi/L	3
LA Canyon near LA	08/05	1 UF	^{239,240}Pu	1.684	0.122	pCi/L	0.04
LA Canyon near LA	08/05	1 UF	^{90}Sr	25.0	2.73	pCi/L	3
LA Canyon near LA	08/22	1 UF	^{241}Am	10.288	0.503	pCi/L	0.04
LA Canyon near LA	08/22	1 UF	Beta	1,637.0	289.0	pCi/L	3
LA Canyon near LA	08/22	1 UF	^{137}Cs	42.28	4.70	pCi/L	4
LA Canyon near LA	08/22	1 UF	^{239,240}Pu	1.285	0.123	pCi/L	0.04
LA Canyon near LA	08/22	1 UF	U	6.58	0.66	µg/L	0.1
LA Canyon near LA	09/20	1 UF	Alpha	175.8	5.0	pCi/L	3
LA Canyon near LA	09/20	1 UF	^{241}Am	7.570	0.443	pCi/L	0.04
LA Canyon near LA	09/20	1 UF	Beta	336.0	5.0	pCi/L	3
LA Canyon near LA	09/20	1 UF	^{137}Cs	18.88	2.40	pCi/L	4
LA Canyon near LA	09/20	1 UF	^{238}Pu	0.541	0.077	pCi/L	0.04
LA Canyon near LA	09/20	1 UF	^{239,240}Pu	5.459	0.336	pCi/L	0.04
Potrillo Canyon near WR	08/17	1 UF	Beta	343.0	46.0	pCi/L	3
Potrillo Canyon near WR	08/17	1 UF	^{137}Cs	5.11	0.97	pCi/L	4
Surface Water							
Acid Weir	06/02	1 UF	^{241}Am	0.207	0.035	pCi/L	0.04
Acid Weir	06/02	1 UF	Beta	27.0	4.0	pCi/L	3
Acid Weir	06/02	1 UF	^{239,240}Pu	2.585	0.157	pCi/L	0.04
DPS-1	06/02	1 UF	Beta	285.0	38.0	pCi/L	3
DPS-1	06/02	1 UF	^{90}Sr	142.1	9.5	pCi/L	3
DPS-4	06/10	1 UF	Beta	81.0	11.0	pCi/L	3
DPS-4	06/10	1 UF	^{90}Sr	41.9	4.1	pCi/L	3
Jemez River	10/07	1 UF	Alpha	7.0	1.2	pCi/L	3
Los Alamos at SR 4	04/29	1 UF	^{239,240}Pu	0.159	0.031	pCi/L	0.04

Table 5-3. Detections of Radionuclides in Surface Waters and Runoff Samples for 1997[a] (Cont.)

Station Name	Date	Code[b]		Analyte	Lab Value	Uncertainty	Units	Detection Limit
Surface Water (Cont.)								
Mortandad at GS-1	06/03	1	UF	Alpha	49.8	9.0	pCi/L	3
Mortandad at GS-1	06/03	1	UF	Alpha	39.8	8.0	pCi/L	3
Mortandad at GS-1	06/03	1	UF	^{241}Am	12.101	0.589	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	^{241}Am	11.219	0.554	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	Beta	69.0	10.0	pCi/L	3
Mortandad at GS-1	06/03	1	UF	Beta	69.0	10.0	pCi/L	3
Mortandad at GS-1	06/03	1	UF	^{137}Cs	33.28	3.80	pCi/L	4
Mortandad at GS-1	06/03	1	UF	^{137}Cs	32.58	3.70	pCi/L	4
Mortandad at GS-1	06/03	1	UF	^{3}H	9095	424	pCi/L	700
Mortandad at GS-1	06/03	1	UF	^{3}H	8797	417	pCi/L	700
Mortandad at GS-1	06/03	1	UF	^{238}Pu	7.011	0.355	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	^{238}Pu	5.984	0.306	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	^{239,240}Pu	4.705	0.249	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	^{239,240}Pu	6.167	0.318	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	^{90}Sr	10.5	2.2	pCi/L	3
Pueblo at SR-502	06/12	1	UF	^{239,240}Pu	0.179	0.028	pCi/L	0.04
Rio Grande at Cochiti	10/07	1	UF	Alpha	10.9	1.7	pCi/L	3
Water Canyon at Beta	06/23	1	UF	^{241}Am	0.289	0.045	pCi/L	0.04

[a] Detection defined as sample value–average blank > 4.66 uncertainty and > detection limit, except values for uranium > 5 µg/L, for gross beta > 20 pCi/L, and for gross alpha > 5 pCi/L.

[b] Codes: UF–unfiltered, F–filtered, T–total as calculated on Table 5-2, 1–primary analysis, R1–lab replicate, D1–lab duplicate.

Table 5-4. Possible Detections of Radionuclides in Surface Waters and Runoff Samples for 1997[a]

Station Name	Date	Code[b]		Analyte	Lab Value	Uncertainty	Units	Detection Limit
Runoff								
Cañada Del Buey at WR	08/02	1	UF	Alpha	233.8	76.0	pCi/L	3
Cañada Del Buey at WR	08/02	1	UF	^{239,240}Pu	0.108	0.034	pCi/L	0.04
G-SWMS-4	07/21	1	UF	Alpha	6.8	2.8	pCi/L	3
G-SWMS-4	07/21	1	UF	^{238}Pu	0.143	0.036	pCi/L	0.04
G-SWMS-5	08/04	1	UF	^{241}Am	0.379	0.120	pCi/L	0.04
G-SWMS-5	08/04	1	UF	^{90}Sr	11.47	4.05	pCi/L	3
G-SWMS-6	10/21	1	UF	Alpha	336.8	87.0	pCi/L	3
LA Canyon near LA	06/07	1	F	Alpha	258.8	86.0	pCi/L	3
LA Canyon near LA	06/07	1	F	^{90}Sr	8.08	1.97	pCi/L	3
LA Canyon near LA	06/07	1	UF	Beta	147.0	38.0	pCi/L	3
LA Canyon near LA	06/07	1	UF	^{90}Sr	7.56	1.77	pCi/L	3
LA Canyon near LA	08/05	1	F	Alpha	16.8	5.0	pCi/L	3
LA Canyon near LA	08/05	1	F	^{238}Pu	0.105	0.027	pCi/L	0.04
LA Canyon near LA	08/05	1	UF	Alpha	13.8	5.0	pCi/L	3
LA Canyon near LA	08/05	1	UF	^{238}Pu	0.140	0.031	pCi/L	0.04
LA Canyon near LA	08/22	1	UF	Alpha	640.8	168.0	pCi/L	3
LA Canyon near LA	08/22	1	UF	^{238}Pu	0.151	0.045	pCi/L	0.04
LA Canyon near LA	08/22	1	UF	^{90}Sr	3.07	0.83	pCi/L	3
LA Canyon near LA	09/20	1	F	^{90}Sr	5.13	1.97	pCi/L	3
LA Canyon near LA	09/20	1	UF	^{90}Sr	7.22	1.83	pCi/L	3
Potrillo Canyon near WR	08/17	1	UF	Alpha	187.8	45.0	pCi/L	3
Potrillo Canyon near WR	08/17	1	UF	^{239,240}Pu	0.218	0.049	pCi/L	0.04
Surface Water								
Acid Weir	06/02	1	UF	^{238}Pu	0.089	0.023	pCi/L	0.04
DPS-4	06/10	1	UF	^{241}Am	0.087	0.028	pCi/L	0.04
DPS-4	06/10	1	UF	^{239,240}Pu	0.056	0.017	pCi/L	0.04
Los Alamos at SR-4	04/29	1	UF	^{241}Am	0.119	0.033	pCi/L	0.04
Mortandad at GS-1	06/03	1	UF	^{90}Sr	9.48	3.50	pCi/L	3
Pueblo 3	06/12	1	UF	^{239,240}Pu	0.063	0.019	pCi/L	0.04

[a] Possible detection defined as 2.33 uncertainty < (sample value–average blank) < 4.66 uncertainty and sample value–average blank > detection limit, except values for uranium > 5 µg/L, for gross beta > 20 pCi/L, and for gross alpha > 5 pCi/L.

[b] Codes: UF–unfiltered, F–filtered, T–total as calculated on Table 5-2, 1–primary analysis, R1–lab replicate, D1–lab duplicate.

Table 5-5. Radionuclides near Department of Energy Derived Concentration Guides in Surface Waters for 1997[a]

Station Name	Date	Code	Analyte	Lab Value	Uncertainty	Units	DOE DCG	Ratio of Value to DCG	Min Std	Detection or Possible Detection[b]
Surface Water										
Acid Weir	06/02	1 UF	^{239,240}Pu	2.585	0.157	pCi/L	30	0.09	1.2	Detect
DPS-1	06/02	1 UF	Beta	285.0	38.0	pCi/L	1,000	0.28	50	Detect
DPS-1	06/02	1 UF	^{90}Sr	142.1	9.5	pCi/L	1,000	0.14	8	Detect
DPS-4	06/10	1 UF	Beta	81.0	11.0	pCi/L	1,000	0.08	50	Detect
DPS-4	06/10	1 UF	^{90}Sr	41.9	4.1	pCi/L	1,000	0.04	8	Detect
Mortandad at GS-1	06/03	1 UF	Alpha	49.8	9.0	pCi/L	30	1.66	15	Detect
Mortandad at GS-1	06/03	1 UF	Alpha	39.8	8.0	pCi/L	30	1.33	15	Detect
Mortandad at GS-1	06/03	1 UF	^{241}Am	11.219	0.554	pCi/L	30	0.37	1.2	Detect
Mortandad at GS-1	06/03	1 UF	^{241}Am	12.101	0.589	pCi/L	30	0.40	1.2	Detect
Mortandad at GS-1	06/03	1 UF	Beta	69.0	10.0	pCi/L	1,000	0.07	50	Detect
Mortandad at GS-1	06/03	1 UF	Beta	69.0	10.0	pCi/L	1,000	0.07	50	Detect
Mortandad at GS-1	06/03	1 UF	^{238}Pu	5.984	0.306	pCi/L	40	0.15	1.6	Detect
Mortandad at GS-1	06/03	1 UF	^{238}Pu	7.011	0.355	pCi/L	40	0.18	1.6	Detect
Mortandad at GS-1	06/03	1 UF	^{239,240}Pu	6.167	0.318	pCi/L	30	0.21	1.2	Detect
Mortandad at GS-1	06/03	1 UF	^{239,240}Pu	4.705	0.249	pCi/L	30	0.16	1.2	Detect
Runoff										
LA Canyon near LA	06/07	1 F	Alpha	258.8	86.0	pCi/L	30	8.63	15	Poss Detect
LA Canyon near LA	06/07	1 F	^{241}Am	2.702	0.205	pCi/L	30	0.09	1.2	Detect
LA Canyon near LA	06/07	1 UF	^{241}Am	5.016	0.308	pCi/L	30	0.17	1.2	Detect
LA Canyon near LA	06/07	1 F	Beta	247.0	37.0	pCi/L	1,000	0.25	50	Detect
LA Canyon near LA	06/07	1 UF	Beta	147.0	38.0	pCi/L	1,000	0.15	50	Poss Detect
LA Canyon near LA	06/07	1 F	^{239,240}Pu	2.387	0.159	pCi/L	30	0.08	1.2	Detect
LA Canyon near LA	06/07	1 UF	^{239,240}Pu	2.208	0.106	pCi/L	30	0.07	1.2	Detect
LA Canyon near LA	08/05	1 F	Alpha	16.8	5.0	pCi/L	30	0.56	15	Poss Detect
LA Canyon near LA	08/05	1 UF	^{241}Am	2.081	0.141	pCi/L	30	0.07	1.2	Detect
LA Canyon near LA	08/05	1 F	^{241}Am	1.309	0.110	pCi/L	30	0.04	1.2	Detect
LA Canyon near LA	08/05	1 UF	^{239,240}Pu	1.684	0.122	pCi/L	30	0.06	1.2	Detect
LA Canyon near LA	08/22	1 UF	Alpha	640.8	168.0	pCi/L	30	21.36	15	Poss Detect
LA Canyon near LA	08/22	1 UF	^{241}Am	10.288	0.503	pCi/L	30	0.34	1.2	Detect
LA Canyon near LA	08/22	1 UF	Beta	1,637.0	289.0	pCi/L	1,000	1.64	50	Detect
LA Canyon near LA	08/22	1 UF	^{239,240}Pu	1.285	0.123	pCi/L	30	0.04	1.2	Detect
LA Canyon near LA	09/20	1 UF	Alpha	175.8	5.0	pCi/L	30	5.86	15	Detect
LA Canyon near LA	09/20	1 UF	^{241}Am	7.570	0.443	pCi/L	30	0.25	1.2	Detect
LA Canyon near LA	09/20	1 UF	Beta	336.0	5.0	pCi/L	1,000	0.34	50	Detect
LA Canyon near LA	09/20	1 UF	^{239,240}Pu	5.459	0.336	pCi/L	30	0.18	1.2	Detect
Cañada Del Buey at WR	08/02	1 UF	Alpha	233.8	76.0	pCi/L	30	7.79	15	Poss Detect
Cañada Del Buey at WR	08/02	1 UF	Beta	616.0	105.0	pCi/L	1,000	0.62	50	Detect

Table 5-5. Radionuclides near Department of Energy Derived Concentration Guides in Surface Waters for 1997[a] (Cont.)

Station Name	Date	Code	Analyte	Lab Value	Uncertainty	Units	DOE DCG	Ratio of Value to DCG	Min Std	Detection or Possible Detection[b]
Runoff (Cont.)										
Potrillo Canyon near WR	08/17	1 UF	Alpha	187.8	45.0	pCi/L	30	6.26	15	Poss Detect
Potrillo Canyon near WR	08/17	1 UF	Beta	343.0	46.0	pCi/L	1,000	0.34	50	Detect
G-SWMS-4	07/21	1 UF	^{239,240}Pu	2.994	0.199	pCi/L	30	0.10	1.2	Detect
G-SWMS-5	08/04	1 UF	Alpha	131.8	4.4	pCi/L	30	4.39	15	Detect
G-SWMS-5	08/04	1 UF	Beta	120.0	4.2	pCi/L	1,000	0.12	50	Detect
G-SWMS-6	10/21	1 UF	Alpha	336.8	87.0	pCi/L	30	11.23	15	Poss Detect
G-SWMS-6	10/21	1 UF	Beta	425.0	60.0	pCi/L	1,000	0.42	50	Detect
G-SWMS-6	10/21	1 UF	^{239,240}Pu	2.094	0.142	pCi/L	30	0.07	1.2	Detect

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[a] Values shown are greater than 1/25 of the DOE public dose DCG and greater than the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.

[b] Detection or possible detection determined according to criteria described in text.

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

	1963–1977	1995			1996			1997		
Radionuclide	**Total Activity Released (mCi)[b]**	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG[c]**	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG[c]**	**Total Annual Activity (mCi)**	**Mean Activity (pCi/L)**	**Ratio of Activity to DCG[c]**
^{3}H	25,150	731	41,400	0.02	1,020	61,700	0.03	1,330	76,300	0.04
^{241}Am	7	1.4	79.4	2.65	1.99	120	4.00	2.56	147	4.90
^{137}Cs	848	6.6	375	0.13	2.20	133	0.04	2.48	142	0.05
^{238}Pu	51	3.4	195	4.88	2.25	136	3.40	1.34	76.7	1.92
^{239,240}Pu	39	0.6	35.6	1.19	0.39	23.8	0.79	0.80	45.9	1.53
^{89}Sr	<1	0.1	6.9	0.0003	0.66	40.2	0.002	0.83	47.7	0.002
^{90}Sr	295	0.6	36.9	0.04	0.60	36.1	0.04	0.50	28.5	0.03
^{234}U	NA	0.2	14.3	0.03	0.19	11.7	0.02	0.08	4.88	0.01
^{235}U	2	.009	0.53	0.0009	0.003	0.18	0.0003	0.007	0.44	0.0007
Constituent		**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**	**Total Annual Mass (kg)**	**Mean Concentration (mg/L)**	**Ratio of Concentration to MCL**
NO_3-N		718	35.6	3.5	1,260	76.4	7.6	1,220	69.6	7.0
Total effluent volume (×10^7 liters)		1.76			1.65			1.75		

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[a] Compiled from Radioactive Liquid Waste Group (EM-RLW) Annual Reports. Data for 1997 are preliminary.
[b] DOE 1979; decay corrected through 12/77.
[c] Public dose limit.

Table 5-7. Chemical Quality of Surface Waters and Runoff Samples for 1997 (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 Chama at Chamita	10/07	1 UF															13			
Rio Chama at Chamita	10/07	1 F	19	29.8	4.9	1.4	12.5	4.5	33.9	<5[f]	79	0.27	<0.02	0.20	0.01	114		95	8.3	240
Rio Grande at Embudo	10/07	1 F	18	28.5	4.7	1.6	11.9	4.6	35.0	<5	79	0.25	<0.02	0.17	0.01	156		91	8.3	239
Rio Grande at Embudo	10/07	1 UF															13			
Rio Grande at Otowi Upper (bank)	12/01	1 F	24	1.3	0.2	<1.0	0.7	6.3	30.0	<5	93	0.12	0.02	0.11	<0.01	194		4	8.4	268
Rio Grande at Otowi Upper (bank)	12/01	1 UF															15			
Rio Grande at Otowi (bank)	12/01	1 F	24	23.9	4.7	2.3	15.0	6.6	29.0	<5	98	0.36	0.03	0.16	<0.01	162		79	8.2	271
Rio Grande at Otowi (bank)	12/01	1 UF															4			
Rio Grande at Frijoles (bank)	09/30	1 F	25	18.4	3.3	2.2	9.7	3.7	20.4	<5	65	0.21	0.03	0.14	0.01	141		60	8.5	171
Rio Grande at Frijoles (bank)	09/30	1 UF															118			
Rio Grande at Cochiti	10/07	1 F	23	21.0	4.1	2.2	11.4	4.2	19.8	<5	69	0.27	<0.02	0.22	0.01	106		69	7.7	189
Rio Grande at Cochiti	10/07	1 UF															32			
Rio Grande at Cochiti	10/07	1 F	15	33.6	5.8	<1.0	12.4	3.7	57.4	<5	77	0.13	<0.02	0.22	0.01	170		108	7.9	263
Rio Grande at Cochiti	10/07	1 UF															95			
Cochiti Lower	10/29	1 F	21	22.3	4.1	2.0	10.4	4.5	25.0	<5	78	0.22	0.02	0.46	0.01	240		73	7.8	217
Cochiti Lower	10/29	1 UF															15			
Cochiti Middle	10/29	1 UF															11			
Cochiti Middle	10/29	1 F	20	22.5	4.2	2.4	10.5	4.5	26.0	<5	73	0.21	0.03	0.33	0.01	220		74	7.7	215
Cochiti Upper	10/29	1 F	21	22.1	4.1	1.8	10.8	4.7	25.0	<5	77	0.21	0.04	0.12	0.01	250		72	7.8	211
Cochiti Upper	10/29	1 UF															11			
Jemez River	10/07	1 F	45	44.3	4.6	9.9	67.6	104.0	11.4	13	158	1.07	<0.02	0.05	0.01	356		130	8.8	638
Jemez River	10/07	1 UF															3			
Pajarito Plateau																				
Guaje Canyon:																				
Guaje Canyon	11/18	1 UF															12			
Guaje Canyon	11/18	1 F	64	7.3	2.7	1.7	9.3	4.8	3.2	<5	52	0.14	0.05	<0.02	<0.01	160		29	7.6	113
Pueblo Canyon:																				
Acid Weir	06/02	1 UF															<1			
Acid Weir	06/02	1 F	18	15.9	1.7	5.0	60.1	86.8	7.7	<5	44	0.25	0.20	0.69	<0.01	262		47	7.0	405
Pueblo 1	06/02	1 F	20	14.3	2.4	3.5	41.7	52.3	7.8	<5	50	0.16	0.28	0.09	<0.01	236		46	7.6	308
Pueblo 1	06/02	1 UF															2			
Pueblo 3	06/12	1 UF															<1			
Pueblo 3	06/12	1 F	86	19.8	5.5	12.9	59.9	37.0	22.8	<5	181	0.44	4.78	0.88	0.01	374		72	7.1	532
Pueblo at SR 502	06/12	1 F	77	18.1	4.4	12.6	64.6	37.2	19.6	<5	142	0.62	5.57	0.83	<0.01	342		63	7.8	477
Pueblo at SR 502	06/12	1 UF															1			

Table 5-7. Chemical Quality of Surface Waters and Runoff Samples for 1997 (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)
Pajarito Plateau (Cont.)																				
DP/Los Alamos Canyon:																				
Los Alamos Canyon Reservoir	12/01	1 F	37	7.8	2.9	2.5	7.2	7.2	4.0	<5	40	0.05	0.07	0.25	<0.01	84		31	7.5	109
Los Alamos Canyon Reservoir	12/01	1 UF															1			
DPS-1	06/02	1 F		53.3	3.6	8.4	110.9											148		
DPS-4	06/10	1 UF															2			
DPS-4	06/10	1 F	19	17.0	1.6	6.7	31.6	35.1	7.0	<5	65	0.86	0.09	0.37	<0.01	108		49	7.7	292
Los Alamos at Upper GS	12/18	1 F		11.7	3.1	3.4	28.1													
Los Alamos at Upper GS	12/18	1 UF															<1			
Los Alamos at SR-4	04/29	1 UF	36	10.2	3.0	2.2	20.7	32.0	7.0	<5	39	0.26	0.06	0.09	<0.01	156		38	7.9	203
Los Alamos at Rio Grande	05/19	1 UF	54	44.0	5.1	3.9	34.6	27.8	19.0	<5	151	0.49	0.31	1.10	<0.01	308	80	131	8.5	428
Sandia Canyon:																				
SCS-1	06/12	1 F	92	18.6	5.2	11.7	94.3	58.3	61.7	<5	138	0.45	2.96	2.11	0.01	462		68	8.3	619
SCS-1	06/12	1 UF															<1			
SCS-2	06/12	1 F	80	18.5	4.2	10.8	90.9	59.6	44.2	<5	142	0.75	2.91	0.50	0.01	424		63	8.6	577
SCS-2	06/12	1 UF															<1			
SCS-3	06/03	1 F	83	21.2	4.6	12.7	109.6	77.9	60.9	<5	145	1.05	3.16	0.26	<0.01	510		72	8.6	680
SCS-3	06/03	1 UF															<1			
Mortandad Canyon:																				
Mortandad at GS-1	06/03	1 F	80	30.4	2.5	5.6	29.8	9.8	9.6	<5	123	0.95	0.27	4.69	<0.01	298		86	8.0	325
Mortandad at GS-1	06/03	1 UF															<1			
Mortandad at GS-1	06/03	1 F		31.4	2.5	5.9	31.0											89		
Mortandad at Rio Grande (A-11)	09/11	1 UF															160			
Mortandad at Rio Grande (A-11)	09/11	1 F	90	19.8	5.7	14.1	64.9	48.1	25.7	<5	119	0.82	5.86	7.47	0.01	380		73	8.1	530
Cañada del Buey:																				
Cañada del Buey	05/22	1 UF	26	10.3	3.0	3.2	15.2	21.5	5.7	<5	32	0.31	<0.02	0.06	<0.01	154	14	38	6.4	163
Pajarito Canyon:																				
Pajarito at Rio Grande	09/29	1 F	75	19.1	4.1	2.4	13.0	6.2	7.0	<5	81	0.46	<0.02	0.74	0.01	195		65	8.6	198
Pajarito at Rio Grande	09/29	1 UF															<1			
Water Canyon:																				
Water Canyon at Beta	06/23	1 UF															<1			
Water Canyon at Beta	06/23	1 F	42	14.1	4.2	4.2	20.7	21.3	5.9	<5	55	0.17	0.07	<0.02	<0.01	190		52	7.7	200
Ancho Canyon:																				
Ancho at Rio Grande	09/29	1 F	74	12.1	2.7	1.7	9.8	3.4	3.4	24	61	0.42	0.04	0.17	0.01	145		41	9.4	130
Ancho at Rio Grande	09/29	1 UF															20			

Table 5-7. Chemical Quality of Surface Waters and Runoff Samples for 1997 (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)
Pajarito Plateau (Cont.)																				
Frijoles Canyon:																				
Frijoles at Monument HQ	11/18	1 F	64	7.6	2.8	1.9	10.0	4.9	3.3	<5	49	0.16	0.03	0.07	<0.01	136		30	7.7	113
Frijoles at Monument HQ	11/18	1 UF															2			
Frijoles at Rio Grande	09/30	1 UF															20			
Frijoles at Rio Grande	09/30	1 F	66	8.7	2.9	1.6	9.6	5.2	3.9	<5	49	0.16	0.14	0.09	0.01	141		34	8.4	122
Runoff Stations																				
DP Canyon near LA	08/05	1 UF		19.2	2.5	7.1	21.8										244	58		
LA Canyon near LA	06/07	1 UF	25	16.4	7.3	10.8	21.2	20.5	6.1	<5	51	0.34	0.81	0.44	0.01	95	2,810	71	7.2	188
LA Canyon near LA	06/07	1 UF		20.4	9.6	10.9	21.3											91		
LA Canyon near LA	08/05	1 UF		16.8	5.4	6.5	16.1										1,233	64		
LA Canyon near LA	08/22	1 UF															6,641			
LA Canyon near LA	09/20	1 UF															3,794			
Los Alamos Canyon at LA	03/26	1 F	31	7.4	2.5	1.5	6.3	9.8	5.5	<5	29	0.08	0.03	0.24	<0.01	96	3	29	7.6	101
Los Alamos Canyon at LA	03/26	1 UF	31	6.9	2.5	1.6	6.1	9.8	5.6	<5	35	0.08	0.03	0.04	<0.01	128	24	28	7.6	96
Cañada del Buey at WR	08/02	1 UF															22,015			
Pajarito at SR 501	03/25	1 F	33	5.1	2.1	<1.0	4.1	4.8	6.8	<5	30	0.07	0.09	0.11	<0.01	116	<1	21	7.6	82
Pajarito at SR 501	03/25	1 UF	33	6.8	2.9	1.6	4.6	4.8	6.9	<5	34	0.07	0.09	0.05	<0.01	112	4	29	7.7	75
Potrillo Canyon near WR	08/17	1 UF															6,362			
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	

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[a] Except where noted.

[b] Codes: UF–unfiltered, F–filtered, 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 specified limit of detection of the analytical method.

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

Table 5-8. Total Recoverable Trace Metals in Surface Waters and Runoff Samples for 1997 (μg/L)

Station Name	Date	Code[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations															
Rio Chama at Chamita	10/07	1	F	<10[b]	<50	<2	30	59	<3	<7	<8	<7	<10	<40	<0.2
Rio Grande at Embudo	10/07	1	F	<10	<50	<2	36	58	<3	<7	<8	<7	<10	<40	<0.2
Rio Grande at Otowi Upper (bank)	12/01	1	F	<10	<50	<2	<20	1	<3	<7	<8	<7	<10	<40	<0.2
Rio Grande at Otowi (bank)	12/01	1	F	<10	53	<2	32	36	<3	<7	<8	<7	<10	<40	<0.2
Rio Grande at Frijoles (bank)	10/30	1	UF												<0.2
Rio Grande at Frijoles (bank)	09/30	1	F	<10	134	<2	28	33	<3	<7	<8	<7	<10	136	
Rio Grande at Cochiti	10/07	1	F	<10	<50	<2	73	56	<3	<7	<8	<7	<10	<40	
Rio Grande at Cochiti	10/07	1	F	<10	<50	<2	54	25	<3	<7	16	<7	<10	65	
Cochiti Lower	10/29	1	F	<10	<50	<2	41	44	<3	<7	<8	<7	<10	<40	<0.2
Cochiti Middle	10/29	1	F	15	983	<2	191	58	6	45	54	49	39	<40	<0.2
Cochiti Upper	10/29	1	F	<10	<50	<2	36	42	<3	<7	<8	<7	<10	<40	<0.2
Jemez River	10/07	1	F	<10	<50	92	832	72	<3	<7	<8	<7	<10	44	
Pajarito Plateau															
Guaje Canyon:															
Guaje Canyon	11/18	1	F	<10	84	<6	23	12	<3	<7	<8	<7	<10	106	<0.2
Pueblo Canyon:															
Acid Weir	06/02	1	F	<10	<50	<2	26	35	<3	<7	<8	<7	<10	<40	<0.2
Pueblo 1	06/02	1	F	<10	<50	<2	23	28	<3	<7	<8	<7	<10	<40	<0.2
Pueblo 3	06/12	1	F	<10	114	9	256	13	<3	<7	<8	<7	<10	203	<0.2
Pueblo at SR 502	06/12	1	F	<10	<50	13	267	22	<3	<7	<8	<7	<10	897	<0.2
DP/Los Alamos Canyon:															
Los Alamos Canyon Reservoir	12/01	1	F	<10	389	<2	<20	23	<3	<7	<8	<7	22	218	<0.2
DPS-1	06/02	1	F	<10	<50	<2	48	168	<3	<7	<8	<7	<10	75	<0.2
DPS-4	06/10	1	F	<10	750	2	46	61	<3	<9	<8	<7	<10	342	<0.2
Los Alamos at Upper GS	12/18	1	UF												<0.2
Los Alamos at Upper GS	12/15	1	F	<10	<50	<2	<20	32	<3	<7	<8	9	<10	<40	
Los Alamos at SR 4	04/29	1	UF	<10	1,216	<2	23	43	<3	<7	<8	<7	<10	848	<0.2
Los Alamos at Rio Grande	05/19	1	UF	<10	1,556	4	100	132	<3	<7	<8	<7	<10	941	<0.3

Table 5-8. Total Recoverable Trace Metals in Surface Waters and Runoff Samples for 1997 (μg/L) (Cont.)

Station Name	Date	Code[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Pajarito Plateau (Cont.)														
Sandia Canyon:														
SCS-1	06/12	1 F	<10	<50	5	78	27	<3	<7	<8	<7	<10	93	
SCS-2	06/12	1 F	<10	58	6	80	21	<3	<7	<8	8	<10	129	<0.2
SCS-3	06/03	1 F	<10	61	5	85	26	<3	<7	<8	<7	11	196	
Mortandad Canyon:														
Mortandad at GS-1	06/03	1 F	<10	160	4	61	23	<3	<7	<8	<7	16	216	<0.2
Mortandad at GS-1	06/03	1 F	<10	<50	3	66	22	<3	<7	<8	<11	16	116	<0.2
Mortandad at Rio Grande (A-11)	09/11	1 F	<10	226	<2	268	42	<3	<7	<8	<7	28	118	0.2
Cañada del Buey:														
Cañada del Buey	05/22	1 UF	22	6,632	2	33	87	<3	<7	<8	<7	17	3,605	0.3
Pajarito Canyon:														
Pajarito at Rio Grande	09/29	1 F	<10	<50	<2	26	39	<3	<7	<8	<7	<10	<40	<0.2
Water Canyon:														
Water Canyon at Beta	06/23	1 F	<10	1,179	<2	38	322	<3	<7	<8	<7	<10	529	<0.2
Ancho Canyon:														
Ancho at Rio Grande	09/29	1 F	<10	<50	<2	23	24	<3	<7	<8	<7	<10	<40	<0.2
Frijoles Canyon:														
Frijoles at Monument HQ	11/18	1 F	<10	116	<6	<20	12	<3	<7	<8	<7	<10	96	<0.2
Frijoles at Rio Grande	09/30	1 F	<10	122	<2	<20	15	<3	<7	<8	<7	<10	98	<0.2
Runoff Stations														
DP Canyon near Los Alamos	08/05	1 UF	<10	7,765	2	27	112	<3	<7	<8	<7	18	4,309	<0.2
LA Canyon near LA	06/07	1 UF	<10	35,937	15	22	287	<3	<7	<13	26	33	20,632	<0.3
LA Canyon near LA	06/07	1 UF	<10	46,753	15	42	416	4	<9	13	39	50	30,136	<0.3
LA Canyon near LA	08/05	1 UF	<10	22,894	5	27	242	<3	<7	10	16	35	14,571	<0.2
Los Alamos Canyon at LA	03/26	1 F	<10	208	<2	<20	24	<3	<7	<8	<7	<10	146	<0.2
Los Alamos Canyon at LA	03/26	1 UF	<10	3,525	<2	<20	35	<3	<7	<8	<7	<10	1,465	<0.2
Pajarito at SR 501	03/25	1 F	<10	2,222	<2	<20	50	<3	<7	<8	<7	<10	906	<0.2
Pajarito at SR 501	03/25	1 UF	<10	5,046	<2	<20	48	<3	<7	<8	<7	<10	1,950	<0.2

Table 5-8. Total Recoverable Trace Metals in Surface Waters and Runoff Samples for 1997 (μg/L) (Cont.)

Station Name	Date	Code[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Water Quality Standards[c]														
EPA Primary Drinking Water Standard					50		2,000	4	5		100			2.0
EPA Secondary Drinking Water Standard				50–200									300	
EPA Action Level												1,300		
EPA Health Advisory														
NM Livestock Watering Standard				5,000	200	5,000			50	1,000	1,000	500		10.0
NMWQCC Groundwater Limit			50	5,000	100	750	1,000		10	50	50	1,000	1,000	2.0
NM Wildlife Habitat Stream Standard														0.012

Table 5-8. Total Recoverable Trace Metals in Surface Waters and Runoff Samples for 1997 (μg/L) (Cont.)

Station Name	Date	Code[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Stations														
Rio Chama at Chamita	10/07	1	F	2	<30	<20	<3	<3	<4	<30	230	<3	<8	<50
Rio Grande at Embudo	10/07	1	F	<2	<30	<20	<3	<3	<4	<30	217	<3	<8	<50
Rio Grande at Otowi Upper (bank)	12/01	1	F	<2	<30	<20	<3	<3	<3	<30	10	<3	<8	<50
Rio Grande at Otowi (bank)	12/01	1	F	9	<30	<20	<3	<3	<3	<30	203	<3	<8	<50
Rio Grande at Frijoles (bank)	10/30	1	UF						<3					
Rio Grande at Frijoles (bank)	09/30	1	F	12	<30	<20	<3	<3		<30	150	<3	<8	<50
Rio Grande at Cochiti	10/07	1	F	<2	<30	<20	<3	<3		<30	281	<3	<8	<50
Rio Grande at Cochiti	10/07	1	F	<2	<30	<20	<3	<3		<30	168	<3	<8	<50
Cochiti Lower	10/29	1	F	<2	<30	<20	<3	<3	<3	<30	189	<3	8	<50
Cochiti Middle	10/29	1	F	56	58	45	<3	3	<3	<56	253	<3	23	<50
Cochiti Upper	10/29	1	F	6	<30	<20	<3	<3	<3	<31	189	<3	<9	<50
Jemez River	10/07	1	F	9	<30	<20	<3	<3		<30	175	<3	<8	<50
Pajarito Plateau														
Guaje Canyon:														
Guaje Canyon	11/18	1	F	7	<30	<20	<3	<3	7	<30	49	<3	<8	<50
Pueblo Canyon:														
Acid Weir	06/02	1	F	11	<30	<20	<3	<3	<3	<30	89	<3	<8	<50
Pueblo 1	06/02	1	F	14	<30	<20	<3	<3	<3	<30	79	<3	<8	<50
Pueblo 3	06/12	1	F	39	<30	<20	<3	<3	<3	<30	96	<3	11	<50
Pueblo at SR 502	06/12	1	F	655	<30	<20	<3	<3	<3	<30	88	<3	<8	<50
DP/Los Alamos Canyon:														
Los Alamos Canyon Reservoir	12/01	1	F	48	<30	<20	<3	<3	<3	<30	68	<3	<8	<50
DPS-1	06/02	1	F	872	<30	<20	<3	<3	<3	<30	253	<3	<8	<50
DPS-4	06/10	1	F	5	<30	<20	<3	<3	<5	<30	95	<3	<8	<50
Los Alamos at Upper GS	12/18	1	UF						<2					
Los Alamos at Upper GS	12/15	1	F	<2	<30	<20	<3	<3		<30	81	<3	<8	<50
Los Alamos at SR 4	04/29	1	UF	36	41	<20	4	<3	<3	<30	73	<3	<8	<50
Los Alamos at Rio Grande	05/19	1	UF	37	<30	<20	<3	<3	<3	<34	318	<3	13	<50

Table 5-8. Total Recoverable Trace Metals in Surface Waters and Runoff Samples for 1997 (μg/L) (Cont.)

Station Name	Date	Code[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Pajarito Plateau (Cont.)														
Sandia Canyon:														
SCS-1	06/12	1	F	25	<30	<20	<3	<3		<42	90	<3	9	78
SCS-2	06/12	1	F	5	67	<23	<3	<3	<3	<30	91	<3	<8	<50
SCS-3	06/03	1	F	2	94	<20	<3	<3		<30	103	<3	<8	<50
Mortandad Canyon:														
Mortandad at GS-1	06/03	1	F	6	406	<20	<3	<3	<3	<30	64	<3	<8	<50
Mortandad at GS-1	06/03	1	F	5	431	<20	<3	<3	<3	<30	68	<3	<8	<50
Mortandad at Rio Grande (A-11)	09/11	1	F	16	<39	<20	<3	<3	<3	<30	89	<3	<12	<50
Cañada del Buey:														
Cañada del Buey	05/22	1	UF	234	120	<20	<3	<3	<3	<30	70	<3	<8	<50
Pajarito Canyon:														
Pajarito at Rio Grande	09/29	1	F	2	<30	<20	<3	<3	<3	<30	117	<3	<26	<50
Water Canyon:														
Water Canyon at Beta	06/23	1	F	5	<30	<20	<3	<3	<3	<30	97	<3	<8	<50
Ancho Canyon:														
Ancho at Rio Grande	09/29	1	F	2	<30	<20	<3	<3	<3	<30	61	<3	<8	<50
Frijoles Canyon:														
Frijoles at Monument HQ	11/18	1	F	7	<30	<20	<3	<3	4	<30	51	<3	<8	<50
Frijoles at Rio Grande	09/30	1	F	3	<30	<22	<3	<3	<3	<30	59	<3	<8	<50
Runoff Stations														
DP Canyon near Los Alamos	08/05	1	UF	157	<30	<20	18	<3	<2	<30	112	<3	9	55
LA Canyon near LA	06/07	1	UF	884	60	<33	80	3	<3	<30	129	<3	32	194
LA Canyon near LA	06/07	1	UF	1,490	65	24	130	<3	<3	<30	158	<3	47	328
LA Canyon near LA	08/05	1	UF	708	41	<20	90	3	<2	<55	113	<3	27	187
Los Alamos Canyon at LA	03/26	1	F	3	<30	<20	<3	<3	<3	<30	56	<3	<8	<50
Los Alamos Canyon at LA	03/26	1	UF	45	<30	<20	<3	<3	<3	<30	57	<3	<8	<50
Pajarito at SR 501	03/25	1	F	7	<30	<20	<3	<3	<3	<30	51	<3	<8	<50
Pajarito at SR 501	03/25	1	UF	18	<30	<20	<3	<3	<3	<30	59	<3	<8	<50

Table 5-8. Total Recoverable Trace Metals in Surface Waters and Runoff Samples for 1997 (μg/L) (Cont.)

Station Name	Date	Code[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 Drinking Water Standard			50										5,000
EPA Action Level						15							
EPA Health Advisory										25,000–90,000		80–110	
NM Livestock Watering Standard						100		50				100	25,000
NMWQCC Groundwater Limit			200	1,000	200	50		50					10,000
NM Wildlife Habitat Stream Standard								2					

[a] Codes: UF–unfiltered, F–filtered, 1–primary analysis, R1–lab replicate, D1–lab duplicate. Note that all Hg and Se samples are unfiltered.

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

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

Table 5-9. Number of Results above the Analytical Limit of Quantitation for Organic Compounds in Surface Waters in 1997

		Type of Organic Compound			
Station Name	**Date**	**Volatile**	**Semivolatile**	**PCB**	**High Explosives**
Number of compounds analyzed		66	71	8	13
Acid Weir	06/02	0	0	0	
Pueblo 3	06/12	0	0	0	
Pueblo at SR-502	06/12	0	0	0	
Los Alamos Canyon Reservoir	12/01	0	0	0	
DPS-1	06/02	0	0	0	
DPS-4	06/10	0	0	0	
Los Alamos at Rio Grande	05/19		0	0	
SCS-1	06/12	0	0	0	
SCS-2	06/12	0	0	0	
SCS-3	06/03	0	0	0	
Mortandad at GS-1	06/03	0	0	0	
Mortandad at GS-1	06/03	0	0	0	
Cañada del Buey	05/22	0	0	0	0
Pajarito at Rio Grande	09/29	0	0	0	
Water Canyon at Beta	06/23	0	0	0	0
Ancho at Rio Grande	09/29	0	0	0	0
Frijoles at Monument HQ	11/18	0	0	0	0
Frijoles at Rio Grande	09/30	0	0	0	0

Table 5-10. Radiochemical Analysis for Sediments in 1997 (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	05/12	1	–17[d] 838[e]	–0.09 1.03	0.09 0.01	1.71 0.17	0.002 0.001	0.003 0.001	0.006 0.001	1.0 9.5	1.3 0.8	2.2 0.2
Rio Grande at Embudo	05/12	1	–262 660	0.67 0.59	0.11 0.02	1.86 0.19	0.001 0.001	0.003 0.001	0.002 0.001	2.8 2.1	2.1 1.0	2.4 0.2
Rio Grande at Frijoles (bank)	09/30	1	–112 720	0.73 1.26	0.06 0.01	2.61 0.26	0.001 0.001	0.002 0.001	0.004 0.001	3.8 2.0	3.6 0.9	2.1 0.2
Rio Grande at Bernalillo	05/09	1	–331 193	–0.57 0.84	<0.01[f]	0.92 0.09	0.001 0.001	0.002 0.001	0.002 0.002	1.1 2.5	0.9 0.7	1.8 0.2
Jemez River	05/09	1	–52 670	2.57 1.99	0.04 0.01	1.66 0.17	0.001 0.001	0.003 0.001	0.003 0.001	2.9 2.7	2.0 1.0	3.1 0.3
Reservoirs on Rio Chama (New Mexico)												
Heron Upper	07/22	1	8 660	0.18 1.35	0.19 0.03	3.02 0.30	0.0002 0.0001	0.0060 0.0003	0.003 0.001	6.9 2.9	6.7 0.7	2.8 0.3
Heron Middle	07/22	1	–272 640	0.93 0.95	0.19 0.03	3.24 0.32	0.0002 0.0001	0.0042 0.0003	0.005 0.001	13.7 3.8	8.6 1.7	3.5 0.4
Heron Middle	07/22	D1	–22 650	0.63 0.71	0.17 0.03	3.81 0.38	0.0007 0.0001	0.0051 0.0003	0.004 0.001	13.4 4.0	10.3 2.0	3.6 0.4
Heron Lower	07/22	1	–122 650	0.60 1.11	0.22 0.03	3.65 0.37	0.0003 0.0003	0.0072 0.0022	0.008 0.002	15.6 4.5	11.7 2.1	3.5 0.3
El Vado Upper	07/22	1	188 670	1.43 1.67	0.07 0.02	3.15 0.32	0.0002 0.0000	0.0040 0.0002	0.001 0.002	8.5 4.0	6.0 1.7	2.4 0.2
El Vado Middle	07/22	1	–282 640	1.04 0.96	0.20 0.03	3.90 0.39	0.0003 0.0001	0.0063 0.0003	0.005 0.004	7.9 2.1	7.8 1.2	2.7 0.3
El Vado Lower	07/22	1	–2 660	8.43 3.66	0.30 0.04	4.11 0.41	0.0008 0.0001	0.0074 0.0004	0.004 0.001	11.8 3.0	8.3 1.2	3.4 0.3
Abiquiu Middle	07/21	1	–152 640	–0.08 1.46	0.21 0.03	2.44 0.24	0.0004 0.0001	0.0068 0.0007	0.005 0.001	9.0 3.0	7.0 2.0	2.4 0.2
Abiquiu Lower	07/21	1	38 660	0.72 0.94	0.19 0.03	3.20 0.32	0.0004 0.0001	0.0054 0.0004	0.002 0.001	8.0 2.0	6.0 1.0	0.2 0.2
Reservoirs on Rio Grande (Colorado)												
Rio Grande Upper	07/24	1	–492 620	0.72 1.01	0.53 0.05	3.62 0.36	0.0007 0.0002	0.0204 0.0032	0.011 0.002	9.9 2.6	7.0 1.1	3.3 0.3
Rio Grande Middle	07/24	1	198 670	0.70 0.71	0.51 0.06	3.51 0.35	0.0008 0.0001	0.0196 0.0010	0.009 0.002	6.9 1.7	5.3 1.0	3.2 0.3
Rio Grande Lower	07/24	1	–242 640	0.62 0.92	0.39 0.04	3.24 0.32	0.0008 0.0001	0.0177 0.0009	0.006 0.002	7.3 1.8	5.8 1.0	3.0 0.3
Reservoirs on Rio Grande (New Mexico)												
Cochiti Upper	10/29	1	148 680	0.90 0.65	0.23 0.03	3.56 0.36	0.0005 0.0001	0.0082 0.0002	0.004 0.001	4.0 3.3	4.9 2.1	2.6 0.3
Cochiti Upper	10/29	D1	–42 670	1.49 0.80	0.22 0.03	3.95 0.40	0.0003 0.0001	0.0075 0.0002	0.011 0.002	5.5 3.6	5.7 2.1	3.3 0.3
Cochiti Middle	10/29	1	–172 660	2.69 1.95	0.40 0.04	5.05 0.51	0.0007 0.0001	0.0134 0.0004	0.006 0.002	15.0 5.7	14.0 3.3	3.5 0.4
Cochiti Lower	10/29	1	108 680	1.84 2.29	0.55 0.05	4.43 0.44	0.0009 0.0001	0.0179 0.0005	0.014 0.005	12.0 5.8	12.0 3.6	3.7 0.4
Pajarito Plateau Stations												
Guaje Canyon:												
Guaje at SR 502	03/17	1		0.76 0.57	0.10 0.02	2.11 0.21	0.003 0.001	0.006 0.002	0.009 0.007	2.2 1.9	1.2 0.4	2.8 0.3
Guaje at SR 502	03/17	R1		0.73 0.33	0.07 0.01	2.33 0.23	0.003 0.001	0.004 0.001		3.2 1.5	1.0 0.7	3.0 0.3
Guaje at SR 502	03/17	D1		0.99 0.82	0.03 0.01	1.98 0.20	–0.001 0.000	0.002 0.001	0.004 0.001	1.9 1.5	1.3 0.8	2.8 0.3
Bayo Canyon:												
Bayo at SR 502	03/17	1		0.86 0.77	0.09 0.02	2.49 0.25	0.000 0.001	0.002 0.001	0.003 0.001	2.9 1.8	1.5 0.9	2.7 0.3
Bayo at SR 502	03/17	D1	2,063 435	0.99 0.68	0.12 0.02	2.05 0.21	0.001 0.001	0.016 0.002	0.008 0.002	2.7 1.8	2.0 0.9	2.7 0.3

Table 5-10. Radiochemical Analysis for Sediments in 1997 (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
Pajarito Plateau Stations (Cont.)												
Acid/Pueblo Canyons:												
Acid Weir	05/06	1	298 690	0.75 0.72	0.24 0.03	1.48 0.15	0.040 0.003	6.418 0.134	0.294 0.012	15.5 2.4	11.9 2.1	2.4 0.2
Pueblo 1	05/06	1	86 736	0.67 1.13	0.08 0.01	1.44 0.14	0.002 0.001	0.003 0.001	0.005 0.001	4.0 1.6	2.0 0.5	2.5 0.3
Pueblo 2	05/07	1		0.59 1.16	0.07 0.01	1.10 0.11	0.005 0.001	0.617 0.015	0.023 0.002	1.3 1.1	0.7 0.6	2.0 0.2
Hamilton Bend Spring	05/07	1		0.19 0.61	<0.03	2.42 0.24	0.001 0.001	0.428 0.011	0.021 0.003	2.8 1.5	1.5 0.8	2.5 0.2
Pueblo 3	05/07	1	551 504	1.03 0.80	0.12 0.02		0.006 0.001	1.103 0.030	0.061 0.005	5.5 2.8	4.0 1.2	3.7 0.4
Pueblo at SR 502	05/04	1	–72 670	0.90 0.78	<0.02	1.11 0.11	0.003 0.001	0.520 0.014	0.030 0.009	1.6 0.7	1.2 0.8	3.0 0.3
DP/Los Alamos Canyons:												
Los Alamos at Bridge	05/07	1	508 710	1.37 0.85	<0.02	2.13 0.21	–0.001 0.001	0.002 0.001	0.007 0.002	2.2 0.9	1.6 0.8	2.2 0.2
Los Alamos at LAO-1	05/07	1	–256 128	0.41 1.15	0.03 0.01	3.31 0.33	0.005 0.001	0.621 0.016	0.012 0.002	4.4 1.9	2.7 1.0	3.2 0.3
Los Alamos at LAO-1	05/07	D1	14 459	0.82 0.77	0.15 0.02	3.40 0.34	0.005 0.001	1.225 0.023	0.030 0.004	6.6 2.1	2.9 1.1	3.7 0.4
Los Alamos at GS-1	05/07	1	–250 98	0.51 0.83	0.14 0.02	2.12 0.21	0.004 0.002	0.449 0.019	0.010 0.004	4.5 1.8	2.2 1.0	2.7 0.3
DPS-1	05/12	1	–22 670	1.87 1.18	0.04 0.01	1.13 0.11	0.000 0.000	0.005 0.001	0.004 0.001	1.7 0.7	3.3 1.1	2.7 0.3
DPS-1	05/12	D1	238 690	1.46 0.88	0.07 0.01	1.09 0.11	0.002 0.001	0.006 0.002	0.009 0.002	1.2 0.6	2.7 1.0	2.1 0.2
DPS-4	05/07	1	1,051 319	0.41 0.62	2.15 0.16	1.29 0.13	0.017 0.002	0.109 0.005	0.194 0.009	2.0 1.2	3.9 1.2	4.0 0.4
Los Alamos at LAO-3	05/07	1	–314 249	0.08 0.53	2.17 0.16	1.84 0.18	0.033 0.003	0.215 0.008	0.260 0.011	3.2 1.5	3.3 1.1	4.6 0.5
Los Alamos at LAO-4.5	05/07	1	–253 235	0.53 0.99	2.64 0.19	2.93 0.29	0.208 0.007	0.479 0.013	0.000 0.000	4.6 1.7	4.7 1.3	5.5 0.6
Los Alamos at SR 4	03/17	1		1.04 1.62	0.64 0.08	1.47 0.15	0.009 0.002	0.092 0.005	0.090 0.005	3.6 1.5	2.5 1.0	2.7 0.3
Los Alamos at Totavi	05/12	1	–982 610	2.06 1.99	0.10 0.02	1.19 0.12	0.000 0.001	0.091 0.005	0.013 0.002	1.3 0.7	1.2 0.8	3.0 0.3
Los Alamos at Otowi	05/12	1	–902 610	0.86 1.54	0.08 0.01	1.20 0.12			0.009 0.002	0.7 0.7	0.9 0.7	2.2 0.2
Sandia Canyon:												
Sandia at SR 4	03/17	1	–58 171	1.57 1.08	0.11 0.02	3.32 0.33	0.002 0.001	0.007 0.001	0.003 0.001	4.2 1.8	3.1 1.1	3.5 0.4
Sandia at SR 4	03/17	R1	478 92									
Mortandad Canyon:												
Mortandad near CMR Building	05/08	1	178 690	1.39 2.30	0.04 0.01	1.00 0.10	0.014 0.002	0.009 0.002	0.007 0.002	2.2 0.8	1.7 0.9	2.5 0.2
Mortandad west of GS-1	05/08	1	158 690	1.35 1.28	0.11 0.02	2.73 0.27	0.003 0.001	0.009 0.001	0.007 0.002	4.2 1.3	4.0 1.2	2.7 0.3
Mortandad at GS-1	05/07	1	18,728 1,500	0.94 0.78	15.70 1.00	0.85 0.08	6.124 0.121	5.696 0.113	11.522 0.329	8.7 1.6	2.7 0.9	14.8 1.5
Mortandad at MCO-5	05/07	1		0.41 0.88	12.40 0.80	1.00 0.10	2.200 0.100	6.090 0.240	5.980 0.230	25.5 4.2	17.3 2.9	13.3 1.3
Mortandad at MCO-5	05/07	D1		1.07 0.82	14.20 0.90	1.78 0.18	2.480 0.100	6.530 0.240	0.000 0.000	27.9 4.5	16.4 2.8	15.6 1.6
Mortandad at MCO-7	05/07	1	6,178 379	0.43 1.61	4.46 0.30	0.82 0.08	0.666 0.016	2.062 0.041	0.000 0.000	7.7 1.9	5.0 1.3	6.7 0.7
Mortandad at MCO-9	05/07	1	–252 156	0.82 0.80	0.24 0.03	3.37 0.34	0.003 0.001	0.013 0.003	0.012 0.004	4.4 1.6	3.6 1.1	5.3 0.5
Mortandad at MCO-13 (A-5)	08/14	1	508 710	0.51 0.60	0.23 0.03	1.93 0.19	0.003 0.001	0.011 0.002	0.004 0.002	3.1 0.7	3.0 0.9	2.5 0.2
Mortandad A-6	08/14	1	188 690	0.89 0.68	2.58 0.19	4.99 0.50	0.005 0.001	0.094 0.005	0.030 0.090	11.8 2.1	13.5 1.5	5.7 0.6
Mortandad A-7	08/14	1	18 670	0.12 0.58	0.23 0.03	3.49 0.35	0.002 0.001	0.008 0.001	0.005 0.002	2.9 0.6	3.1 0.9	3.1 0.3
Mortandad at SR 4 (A-9)	08/14	1	358 700	0.37 0.44	0.13 0.02	2.78 0.28	0.001 0.001	0.001 0.001	0.002 0.003	2.2 0.6	2.0 0.8	2.7 0.3
Mortandad at Rio Grande (A-11)	09/11	1	338 750	0.64 0.69	0.03 0.01	2.01 0.20	0.002 0.001	0.003 0.001	0.002 0.001	1.9 0.9	2.2 0.8	2.1 0.2

Table 5-10. Radiochemical Analysis for Sediments in 1997 (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
Pajarito Plateau Stations (Cont.)												
Cañada del Buey:												
Cañada del Buey at SR 4	03/17	1		0.62 0.57	0.04 0.01	1.62 0.16	0.006 0.002	0.005 0.002	0.003 0.001	3.0 1.6	1.6 0.9	2.5 0.3
TA-54 Area G:												
G-1	04/11	1	–2 680	0.72 0.60	0.06 0.01	1.51 0.15	0.001 0.001	0.004 0.009	0.009 0.003	1.7 0.2	0.8 0.1	2.5 0.2
G-1	04/11	D1	308 700	1.04 1.07	0.01 0.01	1.70 0.17	–0.001 0.000	0.002 0.001	0.004 0.001	3.3 0.3	1.5 0.1	2.7 0.3
G-2	04/11	1	808 730	0.92 0.58	0.09 0.02	1.59 0.16	0.001 0.001	0.004 0.001	0.007 0.002	4.2 0.4	1.7 0.1	2.4 0.2
G-3	04/11	1	118 690	0.89 0.74	0.05 0.01	2.59 0.26	0.000 0.000	0.002 0.001	0.003 0.001	6.8 0.5	2.8 0.2	1.8 0.2
G-4	04/11	1	918 740	1.11 0.54	0.25 0.03	2.95 0.30	0.003 0.001	0.014 0.002	0.008 0.004	7.2 0.5	3.3 0.2	3.7 0.4
G-5	04/11	1	1,518 770	1.47 0.61	0.18 0.02	2.95 0.30	0.011 0.002	0.665 0.005	0.033 0.008	7.0 0.5	3.5 0.2	3.4 0.3
G-6	04/11	1	878 740	1.57 0.85	0.18 0.02	1.36 0.14	0.017 0.002	0.162 0.007	0.038 0.008	5.6 0.5	2.9 0.2	3.6 0.4
G-7	04/11	1	1,548 780	0.81 0.73	0.13 0.02	2.42 0.24	0.116 0.007	0.156 0.009	0.032 0.003	2.8 0.3	1.3 0.1	3.1 0.3
G-8	04/11	1	1,508 770	0.98 0.62	0.47 0.04	1.01 0.10	0.056 0.035	0.049 0.003	0.017 0.002	8.5 0.5	4.7 0.2	3.2 0.3
G-9	04/11	1	178 690	0.61 0.67	0.04 0.01	1.52 0.15	0.013 0.002	0.016 0.002	0.007 0.002	2.0 0.2	0.9 0.1	2.8 0.3
Pajarito Canyon:												
Two Mile at SR 501	05/08	1	–92 670	1.29 1.28	<0.02	1.77 0.18	0.003 0.001	0.002 0.001	0.001 0.001	2.3 0.9	2.1 0.5	3.1 0.3
Pajarito at SR 501	05/08	1	–39 223	–0.09 0.82	0.03 0.01	1.52 0.15	0.002 0.001	0.004 0.001	0.002 0.001	3.3 1.9	1.9 0.9	2.4 0.2
Pajarito at SR 4	12/16	1	738 800	3.66 1.99	0.37 0.04	4.43 0.44	0.004 0.001	0.030 0.002	0.014 0.002	13.0 3.0	11.0 1.0	4.4 0.4
Potrillo Canyon:												
Potrillo at SR 4	03/17	1		0.88 0.63	0.13 0.03	1.71 0.17	0.000 0.001	0.002 0.001	0.003 0.001	2.5 1.4	1.5 0.9	2.7 0.3
Fence Canyon:												
Fence at SR 4	03/17	1	91 61	0.66 0.63	0.33 0.04	2.49 0.25	0.014 0.002	0.017 0.002	0.008 0.004	6.6 2.1	4.1 1.2	3.8 0.4
Cañon de Valle:												
Cañon de Valle at SR 501	03/17	1	199 101	0.39 1.44	0.12 0.02	1.19 0.12	0.002 0.001	0.002 0.001	0.003 0.001	2.9 1.5	1.3 0.8	0.5 0.2
Water Canyon:												
Water at SR 501	03/17	1	197 100	0.94 0.73	0.19 0.03	1.98 0.20	0.000 0.001	0.004 0.001	0.007 0.001	6.5 2.0	3.1 1.1	2.9 0.3
Water at SR 501	03/17	R1	–82 122									
Water at SR 4	03/17	1	850 110	0.84 0.66	0.27 0.04	2.31 0.23	0.001 0.001	0.006 0.001	0.003 0.001	4.9 1.7	3.5 1.1	3.3 0.4
Indio Canyon:												
Indio at SR 4	03/17	1	177 68	0.71 0.77	0.20 0.03	1.52 0.15	0.000 0.001	0.005 0.001	0.006 0.001	2.5 1.3	1.7 0.9	2.6 0.3
Ancho Canyon:												
Ancho at SR 4	03/17	1		1.12 0.69	0.22 0.04	4.08 0.41	0.001 0.001	0.008 0.001	0.012 0.002	4.0 1.7	3.4 1.1	3.2 0.4
Ancho at Rio Grande	09/29	1	78 740	0.67 1.02	0.10 0.02	1.75 0.18	0.001 0.001	0.004 0.001	0.002 0.001	1.6 0.9	2.2 0.8	2.5 0.2
Ancho at Rio Grande	09/29	D1	178 740	1.15 0.92	0.13 0.02	2.27 0.23	0.001 0.000	0.005 0.001	0.008 0.002	2.1 1.1	2.6 0.8	2.3 0.2

Table 5-10. Radiochemical Analysis for Sediments in 1997 (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
Pajarito Plateau Stations (Cont.)												
Chaquehui Canyon:												
Chaquehui at Rio Grande	09/30	1	4,288 970	0.80 1.12	0.16 0.02	2.19 0.22	0.002 0.001	0.004 0.001	0.002 0.001	1.9 0.9	2.4 0.8	2.3 0.2
TA-49, Area AB:												
AB-1	04/23	1	194 196	0.59 1.00	0.38 0.04	2.22 0.22	0.002 0.001	0.111 0.001	0.011 0.002	9.0 1.7	5.5 0.9	3.8 0.4
AB-1	04/24	D1	–112 64	0.94 1.16	0.25 0.03	3.14 0.31	0.002 0.001	0.010 0.001	0.009 0.002	10.1 1.9	4.9 0.8	3.6 0.4
AB-2	04/23	1	–20 133	0.36 1.09	0.31 0.04	2.23 0.22	0.001 0.001	0.052 0.003	0.018 0.002	9.6 1.8	6.0 0.9	3.3 0.3
AB-3	04/23	1	58 170	0.56 1.04	0.18 0.03	2.90 0.29	0.014 0.002	0.621 0.014	0.160 0.009	6.4 1.2	3.3 0.6	3.3 0.3
AB-4	04/23	1	–2 148	0.49 0.97	0.21 0.03	3.19 0.32	0.001 0.001	0.009 0.001	0.005 0.002	9.8 1.8	5.4 0.9	3.7 0.4
AB-4A	04/23	1	–13 117	0.95 0.92	0.32 0.04	2.93 0.29	0.003 0.001	0.017 0.002	0.008 0.002	8.7 1.6	6.2 1.0	3.6 0.4
AB-5	04/23	1	–13 117	0.67 0.69	1.26 0.10	2.61 0.26	0.001 0.001	0.052 0.004	0.020 0.002	10.5 1.9	7.2 1.1	3.7 0.4
AB-6	04/23	1	13 139	0.73 0.74	0.22 0.03	2.60 0.26	0.002 0.001	0.012 0.002	0.008 0.002	9.0 1.6	4.8 0.8	3.1 0.3
AB-7	04/23	1	3,937 349	0.69 0.82	0.09 0.02	1.27 0.13	0.002 0.001	0.004 0.001	0.002 0.002	4.4 0.9	2.6 0.5	3.5 0.4
AB-8	04/23	1	–206 53	1.20 1.20	0.08 0.02	2.03 0.20	0.000 0.000	0.002 0.001	0.003 0.002	7.5 1.4	3.4 0.6	3.2 0.3
AB-9	04/23	1	169 138	0.60 0.77	0.11 0.02	1.41 0.14	0.000 0.000	0.004 0.001	0.006 0.002	3.8 0.7	2.1 0.4	2.6 0.3
AB-10	04/24	1	–83 93	1.33 0.92	0.63 0.06	2.22 0.22	0.001 0.001	0.052 0.004	0.014 0.005	8.5 1.6	6.4 1.0	3.4 0.3
AB-11	04/24	1	–351 –1,000	–0.82 1.35	0.05 0.01	0.97 0.10	0.007 0.002	0.543 0.018	0.003 0.001	2.7 0.6	2.0 0.4	2.6 0.3
Frijoles Canyon:												
Frijoles at Monument HQ	05/08	1	–485 282	0.61 0.58	0.11 0.02	4.80 0.48	0.002 0.001	0.002 0.001	0.004 0.001	3.0 1.6	2.2 0.9	3.8 0.4
Frijoles at Rio Grande	09/30	1	278 750	1.88 1.73	0.05 0.01	1.98 0.20	0.000 0.000	0.004 0.001	0.004 0.001	1.5 0.7	1.5 0.7	2.7 0.3
Standardized Comparisons												
Average Detection Limits			700	1.00	0.05	0.25	0.005[g]	0.005[g]	0.005	1.5	1.5	0.8
Background			3,200[i]	0.87[h]	0.44[h]	4.40[h]	0.006[h]	0.023[h]	0.090[i]	14.8[i]	12.0[i]	8.2[i]
SAL[j]			2,0000	5.9	4.0	95.0	20.0	18.0	17.0			

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[a] Except where noted.

[b] Sample sizes: stream channels–100 g; reservoirs–1000 g.

[c] Codes: 1–primary analysis, D–field duplicate, R–lab replicate.

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

[e] Two columns are listed: the first is the value; the second is the counting uncertainty (1 std dev).

[f] Value is below detection limit.

[g] Limits of Detection for ^{238}Pu and ^{239,240}Pu reservoir analyses are 0.0001 pCi/g.

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

[i] Preliminary upper limit for background values for channel sediments from 1974–1996 (McLin and Lyons, 1998).

[j] Screening Action Level, Environmental Restoration Project, 1997; see text for details.

Table 5-11. Detections of Above-Background Radionuclides in Sediments for 1997[a]

Station Name	Date	Codes[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	Units
Pajarito Plateau Stations								
AB-1	04/23	1	^{239,240}Pu	0.111	0.001	0.005	0.023	pCi/g
AB-2	04/23	1	^{239,240}Pu	0.052	0.003	0.005	0.023	pCi/g
AB-3	04/23	1	^{241}Am	0.160	0.009	0.005	0.090	pCi/g
AB-3	04/23	1	^{238}Pu	0.014	0.002	0.005	0.006	pCi/g
AB-3	04/23	1	^{239,240}Pu	0.621	0.014	0.005	0.023	pCi/g
AB-5	04/23	1	^{137}Cs	1.26	0.10	0.05	0.44	pCi/g
AB-5	04/23	1	^{239,240}Pu	0.052	0.004	0.005	0.023	pCi/g
AB-7	04/23	1	^{3}H	3,937	349	700	3,200	pCi/L
AB-10	04/24	1	^{137}Cs	0.63	0.06	0.05	0.44	pCi/g
AB-10	04/24	1	^{239,240}Pu	0.052	0.004	0.005	0.023	pCi/g
AB-11	04/24	1	^{239,240}Pu	0.543	0.018	0.005	0.023	pCi/g
Acid Weir	05/06	1	Gross Alpha	15.5	2.4	1.5	14.8	pCi/g
Acid Weir	05/06	1	^{241}Am	0.294	0.012	0.005	0.090	pCi/g
Acid Weir	05/06	1	^{238}Pu	0.040	0.003	0.005	0.006	pCi/g
Acid Weir	05/06	1	^{239,240}Pu	6.418	0.134	0.005	0.023	pCi/g
Chaquehui at Rio Grande	09/30	1	^{3}H	4,288	970	700	3,200	pCi/L
DPS-4	05/07	1	^{241}Am	0.194	0.009	0.005	0.090	pCi/g
DPS-4	05/07	1	^{137}Cs	2.15	0.16	0.05	0.44	pCi/g
DPS-4	05/07	1	^{238}Pu	0.017	0.002	0.005	0.006	pCi/g
DPS-4	05/07	1	^{239,240}Pu	0.109	0.005	0.005	0.023	pCi/g
Fence at SR 4	03/17	1	^{238}Pu	0.014	0.002	0.005	0.006	pCi/g
Frijoles at Monument HQ	05/08	1	Total U	4.80	0.48	0.25	4.40	mg/kg
G-5	04/11	1	^{238}Pu	0.011	0.002	0.005	0.006	pCi/g
G-5	04/11	1	^{239,240}Pu	0.665	0.005	0.005	0.023	pCi/g
G-6	04/11	1	^{238}Pu	0.017	0.002	0.005	0.006	pCi/g
G-6	04/11	1	^{239,240}Pu	0.162	0.007	0.005	0.023	pCi/g
G-7	04/11	1	^{238}Pu	0.116	0.007	0.005	0.006	pCi/g
G-7	04/11	1	^{239,240}Pu	0.156	0.009	0.005	0.023	pCi/g
G-8	04/11	1	^{137}Cs	0.47	0.04	0.05	0.44	pCi/g
G-8	04/11	1	^{238}Pu	0.056	0.035	0.005	0.006	pCi/g
G-8	04/11	1	^{239,240}Pu	0.049	0.003	0.005	0.023	pCi/g
G-9	04/11	1	^{238}Pu	0.013	0.002	0.005	0.006	pCi/g

Table 5-11. Detections of Above-Background Radionuclides in Sediments for 1997[a] (Cont.)

Station Name	Date	Codes[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	Units
Pajarito Plateau Stations (Cont.)								
Hamilton Bend Spring	05/07	1	^{239,240}Pu	0.428	0.011	0.005	0.023	pCi/g
Los Alamos at GS-1	05/07	1	^{239,240}Pu	0.449	0.019	0.005	0.023	pCi/g
Los Alamos at LAO-1	05/07	1	^{239,240}Pu	0.621	0.016	0.005	0.023	pCi/g
Los Alamos at LAO-1	05/07	1	^{239,240}Pu	1.225	0.023	0.005	0.023	pCi/g
Los Alamos at LAO-3	05/07	1	^{241}Am	0.260	0.011	0.005	0.090	pCi/g
Los Alamos at LAO-3	05/07	1	^{137}Cs	2.17	0.16	0.05	0.44	pCi/g
Los Alamos at LAO-3	05/07	1	^{238}Pu	0.333	0.003	0.005	0.006	pCi/g
Los Alamos at LAO-3	05/07	1	^{239,240}Pu	0.215	0.008	0.005	0.023	pCi/g
Los Alamos at LAO-4.5	05/07	1	^{137}Cs	2.64	0.19	0.05	0.44	pCi/g
Los Alamos at LAO-4.5	05/07	1	^{238}Pu	0.208	0.007	0.005	0.006	pCi/g
Los Alamos at LAO-4.5	05/07	1	^{239,240}Pu	0.479	0.013	0.005	0.023	pCi/g
Los Alamos at SR 4	03/17	1	^{137}Cs	0.64	0.08	0.05	0.44	pCi/g
Los Alamos at SR 4	03/17	1	^{238}Pu	0.009	0.002	0.005	0.006	pCi/g
Los Alamos at SR 4	03/17	1	^{239,240}Pu	0.092	0.005	0.005	0.023	pCi/g
Los Alamos at SR 4	03/17	1	^{241}Am	0.090	0.005	0.005	0.090	pCi/g
Los Alamos at Totavi	05/12	1	^{239,240}Pu	0.091	0.005	0.005	0.023	pCi/g
Los Alamos at Upper GS	12/18	1	^{239,240}Pu	0.468	0.013	0.005	0.023	pCi/g
Mortandad A-6	08/14	1	Gross Beta	13.5	1.5	1.5	12.0	pCi/g
Mortandad A-6	08/14	1	^{137}Cs	2.58	0.19	0.05	0.44	pCi/g
Mortandad A-6	08/14	1	^{239,240}Pu	0.094	0.005	0.005	0.023	pCi/g
Mortandad A-6	08/14	1	Total U	4.99	0.50	0.25	4.40	mg/kg
Mortandad at GS-1	05/07	1	^{241}Am	11.522	0.329	0.005	0.090	pCi/g
Mortandad at GS-1	05/07	1	^{137}Cs	15.70	1.00	0.05	0.44	pCi/g
Mortandad at GS-1	05/07	1	Gross Gamma	14.8	1.5	0.8	8.2	pCi/g
Mortandad at GS-1	05/07	1	^{3}H	18,728	1,500	700	3,200	pCi/L
Mortandad at GS-1	05/07	1	^{238}Pu	6.124	0.121	0.005	0.006	pCi/g
Mortandad at GS-1	05/07	1	^{239,240}Pu	5.696	0.113	0.005	0.023	pCi/g
Mortandad at MCO-5	05/07	D	Gross Alpha	27.9	4.5	1.5	14.8	pCi/g
Mortandad at MCO-5	05/07	1	Gross Alpha	25.5	4.2	1.5	14.8	pCi/g
Mortandad at MCO-5	05/07	1	^{241}Am	5.980	0.230	0.005	0.090	pCi/g
Mortandad at MCO-5	05/07	D	Gross Beta	16.4	2.8	1.5	12.0	pCi/g
Mortandad at MCO-5	05/07	1	Gross Beta	17.3	2.9	1.5	12.0	pCi/g
Mortandad at MCO-5	05/07	D	^{137}Cs	14.20	0.90	0.05	0.44	pCi/g

Table 5-11. Detections of Above-Background Radionuclides in Sediments for 1997[a] (Cont.)

Station Name	Date	Codes[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	Units
Pajarito Plateau Stations (Cont.)								
Mortandad at MCO-5	05/07	1	^{137}Cs	12.40	0.80	0.05	0.44	pCi/g
Mortandad at MCO-5	05/07	D	Gross Gamma	15.6	1.6	0.8	8.2	pCi/g
Mortandad at MCO-5	05/07	1	Gross Gamma	13.3	1.3	0.8	8.2	pCi/g
Mortandad at MCO-5	05/07	1	^{238}Pu	2.200	0.100	0.005	0.006	pCi/g
Mortandad at MCO-5	05/07	D	^{238}Pu	2.480	0.100	0.005	0.006	pCi/g
Mortandad at MCO-5	05/07	1	^{239,240}Pu	6.090	0.240	0.005	0.023	pCi/g
Mortandad at MCO-5	05/07	D	^{239,240}Pu	6.530	0.240	0.005	0.023	pCi/g
Mortandad at MCO-7	05/07	1	^{137}Cs	4.46	0.30	0.05	0.44	pCi/g
Mortandad at MCO-7	05/07	1	^{3}H	6,178	379	700	3,200	pCi/L
Mortandad at MCO-7	05/07	1	^{238}Pu	0.666	0.016	0.005	0.006	pCi/g
Mortandad at MCO-7	05/07	1	^{239,240}Pu	2.062	0.041	0.005	0.023	pCi/g
Mortandad near CMR Bldg	05/08	1	^{238}Pu	0.014	0.002	0.005	0.006	pCi/g
Pajarito at SR 4	12/16	1	^{239,240}Pu	0.030	0.002	0.005	0.023	pCi/g
Pajarito at SR 4	12/16	1	Total U	4.43	0.44	0.25	4.40	mg/kg
Pueblo 2	05/07	1	^{239,240}Pu	0.617	0.015	0.005	0.023	pCi/g
Pueblo 3	05/07	1	^{238}Pu	0.006	0.001	0.005	0.006	pCi/g
Pueblo 3	05/07	1	^{239,240}Pu	1.103	0.030	0.005	0.023	pCi/g
Pueblo at SR 502	05/04	1	^{239,240}Pu	0.520	0.014	0.005	0.023	pCi/g
Reservoirs								
Cochiti Middle	10/29	1	Total U	5.05	0.51	0.25	4.40	mg/kg
Cochiti Lower	10/29	1	Total U	4.43	0.44	0.25	4.40	mg/kg
Cochiti Lower	10/29	1	^{137}Cs	0.55	0.05	0.05	0.44	pCi/g
Rio Grande Middle	07/24	1	^{137}Cs	0.51	0.05	0.05	0.44	pCi/g
Rio Grande Upper	07/24	1	^{137}Cs	0.53	0.05	0.05	0.44	pCi/g

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[a] Detection defined as value ≥ 4.66*uncertainty and ≥ detection limit and ≥ background.

[b] Codes: 1–primary analysis, D–field duplicate, R–lab replicate.

[c] Radioactivity counting uncertainty (1 std dev).

Table 5-12. Possible Detections of Above-Background Radionuclides in Sediments for 1997[a]

Station Name	Date	Codes[b]	Analyte	Value	Uncertainty[c]	Detection Limit	Background	Units
Pajarito Plateau Stations								
AB-11	04/24	1	^{238}Pu	0.007	0.002	0.005	0.006	pCi/g
Cañada del Buey at SR 4	03/17	1	^{238}Pu	0.006	0.002	0.005	0.006	pCi/g
G-5	04/11	1	^{90}Sr	1.47	0.61	1.00	0.87	pCi/g
Pueblo 3	05/07	1	^{238}Pu	0.006	0.001	0.005	0.006	pCi/g
Reservoirs								
Heron Lower	07/22	1	Gross Alpha	15.6	4.5	1.5	14.8	pCi/g
Cochiti Lower	10/29	1	Gross Beta	12.0	3.6	1.5	12.0	pCi/g
Cochiti Middle	10/29	1	Gross Alpha	15.0	5.7	1.5	14.8	pCi/g
Cochiti Middle	10/29	1	Gross Beta	14.0	3.3	1.5	12.0	pCi/g

[a] Possible detection defined as 2.33* ≤ value ≤ 4.66* and value ≥ detection limit and value ≥ background.

[b] Codes: 1–primary analysis, D–field duplicate R–lab replicate.

[c] Radioactivity counting uncertainty (1 std dev).

Table 5-13. Plutonium Analysis of Reservoir Sediments from the Rio Chama and Rio Grande (fCi/g)

Year	Location[a]	^{238}Pu	Uncertainty[b]	^{239,240}Pu	Uncertainty[b]	Ratio (^{239,240}Pu/^{238}Pu)
Abiquiu Reservoir (Rio Chama)						
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[c]	Mean	13.7	1.7	8.0	1.3	0.6
1996	Mean	0.2	0.0	4.6	0.4	23.0
1997	Upper	No sample collected in 1997				
1997	Middle	0.4	0.1	6.8	0.7	17.0
1997	Lower	0.4	0.1	5.4	0.4	13.5
1997	Mean	0.4	0.1	6.1	0.6	15.3
1984–97	Mean	0.3	0.1	5.4	0.4	17.9
1984–97	Std Dev	0.2	0.1	3.4	0.3	7.8
1984–97	Count	13	13	13	13	13
Cochiti Reservoir (Rio Grande)						
1984	Mean	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[c]	Mean	7.6	1.4	12.5	1.8	1.6
1996	Mean	0.9	0.1	18.1	0.8	20.1
1997	Upper	0.4	0.1	7.9	0.2	19.8
1997	Middle	0.7	0.1	13.4	0.4	19.1
1997	Lower	0.9	0.1	17.9	0.5	19.9
1997	Mean	0.7	0.1	13.1	0.4	19.6
1984–97	Mean	1.5	0.2	19.3	0.4	16.3
1984–97	Std Dev	1.2	0.1	11.2	0.3	7.6
1984–97	Count	13	13	13	13	13

[a] Reservoir sample locations: Upper, Middle, or Lower end; or mean of all three sample locations.

[b] Analytical counting uncertainity (1 std dev).

[c] Uncertainties for 1995 were not within quality control specifications; data not used for long-term statistics.

Table 5-14. Total Recoverable Trace Metals in Sediments for 1997 (mg/kg)[a,b]

Station Name	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Stations														
Rio Chama at Chamita	05/12	1	<2[d]	3,691	4.9	<3	61.0	0.3	<0.9	2.7	6.7	4.1	6,301	<0.05
Rio Grande at Embudo	05/12	1	<2	4,267	3.2	<3	64.0	0.3	<0.9	2.9	6.5	4.7	6,632	<0.05
Rio Grande at Otowi (bank)	12/16	1	<10	2,422	1.2	<15	31.5	1.0	<4.5	<5.0	<9.0	<5.0	6,221	<0.05
Rio Grande at Bernalillo	05/01	1	<2	2,329	<0.6	<3	26.5	<0.2	<0.9	<1.0	1.9	<1.0	2,795	<0.05
Jemez River	05/09	1	<2	1,648	4.1	<3	22.6	0.2	<0.9	1.4	2.7	1.3	2,659	<0.05
Reservoirs on Rio Chama (New Mexico)														
El Vado Upper	07/22	1	<2	9,084	7.3	<3	107.4	0.5	<0.9	5.9	11.1	11.0	15,756	<0.05
El Vado Middle	07/22	1	<2	22,916	11.6	<3	183.6	1.3	<0.9	11.2	26.8	22.7	25,750	<0.05
El Vado Lower	07/22	1	<2	25,689	10.6	<3	215.1	1.4	<0.9	10.7	26.1	22.7	26,008	<0.05
Reservoirs on Rio Grande (Colorado)														
Rio Grande Upper	07/24	1	<2	15,023	4.8	<3	215.8	0.9	<0.9	7.5	8.3	12.7	21,113	<0.05
Rio Grande Middle	07/24	1	<2	15,350	4.6	<3	238.6	0.9	<0.9	9.0	6.7	16.7	22,509	<0.05
Rio Grande Lower	07/24	1	<2	10,048	4.7	<3	166.3	0.5	<0.9	7.5	4.4	9.7	19,192	<0.05
Pajarito Plateau Stations														
Guaje Canyon:														
Guaje at SR 502	03/17	1	<2	3,111	0.3	<3	60.3	0.2	<0.9	1.7	2.7	2.2	4,194	<0.05
Guaje at SR 502	03/17	D1	<2	2,274	<0.2	<3	27.5	0.2	<0.9	1.2	1.7	1.9	3,209	<0.05
Guaje at SR 502	03/17	D2	<2	2,275	<0.2	<3	47.3	0.3	<0.9	3.8	8.0	1.6	14,261	<0.05
Guaje at SR 502	03/17	R1												<0.05
Bayo Canyon:														
Bayo at SR 502	03/17	1	<2	4,593	0.9	<3	71.8	0.4	<0.9	3.0	5.4	3.2	7,461	<0.05
Bayo at SR 502	03/17	D1	<2	2,550	<0.2	<3	30.1	0.2	<0.9	1.9	3.3	2.1	4,967	<0.05
Bayo at SR 502	03/17	R1												<0.05
DP/Los Alamos Canyons:														
Los Alamos at Totavi	05/12	1	<2	2,334	<0.2	<3	30.5	0.3	<0.9	1.2	2.1	1.7	2,591	<0.05
Los Alamos at Otowi	05/12	1	<2	1,671	<0.2	<3	19.4	<0.2	<0.9	1.0	2.3	1.7	2,613	<0.05
Sandia Canyon:														
Sandia at Rio Grande	09/29	1	<2	1,245	<0.2	<3	18.8	<0.2	<0.9	<1.0	1.1	2.4	2,352	<0.05

Table 5-14. Total Recoverable Trace Metals in Sediments for 1997 (mg/kg)[a,b] (Cont.)

Station Name	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Pajarito Plateau Stations (Cont.)														
Cañada Ancha:														
Cañada Ancha at Rio Grande	09/29	1	<2	2,022	1.2	<3	34.8	<0.2	<0.9	1.1	1.9	13.3	3,327	<0.05
Mortandad Canyon:														
Mortandad A-8	08/14	1	<2	3,031	0.5	<3	33.3	0.4	<0.9	1.3	2.0	2.7	3,970	<0.05
Mortandad A-10	08/14	1	<2	2,409	0.5	<3	33.2	0.3	<0.9	1.5	2.3	2.0	4,238	4.00
TA-54 Area G:														
G-1	04/11	1	<2	1,476	0.4	<3	19.9	<0.2	<0.9	<1.0	<0.9	1.2	1,992	<0.05
G-1	04/11	D1	<2	1,916	0.5	<3	16.8	<0.2	<0.9	<1.0	1.2	1.4	2,917	<0.05
G-2	04/10	1	<2	2,630	0.8	<3	30.6	0.2	<0.9	1.8	2.7	2.0	5,759	<0.05
G-3	04/11	1	<2	1,288	0.6	<3	18.2	<0.2	<0.9	1.2	3.8	4.2	3,068	<0.05
G-4	04/11	1	<2	6,299	1.1	<3	57.4	0.5	<0.9	2.3	4.1	3.2	7,456	<0.05
G-5	04/11	1	<2	5,651	1.2	<3	52.1	0.5	<0.9	2.2	3.6	2.5	6,418	<0.05
G-6	04/11	1	<2	7,978	1.6	<3	69.3	0.5	<0.9	2.9	5.5	3.5	8,542	0.06
G-7	04/11	1	<2	2,784	0.8	<3	21.9	<0.2	<0.9	<1.0	1.4	1.5	3,169	0.05
G-8	04/11	1	<2	5,951	1.3	<3	38.2	0.3	<0.9	2.1	4.6	2.6	7,771	4.26
G-9	04/11	1	<2	2,750	0.6	<3	21.4	<0.2	<0.9	<1.0	1.7	1.3	2,840	0.05
Cañon de Valle:														
Cañon de Valle at SR 501	03/17	1	<2	2,037	0.8	<3	20.2	0.2	<0.9	1.5	4.8	2.4	4,486	<0.05
Cañon de Valle at SR 501	03/17	R1												<0.05
Water Canyon:														
Water at SR 501	03/17	1	<2	7,201	1.0	<3	76.7	0.6	<0.9	3.1	5.6	3.8	7,811	<0.05
Water at SR 501	03/17	R1												<0.05
Ancho Canyon:														
Ancho at Rio Grande	09/29	1	<2	3,977	0.5	<3	35.0	0.2	<0.9	1.7	4.2	6.1	5,988	<0.05
Ancho at Rio Grande	09/29	D1	<2	10,470	1.9	<3	99.6	0.7	<0.9	3.3	7.8	7.1	9,804	<0.05
Chaquehui Canyon:														
Chaquehui at Rio Grande	09/30	1	<2	7,539	1.4	<3	85.3	0.5	<0.9	4.2	7.4	8.8	11,441	<0.05

Table 5-14. Total Recoverable Trace Metals in Sediments for 1997 (mg/kg)[a,b] (Cont.)

Station Name	Date	Code[c]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Pajarito Plateau Stations (Cont.)														
TA-49 Area AB:														
AB-1	04/24	1	<2	8,973	2.2	<3	70.7	0.5	<0.9	3.3	5.1	1.5	8,318	<0.05
AB-1	04/23	D1	<2	9,891	2.5	<3	74.9	0.6	<0.9	3.3	6.1	1.5	8,752	<0.05
AB-2	04/23	1	<2	15,448	4.6	<3	189.7	0.9	<0.9	7.5	9.9	8.3	12,702	<0.05
AB-3	04/23	1	<2	6,505	1.1	<3	53.7	0.3	<0.9	2.0	3.9	1.8	5,411	<0.05
AB-4	04/23	1	<2	15,352	1.4	<3	164.4	0.9	<0.9	5.5	10.5	7.6	11,297	<0.05
AB-4A	04/23	1	<2	9,919	2.4	<3	95.1	0.6	<0.9	3.1	5.1	1.8	6,585	<0.05
AB-5	04/23	1	<2	12,310	2.2	<3	111.6	0.8	<0.9	4.4	9.1	7.0	11,949	<0.05
AB-6	04/23	1	<2	11,398	2.3	<3	116.2	0.7	<0.9	4.4	8.3	5.5	9,957	<0.05
AB-7	04/23	1	<2	5,992	0.8	<3	41.9	0.3	<0.9	1.3	3.0	1.8	5,044	<0.05
AB-8	04/23	1	<2	9,400	3.4	<3	78.4	0.7	<0.9	2.8	6.5	1.4	9,359	<0.05
AB-9	04/23	1	<2	6,042	2.1	<3	39.6	0.3	<0.9	<1.0	3.0	1.6	4,438	<0.05
AB-10	04/24	1	<2	2,036	0.5	<3	20.9	<0.2	<0.9	<1.0	1.8	<1.0	5,135	<0.05
AB-11	04/24	1	<2	13,157	<0.2	<3	66.7	0.6	<0.9	1.6	6.2	2.5	7,399	<0.05
Frijoles Canyon:														
Frijoles at Monument HQ	05/08	1	<2	7,233	<1.4	<3	48.0	0.6	<0.9	<1.0	4.1	<1.0	6,269	<0.05
Frijoles at Rio Grande	09/30	1	<2	862	0.6	<3	15.3	<0.2	<0.9	<1.0	2.4	2.4	1,067	<0.05
Standardized Comparisons														
Detection Limits			2	7	0.2	3	0.2	0.2	0.9	1.0	0.9	1.0	1	0.05
Background–Stream Channels[e]			3	6,934	5.3	64	3,39.2	0.7	1.0	10.5	13.9	9.3	13,250	0.11
Background–Reservoirs[e]			4	24,290	18.9	7	269.6	1.3	1.3	12.3	22.5	24.2	29,257	0.06
SAL[f]			380	78,000		5,900	5,300		38	4,600	30[g]	2,800		23

Table 5-14. Total Recoverable Trace Metals in Sediments for 1997 (mg/kg)[a,b] (Cont.)

Station Name	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Stations													
Rio Chama at Chamita	05/12	1	138.5	<5	<4.0	11.6	<0.3	<1.20	<5	18.6	<0.3	11.6	22.1
Rio Grande at Embudo	05/12	1	184.0	<5	5.4	7.8	<0.3	<0.33	<5	21.8	<0.3	11.4	24.9
Rio Grande at Otowi (bank)	12/16	1	99.2	<25	<20.0	<5.0	<0.3	<0.50	<25	13.4	0.4	18.6	17.6
Rio Grande at Bernalillo	05/01	1	53.5	<5	<4.0	1.0	<0.3	<0.50	<5	14.8	<0.3	6.0	8.5
Jemez River	05/09	1	171.0	<5	<4.0	2.3	<0.3	<0.33	<5	15.9	<0.3	5.4	8.4
Reservoirs on Rio Chama (New Mexico)													
El Vado Upper	07/22	1	269.3	<5	10.2	10.0	<1.5	0.65	<5	99.0	0.4	26.8	43.3
El Vado Middle	07/22	1	729.6	<5	22.1	20.0	<1.5	1.18	<5	72.8	0.8	56.7	80.1
El Vado Lower	07/22	1	889.3	<5	23.6	29.0	3.0	1.15	<5	72.5	1.1	58.9	91.7
Reservoirs on Rio Grande (Colorado)													
Rio Grande Upper	07/24	1	356.4	<5	4.4	15.0	<1.5	0.37	<5	64.6	0.4	39.6	75.5
Rio Grande Middle	07/24	1	501.8	<5	8.4	17.0	<1.5	0.55	<5	74.4	0.4	40.7	85.1
Rio Grande Lower	07/24	1	386.8	<5	<4.0	11.0	<1.5	<0.35	<5	51.0	<0.3	29.1	60.5
Pajarito Plateau Stations													
Guaje Canyon:													
Guaje at SR 502	03/17	1	269.0	<5	<4.0	3.8	<0.3	<0.30	<5	8.3	<0.3	6.5	12.1
Guaje at SR 502	03/17	D1	112.0	<5	<4.0	3.3	<0.3	<0.30	<5	6.4	<0.3	4.6	9.8
Guaje at SR 502	03/17	D2	545.0	<5	4.4	4.5	<0.3	<0.30	<5	5.6	<0.3	20.3	37.1
Guaje at SR 502	03/17	R1											
Bayo Canyon:													
Bayo at SR 502	03/17	1	221.0	<5	<4.0	7.3	<0.3	<0.30	<5	16.2	<0.3	12.7	18.3
Bayo at SR 502	03/17	D1	128.0	<5	<4.8	3.3	<0.3	<0.30	<5	8.1	<0.3	7.6	13.9
Bayo at SR 502	03/17	R1											
DP/Los Alamos Canyons:													
Los Alamos at Totavi	05/12	1	93.1	<5	<4.0	2.6	<0.3	<0.33	<5	8.4	<0.3	3.9	19.0
Los Alamos at Otowi	05/12	1	60.0	<5	<4.0	2.6	<0.3	<0.33	<5	5.9	<0.3	3.6	13.0
Sandia Canyon:													
Sandia at Rio Grande	09/29	1	60.2	<5	<4.0	1.5	<0.3	<0.38	<5	6.2	<0.3	3.9	8.1

Table 5-14. Total Recoverable Trace Metals in Sediments for 1997 (mg/kg)[a,b] (Cont.)

Station Name	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Pajarito Plateau Stations (Cont.)													
Cañada Ancha:													
Cañada Ancha at Rio Grande	09/29	1	79.0	<5	<4.0	2.3	<0.3	<0.38	<5	13.7	<0.3	6.4	12.3
Mortandad Canyon:													
Mortandad A-8	08/14	1	185.2	<5	<4.0	7.2	<0.3	<0.37	<5	4.5	<0.3	4.2	23.2
Mortandad A-10	08/14	1	180.4	<5	<4.0	6.9	<0.3	<0.37	<5	5.3	<0.3	5.6	17.0
TA-54 Area G:													
G-1	04/11	1	75.9	<5	<4.0	2.2	<0.3	<0.38	<5	3.8	<0.3	1.8	22.3
G-1	04/11	D1	94.0	<5	<4.0	4.4	<0.3	<0.38	<5	2.9	<0.3	2.2	23.9
G-2	04/10	1	183.1	<5	<4.0	5.6	0.4	<0.38	<5	6.2	<0.3	5.6	38.0
G-3	04/11	1	61.8	<5	<4.0	10.8	<0.3	<0.38	<5	12.9	<0.3	5.2	42.1
G-4	04/11	1	311.8	<5	<4.0	9.0	<0.3	<0.38	<5	8.8	<0.3	7.2	51.7
G-5	04/11	1	235.3	<5	<4.0	7.3	<0.3	<0.38	<5	9.2	<0.3	6.7	39.7
G-6	04/11	1	274.4	<5	5.9	9.1	<0.3	<0.38	<5	13.6	<0.3	10.3	51.2
G-7	04/11	1	118.8	<5	<4.0	3.6	<0.3	<0.38	<5	3.5	<0.3	2.8	23.4
G-8	04/11	1	227.6	<5	<4.0	8.7	<0.3	<0.38	<5	7.5	<0.3	9.5	55.0
G-9	04/11	1	97.0	<5	<4.0	3.8	<0.3	<0.38	<5	4.1	<0.3	3.7	24.0
Cañon de Valle:													
Cañon de Valle at SR 501	03/17	1	88.9	<5	<4.0	13.0	<0.3	<0.30	<5	6.2	<0.3	6.1	19.4
Cañon de Valle at SR 501	03/17	R1											
Water Canyon:													
Water at SR 501	03/17	1	381.0	<5	<4.0	10.5	<0.3	<0.30	<5	22.0	<0.3	12.0	33.3
Water at SR 501	03/17	R1											
Ancho Canyon:													
Ancho at Rio Grande	09/29	1	116.0	<5	4.2	4.6	0.3	<0.38	<5	10.0	<0.3	8.1	31.7
Ancho at Rio Grande	09/29	D1	231.7	<5	5.3	18.0	<0.3	0.51	<5	24.2	0.3	13.7	32.3
Chaquehui Canyon:													
Chaquehui at Rio Grande	09/30	1	285.6	<5	10.3	9.8	<0.3	<0.38	<5	19.5	<0.3	14.3	33.4

Table 5-14. Total Recoverable Trace Metals in Sediments for 1997 (mg/kg)[a,b] (Cont.)

Station Name	Date	Code[c]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Pajarito Plateau Stations (Cont.)													
TA-49 Area AB:													
AB-1	04/24	1	273.3	<5	<4.0	13.3	<0.4	<0.70	<5	12.9	<0.3	11.3	322.8
AB-1	04/23	D1	269.0	<5	5.6	17.7	<0.4	<0.70	<5	14.3	<0.3	12.0	321.2
AB-2	04/23	1	594.4	<5	8.0	15.3	0.5	<0.70	<5	47.2	<0.3	20.8	176.8
AB-3	04/23	1	155.5	<5	<4.0	6.8	<0.4	<0.70	<5	9.5	<0.3	6.4	45.4
AB-4	04/23	1	340.3	<5	8.3	15.4	<0.4	<0.70	<5	28.2	0.3	17.8	31.7
AB-4A	04/23	1	226.9	<5	4.4	14.0	<0.4	<0.70	<5	15.0	<0.3	7.7	17.6
AB-5	04/23	1	386.6	<5	6.7	19.9	<0.4	<0.70	<5	22.6	0.3	15.1	55.2
AB-6	04/23	1	293.2	<5	5.2	12.4	<0.4	<0.70	<5	21.8	0.3	14.6	26.6
AB-7	04/23	1	127.2	<5	<4.0	5.0	<0.4	<0.70	<5	7.5	<0.3	5.0	20.0
AB-8	04/23	1	251.1	<5	<4.0	21.2	<0.4	<0.70	<5	15.7	0.6	12.8	22.4
AB-9	04/23	1	105.5	<5	<4.0	4.3	<0.4	<0.70	<5	7.3	<0.3	4.5	18.8
AB-10	04/24	1	128.8	<5	<4.0	4.6	<0.4	<0.70	<5	3.9	<0.3	5.6	19.2
AB-11	04/24	1	151.9	<5	4.4	7.4	<0.4	<0.70	<5	12.9	<0.3	6.8	26.9
Frijoles Canyon:													
Frijoles at Monument HQ	05/08	1	217.0	<5	<4.0	5.8	<0.3	<0.50	<5	12.3	<0.3	6.0	52.4
Frijoles at Rio Grande	09/30	1	19.4	<5	4.1	0.6	<0.3	<0.38	<5	4.1	<0.3	2.6	3.9
Standardized Comparisons													
Detection Limits			0.3	5	4.0	0.3	0.3	0.24	5	0.2	0.3	1.3	0.8
Background–Stream Channels[e]			416.0	3	11.6	8.7	2.9	0.30	20	76.8	6.8	32.4	47.9
Background–Reservoirs[e]			836.0	1	25.1	19.1	0.3	1.20	9	99.8	34.8	45.0	105.1
SAL[f]			390	380	1,500	400	31	380	46,000	46,000	6.4	540	23,000

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[a] Sample Sizes: stream channels and reservoirs—100 g.

[b] Analytical uncertainities are approximately 10% of reported values.

[c] Codes: 1–primary analysis, D–field duplicate, R–lab replicate.

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

[e] Upper limit for background based on 1993–96 surveillance data (McLin and Lyons, 1998).

[f] Screening Action level from ER Project, March 1997; see text for details. All units in mg/kg.

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

Table 5-15. Number of Analyses Above Analytical Limit of Quantitation for Organic Compounds in Sediment Samples for 1997

Station Name	Date	Code[a]	Semivolatile[b]	PCB[c]	HE[d]
Number of Compounds Analyzed			69	4	14
TA-49 Area AB					
AB-1	04/23	1	0	0	
AB-1	04/24	D	0	0	
AB-2	04/23	1	0	0	
AB-3	04/23	1	0	0	
AB-4	04/23	1	0	0	
AB-4A	04/23	1	0	0	
AB-5	04/23	1	0	0	
AB-6	04/23	1	0	0	
AB-7	04/23	1	0	0	
AB-8	04/23	1	0	0	
AB-9	04/23	1	0	0	
AB-10	04/24	1	0	0	
AB-11	04/24	1	0	0	
Frijoles Canyon					
Frijoles at Monument HQ	05/08	1	0	0	
Frijoles at Monument HQ	05/30	1			0

[a] Codes: 1–primary analysis, 2–secondary analysis, D–field duplicate, R–lab replicate.
[b] Semivolatile organic compounds (SVOC).
[c] Polychlorinated biphenyl compounds (PCB).
[d] High-explosive compounds.

Table 5-16. Radiochemical Analyses of Groundwater for 1997 (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	
Regional Aquifer Wells																							
Test Wells:																							
Test Well 1	08/11	1	UF	468	690[c]	0.1	0.9	0.26	0.29	1.90	0.19	0.008	0.012	0.012	0.012	–0.015[d]	0.013	0.5	1.6	3.0	2.9	–40	47
Test Well 2	12/11	1	UF	–162	670	0.8	1.0	0.74	2.33	0.00	0.01	–0.012	0.017	–0.016	0.023	–0.047	0.017	0.2	0.8	0.7	1.5	52	49
Test Well 3	08/11	1	UF	–2,052	500	1.0	1.3	–0.92	0.36	0.73	0.08	–0.023	0.004	0.009	0.012	0.002	0.029	0.1	0.7	2.2	1.7	–59	47
Test Well 4	08/11	1	UF	–302	640	1.3	1.7	0.21	0.24	0.45	0.05	–0.008	0.009	0.010	0.011	–0.001	0.014	0.2	0.9	1.6	1.6	–11	47
Test Well DT-5A	03/07	1	UF	104	216	–0.07	0.4	0.35	0.53	0.45	0.05	0.001	0.020	–0.009	0.004	–0.016	0.012	0.4	0.6	1.3	0.5	–28	50
Test Well DT-5A	03/07	2	UF	69	188																		
Test Well DT-5A	03/07	R1	UF																			160	50
Test Well DT-5A	05/13	1	UF	185	201	0.8	1.8	0.96	2.67	0.08	0.01	–0.007	0.009	–0.010	0.009	–0.019	0.014	0.4	0.4	–0.2	0.4	–52	47
Test Well DT-5A	10/16	1	UF	–222	700	–1.1	1.3	0.10	1.39	0.49	0.05	0.011	0.013	0.012	0.012	–0.006	0.013	0.3	1.1	0.7	0.5	–115	48
Test Well DT-9	05/13	1	UF	1	166	0.9	1.6	1.10	0.42	0.43	0.05	0.003	0.010	0.000	0.010	–0.014	0.016	0.0	0.2	0.2	0.4	–31	47
Test Well DT-9	10/15	1	UF	–172	700	–1.6	1.5	–0.82	0.80	0.61	0.06	–0.007	0.011	0.004	0.012	–0.015	0.011	0.1	0.7	0.3	1.4	–123	48
Test Well DT-10	05/14	1	UF	–59	148	–0.6	1.2	0.02	0.24	0.46	0.05	–0.025	0.007	–0.020	0.010	–0.005	0.018	–0.2	0.2	–1.3	0.3	–27	47
Test Well DT-10	10/16	1	UF	–232	700	–3.4	2.2	–0.91	0.80	0.74	0.08	0.021	0.014	–0.002	0.010	0.019	0.030	0.9	3.1	1.7	1.6	–28	49
Water Supply Wells:																							
O-1	01/08	1	UF	169	136	0.1	0.4	0.31	0.48	1.72	0.17	0.005	0.018	–0.012	0.011	–0.033	0.014	2.8	1.0	0.6	0.5	62	50
O-1	01/08	D1	UF					0.13	0.18									2.8	1.0	0.3	0.4		
O-1	01/08	R1	UF	–144	133							–0.018	0.010	–0.016	0.009	0.025	0.027						
O-1	04/17	1	UF			0.0	0.3																
O-1	04/19	1	UF			0.0	0.3																
O-1	04/19	D1	UF			0.6	0.3																
O-4	06/25	1	UF	288	710	0.2	2.0	–0.85	0.80	0.85	0.09	–0.014	0.022	–0.014	0.017	0.022	0.021	0.5	4.0	2.5	1.8	–10	47
PM-1	06/25	1	UF	88	700	–0.9	1.8	–0.74	0.12	1.87	0.19	0.018	0.015	0.029	0.019	–0.045	0.022	2.5	6.1	3.8	1.9	1	47
PM-2	06/25	1	UF	368	720	–1.2	1.8	–0.76	0.08	0.47	0.05	–0.006	0.019	–0.005	0.020	–0.003	0.019	0.0	0.7	1.5	0.6	–9	47
PM-3	06/25	1	UF	658	730	0.1	2.2	–0.88	0.80	1.03	0.11	–0.035	0.007	–0.017	0.010	0.000	0.016	–0.3	0.3	2.3	1.8	17	47
PM-4	06/25	1	UF	58	700	–1.2	2.2	–1.08	0.80	0.35	0.04	–0.007	0.011	0.019	0.016	–0.035	0.026	0.5	4.5	1.4	1.6	8	47
PM-5	06/25	1	UF	–2	690	–0.5	2.5	–0.72	0.16	0.55	0.06	–0.026	0.008	0.001	0.014	0.004	0.017	0.1	0.9	1.2	1.6	–6	47
G-1	12/08	1	UF	198	720	5.2	1.4	–0.13	1.03	0.64	0.07	0.005	0.010	0.015	0.012	–0.008	0.020	–0.2	0.1	2.1	1.7	29	49
G-1A	06/25	1	UF	–82	690	–1.1	2.7	–1.00	0.80	0.43	0.05	–0.023	0.007	0.011	0.015	–0.001	0.034	0.0	0.4	1.7	1.7	15	47
G-2	06/25	1	UF	388	720	0.0	1.3	–0.93	0.80	0.92	0.09	–0.029	0.005	0.010	0.013	–0.004	0.017	–0.3	0.2	1.5	1.6	21	47
G-4	06/25	1	UF	–52	690	–0.2	1.0	–0.59	0.36	0.91	0.09	–0.032	0.010	0.006	0.012	–0.015	0.015	0.2	1.5	1.5	1.6	–16	47
G-5	06/25	1	UF	458	720	–0.7	1.4	–0.70	0.18	0.98	0.10	–0.005	0.010	–0.001	0.011	–0.015	0.014	0.5	2.9	0.9	1.5	9	47
G-6	06/25	1	UF	158	700	–4.4	2.7	–1.01	0.80	0.59	0.06	–0.014	0.011	0.012	0.015	–0.003	0.044	–0.4	0.4	1.4	1.6	4	47

Table 5-16. Radiochemical Analyses of Groundwater for 1997 (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	
Regional Aquifer Springs																							
White Rock Canyon Group I:																							
Sandia Spring	08/19	1	UF	118	720	1.8	1.6	–0.82	0.36	1.02	0.11	–0.018	0.053	–0.001	0.011	0.023	0.021	2.8	3.2	3.5	1.8	–39	47
Spring 3	11/18	1	UF	48	710	0.3	1.2	1.06	0.38	1.57	0.16	–0.003	0.009	0.009	0.011	0.029	0.040	1.7	8.3	2.6	1.8	2	49
Spring 3AA	11/18	1	UF	98	710	0.7	1.1	0.40	1.83	1.34	0.14	–0.023	0.002	–0.003	0.008	–0.020	0.012	0.4	2.5	2.7	1.8	21	49
Spring 4A	11/18	1	UF	–292	680	0.4	1.0	–1.69	0.36	1.20	0.12	–0.008	0.008	–0.007	0.008	–0.035	0.011	0.3	2.7	0.3	1.4	–20	48
Spring 5	09/29	1	UF	–432	650	–0.4	1.1	–0.36	0.22	0.55	0.06	–0.008	0.012	0.024	0.014	–0.038	0.014	0.3	1.2	1.1	1.6	–4	49
Ancho Spring	11/19	1	UF	–282	690	1.2	1.2	–0.28	0.81	0.29	0.03	0.029	0.014	0.007	0.012	–0.001	0.030	0.5	2.1	2.5	1.8	17	49
White Rock Canyon Group II:																							
Spring 6A	09/29	1	UF	–52	670	–0.3	1.1	0.29	0.32	0.28	0.03	–0.016	0.012	0.006	0.015	0.002	0.019	0.5	2.7	1.6	1.6	–6	49
Spring 7	09/29	1	UF	108	680	–0.1	1.1	–0.50	0.48	1.13	0.12	–0.018	0.004	0.002	0.010	–0.024	0.013	0.8	5.8	1.4	1.6	–26	48
Spring 7	09/29	1	UF	218	690	0.0	1.0	–0.48	0.52	1.15	0.12	0.002	0.010	–0.011	0.008	0.008	0.017	0.8	5.8	1.4	1.6	23	49
Spring 8B	09/30	1	UF	–2	680	–0.6	1.3	–1.24	0.36	0.09	0.01	–0.029	0.002	–0.003	0.009	–0.023	0.014	0.4	2.3	0.6	1.4	–19	49
Spring 9	09/30	1	UF	98	680	–0.2	1.3	–0.92	0.36	0.21	0.02	–0.018	0.006	0.009	0.012	0.020	0.022	0.2	1.0	0.3	1.3	9	49
White Rock Canyon Group III:																							
Spring 1	08/19	1	UF	68	720	1.0	1.3	–1.14	0.36	2.59	0.26	0.009	0.011	–0.005	0.008	0.004	0.018	1.4	3.1	2.7	1.7	–24	47
Spring 2	08/19	1	UF	8	710	2.3	1.6	0.19	1.51	2.61	0.26	–0.032	0.013	0.035	0.029	–0.009	0.030	3.0	5.6	4.3	0.8	–29	47
White Rock Canyon Group IV:																							
La Mesita Spring	12/08	1	UF	–312	680	0.2	0.9	1.96	0.53	12.13	1.22	–0.025	0.002	0.025	0.014	–0.023	0.013	12.8	3.0	14.0	5.0	–30	48
Other Springs:																							
Sacred Spring	07/08	1	UF	–372	750	0.0	2.0	0.48	1.95	0.32	0.04	–0.024	0.002	–0.006	0.008	0.000	0.020	0.8	40.3	1.6	0.6	13	47
Canyon Alluvial Groundwater Systems																							
Acid/Pueblo Canyons:																							
APCO-1	12/10	1	UF	288	690	2.3	2.5	0.00	0.23	0.59	0.06	–0.008	0.013	0.036	0.016	0.030	0.026	0.1	0.8	15.0	5.0	–1	48
Cañada del Buey:																							
CDBO-6	06/16	1	UF	98	710	1.1	1.1	–0.34	0.71	0.65	0.07	–0.026	0.011	0.012	0.016	0.004	0.020	16.6	7.3	18.4	5.8	30	47
CDBO-7	06/16	1	UF	–112	700	5.2	1.8	–0.22	0.27	2.11	0.21	–0.014	0.010	–0.012	0.010	0.011	0.023	50.4	20.5	57.1	21.2	3	47

Table 5-16. Radiochemical Analyses of Groundwater for 1997 (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	
Canyon Alluvial Groundwater Systems (Cont.)																							
DP/Los Alamos Canyons:																							
LAO-C	06/17	1	UF	168	710	0.8	1.0	–0.54	0.42	0.07	0.01	–0.026	0.009	0.005	0.013	–0.010	0.016	1.4	10.2	2.2	1.7	–4	47
LAO-0.7	06/18	1	UF	–142	690	0.5	1.4	–0.38	0.67	0.23	0.03	–0.023	0.007	0.261	0.038	0.002	0.021	4.2	4.4	5.3	2.0	–5	47
LAO-1	06/18	1	UF	468	730	7.1	1.8	0.16	1.47	0.13	0.02	–0.026	0.006	0.105	0.024	–0.043	0.015	0.3	0.7	13.9	2.5	–16	47
LAO-2	08/04	1	UF	98	680	15.6	2.5	–0.78	0.07	0.24	0.03	–0.006	0.012	0.002	0.013	0.015	0.017	–1.6	1.5	33.0	4.0	–11	47
LAO-3A	08/04	1	UF	188	680	34.8	3.5	–0.02	0.30	0.20	0.02	–0.004	0.010	0.028	0.015	0.002	0.021	–2.1	0.4	83.0	6.0	–32	47
LAO-4	08/04	1	UF	378	690	4.4	1.4	2.36	0.66	0.11	0.01	–0.001	0.010	0.006	0.011	0.048	0.023	–0.8	3.2	12.8	1.5	283	49
LAO-4.5C	08/04	1	UF	88	670	3.2	1.7	–0.21	0.92	–0.03	0.01	–0.004	0.009	0.001	0.011	0.005	0.016	0.2	9.7	6.8	2.1	639	69
LAO-6A	08/04	1	UF	248	680	1.7	1.3	–0.44	0.57	0.09	0.01	–0.008	0.010	0.013	0.014	–0.053	0.012	0.3	5.3	5.6	2.0	34	47
Mortandad Canyon:																							
MCO-3	08/07	1	UF	11,428	1,300	20.2	3.4	0.55	0.36	1.85	0.19	16.202	0.756	12.522	0.594	14.093	0.697	18.8	12.0	136.0	22.0	140	48
MCO-4B	08/05	1	UF	20,128	1,600	38.3	4.3	7.65	1.14	1.96	0.20	–0.012	0.010	0.013	0.015	0.591	0.054	5.8	4.9	131.0	11.0	–5	47
MCO-5	08/05	1	UF	17,728	1,500	32.3	3.2	0.88	0.39	1.78	0.18	0.019	0.013	0.076	0.021	0.485	0.050	7.6	10.0	131.0	16.0	–19	47
MCO-6	08/05	1	UF	18,328	1,500	32.4	3.5	0.54	0.36	2.45	0.25	0.008	0.014	0.014	0.013	0.416	0.045	5.9	7.8	132.9	13.8	1	48
MCO-7A	06/13	1	UF	15,928	1,500	1.4	1.6	–0.39	0.19	2.81	0.28	–0.017	0.006	0.002	0.011	0.053	0.029	10.8	7.8	48.9	10.1	19	47
MCO-7.5	06/13	1	UF	18,428	1,600	1.1	1.8	–0.33	0.73	1.86	0.19	0.007	0.012	–0.009	0.012	0.185	0.037	26.5	10.4	80.5	12.0	25	47
Pajarito Canyon:																							
PCO-1	06/16	1	UF	318	720	0.9	1.2	0.67	0.33	0.07	0.01	0.002	0.011	0.007	0.014	–0.082	0.021	0.6	4.6	2.1	0.7	21	47
Intermediate Perched Groundwater Systems																							
Pueblo/Los Alamos Canyon Area:																							
Test Well 1A	08/11	1	UF	–272	640	1.2	1.3	0.61	0.33	0.24	0.03	0.001	0.010	0.003	0.011	–0.014	0.013	–0.7	0.7	3.2	3.0	–75	47
Test Well 2A	12/11	1	UF	1,778	790	0.4	1.0	1.33	0.48	0.00	0.01	–0.009	0.007	0.013	0.011	–0.004	0.013	0.0	0.3	1.0	1.5	74	49
Basalt Spring	08/14	1	UF	18	710	2.6	2.4	–0.83	0.36	2.22	0.23	–0.014	0.006	0.476	0.050	–0.007	0.015	8.4	7.6	22.1	4.1	–55	47

Table 5-16. Radiochemical Analyses of Groundwater for 1997 (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	
Perched Groundwater System in Volcanics:																							
Water Canyon Gallery	12/01	1	UF	38	670	–0.2	1.0	–0.75	0.10	0.19	0.02	–0.025	0.007	–0.017	0.009	0.039	0.029	–0.3	0.2	0.7	1.5	–7	48
Pueblo of San Ildefonso																							
LA-1B	10/06	1	UF	408	680	–0.2	1.0	1.29	0.42	0.00	0.01	–0.020	0.007	–0.014	0.008	–0.046	0.013	4.6	1.0	6.1	0.7	22	48
LA-5	07/07	1	UF	–492	740	–0.2	1.7	–0.63	0.29	1.10	0.11	–0.006	0.009	–0.009	0.007	0.015	0.045	1.2	3.2	2.3	1.7	–8	47
Eastside Artesian Well	10/06	1	UF	248	670	–0.4	1.0	–0.10	0.28	–0.01	0.01	–0.025	0.006	–0.012	0.010	–0.011	0.014	1.0	0.4	0.2	0.1	54	48
Halladay House Well	08/13	1	UF	–292	690	0.8	1.5	–1.21	0.36	1.48	0.15	0.025	0.014	–0.002	0.009	–0.016	0.015	1.2	3.4	0.8	1.5	–60	47
Pajarito Well (Pump 1)	07/08	1	UF	–142	770	0.7	1.9	–0.36	0.69	11.01	1.10	–0.020	0.001	0.001	0.010	–0.006	0.044	1.3	1.4	2.6	1.7	45	47
Don Juan Playhouse Well	10/06	1	UF	778	710	0.3	1.0	–0.31	0.21	6.97	0.70	–0.001	0.009	0.012	0.012	–0.001	0.015	6.5	1.0	2.4	0.3	46	48
Otowi House Well	10/06	1	UF	288	680	0.2	0.9	0.88	0.40	1.41	0.14	–0.001	0.014	0.006	0.014	–0.025	0.016	5.5	1.1	2.2	0.3	12	48
New Community Well	07/07	1	UF	368	800	0.0	1.5	–0.28	0.18	22.49	2.25	–0.012	0.006	0.029	0.013	–0.002	0.018	11.6	4.0	10.3	2.2	16	47
Sanchez House Well	07/08	1	UF	–242	760	–0.3	2.1	–0.28	0.81	13.18	1.32	–0.018	0.006	0.019	0.014	–0.022	0.014	1.7	1.3	6.4	1.9	–34	47
Limits of Detection				700		3		4		0.1		0.04		0.04		0.04		3		3		120	
Water Quality Standards[e]																							
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													

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[a] Except where noted.

[b] Codes: UF–unfiltered, F–filtered, 1–primary analysis, 2–second analysis, R1–lab replicate, D1–lab duplicate.

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

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

[e] Standards given here for comparison only, see Appendix A.

Table 5-17. Detections of Radionuclides in Groundwater for 1997[a]

Station Name	Date	Code[b]		Analyte	Lab Value	Uncertainty	Units	Detection Limit
La Mesita Spring	12/08	1	UF	U	12.13	1.22	µg/L	0.1
LAO-0.7	06/18	1	UF	^{239,240}Pu	0.261	0.038	pCi/L	0.04
LAO-2	08/04	1	UF	Beta	33	4	pCi/L	3
LAO-2	08/04	1	UF	^{90}Sr	15.6	2.5	pCi/L	3
LAO-3A	08/04	1	UF	Beta	83	6	pCi/L	3
LAO-3A	08/04	1	UF	^{90}Sr	34.8	3.5	pCi/L	3
LAO-4	08/04	1	UF	Gamma	283	49	pCi/L	120
LAO-4.5C	08/04	1	UF	Gamma	639	69	pCi/L	120
MCO-3	08/07	1	UF	^{241}Am	14.093	0.697	pCi/L	0.04
MCO-3	08/07	1	UF	Beta	136	22	pCi/L	3
MCO-3	08/07	1	UF	^{3}H	11,428	1,300	pCi/L	700
MCO-3	08/07	1	UF	^{238}Pu	16.202	0.756	pCi/L	0.04
MCO-3	08/07	1	UF	^{239,240}Pu	12.522	0.594	pCi/L	0.04
MCO-3	08/07	1	UF	^{90}Sr	20.2	3.4	pCi/L	3
MCO-4B	08/05	1	UF	^{241}Am	0.591	0.054	pCi/L	0.04
MCO-4B	08/05	1	UF	Beta	131	11	pCi/L	3
MCO-4B	08/05	1	UF	^{137}Cs	7.65	1.14	pCi/L	4
MCO-4B	08/05	1	UF	^{3}H	20,128	1,600	pCi/L	700
MCO-4B	08/05	1	UF	^{90}Sr	38.3	4.3	pCi/L	3
MCO-5	08/05	1	UF	^{241}Am	0.485	0.050	pCi/L	0.04
MCO-5	08/05	1	UF	Beta	131	16	pCi/L	3
MCO-5	08/05	1	UF	^{3}H	17,728	1,500	pCi/L	700
MCO-5	08/05	1	UF	^{90}Sr	32.3	3.2	pCi/L	3
MCO-6	08/05	1	UF	^{241}Am	0.416	0.045	pCi/L	0.04
MCO-6	08/05	1	UF	Beta	133	14	pCi/L	3
MCO-6	08/05	1	UF	^{3}H	18,328	1,500	pCi/L	700
MCO-6	08/05	1	UF	^{90}Sr	32.4	3.5	pCi/L	3
MCO-7A	06/13	1	UF	Beta	49	10	pCi/L	3
MCO-7A	06/13	1	UF	^{3}H	15,928	1,500	pCi/L	700
MCO-7.5	06/13	1	UF	^{241}Am	0.185	0.037	pCi/L	0.04
MCO-7.5	06/13	1	UF	Beta	80	12	pCi/L	3
MCO-7.5	06/13	1	UF	H-3	18,428	1,600	pCi/L	700
Basalt Spring	08/14	1	UF	Beta	22	4	pCi/L	3
Basalt Spring	08/14	1	UF	^{239,240}Pu	0.476	0.050	pCi/L	0.04
Pajarito Well (Pump 1)	07/08	1	UF	U	11.01	1.10	µg/L	0.1
Don Juan Playhouse Well	10/06	1	UF	Alpha	6.5	1.0	pCi/L	3
Don Juan Playhouse Well	10/06	1	UF	U	6.97	0.70	µg/L	0.1
Otowi House Well	10/06	1	UF	Alpha	5.5	1.1	pCi/L	3
New Community Well	07/07	1	UF	U	22.49	2.25	µg/L	0.1
Sanchez House Well	07/08	1	UF	U	13.18	1.32	µg/L	0.1

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[a] Detection defined as sample value–average blank > 4.66* uncertainty and > detection limit, except values shown for uranium > 5 µg/L, for gross alpha > 5 pCi/L, and for gross beta > 20 pCi/L.

[b] Codes: UF–unfiltered, F–filtered, 1–primary analysis, 2–second analysis, R1–lab replicate, D1–lab duplicate.

Table 5-18. Possible Detections of Radionuclides in Groundwater for 1997[a]

Station Name	Date	Code[b]		Analyte	Lab Value	Uncertainty	Units	Detection Limit
G-1	12/08	1	UF	^{90}Sr	5.19	1.39	pCi/L	3
La Mesita Spring	12/08	1	UF	Alpha	12.8	3.0	pCi/L	3
CDBO-7	06/16	1	UF	Alpha	50.4	20.5	pCi/L	3
CDBO-7	06/16	1	UF	^{90}Sr	5.22	1.75	pCi/L	3
CDBO-7	06/16	1	UF	Beta	57.1	21.2	pCi/L	3
LAO-1	06/18	1	UF	^{90}Sr	7.1	1.82	pCi/L	3
LAO-1	06/18	1	UF	^{239,240}Pu	0.105	0.024	pCi/L	0.04
LAO-4	08/04	1	UF	^{90}Sr	4.44	1.42	pCi/L	3
MCO-3	08/07	1	UF	Gamma	140	48	pCi/L	120
MCO-5	08/05	1	UF	^{239,240}Pu	0.076	0.021	pCi/L	0.04
MCO-7.5	06/13	1	UF	Alpha	26.5	10.4	pCi/L	3
New Community Well	07/07	1	UF	Alpha	11.6	4.0	pCi/L	3
DI Blank	06/17	1	UF	^{239,240}Pu	0.079	0.025	pCi/L	0.04
DI Blank	06/17	1	UF	^{238}Pu	0.065	0.024	pCi/L	0.04
DI Blank	05/15	1	UF	^{241}Am	0.101	0.025	pCi/L	0.04
DI Blank	07/09	1	UF	^{241}Am	0.109	0.025	pCi/L	0.04
DI Blank	12/10	1	UF	^{241}Am	0.082	0.022	pCi/L	0.04

[a] Possible detection defined as 2.33 × uncertainty ≤ sample value-average blank ≤ 4.66 × uncertainty and sample value-average blank > detection limit, except values shown for uranium > 5 µg/L, for gross alpha > 5 pCi/L, and for gross beta > 20 pCi/L.

[b] Codes: UF–unfiltered, F–filtered, 1–primary analysis, 2–second analysis, R1–lab replicate, D1–lab duplicate.

Table 5-19. Radionuclides near Department of Energy Derived Concentration Guides in Groundwater for 1997[a]

Station Name	Date	Code	Analyte	Lab Value	Uncertainty	Units	DOE DCG	Ratio of Value to DCG	Minimum Standard	Detect or Possible Detection[b]
CDBO-7	06/16	1 UF	Alpha	50.4	20.5	pCi/L	30	1.68	15	Possible Detect
CDBO-7	06/16	1 UF	Beta	57.1	21.2	pCi/L	1,000	0.06	50	Possible Detect
LAO-3A	08/04	1 UF	Beta	83.0	6.0	pCi/L	1,000	0.08	50	Detect
MCO-3	08/07	1 UF	^{241}Am	14.093	0.697	pCi/L	30	0.47	1.2	Detect
MCO-3	08/07	1 UF	Beta	136.0	22.0	pCi/L	1,000	0.14	50	Detect
MCO-3	08/07	1 UF	^{238}Pu	16.202	0.756	pCi/L	40	0.41	1.6	Detect
MCO-3	08/07	1 UF	^{239,240}Pu	12.522	0.594	pCi/L	30	0.42	1.2	Detect
MCO-4B	08/05	1 UF	Beta	131.0	11.0	pCi/L	1,000	0.13	50	Detect
MCO-5	08/05	1 UF	Beta	131.0	16.0	pCi/L	1,000	0.13	50	Detect
MCO-6	08/05	1 UF	Beta	132.9	13.8	pCi/L	1,000	0.13	50	Detect
MCO-7.5	06/13	1 UF	Alpha	26.5	10.4	pCi/L	30	0.88	15	Possible Detect
MCO-7.5	06/13	1 UF	Beta	80.5	12.0	pCi/L	1,000	0.08	50	Detect

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[a] Values shown are greater than 1/25 of the DOE public dose DCG and greater than the minimum standard shown. The minimum standard is either a DOE DCG for DOE-administered drinking water systems or an EPA drinking water standard.

[b] Detection or possible detection determined according to criteria described in text.

Table 5-20. Tritium Data for Regional Aquifer Test Wells at Technical Area 49

Station	Date	TU[a]	ΔTU[b]	pCi/L	ΔpCi/L
DT-10	05/20/93	0.41	0.09	1.31	0.29
DT-10	05/30/95	0.99	0.09	3.16	0.29
DT-10	09/19/96	0.25	0.09	0.80	0.29
DT-10	12/05/96	0.01	0.09	0.03	0.29
DT-10	05/13/97	0.10	0.09	0.32	0.29
DT-10	10/16/97	–0.02[c]	0.09	–0.06	0.29
Mean		0.29	0.09	0.93	0.29
DT-5A	10/23/91	–0.07	0.09	–0.22	0.29
DT-5A	05/20/93	0.07	0.09	0.22	0.29
DT-5A	11/27/96	0.08	0.09	0.26	0.29
DT-5A	03/07/97	0.15	0.09	0.48	0.29
DT-5A	10/16/97	–0.08	0.09	–0.26	0.29
Mean		0.03	0.09	0.10	0.29
DT-9	05/20/93	0.14	0.09	0.45	0.29
DT-9	05/31/95	0.47	0.09	1.50	0.29
DT-9	09/18/96	0.09	0.09	0.29	0.29
DT-9	12/05/96	0.02	0.09	0.06	0.29
DT-9	05/13/97	0.12	0.09	0.38	0.29
DT-9	10/15/97	0.04	0.09	0.13	0.29
Mean		0.15	0.09	0.47	0.29

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

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

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

Table 5-21. Chemical Quality of Groundwater for 1997 (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)
Regional Aquifer Wells																				
Test Wells:																				
Test Well 1	08/11	1 UF	44	43.3	9.0	2.4	15.2	31.8	21.0	<5[f]	110	0.45	<0.02	5.52	<0.01	253		145	8.0	405
Test Well 2	12/11	1 UF	6	7.4	1.9	1.6	20.7	3.8	1.4	<5	89	0.45	0.02	<0.02	<0.01	64	<1	26	7.9	139
Test Well 3	08/11	1 UF	80	14.9	4.8	1.3	10.5	4.6	4.0	<5	84	0.48	<0.02	0.69	<0.01	159		57	7.6	173
Test Well 4	08/11	1 UF	36	9.9	5.4	1.5	9.4	3.6	2.0	<5	72	0.25	<0.02	0.16	<0.01	108		47	8.1	144
Test Well DT-5A	03/07	1 UF	73	7.2	2.2	1.0	9.8	3.5	3.0	<5	52	0.22	<0.02	0.33	<0.01	130	<1	27	7.9	113
Test Well DT-5A	03/07	R1 UF		7.2	2.2	1.2	9.8	3.6	2.8		53		<0.02	0.34	<0.01	144		27		
Test Well DT-5A	05/13	1 UF	48	7.0	2.2	<1.0	10.2	4.0	3.0	<5	47	0.24	<0.02	<0.02	<0.01	100	2	26	7.9	102
Test Well DT-5A	10/16	1 UF	67	6.6	1.9	1.6	8.5	2.7	2.7	<5	59	0.22	<0.02	0.12	0.01	162	<1	25	8.0	110
Test Well DT-9	05/13	1 UF	72	9.1	2.6	<1.0	10.0	4.1	3.3	<5	56	0.31	0.05	0.37	<0.01	142	1	34	8.2	115
Test Well DT-9	10/15	1 UF	77	11.8	3.4	<1.0	10.3	2.7	2.7	<5	53	0.29	<0.02	0.37	0.01	175	<1	44	7.6	116
Test Well DT-10	05/14	1 UF	72	8.6	2.5	<1.0	9.3	4.0	3.0	<5	53	0.31	0.02	0.41	<0.01	108	3	32	8.2	115
Test Well DT-10	10/16	1 UF	70	11.3	3.5	1.3	11.1	2.7	2.6	<5	64	0.26	<0.02	0.23	0.01	176	<1	43	7.4	131
Water Supply Wells:																				
O-1	01/08	1 UF	38	3.5	0.8	<1.0	63.8	6.0	6.0	5	144	0.35			<0.01	224	17	12	8.7	285
O-1	01/08	R1 UF	39	3.0	0.3	<1.0	63.9					0.37			<0.01	218	19	9		
O-4	06/25	1 UF	97	21.4	8.1	3.8	19.5	8.1	6.2	<5	113	0.30	0.08	0.72	<0.01	190		87	7.9	256
PM-1	06/25	1 UF	79	26.3	6.4	3.9	19.7	8.8	9.0	<5	<5	0.23	0.04	0.48	<0.01	280		92	1.7	12,000
PM-2	06/25	1 UF	83	9.0	2.7	1.5	9.4	3.4	2.8	<5	49	0.22	0.05	0.32	<0.01	84		34	8.0	111
PM-3	06/25	1 UF	92	23.9	7.7	3.6	16.9	7.5	5.9	<5	116	0.34	0.04	0.45	<0.01	138		91	8.3	254
PM-4	06/25	1 UF	90	11.4	3.9	2.9	12.5	3.9	3.5	<5	66	0.29	0.06	0.34	<0.01	72		45	8.1	143
PM-5	06/25	1 UF	94	11.1	3.6	2.7	12.5	3.6	3.1	<5	61	0.26	0.04	0.35	<0.01	64		42	8.1	131
G-1	12/08	1 UF	79	12.5	0.5	2.5	20.9	3.6	4.4	<5	74	0.40	<0.02	0.48	<0.01	136	<1	33	7.3	164
G-1A	06/25	1 UF	75	9.9	0.4	2.9	30.8	4.8	5.3	<5	84	0.63	0.04	0.45	<0.01	74		27	8.5	188
G-2	06/25	1 UF	76	10.3	0.5	3.0	34.0	4.2	4.9	<5	92	0.81	0.02	0.46	<0.01	150		28	8.5	205
G-4	06/25	1 UF	63	18.2	3.7	2.3	11.5	4.2	4.4	<5	76	0.28	<0.02	0.63	<0.01	84		61	8.3	168
G-5	06/25	1 UF	63	17.2	3.7	2.9	11.3	4.2	4.5	<5	75	0.31	<0.02	0.64	<0.01	86		58	8.3	164
G-6	06/25	1 UF	62	17.5	2.9	2.7	14.8	4.0	4.2	<5	68	0.27	<0.02	0.47	<0.01	110		56	8.3	162

Table 5-21. Chemical Quality of Groundwater for 1997 (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)
Regional Aquifer Springs																				
White Rock Canyon Group I:																				
Sandia Spring	08/19	1 UF	49	27.6	1.7	2.1	16.3	4.5	5.7	<5	108	0.63	<0.02	0.11	<0.01	316	<1	76	7.7	229
Spring 3	11/18	1 F	53	22.2	1.8	<1.0	15.1	5.5	6.0	<5	85	0.45	<0.02	1.35	<0.01	132		63	7.9	199
Spring 3	11/18	1 UF															1			
Spring 3AA	11/18	1 F	44	16.9	0.3	1.6	14.3	4.1	4.0	<5	82	0.44	<0.02	0.61	<0.01	60		43	8.2	167
Spring 3AA	11/18	1 UF															121			
Spring 4A	11/18	1 F	70	21.2	4.5	<1.0	11.1	6.2	6.0	<5	81	0.53	<0.02	1.01	<0.01	170		71	8.1	193
Spring 4A	11/18	1 UF															1			
Spring 5	09/29	1 F	73	16.4	4.3	1.8	11.2	5.3	6.0	<5	76	0.42	<0.02	0.77	0.01	178		59	8.4	176
Spring 5	09/29	1 UF															5			
Ancho Spring	11/19	1 F	77	12.1	2.8	<1.4	9.2	3.9	3.0	<5	57	0.30	0.10	0.40	<0.01	162		42	7.8	130
Ancho Spring	11/19	1 UF															5			
White Rock Canyon Group II:																				
Spring 6A	09/29	1 F	77	11.3	3.3	1.5	9.8	3.4	3.8	<5	63	0.35	0.02	1.76	0.01	164		42	7.8	141
Spring 6A	09/29	1 UF															3			
Spring 7	09/29	1 F	81	15.8	3.4	2.4	18.8	3.8	7.7	<5	98	0.38	<0.02	0.46	0.01	212		53	7.6	691
Spring 7	09/29	1 F	81	16.1	3.3	2.4	18.6	3.9	7.8	<5	85	0.38	0.06	0.48	0.01	183		54	7.9	197
Spring 7	09/29	1 UF															59			
Spring 7	09/29	1 UF															39			
Spring 8B	09/30	1 F	89	10.9	3.0	1.8	11.7	3.2	4.0	<5	63	0.43	0.03	0.02	0.01	158		39	8.2	139
Spring 8B	09/30	1 UF															<1			
Spring 9	09/30	1 F	80	9.5	2.7	1.3	10.9	3.3	3.5	<5	61	0.44	<0.02	0.12	0.01	151		35	8.2	444
Spring 9	09/30	1 UF															18			
White Rock Canyon Group III:																				
Spring 1	08/19	1 UF	34	14.4	1.0	2.0	29.7	4.4	8.2	<5	98	0.53	<0.02	0.41	<0.01	54	3	40	8.1	224
Spring 2	08/19	1 UF	33	13.0	0.6	1.3	35.8	4.3	5.6	<5	104	0.59	<0.02	0.04	<0.01	1,214	<1	35	8.2	229
White Rock Canyon Group IV:																				
La Mesita Spring	12/08	1 F	30	35.8	0.9	2.3	26.3	7.4	13.6	5	123	0.22	0.11	1.96	<0.01	204		93	8.2	313
La Mesita Spring	12/08	1 UF															222			
Other Springs:																				
Sacred Spring	07/08	1 UF	28	20.2	0.5	<1.0	21.0	3.5	5.9	<5	101	0.50	0.03	0.39	<0.01	182		52	7.5	213

Table 5-21. Chemical Quality of Groundwater for 1997 (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)
Canyon Alluvial Groundwater Systems																					
Acid/Pueblo Canyons:																					
APCO-1	12/10	1	UF	76	22.7	5.9	13.3	60.5	42.3	22.3	6	93	0.98	4.14	6.29	<0.01	376	8	81	7.1	556
Cañada del Buey:																					
CDBO-6	06/16	1	UF	60	16.5	4.2	3.2	19.9	11.6	8.8	<5	61	0.15	0.45	0.08	<0.01	322	660	59	7.2	186
CDBO-6	06/16	1	UF												0.12						
CDBO-6	09/13	1	UF												0.11						
CDBO-6	12/03	1	UF												0.23						
CDBO-7	06/16	1	UF	69	17.9	4.1	3.1	20.9	8.7	7.4	<5	81	0.12	0.32	0.02	<0.01	220	742	62	7.3	195
CDBO-7	06/16	1	UF												0.04						
CDBO-7	09/13	1	UF												0.11						
CDBO-7	12/03	1	UF												0.10						
DP/Los Alamos Canyons:																					
LAO-C	06/17	1	UF	37	11.3	2.8	3.4	23.6	26.6	6.1	<5	41	0.10	0.10	0.05	<0.01	170	<1	40	7.4	194
LAO-0.7	06/18	1	UF	36	12.6	2.6	3.7	31.0	38.1	6.6	<5	37	0.17	0.09	0.08	<0.01	182	14	42	7.0	237
LAO-1	06/18	1	UF	38	11.9	2.5	3.1	32.4	37.5	6.7	<5	44	0.25	0.08	0.04	<0.01	182	2	40	7.1	242
LAO-2	08/04	1	UF	61	21.2	6.1	4.5	31.5	32.0	10.0	<5	104	0.59	0.10	0.46	<0.01	186		78	7.1	340
LAO-3A	08/04	1	UF	55	17.7	3.9	6.0	30.0	24.0	14.0	<5	93	0.88	<0.02	0.66	<0.01	223		60	7.4	303
LAO-4	08/04	1	UF	45	14.1	4.1	4.4	27.4	26.0	10.0	<5	80	0.64	<0.02	0.03	<0.01	168		52	6.9	269
LAO-4.5C	08/04	1	UF	43	12.2	3.9	3.6	27.6	32.0	9.0	<5	67	0.72	0.10	0.03	<0.01	167		46	7.0	260
LAO-6A	08/04	1	UF	46	13.0	4.4	2.6	29.6	40.0	9.0	<5	66	0.47	<0.02	0.07	<0.01	202		50	6.9	279
Mortandad Canyon:																					
MCO-3	08/07	1	UF	46	22.1	2.8	7.9	40.0	8.0	12.0	<5	105	1.08	0.22	3.86	<0.01	274		67	7.5	288
MCO-4B	08/05	1	UF	34	27.3	2.5	14.3	79.1	19.5	14.0	<5	172	1.49	<0.02	19.10	<0.01	429		78	7.4	583
MCO-5	08/05	1	UF	35	26.6	2.8	15.4	75.3	20.1	15.0	<5	167	1.54	0.02	19.90	<0.01	441		78	7.4	584
MCO-6	08/05	1	UF	36	29.4	3.1	18.8	83.6	22.0	15.0	<5	184	1.69	0.06	23.50	<0.01	443		86	7.3	641
MCO-7A	06/13	1	UF	37	24.8	6.1	19.9	89.7	19.5	19.2	<5	165	1.74	0.34	22.00	<0.01	412	2	87	7.3	599
MCO-7.5	06/13	1	UF	40	25.6	6.2	13.7	99.9	18.2	19.0	<5	166	1.71	0.08	24.10	<0.01	460	4	89	7.8	619
Pajarito Canyon:																					
PCO-1	06/16	1	UF	38	16.5	4.6	3.9	26.1	26.1	12.4	<5	61	0.14	0.05	0.17	<0.01	212	2	60	7.2	237

Table 5-21. Chemical Quality of Groundwater for 1997 (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)
Intermediate Perched Groundwater Systems																				
Pueblo/Los Alamos Canyon Area:																				
Test Well 1A	08/11	1 UF	1	11.0	3.2	3.6	40.4	66.6	5.0	<5	50	0.98	0.42	<0.02	<0.01	196		40	8.8	330
Test Well 2A	12/11	1 UF	16	2.1	0.4	<1.0	1.1	45.8	10.9	<5	82	0.19	0.07	<0.02	<0.01	196	<1	7	8.0	337
Basalt Spring	08/14	1 UF	65	16.0	4.0	8.1	44.6	27.7	22.0	<5	92	0.47	<0.02	2.36	<0.01	306	<1	57	7.3	353
Perched Groundwater System in Volcanics:																				
Water Canyon Gallery	12/01	1 UF	47	6.7	3.1	<1.0	5.4	3.4	2.0	<5	43	0.06	<0.02	0.24	<0.01	70	<1	30	7.6	89
Pueblo of San Ildefonso:																				
LA-1B	10/06	1 UF	2	2.3	<0.1	1.6	134.7	23.4	29.2	50	278	3.24	<0.02	0.05	0.01	354		6	9.5	650
LA-5	07/07	1 UF	42	18.6	0.8	1.1	14.4	4.2	6.2	<5	79	0.35	<0.02	0.60	<0.01	162		50	8.3	175
Eastside Artesian Well	10/06	1 UF	1	3.0	0.1	<1.0	83.6	4.6	18.4	27	191	0.81	<0.02	0.02	0.01	228		8	9.5	405
Halladay House Well	08/13	1 UF	28	4.0	<0.1	<1.0	42.6	5.4	13.1	<5	88	0.56	<0.02	0.54	<0.01	160	<1	10	8.9	201
Pajarito Well (Pump 1)	07/08	1 UF	39	53.3	5.6	3.2	306.1	197.0	51.5	<5	554	0.34	<0.02	0.22	<0.01	1,082		156	7.7	1,710
Don Juan Playhouse Well	10/06	1 UF	24	6.4	0.4	<1.0	62.5	4.5	17.8	12	122	0.60	<0.02	2.06	0.01	184		18	8.8	325
Otowi House Well	10/06	1 UF	62	77.2	5.6	2.7	40.4	56.3	33.5	<5	204	0.37	<0.02	1.20	0.01	344		216	7.1	607
New Community Well	07/07	1 UF	27	15.3	1.0	<1.0	74.7	8.8	33.6	<5	166	0.14	<0.02	1.47	<0.01	296		42	8.4	437
Sanchez House Well	07/08	1 UF	42	31.6	2.3	<1.0	97.4	52.5	47.5	<5	194	1.18	0.02	1.76	<0.01	440		88	7.9	636
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	

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[a] Except where noted.

[b] Codes: UF–unfiltered, F–filtered, 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 specified limit of detection of the analytical method.

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

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Aquifer Wells															
Test Wells:															
Test Well 1	08/11	1	UF	<10[b]	243	<2	51	84	<3	<7	<8	<7	11	1,340	<0.2
Test Well 2	12/11	1	UF	<10	96	<2	<20	16	<3	<7	<8	<7	<10	4,783	<0.2
Test Well 3	08/11	1	UF	<10	107	2	41	28	<3	<7	<8	<7	15	708	<0.2
Test Well 4	08/11	1	UF	<10	163	<2	<20	79	<3	<7	<8	12	73	9,120	<0.2
Test Well DT-5A	03/07	1	UF	<10	<50	<5	<20	21	<3	<7	<8	<7	13	293	<0.4
Test Well DT-5A	03/07	R1	UF	<10	<50	<4	<20	21	<3	<7	<8	<7	13	67	<0.4
Test Well DT-5A	05/13	1	UF	<10	103	<2	21	16	<3	<7	<8	<7	<10	1,437	<0.3
Test Well DT-5A	10/16	1	UF	<10	<50	<6	26	16	<3	<7	<8	<7	<10	52	<0.2
Test Well DT-9	05/13	1	UF	<10	<50	<2	<20	15	<3	<7	<8	<7	<10	206	<0.3
Test Well DT-9	10/15	1	UF	<10	<50	<6	<20	6	<3	<7	<8	<7	<10	207	<0.2
Test Well DT-10	05/14	1	UF	<10	<50	<2	<20	14	<3	<7	<8	<7	<10	55	<0.3
Test Well DT-10	10/16	1	UF	<10	<50	<2	34	8	<3	<7	<8	<7	<10	502	<0.2
Water Supply Wells:															
O-1	01/08	1	UF	<10	1,000	6	71	34	<3	<7	<8	16	<10	4,483	<0.3
O-1	01/08	R1	UF	<10	<500	6	71	30	<3	<7	<8	15	<10	4,104	<0.3
O-4	06/25	1	UF	<10	61	<2	55	48	<3	<7	<8	<8	<10	<40	<0.2
PM-1	06/25	1	UF	<10	101	<2	63	78	<3	<7	<8	<7	<10	<40	<0.2
PM-2	06/25	1	UF	<10	<50	<2	<20	32	<3	<7	<8	10	313	7,418	<0.2
PM-3	06/25	1	UF	11	131	2	47	53	<3	<7	<8	<7	<10	57	<0.2
PM-4	06/25	1	UF	<10	<50	2	<20	31	<3	<7	<8	7	<10	<40	<0.2
PM-5	06/25	1	UF	<10	359	<2	46	33	<3	<7	<10	28	<10	252	<0.2
G-1A	06/25	1	UF	<10	<50	14	32	40	<3	<7	<8	9	<10	<40	<0.2
G-2	06/25	1	UF	<10	<50	35	36	68	<3	<7	<8	10	<10	<40	<0.2
G-4	06/25	1	UF	<10	<50	2	<33	20	<3	<7	<8	<7	<10	<40	<0.2
G-5	06/25	1	UF	<10	<50	2	<20	15	<3	<7	<8	<7	<10	<40	<0.2
G-6	06/25	1	UF	<10	59	3	<34	14	<3	<7	<8	<7	<10	58	<0.2
Regional Aquifer Springs															
White Rock Canyon Group I:															
Sandia Spring	08/19	1	UF	<10	137	<6	50	91	<3	<7	<8	<7	<10	170	<0.2
Spring 5	09/29	1	F	113	<50	<2	29	45	<3	<7	<11	<7	<10	<40	

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Regional Aquifer Springs (Cont.)															
White Rock Canyon Group II:															
Spring 6A	09/29	1	F	<10	<50	<2	26	25	<3	<9	<8	<7	<10	<40	
Spring 7	09/29	1	F	<10	<50	<2	32	51	<3	<7	<8	<7	<10	<40	
Spring 7	09/29	1	F	174	<50	<2	35	40	<3	<7	<8	<7	<10	40	
Spring 8B	09/30	1	F	<10	<50	<2	29	25	<3	<7	<8	<7	<10	<40	
Spring 9	09/30	1	F	<10	<50	<2	30	16	<3	<7	<8	<7	<10	<40	
White Rock Canyon Group III:															
Spring 1	08/19	1	UF	<10	<50	<6	46	22	<3	<7	<8	<7	<10	<40	<0.2
Spring 2	08/19	1	UF	<10	<50	<6	51	20	<3	<7	<8	<7	<10	<40	<0.2
White Rock Canyon Group IV:															
La Mesita Spring	12/08	1	F	<10	<50		80	127	<3	<7	<20	<7	<10	112	
Other Springs:															
Sacred Spring	07/08	1	UF	<10	<50	<2	42	96	<3	<7	<8	<7	<10	104	<0.2
Canyon Alluvial Groundwater Systems															
Acid/Pueblo Canyons:															
APCO-1	12/10	1	UF	<10	832	7	233	19	<3	<7	<8	<7	<10	579	<0.2
Cañada del Buey:															
CDBO-6	06/16	1	UF	<10	8,157	2	38	134	<3	<7	<8	<7	<10	4,571	<0.2
CDBO-7	06/16	1	UF	<10	5,432	2	41	182	<3	<7	<8	<7	<10	2,377	<0.2
DP/Los Alamos Canyons:															
LAO-C	06/17	1	UF	<10	1,896	<2	<20	45	<3	<7	<8	<7	<10	838	<0.2
LAO-0.7	06/18	1	UF	<10	3,466	2	<20	58	<3	<7	<8	<7	<10	1,478	<0.2
LAO-1	06/18	1	UF	<10	2,272	2	<28	36	<3	<7	<8	11	<10	964	<0.2
LAO-2	08/04	1	UF	<10	356	<2	42	56	<3	<7	<8	<7	<10	179	<0.2
LAO-3A	08/04	1	UF	<10	444	<2	34	56	<3	<7	<8	<7	<10	177	<0.2
LAO-4	08/04	1	UF	<10	292	<3	27	52	<3	<7	<8	<7	<10	119	<0.2
LAO-4.5C	08/04	1	UF	<10	386	<2	26	42	<3	<7	<8	<7	<10	193	<0.2
LAO-6A	08/04	1	UF	<10	228	<2	38	36	<3	<7	<8	<7	<10	100	<0.2

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Canyon Alluvial Groundwater Systems (Cont.)															
Mortandad Canyon:															
MCO-3	08/07	1	UF	<10	14,662	2	88	81	<3	<7	<8	19	44	8,471	<0.2
MCO-4B	08/05	1	UF	<10	423	<2	62	85	<3	<7	<8	<7	14	234	<0.2
MCO-5	08/05	1	UF	<10	248	<2	57	91	<3	<7	<8	<7	11	98	<0.2
MCO-6	08/05	1	UF	<10	76	<2	62	99	<3	<7	<8	<7	11	<40	<0.2
MCO-7A	06/13	1	UF	<10	399	<2	76	221	<3	<7	<8	<7	<10	219	<0.2
MCO-7.5	06/13	1	UF	<10	183	<2	78	209	<3	<7	<8	<7	<10	104	<0.2
Pajarito Canyon:															
PCO-1	06/16	1	UF	<10	990	<2	34	93	<3	<11	<8	<7	<10	501	<0.2
Intermediate Perched Groundwater Systems															
Pueblo/Los Alamos Canyon Area:															
Test Well 1A	08/11	1	UF	<10	<50	<2	140	68	<3	<7	<8	<7	10	3,032	<0.2
Test Well 2A	12/11	1	UF	<10	<50	<2	<20	2	<3	<7	<8	<7	<10	54	<0.2
Basalt Spring	08/14	1	UF	<10	<50	<6	186	61	<3	<7	<8	<7	<10	42	<0.2
Perched Groundwater System in Volcanics:															
Water Canyon Gallery	12/01	1	UF	<10	100	<6	<20	11	<3	<7	<8	<7	<10	51	<0.2
Pueblo of San Ildefonso:															
LA-1B	10/06	1	UF	<10	<50	7	272	23	<3	<7	<8	<7	<10	103	<0.2
LA-5	07/07	1	UF	<10	<50	<2	<20	65	<3	<7	<8	<7	<10	119	<0.2
Eastside Artesian Well	10/06	1	UF	<10	<50	<2	152	2	<3	<7	<8	<7	<10	107	0.2
Halladay House Well	08/13	1	UF	105	63	6	67	41	<3	<7	<8	10	<10	148	<0.2
Pajarito Well (Pump 1)	07/08	1	UF	<10	<50	5	1,388	94	<3	<7	<8	<7	<11	188	<0.2
Don Juan Playhouse Well	10/06	1	UF	<10	<50	6	98	2	<3	<7	<8	9	<10	<40	<0.2
Otowi House Well	10/06	1	UF	<10	<50	<2	99	336	<3	<7	<8	<7	12	<40	<0.2
New Community Well	07/07	1	UF	<10	<50	<2	39	16	<3	<7	<8	<7	<10	<40	<0.2
Sanchez House Well	07/08	1	UF	<10	<50	10	244	111	<3	<7	<8	<7	15	<40	<0.2

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
Water Quality Standards[c]														
EPA Primary Drinking Water Standard					50		2,000	4	5		100			2
EPA Secondary Drinking Water Standard				50–200									300	
EPA Action Level												1,300		
EPA Health Advisory														
NMWQCC Livestock Watering Standard				5,000	200	5,000			50	1,000	1,000	500		10
NMWQCC Groundwater Limit			50	5,000	100	750	1,000		10	50	50	1,000	1,000	2

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[a] Codes: UF–unfiltered, F–filtered, 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 Livestock Watering 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 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Aquifer Wells													
Test Wells:													
Test Well 1	08/11	1 UF	63	<30	<20	88	9	<3	<50	269	<3	<8	1,167
Test Well 2	12/11	1 UF	83	<30	<20	45	<3	<2		35	<3	<8	1,111
Test Well 3	08/11	1 UF	23	<30	<20	15	<6	<3	<30	71	<3	10	126
Test Well 4	08/11	1 UF	81	<30	<20	101	<6	<3	53	53	<3	<8	2,825
Test Well DT-5A	03/07	1 UF	<2	<30	30	4	<3	<2	37	41	<3	14	193
Test Well DT-5A	03/07	R1 UF	<2	<30	<20	<3	<3	<2	<30	42	<3	12	191
Test Well DT-5A	05/13	1 UF	55	<30	<20	4	4	<3	<31	38	<3	<8	573
Test Well DT-5A	10/16	1 UF	<2	<30	<20	<3	<3	<3	38	36	<3	12	1,537
Test Well DT-9	05/13	1 UF	<2	<30	<20	5	<3	<3	<32	47	<3	<8	204
Test Well DT-9	10/15	1 UF	4	<30	<20	3	<3	<3	<37	49	<3	<8	93
Test Well DT-10	05/14	1 UF	<2	<30	<20	3	<3	<3	<30	44	<3	<8	188
Test Well DT-10	10/16	1 UF	5	<30	<20	3	<3	<3	<30	49	<3	<8	99
Water Supply Wells:													
O-1	01/08	1 UF	300	<30	<20	3	<3	14	<30	26	<3	37	172
O-1	01/08	R1 UF	277	<30	<20	<3	<3	5	<30	24	<3	43	135
O-4	06/25	1 UF	<2	<30	<20	3	<3	<3	<30	112	<3	14	76
PM-1	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	142	<3	11	<50
PM-2	06/25	1 UF	25	<30	<20	19	<3	<3	<43	40	<3	<8	173
PM-3	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	123	<3	<14	<50
PM-4	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	53	<3	<12	<50
PM-5	06/25	1 UF	<2	<34	<29	4	<3	<3	<30	47	<3	<8	<50
G-1A	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	74	<3	42	<50
G-2	06/25	1 UF	<2	<30	<20	<3	<3	<3	<65	80	<3	71	<50
G-4	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	102	<3	15	<50
G-5	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	80	<3	15	<50
G-6	06/25	1 UF	<2	<30	<20	<3	<3	<3	<30	79	<3	15	<50
Regional Aquifer Springs													
White Rock Canyon Group I:													
Sandia Spring	08/19	1 UF	38	<30	<20	<3	<3	<4	<30	313	<3	<8	<50
Spring 5	09/29	1 F	2	<30	<20	<3	<3		<30	87	<3	<11	<50

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Regional Aquifer Springs (Cont.)														
White Rock Canyon Group II:														
Spring 6A	09/29	1	F	2	<30	<20	<3	<3		<52	58	<3	<8	<50
Spring 7	09/29	1	F	12	<30	<20	<3	<3		<30	100	<3	<8	<50
Spring 7	09/29	1	F	12	<30	<20	<3	<3		<77	104	<3	<8	<50
Spring 8B	09/30	1	F	7	<30	<44	<3	<3		<40	55	<3	<8	<50
Spring 9	09/30	1	F	<2	<30	<20	<3	<3		<113	49	<3	<8	<50
White Rock Canyon Group III:														
Spring 1	08/19	1	UF	<2	<30	<20	<3	<3	<4	<41	203	<3	12	<50
Spring 2	08/19	1	UF	4	<30	<20	<3	<3	<4	<30	175	<3	<8	<50
White Rock Canyon Group IV:														
La Mesita Spring	12/08	1	F	<2	<30	<20				<30	817		9	<50
Other Springs:														
Sacred Spring	07/08	1	UF	17	<30	<20	<3	<5	<3	<30	465	<3	<8	<50
Canyon Alluvial Groundwater Systems														
Acid/Pueblo Canyons:														
APCO-1	12/10	1	UF	37	<30	<20	<3	<3	<4	<30	101	<3	10	<50
Cañada del Buey:														
CDBO-6	06/16	1	UF	64	<30	<23	8	<3	<3	<30	111	<3	<8	<50
CDBO-7	06/16	1	UF	123	<30	<20	5	<3	<3	<30	122	<3	<8	<50
DP/Los Alamos Canyons:														
LAO-C	06/17	1	UF	<8	<30	<20	<3	<3	<3	<30	76	<3	<8	<50
LAO-0.7	06/18	1	UF	406	<30	<20	3	<3	<3	<30	89	<3	<8	<50
LAO-1	06/18	1	UF	9	<33	<20	<3	<3	<3	<30	85	<3	<8	<50
LAO-2	08/04	1	UF	2	624	<20	<3	3	<3	32	153	<3	<8	<50
LAO-3A	08/04	1	UF	2	643	<20	<3	<3	<3	<102	121	<3	<8	<50
LAO-4	08/04	1	UF	<2	174	<20	<3	<3	<3	35	106	<3	<8	<50
LAO-4.5C	08/04	1	UF	<2	<30	<20	<3	4	<3	<44	92	<3	<8	<50
LAO-6A	08/04	1	UF	<2	<30	<20	<3	<3	<3	40	105	<3	<8	<50

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]		Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
Canyon Alluvial Groundwater Systems (Cont.)														
Mortandad Canyon:														
MCO-3	08/07	1	UF	408	224	<20	9	<5	<3	47	55	<3	14	82
MCO-4B	08/05	1	UF	6	183	<20	<3	<6	<3	<30	114	<3	<8	<50
MCO-5	08/05	1	UF	<2	161	<20	<3	7	<3	<30	126	<3	<8	<50
MCO-6	08/05	1	UF	<2	172	<39	<3	<6	<3	<30	140	<3	<8	<50
MCO-7A	06/13	1	UF	<5	109	<26	<3	<3	<3	<30	165	<3	<8	<50
MCO-7.5	06/13	1	UF	<9	60	<20	<3	<3	<3	<30	165	<3	<8	<50
Pajarito Canyon:														
PCO-1	06/16	1	UF	8	<30	<20	<3	6	<3	<30	117	<3	<8	<50
Intermediate Perched Groundwater Systems														
Pueblo/Los Alamos Canyon Area:														
Test Well 1A	08/11	1	UF	70	<30	<20	5	<6	<3	<45	87	<3	<8	8,136
Test Well 2A	12/11	1	UF	6	<30	<20	<3	<3	<2	11	<3	<8	229	
Basalt Spring	08/14	1	UF	<2	<30	<34	<3	<3	<4	<30	98	<3	<8	<50
Perched Groundwater System in Volcanics:														
Water Canyon Gallery	12/01	1	UF	<2	<30	<20	<3	<3	<3	<30	49	<3	<8	<50
Pueblo of San Ildefonso:														
LA-1B	10/06	1	UF	12	<30	<33	<3	<3	<3	<30	64	<3	<8	<50
LA-5	07/07	1	UF	4	<30	<20	<3	<5	<3	<30	222	<3	12	<50
Eastside Artesian Well	10/06	1	UF	9	<30	<48	<3	<3	<3	<30	54	<3	<8	<50
Halladay House Well	08/13	1	UF	<3	<30	<20	<3	<3	5	<36	128	<3	18	<50
Pajarito Well (Pump 1)	07/08	1	UF	<2	<30	<20	<3	<8	<3	30	1,360	<3	16	<50
Don Juan Playhouse Well	10/06	1	UF	<2	<30	<20	<3	<3	<3	<30	88	<3	18	<50
Otowi House Well	10/06	1	UF	<2	<30	<41	<3	<3	<3	<34	873	<3	<8	251
New Community Well	07/07	1	UF	<2	<30	<20	<3	<5	<3	<30	201	<3	<8	<50
Sanchez House Well	07/08	1	UF	<2	<30	<20	<3	<5	<3	<30	346	<3	14	<50

Table 5-22. Total Recoverable Trace Metals in Groundwater for 1997 (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		50				100	25,000
NMWQCC Groundwater Limit			200	1,000	200	50		50					10,000

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[a] Codes: UF–unfiltered, F–filtered, 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 Livestock Watering 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 5-23. Number of Results above the Analytical Limit of Quantitation for Organic Compounds in Groundwater for 1997

		Type of Organic Compound[a]			
Station Name	**Date**	**Volatile**	**Semivolatile**	**PCB**	**HE**
Number of Compounds Analyzed		66	71	8	13
Test Well 1	08/11	0	0	0	
Test Well 3	08/11	0	0	0	
Test Well 4	08/11	0	0	1	
Test Well DT-5A	03/07	0	0	0	0
Test Well DT-5A	05/13	0	0	0	0
Test Well DT-5A	10/16	0	0	0	0
Test Well DT-9	05/13	0	0	0	0
Test Well DT-9	10/15	0	0	0	0
Test Well DT-10	05/14	0	0	0	0
Test Well DT-10	10/16	0	0	0	0
Spring 3	11/18	0	0	0	
Spring 3AA	11/18	0	0	0	0
Spring 4A	11/18				0
Spring 5	09/29	0	0	0	0
Ancho Spring	11/19				0
Ancho Spring	11/19				0
Spring 6A	09/29	0	0	0	0
Spring 7	09/29	0	0	0	0
Spring 7	09/29	0	0	0	0
Spring 8B	09/30	0	0	0	0
Spring 9	09/30	0	0	0	0
APCO-1	12/10	0	0	0	
CDBO-6	06/16	0	0	0	
CDBO-7	06/16	0	0	0	
LAO-C	06/17	0	0	0	
LAO-0.7	06/18	0	0	0	
LAO-1	06/18	0	0	0	
LAO-2	08/04	0	0	0	
LAO-3A	08/04	0	0	0	
LAO-4	08/04	0	0	0	
LAO-4.5C	08/04	0	0	0	
LAO-6A	08/04	0	0	0	
MCO-3	08/07	0	0	0	
PCO-1	06/16	0	0	0	
Test Well 1A	08/11	0	0	0	
Test Well 2A	12/11	0	0	0	
Basalt Spring	08/14	0	0	0	
Water Canyon Gallery	12/01	0	0	0	

[a] Volatiles, semivolatiles, polychlorinated biphenyls, and high explosives.

Table 5–24. Quality Assurance Sample Results for Radiochemical Analysis in 1997 (pCi/L[a])

Station Name	Date	^{3}H		^{90}Sr		^{137}Cs		U (µg/L)		^{238}Pu		^{239,240}Pu		^{241}Am		Gross Alpha		Gross Beta		Gross Gamma	
DI Blank	05/15	331	196[b]	–0.1[c]	1.0	1.4	0.3	0.03	0.01	0.019	0.011	0.008	0.009	0.101	0.025	1.1	0.3	8.4	1.4	27	47
DI Blank	06/12	–116	264	–0.2	0.9	0.9	1.3	0.06	0.01	0.003	0.010	0.003	0.010	0.020	0.017	0.0	0.0	0.2	0.6	28	48
DI Blank	06/17	240	710	0.6	1.2	1.1	1.6	0.08	0.01	0.065	0.024	0.079	0.025	0.035	0.022	0.2	0.6	0.4	0.9	62	47
DI Blank	06/25	470	710	–1.1	1.2	0.6	0.9	0.08	0.01	0.027	0.017	0.012	0.013	0.032	0.013	–0.1	0.2	0.1	0.4	48	47
DI Blank	07/09	110	770	–0.1	1.4	0.0	0.0	0.00	0.01	0.028	0.011	0.025	0.010	0.109	0.025	0.4	2.0	0.5	1.0	65	47
DI Blank	08/06	550	690	0.2	0.8	1.5	0.4	0.00	0.01					0.039	0.016	–0.1	0.2	–0.2	1.5	70	47
DI Blank	09/29	210	680																		
DI Blank	10/29			–0.3	0.9			0.00	0.01	–0.005	0.009	0.007	0.007	0.004	0.013	0.1	0.1	–0.2	0.7	–26	48
DI Blank	12/10	190	670	0.3	1.0	0.0	0.0	0.00	0.01	0.011	0.020	0.025	0.028	0.082	0.022	–0.1	0.1	0.1	0.2	71	49
DI Blank	12/12	–440	630	–0.4	0.9	1.1	1.7	0.00	0.01	0.007	0.007	0.009	0.008	0.036	0.012	0.1	0.2	–0.3	1.9	86	49
Analytical Detection Limit		700		3.0		4.0		0.10		0.040		0.040		0.040		3.0		3.0		120	
Average of Blank Value		172		–0.1		0.8		0.03		0.019		0.021		0.051		0.2		1.0		48	
Standard Deviation of Blank Value		301		0.5		0.6		0.04		0.022		0.025		0.037		0.4		2.8		34	
Std Dev of Blank/Detection Limit (should be <0.22)		0.43		0.17		0.14		0.36		0.54		0.62		0.93		0.13		0.93		0.28	
Spiked Sample	06/16			5.3	1.6	0.2	0.3	0.03	0.01	0.109	0.024	0.112	0.025	0.077	0.032	0.5	0.7	10.4	2.2	14	47
Spiked Sample	06/25			2.2	1.3	–0.8	0.0	0.03	0.01	0.056	0.029	0.109	0.030	0.039	0.022	0.5	0.9	9.0	2.1	–11	47
Spiked Sample	07/09			4.9	1.7	–0.7	0.2	–0.03	0.01	0.062	0.017	0.130	0.023	0.099	0.031	1.1	1.0	10.6	2.2	–39	47
Spiked Sample	08/12			5.4	1.4	–0.3	0.8	0.22	0.03	0.116	0.026	0.078	0.023	0.119	0.027	0.2	13.1	8.9	2.1	–65	47
Spiked Sample	10/01			8.2	2.5	1.0	2.7	–0.03	0.01	0.118	0.025	0.074	0.022	0.062	0.023	0.4	1.5	9.8	2.2	19	49
Spiked Sample	10/08	168	670	4.3	1.3	–0.2	0.2	0.00	0.01	0.076	0.021	0.123	0.025	0.087	0.028	11.6	1.5	12.3	0.8	1	48
Spiked Sample	11/25	238	720	5.9	1.3	–0.8	0.4	–0.03	0.01	0.122	0.027	0.106	0.025	0.094	0.029	0.8	1.0	11.0	2.0	53	49
Spiked Sample	12/03			4.5	1.3	2.0	0.5	–0.03	0.01	0.141	0.028	0.096	0.023	0.093	0.026	0.5	1.3	10.0	2.2	2	49
Average of Spiked Values		203		5.1		0.0		0.02		0.100		0.104		0.084		2.0		10.2		–3	
Standard Deviation of Spiked Values		49		1.7		1.0		0.09		0.031		0.020		0.024		3.9		1.1		36	
Spiked Concentration		0		5.0		0.0		0.00		0.100		0.100		0.100							
Calculated Detection Limit (Standard Deviation of Spikes × 4.66)				7.9						0.145		0.093		0.113							

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[a] Except where noted.

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

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

Table 5-25. Quality Assurance Sample Results for Metals Analysis in 1997 (μg/L)

Station Name	Date	Codes[a]	Ag	Al	As	B	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg
DI Blank	05/15	UF	<10	<50	<2	<20	<1	<3	<7	<8	<7	<10	315	<0.3
DI Blank	06/12	UF	<10	<50	<2	<20	<1	<3	<7	<8	<7	<10	<40	<0.2
DI Blank	06/17	UF	<10	<50	<2	<28	<6	<3	<7	<8	<7	<10	<40	<0.2
DI Blank	06/25	UF	11	<50	<2	<20	<1	<3	<7	<13	<7	<10	<40	<0.2
DI Blank	07/09	UF	<10	<50	<2	<20	<1	<3	<7	<8	<7	11	<40	<0.2
DI Blank	08/06	UF	<10	<50	<2	<20	<1	<3	<7	<8	<7	<10	<40	<0.2
DI Blank	09/29	UF	<10	<50	<2	<20	<1	<3	<7	<8	<7	<10	<40	
DI Blank	12/10	UF	<10	<50	<2	26	1	<3	<7	<8	20	<10	155	<0.2
DI Blank	12/12	UF	<10	<50	<2	<20	<1	<3	<7	<8	<7	<10	<40	<0.2
Spiked Sample	06/16	UF	26	79	<2	<20	512	<3	<7	<8	<7	<10	44	2.3
Spiked Sample	06/25	UF	30	<50	<2	<20	493	<3	<7	<8	<7	<10	<40	3.1
Spiked Sample	07/09	UF	23	<50	<2	<20	510	<3	<7	<8	<7	11	53	2.8
Spiked Sample	08/12	UF	22	<50	<2	<20	498	<3	<7	<8	<7	<10	<40	3.2
Spiked Sample	10/01	UF	21	<50	<2	<20	490	<3	<7	<8	<7	<10	59	
Spiked Sample	10/08	UF	22	<50	<2	50	526	<3	<7	<8	<7	<10	67	<0.2
Spiked Sample	11/25	UF	41	727	<2	118	480	3	44	49	42	33	41	3.1
Spiked Sample	12/03	UF	13	<50	<2	<20	492	<3	<7	<8	<7	<10	<40	
Average of Spiked Values			25				500							2
Standard Deviation of Spiked Values			8				15							1
Spiked Concentration			25				500							5.0

Table 5-25. Quality Assurance Sample Results for Metals Analysis in 1997 (μg/L) (Cont.)

Station Name	Date	Codes[a]	Mn	Mo	Ni	Pb	Sb	Se	Sn	Sr	Tl	V	Zn
DI Blank	05/15	UF	<2	<30	<20	<3	<3	<3	<30	<2	<3	<8	<50
DI Blank	06/12	UF	<2	<30	<20	<3	<3	<3	<30	<2	<3	<8	<50
DI Blank	06/17	UF	<2	<30	<20	<3	<3	<3	<30	5	<3	<8	<50
DI Blank	06/25	UF	<2	<30	<20	<3	<3	<3	<30	<2	<3	<8	<50
DI Blank	07/09	UF	<2	<30	<20	<3	<5	<3	<30	2	<3	<8	<50
DI Blank	08/06	UF	<2	<30	<20	<3	<3	<3	<45	<2	<3	<8	<50
DI Blank	09/29	UF	<2	<30	<20	<3	<3		43	<2	<3	<8	<50
DI Blank	12/10	UF	<2	<30	<40	<3	<3	<4	<30	<2	<3	<8	<50
DI Blank	12/12	UF	<2	<30	<20	<3	3	<2	<30	3	<3	<8	63
Spiked Sample	06/16	UF	<2	<30	<20	8	<3	<3	<30	3	<3	<8	<50
Spiked Sample	06/25	UF	<2	<30	<20	7	<3	<3	<30	<2	<3	<8	<50
Spiked Sample	07/09	UF	3	<30	<20	9	<3	<3	<49	6	<3	<8	<50
Spiked Sample	08/12	UF	<2	<30	<20	7	<6	<3	<30	<2	<3	<8	<50
Spiked Sample	10/01	UF	<2	<30	<34	9	<3		35	<2	<3	<8	<50
Spiked Sample	10/08	UF	<2	<30	<20	8	<3	<4	<30	<2	<3	<8	<50
Spiked Sample	11/25	UF	50	50	<32	10	<3	<3	<30	55	<3	19	<50
Spiked Sample	12/03	UF	<2	<30	<20	8	<3		<30	<2	<3	<8	<50
Average of Spiked Values						8							
Standard Deviation of Spiked Values						1							
Spiked Concentration						7.5							

J. Figures

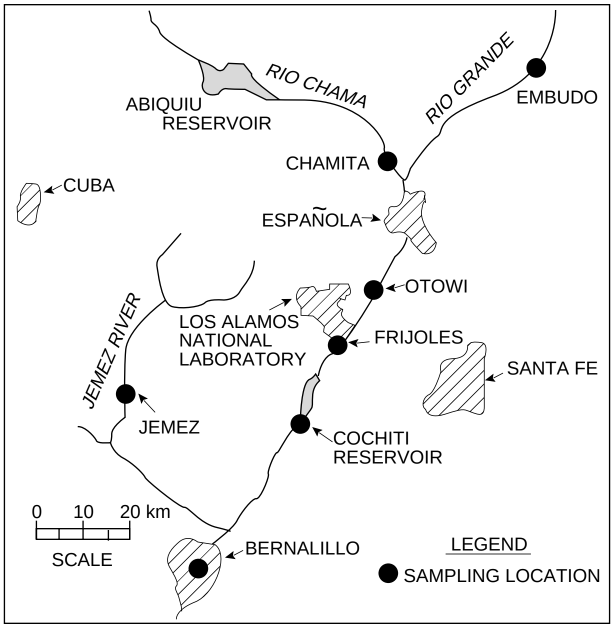


Figure 5-1. Regional surface water and sediment sampling locations.

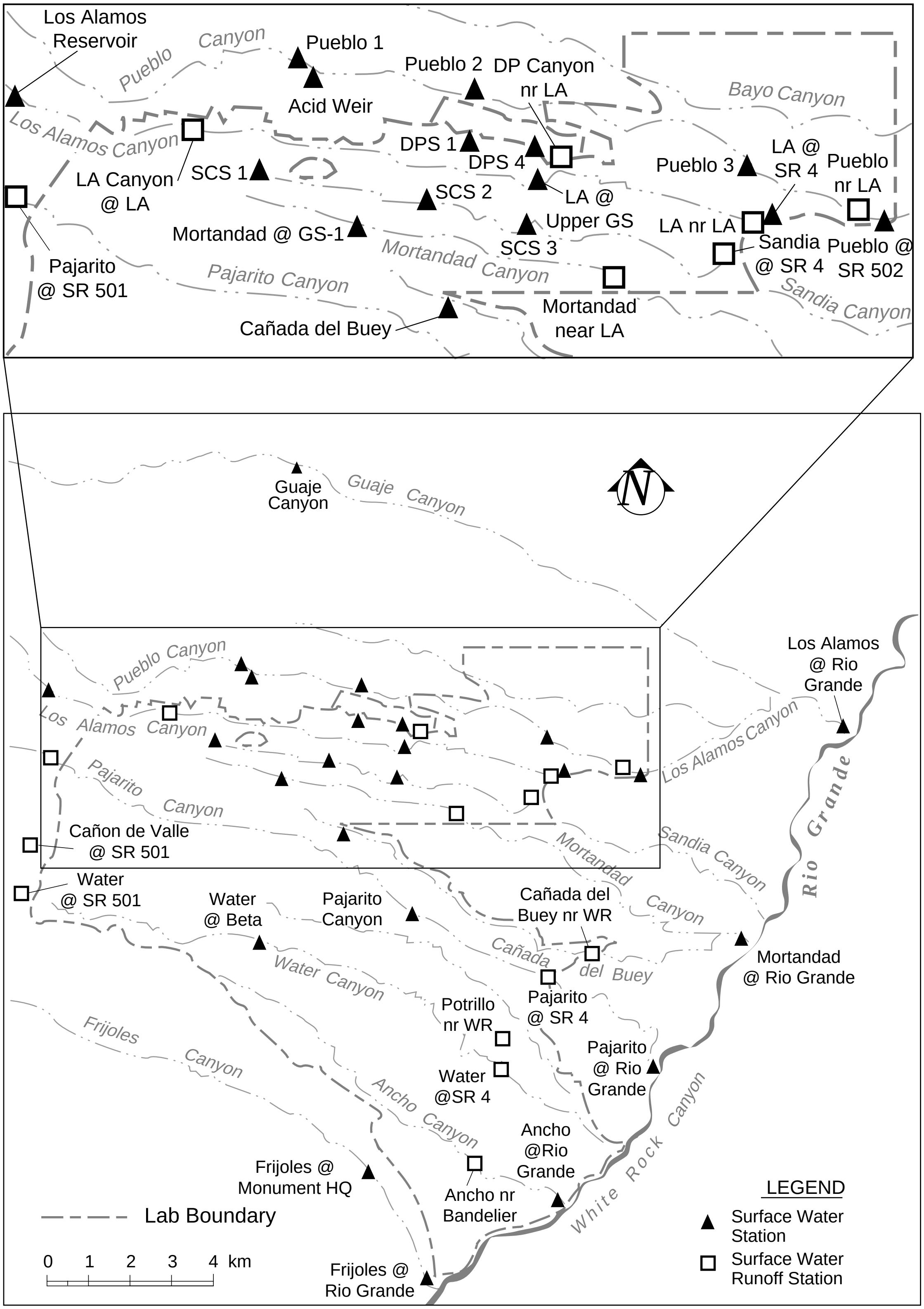


Figure 5-2. Surface water sampling locations in the vicinity of Los Alamos National Laboratory.

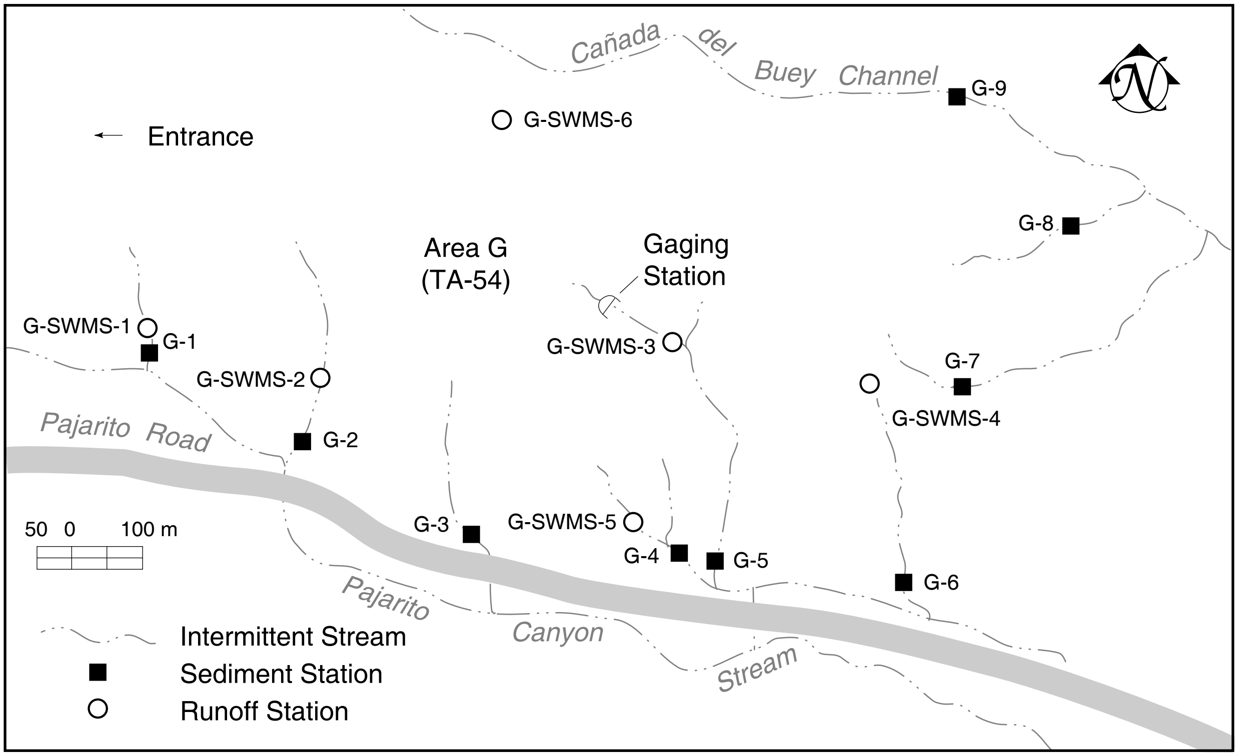


Figure 5-3. Sediment and runoff sampling stations at TA-54, Area G.

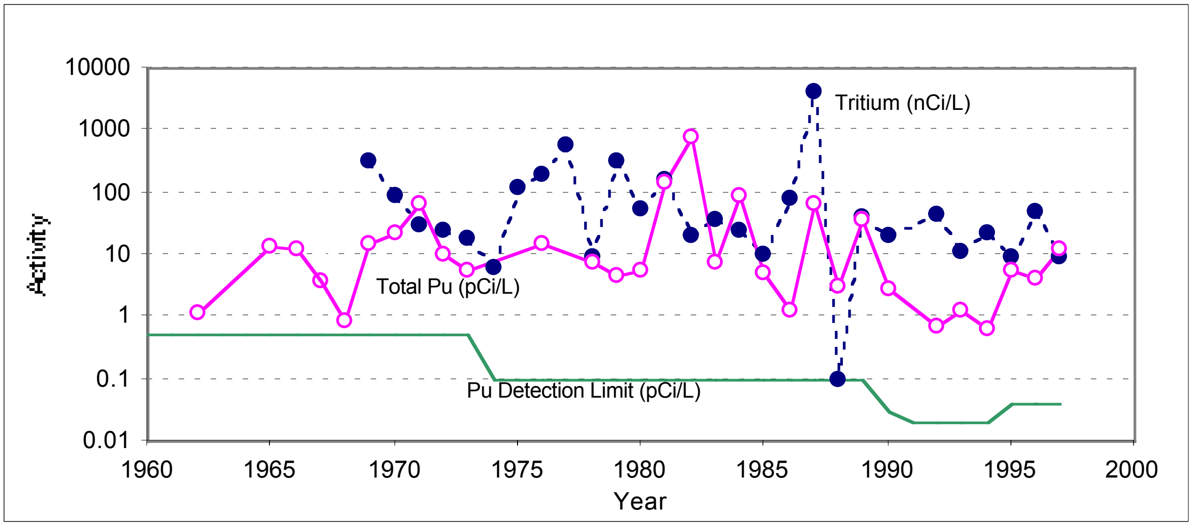


Figure 5-4. Tritium and plutonium activity at Mortandad Canyon at Gaging Station 1.

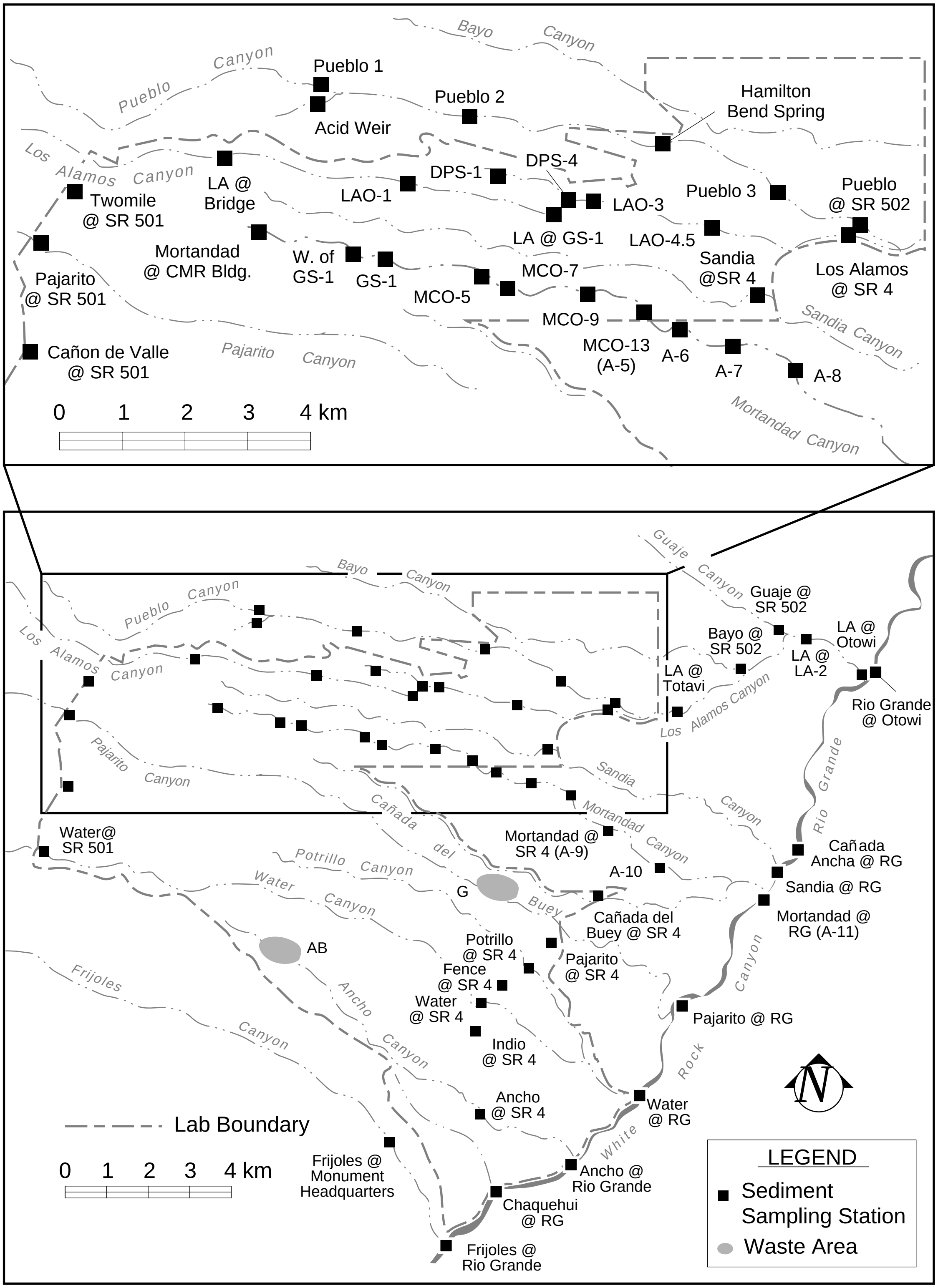


Figure 5-5. Sediment sampling stations on the Pajarito Plateau near Los Alamos National Laboratory. Solid waste management areas with multiple sampling locations are shown in Figures 5-3 and 5-6.

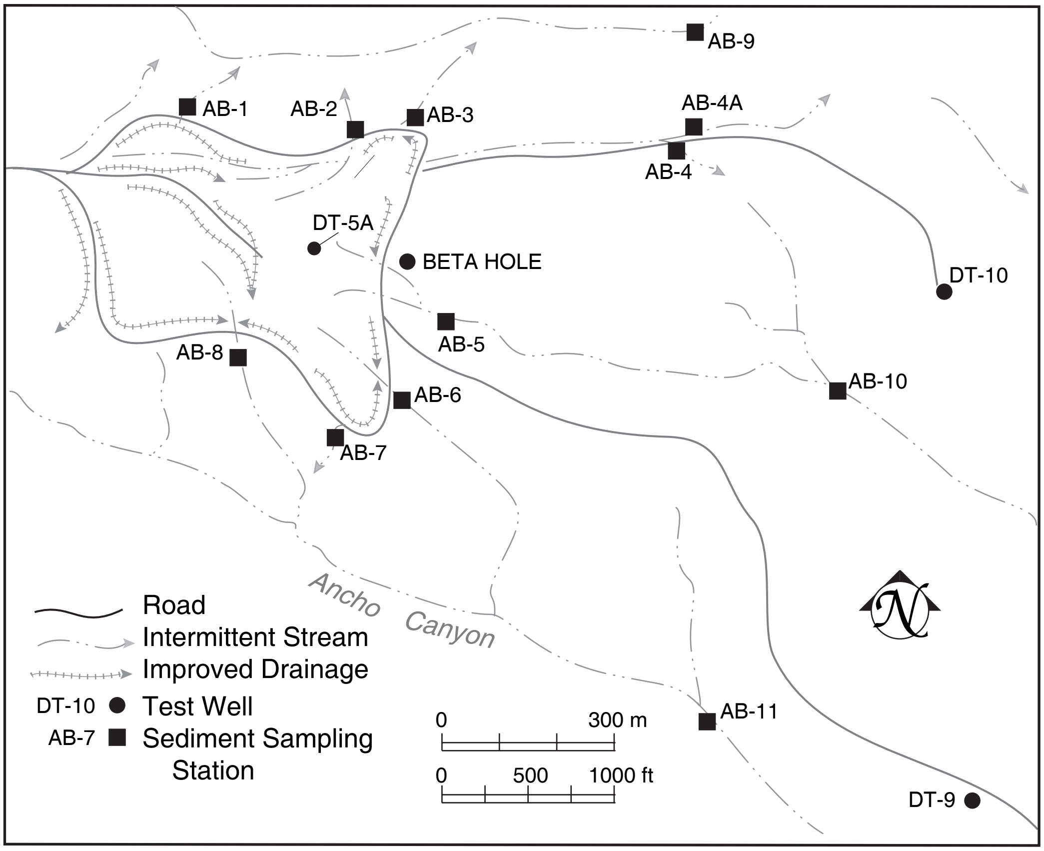
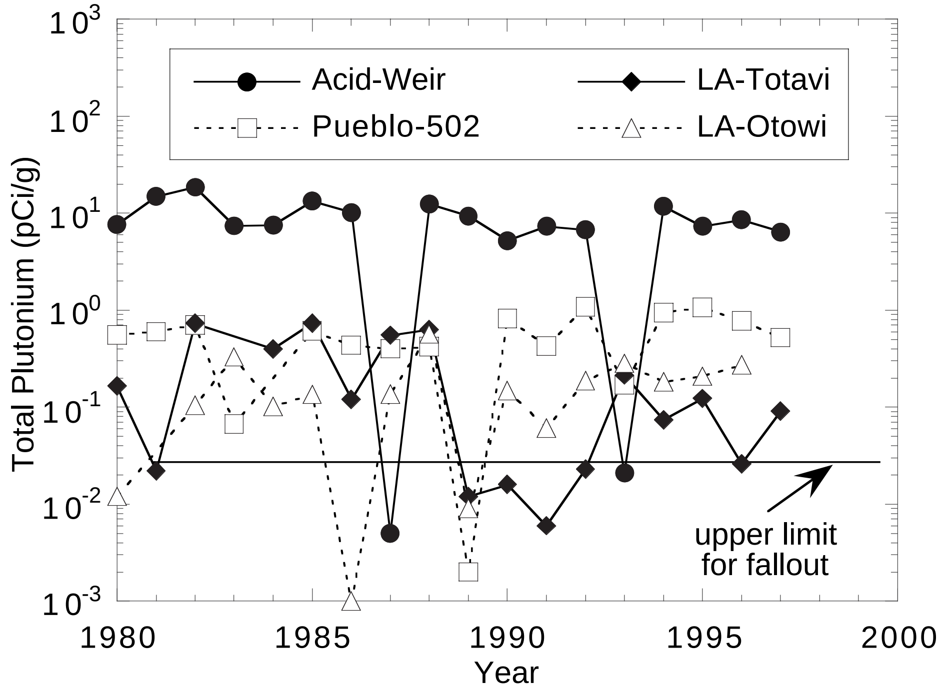


Figure 5-6. Sediment sampling stations at TA-49, Area AB.



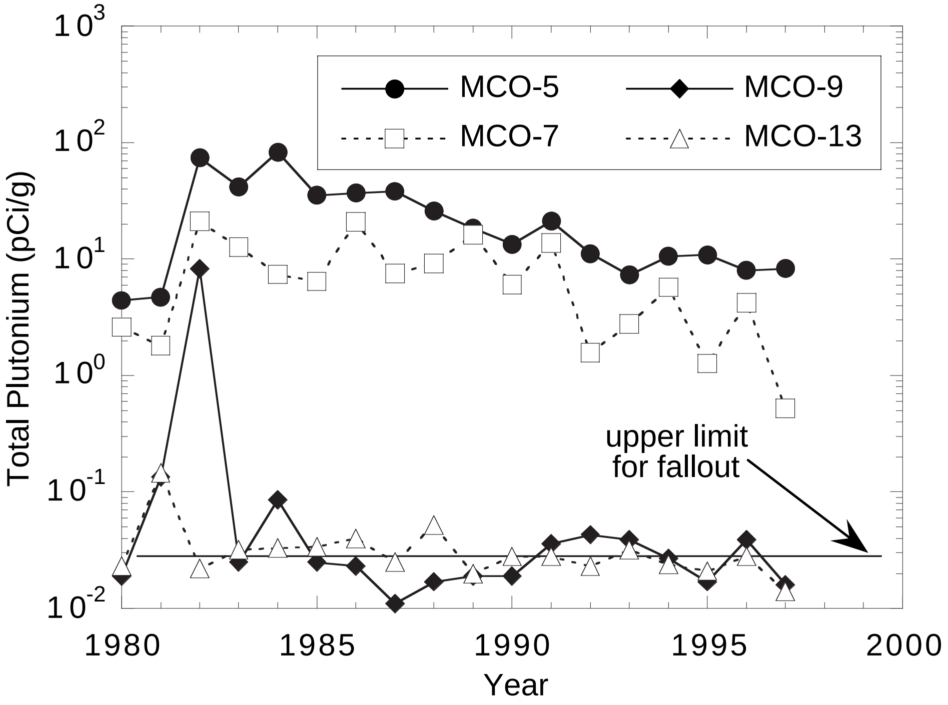


Figure 5-7. Total plutonium activity in Pueblo (top) and Mortandad (bottom) Canyons channel sediments.

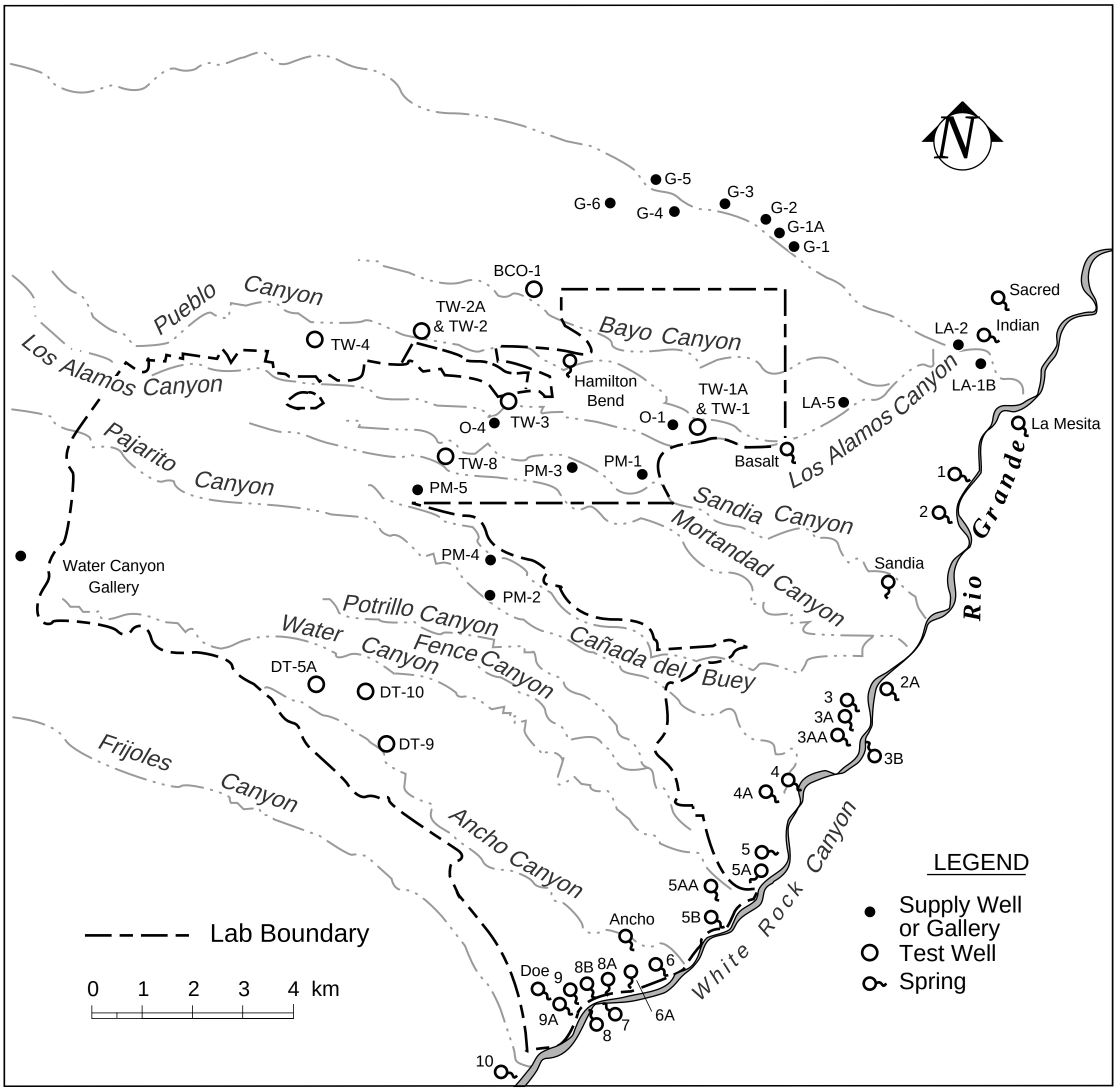


Figure 5-8. Springs and deep and intermediate wells used for groundwater sampling.

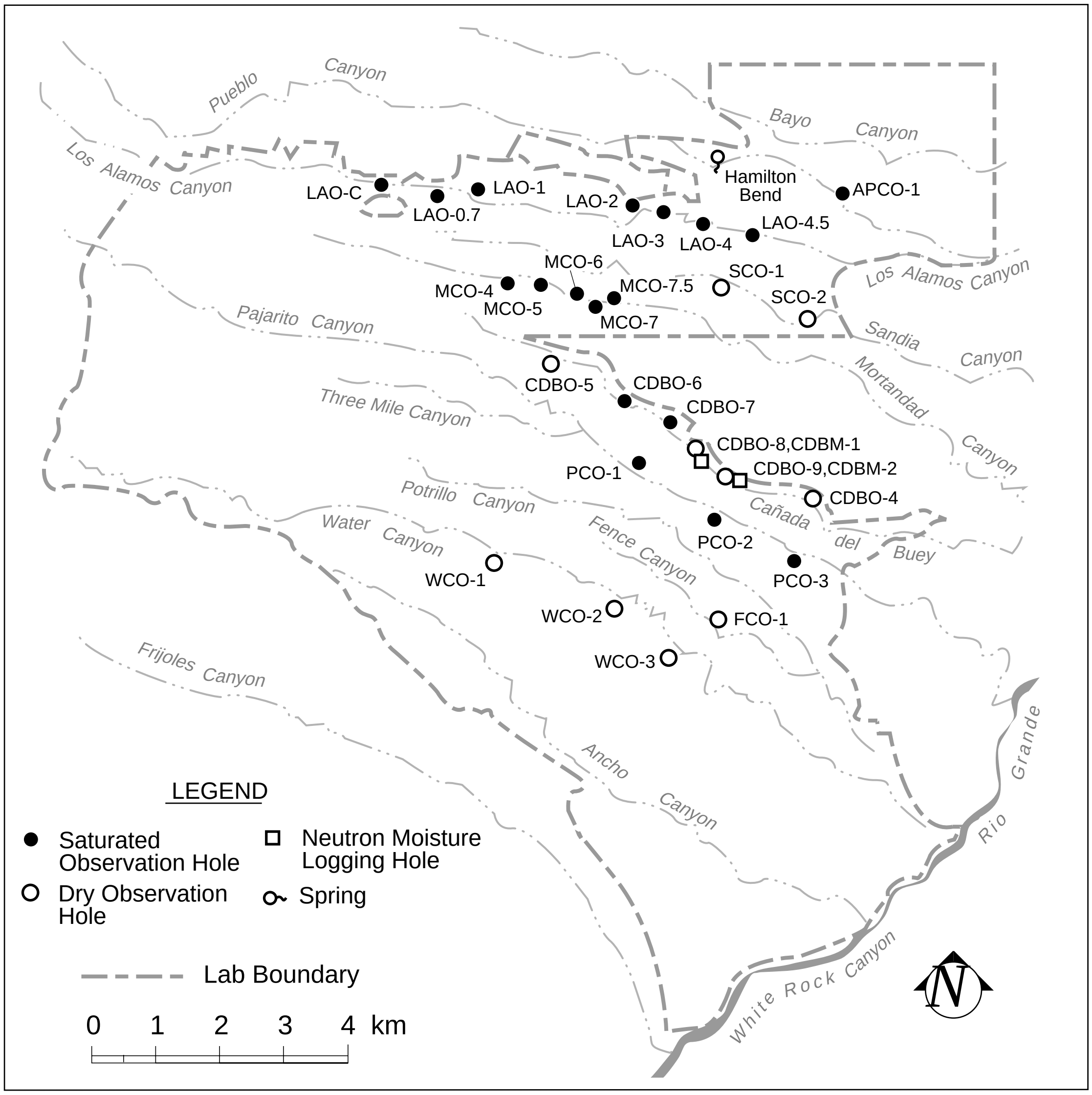


Figure 5-9. Observation wells and springs used for alluvial groundwater sampling and shallow neutron moisture holes.

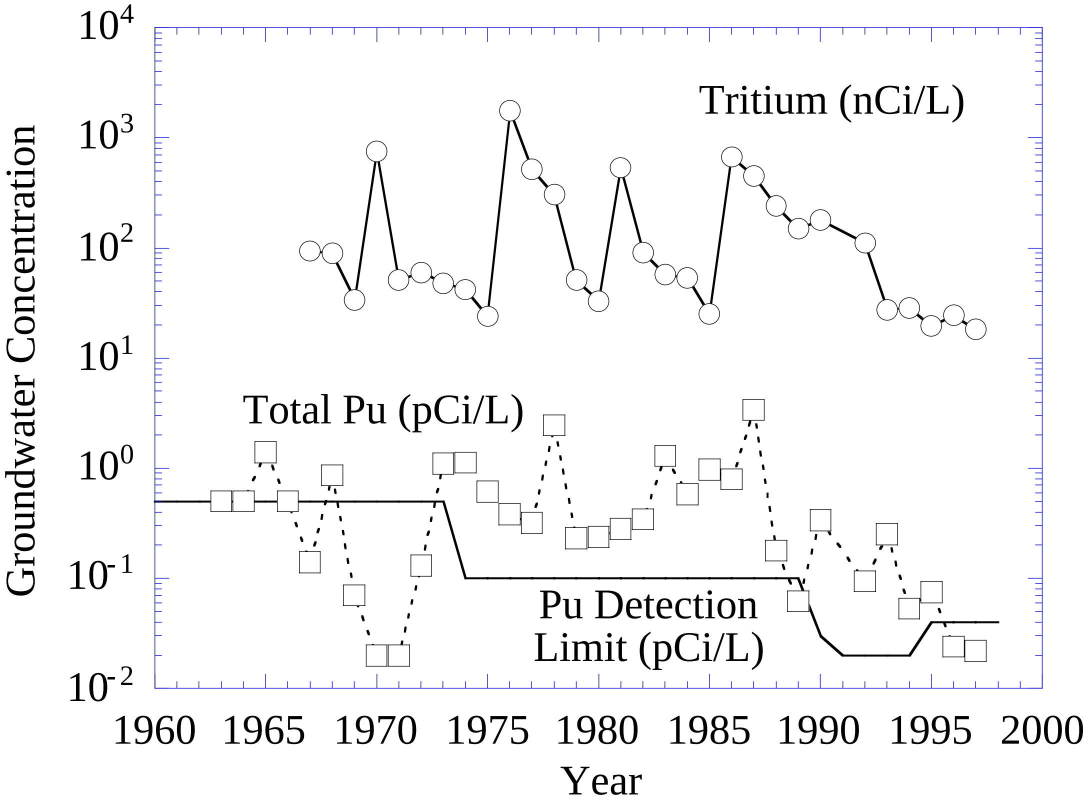


Figure 5-10. Tritium and plutonium concentrations in water samples from Mortandad Canyon Alluvial Observation Well MCO-6.

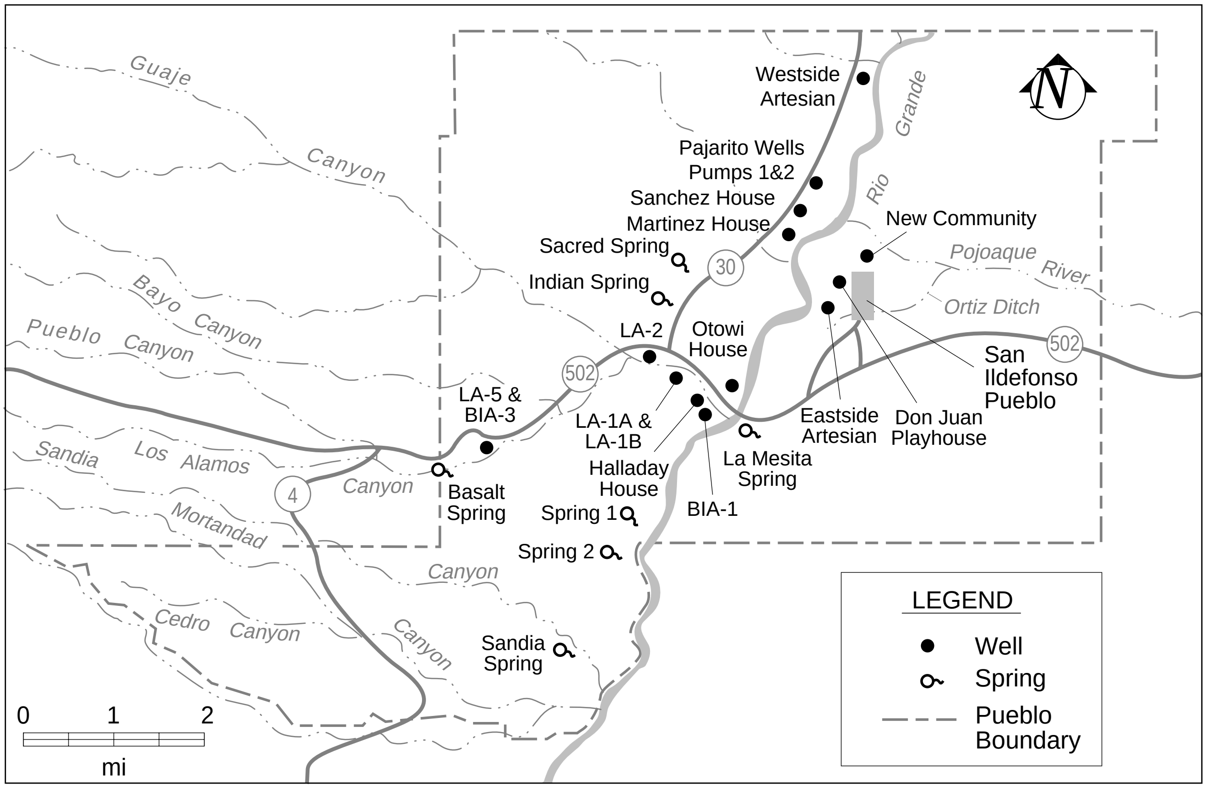


Figure 5-11. Springs and groundwater stations on or adjacent to Pueblo of San Ildefonso land.

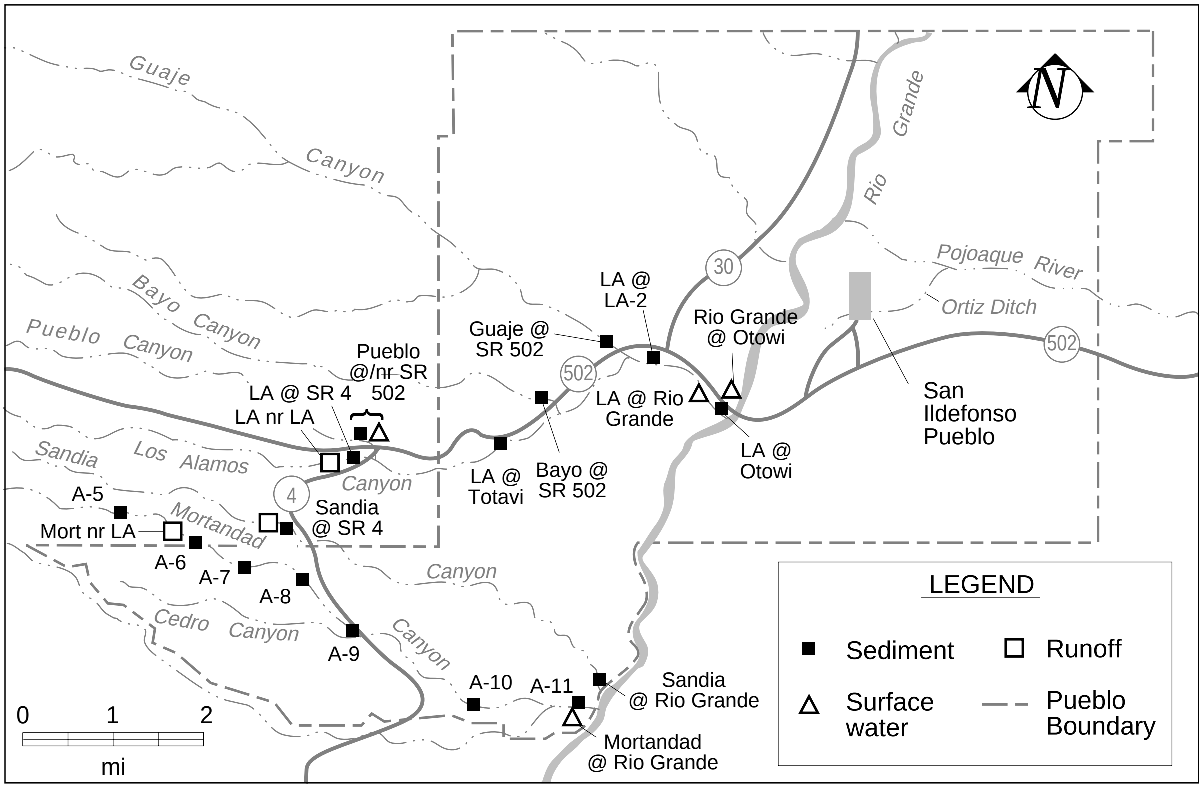


Figure 5-12. Sediment and surface water stations on or adjacent to Pueblo of San Ildefonso land.

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6. Soil, Foodstuffs, and Associated Biota

primary author:

Phillip Fresquez

Highlights from 1997

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 in northern New Mexico. Radionuclides in soils collected from regional background areas are from natural sources and/or worldwide fallout. Most radionuclide concentrations in soils collected from on-site and perimeter areas were within or just above the range of background concentrations and were far below LANL screening action levels (SALs). Trend analysis show that most radionuclides, with the exception of plutonium-238, in soils from on-site and perimeter areas significantly decreased over time so that by 1997 most radionuclides in soils from on-site and, especially from perimeter areas, have values similar to soils collected from regional background locations. These trends were especially apparent for tritium and uranium in soils from on-site areas. Soils were also analyzed for trace and heavy metals, and most metals were within the range of background concentrations and well below LANL SALs.

Foodstuffs and biota samples (milk, eggs, fruits, vegetables, honey, elk, deer, fish, herbal tea, piñon, and beef cows) 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. Foodstuffs and biota samples from the Laboratory, with the exception of wild edible plants and fruits from Mortandad Canyon, and perimeter locations showed no radioactivity that could be distinguished from regional background levels. Wild edible plants and fruits collected along the length of Mortandad Canyon contained concentrations of strontium-90; cesium-137; plutonium-238; plutonium-239, -240; and americium-241 above background concentrations. Also, some radionuclides in bone of elk and deer tended to be just above upper limit background levels. Most heavy metal elements in produce collected from Laboratory and perimeter areas were within background concentrations.

A. Soil Monitoring

1. Introduction

A soil sampling and analysis program provides the most direct means of determining the concentration/activity, inventory, and distribution of radionuclides and radioactivity around nuclear facilities (DOE 1991). This program is mandated by Department of Energy (DOE) Orders 5400.1 and 5400.5 and proposed 10 CFR 834. 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., firing sites), or through liquid effluents released to a stream that is subsequently used for irrigation. 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 a person (Fresquez et al., 1998). This program evaluates radionuclides, radioactivity, and nonradionuclides (heavy metals) in soils collected from regional (background) locations, around the perimeter of the Laboratory, and on-site (Los Alamos National Laboratory—LANL or the Laboratory). On-site and perimeter areas are compared to regional background areas—these background areas are distant from the Laboratory, and their radionuclide and nonradionuclide contents are due to naturally occurring elements and/or to worldwide fallout. Potential radiation doses to individuals from exposure to soils are presented in Chapter 3.

2. Monitoring Network

Soil surface samples (0- to 2-in. depth) are collected from relatively level, open, and undisturbed areas at background locations (3 sites), LANL's perimeter (10 sites), and at LANL (12 sites) (see Figure 6-1). Areas sampled at LANL are not from solid waste management units (SWMUs)—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 Technical Area [TA] 54, Area G). Instead, the majority of on-site soil-sampling stations are located close to, and downwind from if possible, major facilities and/or operations at LANL in an effort to assess radionuclides, 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 and active firing sites). The ten perimeter stations are located on the north (four), east (four), west (one) and southwest (one) side of the Laboratory. All areas are compared to soils collected from background locations in northern NM where radionuclides, radioactivity, and heavy metals are from natural and/or worldwide fallout events; these areas are located around the Embudo, Cochiti, and Jemez areas.

a. Regional Background Stations. The regional background stations for soils are located in northern New Mexico surrounding the Laboratory: Embudo to the north, Cochiti to the south; and Jemez to the west. All are more than 32 km from the Laboratory and are beyond the range of potential influence from normal Laboratory operations (DOE 1991).

b. Perimeter Stations. Ten soil sampling stations are located within 4 km 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 are collected from 12 on-site stations; they are mostly located near and downwind from Laboratory facilities that are the principal sources of airborne emissions or fugitive dust at LANL.

3. Sampling Procedures, Data Management, and Quality Assurance

Collection of samples for chemical and radiochemical analyses follows a set procedure to ensure proper sample collection, processing, 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, data handling, validation and tabulation can be found in the ESH-20 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 1997. Most radionuclide concentrations and radioactivity in soils collected from on-site and perimeter stations were within regional statistical reference levels (RSRLs). The RSRL is the (95%) upper limit background concentration (mean plus two standard deviations from data collected from Embudo, Cochiti, and Jemez from 1993 through 1997) for worldwide fallout of tritium; strontium-90; cesium-137; americium-241; plutonium-238; and plutonium-239, -240; total uranium; and gross alpha, beta, and gamma radioactivity. The average concentrations of strontium-90; total uranium; plutonium-239, -240; and americium-241 in on-site and perimeter soils were just above RSRLs. These values, however, were low and they 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 per year dose.

The slightly higher radionuclide concentrations of strontium-90; total uranium; plutonium-239, -240; and americium-241 in soils collected from on-site and perimeter areas as compared to regional background locations may be, in part, due to Laboratory operations, but probably more to worldwide fallout from nuclear weapons testing, the burn up of a satellite power source in the atmosphere, and reactor accidents (e.g., Chernobyl). In the case of uranium, the slightly higher concentrations ar probably due to naturally occurring minerals in the earth's crust. Radionuclides due to fallout vary from one area to another depending on wind patterns, elevation, and precipitation (Whicker and Schulz, 1982). Usually, higher amounts of radionuclides from fallout occur at higher elevations that receive greater amounts of precipitation than in areas at lower elevations that receive lower amounts of precipitation. Most of the regional areas, for example, ranged from 5,600 ft to 6,300 ft above sea level and have an average rainfall of approximately 10 in. per year (Bowen 1990). By contrast, the on-site and perimeter areas were located above 7,200 ft above sea level and receive about 19 in. of rainfall on average per year. The higher levels of uranium detected in the soils collected from the on-site and perimeter areas as compared with background areas may be a result of differences in the geology or mineralogy of the soils between the two sites. Soils in the Los Alamos area are derived from Bandelier (volcanic) tuff and have higher-than-average natural uranium contents, ranging from 3 to 11 µg of uranium per gram of soil (Crowe et al., 1978).

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 1997 soil sampling program can be found in Table 6-2.

All concentrations of heavy metals measured in soils collected from perimeter and on-site areas were within RSRLs, and 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). Results of cadmium, mercury, and antimony were not reported this year (see Table 6-2) because the minimum detection levels (MDLs) reported for these metals were higher than what has been normally employed in the past and, therefore, could not be compared to past results. All cadmium, mercury, and antimony results from soils collected from perimeter and on-site areas, however, were similar to background.

6. Long-Term Trends

All soils collected from on-site and perimeter stations from 1974 through 1996 were subjected to a Mann-Kendal test for trend analysis (Fresquez et al., 1998). Although some radionuclide and radioactivity levels were generally higher in perimeter and on-site soils as compared with background, most radionuclides, with the exception of plutonium-238 in soils from perimeter areas, exhibited decreasing concentrations over time. The statistically significant (but very small) increase of plutonium-238 in perimeter soils over time may be related to the resuspension and redistribution of global fallout and/or to past LANL operations. Plutonium-238 and plutonium-239, -240 in soils from background areas also exhibited statistically increasing trends, but in this case, the small increase in plutonium levels in soils from background areas was probably a reflection of the redistribution of fallout. The plutonium levels in background soils, for example, were still well within worldwide fallout concentrations.

The decreasing concentrations of the other isotopes in soils collected from perimeter and on-site areas over time may be a result of (1) cessation of above-ground nuclear weapons testing in the early 1960s, (2) weathering (e.g., water and wind erosion, and leaching), (3) radioactive decay (half-life), and (4) reductions in operations and/or better engineering controls employed by LANL. Tritium, which has a half-life of about 12 years, exhibited the greatest decrease in activity over the 20-plus-year period of this study at all three sites: background, perimeter, and on-site. Indeed, by 1996, the majority of radionuclides and radioactivity in soils collected from both perimeter and on-site areas were statistically similar to values detected in regional background locations.

B. Foodstuffs and Associated Biota Monitoring

1. Introduction

There is a high diversity of wild and domestic edible plant, fruit, and animal products that are grown and/or are harvested in the area surrounding the Laboratory. Ingestion of foodstuffs constitutes a critical pathway by which radionuclides can be transferred to humans (Whicker and Schultz 1982). For this reason, samples of milk, eggs, produce (wild and domestic fruits, vegetables, and grains), fish, honey, herbal teas, piñon, domestic animals, and elk and deer bone and meat are collected annually from Laboratory property. This Foodstuffs and Biota Monitoring program is mandated by DOE Orders 5400.1 and 5400.5, and proposed 10 CFR 834. The two main objectives of the program are to (1) determine and compare radioactive and heavy metals constituents in foodstuffs and biota between on-site LANL and perimeter areas with regional background area; and (2) calculate a committed effective dose equivalent (CEDE) to surrounding area residents (e.g., Los Alamos townsite, White Rock/Pajarito Acres townsite, the Pueblo of San Ildefonso, and Cochiti Pueblo). Potential radiation doses to individuals from the ingestion of foodstuffs are presented in Chapter 3.

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 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 in northern New Mexico; these gardens are located in the Española, Santa Fe, and Jemez areas. The regional sampling locations are far enough away from the Laboratory that they are unaffected by the Laboratory 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, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Produce Sampling and Processing for the Foodstuffs Monitoring Program, “LANL-ESH-20-SF-OP-001, RO, 1997.

c. Radiochemical Analytical Results. Concentrations of radionuclides in produce collected from on-site, perimeter, and regional background locations during the 1997 growing season can be found in Table 6-3. Most radionuclide concentrations in fruits and vegetables collected from on-site (mesa tops) and perimeter areas were less than the RSRL, defined as the upper (95%) limit background concentration (mean plus two standard deviations) for worldwide fallout of tritium; strontium-90; cesium-137; americium-241; plutonium-238; and plutonium-239, -240; and total uranium compiled from 1993 to 1997. Only a few radionuclide values at a few sites, from the Los Alamos townsite (tritium; plutonium-238; and plutonium-239, -240) and White Rock/Pajarito Acres (plutonium-239, -240 and americium-241) townsites, were higher than the RSRL (see Table 6-3). In most instances, however, they were just above the RSRL, and the higher concentrations are probably a reflection of incomplete washing procedures rather than contamination effects from the Laboratory. Also, as in past years, tritium appears to be higher in on-site and Los Alamos townsite produce samples than in regional background samples.

In contrast to produce samples collected from the mesa-top areas, concentrations of most radionuclides, with the exception of tritium and total uranium, in wild edible plants and fruits collected along the length of Mortandad Canyon were above the RSRLs. Almost all of the radionuclides in these edible wild plants and fruits were elevated above produce commonly collected from regional background locations. Cesium-137 ranged from 0.02 pCi per gram dry in currants to a high of 2.7 pCi per gram dry in acorns; strontium-90 ranged from 0.05 to a high of 9.4 pCi per gram dry in strawberries; and, wild rhubarb contained the highest concentrations of total uranium (36 ng per gram dry); plutonium-238 (9.9 pCi per gram dry); plutonium-239, -240 (10.6 pCi per gram dry); and americium-241 (24.0 pCi per gram dry). These results are similar to a study conducted in Los Alamos Canyon in 1996 (Fresquez et al., 1998), in that the concentrations of most radionuclides measured in most produce samples collected from both canyons were far above background concentrations. In general, levels of strontium-90 and cesium-137 in produce from Mortandad Canyon were lower in concentration than levels detected in pinto beans, zucchini squash, and sweet corn grown in Los Alamos Canyon, whereas total uranium; plutonium-238; plutonium-239, -240; and americium-241 concentrations in wild edible plants and fruits, particularly wild rhubarb, collected in Mortandad Canyon were generally higher than concentrations in produce grown in Los Alamos Canyon.

d. 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 6-4). 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. However, none of the means for barium, chromium, nickel, and lead in produce from any of the sites were higher than the RSRL.

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**.**

b. Sampling Procedures, Data Management, and Quality Assurance. Honey is collected directly from the beekeepers. The honey samples in glass quart jars are submitted under full chain-of-custody to CST-9 for radiochemical analyses 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 ESH-20 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 1997 season are presented in Table 6-5. Most radionuclide concentrations in honey collected from perimeter hives were below RSRLs, with the exception of strontium-90 from Los Alamos. The strontium-90 value in honey collected from Los Alamos, however, was not a detectable value (i.e., where the result is greater than two times the counting uncertainty).

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 (background).

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 under chain-of-custody 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 ESH-20 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, the Pueblo of San Ildefonso, and Española area can be found in Table 6-6. All radionuclide values in eggs collected from Los Alamos townsite and the Pueblo of San Ildefonso were less than the RSRLs.

5. Milk

a. Monitoring Network. Goat's milk was collected from the Los Alamos townsite and cow's milk was collected from the closest working dairy—approximately 40 km away—from the Laboratory. Milk from these areas was compared to milk collected from a dairy located in Albuquerque, NM.

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. Goat milk was collected directly from the producer in Los Alamos (this milk is for family use and is not sold to the public). All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the ESH-20 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 1997 are summarized in Table 6-7. Concentrations of plutonium-239, -240; tritium; cesium-137; and iodine-131 in goat's milk collected from the Los Alamos townsite were just above RSRLs determined for cow's milk. However, of these radionuclides, only plutonium-239, -240 was a detectable value (a concentration where the result is greater than two times its counting uncertainty) and should be viewed with caution because these results were compared to cow's milk and not to goat's milk; and goats tend to forage on a wider diversity of plants than dairy cows and the milk would be expected to have a different chemistry makeup. Most radionuclide concentrations in milk collected from the Pojoaque Valley, with the exception of tritium, although the value was not considered a detectable value, were within RSRLs. Results were similar to those obtained in previous years, neither increasing nor decreasing trends are evident. Tritium and strontium-90 levels, in particular, compare well with tritium and strontium-90 levels in milk from other background states around the Country (Black et al., 1994).

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., 1994).

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 gill nets (Salazar 1984) and transported under ice to the laboratory for preparation. At the laboratory fish are gutted, head and tails removed, and washed. Muscle (plus associated bone) tissue is processed; wet, dry, and ash weights are determined, and ash is submitted for analysis. Concentrations of tritium; total uranium; strontium-90; plutonium-238; plutonium-239, -240; americium-241; and cesium-137 are determined. All results are reported on an oven-dry-weight basis (dry g). Heavy and trace metals in fish were also analyzed (this year only mercury was determined). The complete fish are submitted under full chain of custody directly to CST-9 for metals analysis. Results are reported on a wet basis. All QA/QC protocols, chemical analysis, data handling, validation and tabulation can be found in the ESH-20 OP entitled, “Fish Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-002, RO, 1997.

c. Radiochemical Analytical Results. Concentration of radionuclides in game and nongame fish collected upstream and downstream of the Laboratory in 1997 are presented in Table 6-8. In general, the concentrations of most radionuclides in game and nongame fish collected from Cochiti reservoir were not higher than RSRLs from similar fish collected from Abiquiu reservoir. These results compare well with radionuclide contents in crappie, trout, and salmon from comparable (background) reservoirs and lakes in Colorado (Whicker et al., 1972, Nelson and Whicker 1969).

The only radionuclide that was found to be higher in fish from Cochiti Reservoir as compared to background fish from Abuiquiu reservoir was uranium in nongame fish. Past studies on uranium in fish from Cochiti reservoir have shown that the uranium is of natural origin. The isotopic ratio of uranium-235 to uranium-238 in Cochiti bottom-feeding fish collected during 1993 (1.25×10^{13} atoms uranium-235/ash g to 1.74×10^{15} atoms uranium-238/ash g) and 1994 (1.20×10^{13} atoms uranium-235/ash g to 1.65×10^{15} atoms uranium-238/ash g) were consistent with naturally occurring uranium (i.e., 0.0072 ratio). In other words, there was no evidence of depleted uranium—a by-product of uranium enrichment processes—in fish samples collected from Cochiti Reservoir in past years, although depleted uranium has been used in dynamic weapons testing at LANL firing sites since the mid-1940s (Becker 1992). Also, there was no evidence of uranium-236; this isotope does not occur in nature and is indicative of the presence of anthropogenic (man-made) uranium. The higher concentrations of uranium in nongame fish from Cochiti can be attributed to one or more of the following: (1) Cochiti receives greater amounts of sediments than the other reservoirs (ESP 1995), (2) there are more uranium-bearing minerals around the Cochiti area (e.g., uranium in Bandelier Tuff around the Los Alamos area ranges in concentration from 4.0 to 11.4 µg per gram [Crowe et al., 1978]) than in areas upstream of Cochiti (e.g., uranium in soils from northern New Mexico ranges in concentration from 1.3 to 4.05 µg per gram [Purtymun et al., 1987; Fresquez et al., 1996]), and (3) some uranium may be entering Cochiti Reservoir via the Santa Fe River as this river flows past the edge of an abandoned 25-acre uranium mine site (La Bajada Uranium Mine) approximately 9.7 km upstream and northeast of Cochiti Reservoir (Fresquez and Armstrong 1996).

As expected, the nongame fish from both downstream and upstream reservoirs from LANL contained higher average uranium contents (17.2 ng per dry gram) than the surface-feeders (2.6 ng per dry gram).

The higher concentration of uranium in bottom-feeders as compared to surface-feeders is attributed to the ingestion of sediments on the bottom of the lake (Gallegos et al., 1971). Sediments represent the accumulation or sink compartment for most radionuclides (Whicker and Schultz 1982).

d. Long-Term Trends. 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, -240 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 per year (46 lb per year) of game fish and nongame fish from Cochiti reservoir after natural background has been subtracted was 0.005 and 0.009 mrem per year, respectively. The highest dose was <0.01% of the International Commission on Radiological Protection (ICRP) permissible dose limit for protecting members of the public.

e. Nonradiological Analytical Results. The results of the heavy metal analysis in fish samples from Cochiti and Abiquiu reservoirs in past years showed that mercury was the only element to be detected above the minimum level of detection. For this reason, mercury was the only element analyzed in fish in 1997. Results can be found in Table 6-9. All concentrations of mercury in fish from Cochiti Reservoir were within the RSRL (<0.41 µg per gram wet). Mercury concentrations in fish occurring in lakes and reservoirs in the State of New Mexico have been of significant concern to the public for several years. However, based on six years of data, mercury concentrations in fish upstream of LANL, have been consistently higher, albeit slightly, than mercury concentrations downstream of the Laboratory. Also, mercury levels in all fish collected from Cochiti and Abiquiu Reservoirs were lower than 0.50 µg per gram wet which is typical of nonpolluted fresh water systems (Abernathy and Cumbie 1977).

7. Game Animals (Elk and Deer)

a. Monitoring Network. Samples of elk and deer are collected as road kill on an annual basis from Laboratory areas and the meat and bone is analyzed for a host of radionuclides. These data, from meat and bone samples, were compared to radionuclide concentration in meat and bone samples from elk and deer collected from regional background locations.

b. Sampling Procedures, Data Management, and Quality Assurance. Samples of elk and deer meat and bone tissue are collected (1,000 g each) from fresh road kills around and within the Laboratory. Background samples are collected from the New Mexico Department of Game and Fish during this same period of time. Samples are submitted to CST-9 for the determination of tritium; total uranium; strontium-90; plutonium-238; plutonium-239, -240; cesium-137; and americium-241. All results are reported on an oven-dry-weight basis (dry per gram). All QA/QC protocols, chemical analysis, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Game Animal Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-003, RO, 1997.

c. Radiochemical Analytical Results. Results of road kill elk and deer collected during 1996 and 1997 can be found in Tables 6-10 and 6-11.

Most radionuclides, with the exception of strontium-90 and plutonium-239, -240, found in muscle tissue of elk collected from LANL lands were within RSRLs (Table 6-10). Of the strontium-90 and plutonium-239, -240 concentrations that were in higher concentrations in muscle of elk from LANL lands as compared to the RSRLs, only the strontium-90 values were at detectable levels (i.e., where the analytical result was higher than two times the counting uncertainty). Most of the plutonium-239, -240 levels in muscle from LANL elk that were higher than the RSRL’s, on the other hand, were nondetectable values. Although the levels of strontium-90 in bone tissues of elk from on-site areas were higher in concentration than the current year’s regional background mean concentration, they were still well within the upper limit background concentration (e.g. the RSRL). Another radionuclide that appears to be in higher concentrations in bone tissue of elk collected from LANL lands as compared to regional background was uranium, although only two of the five uranium values in elk bone from LANL elk (that were higher than the RSRL) were detectable values.

Most radionuclides in muscle tissue of deer collected from LANL lands were within RSRLs (Table 6-11). With regard to bone tissue of deer on LANL lands, some radionuclides, particularly plutonium-238 and plutonium-239, -240, were in higher concentrations than the RSRL; most of these values, however, were not at detectable levels (i.e., the values were less than two times the counting uncertainty). Nevertheless one of these animals (TA-53, LANSCE Road) had three out of seven radionuclides higher than the RSRL's in the bone tissue samples.

8. Domestic Animals.

a. Monitoring Network. Cattle owned by the Pueblo of San Ildefonso graze the boundaries of LANL on a regular basis and are offered by the Pueblo for sampling and analysis. Meat and bone tissue collected from the beef cattle from the Pueblo of San Ildefonso are compared to similar tissues from beef cattle collected from regional background locations.

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analyses, data handling, validation, and tabulation can be found in the ESH-20 OP entitled, “Game Animal Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-003, 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 1997 year can be found in Table 6-12. In general, most radionuclides, with the exception of plutonium-239, -240 in muscle and total uranium in bone, of a domestic steer collected from the Pueblo of San Ildefonso were within RSRLs. Of these two elements, only total uranium, was a detectable value (the analytical result was greater that two times the counting uncertainty).

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 and used as a background value.

b. Sampling Procedures, Data Management, and Quality Assurance. Tap water is added to the vegetative portion of Navajo Tea and brought to a boil. After the tea is cooled it is poured into a suitable container and submitted to chemistry as a liquid. All QA/QC protocols, chemical analysis, and data handling, validation and tabulation can be found in the ESH-20 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 liquid tea analysis collected during the 1997 year can be found in Table 6-13. Most radionuclides in tea collected from the perimeter areas around LANL were within RSRLs, with the following exceptions: tea from Los Alamos, White Rock/Pajarito Acres and the Pueblo of San Ildefonso contained concentrations slightly higher than the RSRL of plutonium-239, -240; tea from Los Alamos townsite and White Rock/Pajarito Acres contained concentrations higher than the RSRL of tritium; and tea from San Ildefonso contained concentrations higher than the RSRL of strontium-90.

10. Piñon

a. Monitoring Network. Because piñon nuts are produced every 7 to 10 years by piñon pine trees in the semiarid Southwest, the collection of piñon shoot tips, a more conservative medium, will be harvested on an annual basis to determine the dose from the ingestion of this very popular product. Piñon tree shoot tips were collected from three perimeter areas surrounding the Laboratory: Los Alamos townsite on the north, White Rock/Pajarito Acres on the south east, and Pueblo of San Ildefonso lands on the east. Piñon tree shoot tips were collected from the Jemez area to provide background measurements**.**

b. Sampling Procedures, Data Management, and Quality Assurance. All QA/QC protocols, chemical analysis, data handling, validation and tabulation can be found in the ESH-20 OP entitled, “Produce Sampling and Processing for the Foodstuffs Monitoring Program,” LANL-ESH-20-SF-OP-001, RO, 1997.

c. Radiochemical Analytical Results. Results of the piñon tree shoot tips collected during 1997 can be found in Table 6-14. Most radionuclides in piñon tree shoot tips from the perimeter areas of LANL were within the RSRLs. However, piñon tree shoot tips collected from the White Rock/Pajarito Acres area and, especially from the Pueblo of San Ildefonso, contained higher (and detectable) concentrations of total uranium than the RSRL.

C. Other Environmental Surveillance Program Activities around Los Alamos National Laboratory, Special Studies, and Long-Term Data Evaluations

1. Tritium Concentrations in Bees and Honey at Los Alamos National Laboratory: 1979–1996

Honeybees are effective monitors of environmental pollution. The objective of this study was to summarize tritium concentrations in bees and honey collected from within and around LANL over an 18-year period. Based on the long-term average, bees from 9 out of 11 hives and honey from 6 out of 11 hives on LANL lands contained tritium that was significantly higher ($p < 0.05$) than background. The highest average concentration of tritium in bees (435 pCi per milliliter) collected over the years was from TA-54—a low-level radioactive waste disposal site (Area G). Similarly, the highest average concentration of tritium in honey (709 pCi per milliliter) was collected from a hive located near three tritium storage ponds at LANL TA-53. The average concentration of tritium in bees and honey from background hives was 1.0 pCi per milliliter and 1.5 pCi per milliliter, respectively. Although the concentrations of tritium in bees and honey from most LANL and perimeter (White Rock/Pajarito Acres) areas were significantly higher than background, most areas, with the exception of TA-53 and TA-54, generally exhibited decreasing tritium concentrations over time (Fresquez et al., 1996).

2. Baseline Concentrations of Radionuclides and Heavy Metals in Soils and Vegetation around the Dual Axis Radiographic Hydrodynamic Test Facility: Construction Phase (1996)

As part of the Department of Energy's Mitigation Action Plan for the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility at LANL, baseline concentrations of radionuclides (tritium, cesium-137, strontium-90, plutonium-238, plutonium-239, americium-241, and total uranium) and heavy metals (silver, arsenic, barium, beryllium, cadmium, chromium, copper, mercury, nickel, lead, antimony, selenium and thallium) in soil, sediment, and vegetation (overstory and understory) around the DARHT facility during the construction phase in 1996. Also, uranium and beryllium concentrations in soil samples collected in 1993 from within the proposed DARHT facility area are reported. Most radionuclides in soils, sediments, and vegetation were within current background and/or long-term RSRLs (Fresquez et al., 1997a).

3. Radionuclides in Soils Collected from within and around Los Alamos National Laboratory: 1974–1996

A soil sampling program is the most direct means of determining the types, concentration/activity, and distribution of radionuclides within and around nuclear facilities. LANL, for example, has had a soil surveillance program since the early 1970s, and the purpose of this paper was to (1) evaluate this 20+ year data set to determine if there are any statistical differences in radionuclides (tritium; cesium-137; plutonium-238; plutonium-239, -240; americium-241; strontium-90; and total uranium) and radioactivity (gross alpha, beta, and gamma), as a function of air emissions and fugitive dust, in surface soils (0–5 cm depth) collected from LANL, perimeter and background sites, and (2) determine if radionuclide concentrations are increasing or decreasing over time. Also, the total effective dose equivalent (TEDE) and the corresponding risk of excess cancer fatalities (RECF) to a perimeter community were estimated. Based on the long-term average, 9 out of the 10 radionuclide parameters measured in LANL soils were significantly ($p<0.05$) higher in concentration than background ($n = 6$). Perimeter soils showed less differences with only 4 out of the 10 parameters being statistically higher in concentration than regional background. Most radionuclides in LANL and perimeter areas, with the exception of plutonium-238 in soils from perimeter areas, significantly decrease in concentration over time, so that by 1996 most radionuclides were approaching values similar to regional background. The maximum net positive TEDE (i.e., the TEDE + two sigma for each radioisotope minus background and then only the positive doses summed) for a resident living around the perimeter of LANL, as modeled by the residual radioactive (RESRAD) code using a residential scenario for soils collected from 1974–1996, 1993–1996, and 1996 was 2.9 mrem per year (29 µSv per year), 2.3 mrem per year (23 µSv per year), and 0.8 mrem per year (8 µSv per year), respectively. All upper bound TEDEs were far below the ICRP permissible dose limit of 100 mrem per year (1,000 µSv per year) for all pathways, and the highest TEDE corresponds to a RECF of 1.5×10^{-6}—an estimate far below the Environmental Protection Agency guideline of 10^{-4} (Fresquez et al., 1998).

4. Radionuclide Concentrations in Soils and Vegetation at Radioactive-Waste Disposal Technical Area 54, Area G during the 1997 Growing Season

Soil and overstory and understory vegetation (washed and unwashed) collected at eight locations within and around TA-54, Area G—a low-level radioactive solid-waste disposal facility at LANL—were analyzed for tritium, strontium-90, plutonium-238, plutonium-239, cesium-137, uranium-234, uranium-235, uranium-238, total uranium, americium-241, actinium-228, bismuth-214, cobalt-60, potassium-40, manganese-54, sodium-22, lead-214, and thallium-208. Also, heavy metals (silver, arsenic, barium, beryllium, cadmium, chromium, mercury, nickel, lead, antimony, selenium and thallium) in soil and vegetation were determined. In general, most radionuclide concentrations, with the exception of tritium and plutonium-239, in soils and washed and unwashed overstory and understory vegetation collected from within and around TA-54, Area G were within upper limit background concentrations. Tritium was detected as high as 14,744 pCi per milliliter in understory vegetation collected from transuranic (TRU) waste pad #4, and the TRU waste pad area contained the highest levels of plutonium-239 in soils and in understory vegetation when compared to other areas at TA-54, Area G (Fresquez et al., 1997b).

5. The Distributions and Diversity of Fungal Species in and adjacent to the Los Alamos National Laboratory

Previously archived information representing 43 sample locations was used to perform a preliminary evaluation of the distributions and diversity of fungal species at LANL and in adjacent environments. Presence-absence data for 71 species of fungi in 5 habitats: piñon-juniper, canyon-bottom ponderosa pine, ponderosa pine, canyon-bottom mixed conifer, and mixed conifer were analyzed. The results indicate that even though fungi occur in each of the habitats, fungal species are not distributed evenly among these habitats. The richness of fungal species is greater in the canyon-bottom mixed conifer and mixed conifer habitats than in the piñon-juniper, canyon-bottom ponderosa pine, or ponderosa pine habitats. All but three of the fungal species were recorded in either the canyon-bottom mixed conifer or the mixed conifer habitats, and all but seven of the fungal species were found in the mixed conifer habitat. In addition, species fidelity increases from the piñon-juniper to the mixed conifer. Five of the species have a high fidelity to the mixed conifer, and 13 species have a high fidelity to either the canyon-bottom mixed conifer or the mixed conifer habitats. In contrast, only eight fungal species were found in the piñon-juniper habitat, and none of these were found with high fidelity or in high abundance. Finally, only two species of fungi were collected in all five of the habitats (Balice et al., 1997a).

6. A Survey of Macromycete Diversity at Los Alamos National Laboratory, Bandelier National Monument, and Los Alamos County

A 5-year survey (1991 to 1995) was completed of macromycetes found in Los Alamos County, Los Alamos National Laboratory, and Bandelier National Monument. A database of 1,048 collections has been compiled, including their characteristics and identifications. The database represents 123 (98%) genera and 175 (73%) species reliably identified. Issues of habitat loss, species extinction, and ecological relationships are addressed, and comparisons with other surveys are made (Jarmie and Rogers 1997).

7. Preliminary Vegetation and Land Cover Classification for the Los Alamos Region

The major vegetation and land cover types in the Los Alamos region were classified according to a hierarchical scheme. Ten Level I cover types were identified, and each of these was subdivided into two or more Level II cover types. For identification purposes, a dichotomous key was developed. The Level I classes reflect major physiognomic and floristic groupings and correspond to the categories that arose during supervised and unsupervised classifications of Thematic mapper imagery. The Level II divisions are based on the dominant or codominant species and the characteristics of the physical environment. The implications of these land cover classes to management of vegetation and wildlife, particularly threatened and endangered species, are discussed where appropriate (Balice et al., 1997b).

8. Development of a Land Cover Map for Los Alamos National Laboratory and Vicinity

LANL's Threatened and Endangered Species Habitat Management Plan calls for identifying areas on LANL property that are suitable or potentially suitable habitat for federally listed species. The production of a land cover map was the first step toward meeting this goal. A 1992 Landsat thematic mapper image was sorted into 30 classes using the Iterative Self-Organizing Data Analysis Technique. These 30 classes were aggregated into 10 land cover types through field surveys, aerial photo interpretation, and the incorporation of topographic information. The resulting cover types include major vegetational zones and physiognomic types that are important to the distribution and abundance of several threatened and endangered species. The final land cover map has been integrated into an ARC/INFO geographic information system, along with habitat criteria and other environmental and biological data (Koch et al., 1997).

9. Honey Bees as Indicators of Radionuclide Contamination: Exploring Colony Variability and Temporal Contaminant Accumulation

Two aspects of using honey bees, (*Apis mellifera*), as indicators of environmental radionuclide contamination were investigated: colony variability and temporal contaminant accumulation. Two separate field experiments were conducted in areas with bioavailable radionuclide contamination. Bees were collected from colonies, analyzed for concentrations of radionuclides, and the results were compared using graphical and statistical methods. The first experiment indicates that generally a low variability exists between samples collected within the same colony. A higher variability exists between samples collected from adjacent colonies. Levels of tritium and sodium-22 found in samples taken from similar colonies were inconsistent, while levels of cobalt-57, cobalt-60, and manganese-54 were consistent. A second experiment investigated the accumulation of radionuclides over time by comparing colonies that had been in the study area for different periods of time. This experiment demonstrated that there is indeed a significant accumulation of radionuclides within colonies (Haarmann 1997).

10. Radionuclide Concentrations in Honey Bees from Technical Area 54, Area G during 1997

Honey bees were collected from two colonies located at TA-54, Area G and from one control background colony located near Jemez Springs. Samples were analyzed for the following: cesium-137; americium-241; plutonium-238; plutonium-239, -240; tritium; total uranium; and gross gamma activity. TA-54, Area G sample results from both colonies were higher than the upper (95%) level background concentration for plutonium-238 and tritium (Haarmann and Fresquez 1998).

11. A Spatially-Dynamic Preliminary Risk Assessment of the Bald Eagle at the Los Alamos National Laboratory

The Endangered Species Act of 1973 and the Record of Decision on DARHT at the Laboratory require that DOE protect the bald eagle (*Haliaeetus leucocephalus*), a state and federally listed species, from stressors such as contaminants. A preliminary risk assessment of the bald eagle was performed. Estimated exposure doses to the eagle for radionuclide, inorganic metal, and organic contaminants were derived for varying ratios of aquatic fish vs. terrestrial simulated diet and compared against toxicity reference values to generate hazard indices. Results indicate that no appreciable impact to the bald eagle is expected from contaminants at LANL from soil ingestion and food consumption pathways. This includes a measure of cumulative effects from multiple contaminants that assumes linear additive toxicity. Improving model realism by weighting simulated eagle foraging based on distance from potential roost sites increased the hazard indices by 76% but still to inconsequential levels. Information on risk by specific geographical location was generated, and can be used to manage contaminated areas, eagle habitat, facility siting, and/or facility operations in order to maintain risk from contaminants at low levels (Gonzales et al., 1998).

12. Radionuclide Contaminant Analysis of Small Mammals at Technical Area 54, Area G, 1996 (with cumulative summary for 1994–96)

Small mammals which live in the vicinity of two waste burial sites at TA-54, Area G and a control site were sampled to (1) identify radionuclides that are present within rodent tissues at waste burial sites, (2) to compare the amount of radionuclide uptake by small mammals at waste burial sites to a control site, and (3) to identify the primary mode of contamination to small mammals, either through surface contact or ingestion/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. Higher 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. Due to low sample sizes of the total number of animals captured, statistical analysis to compare site to site could not be conducted. However, mean concentrations of total uranium, plutonium-238, plutonium-239, and cesium-137 in rodent carcasses were higher at Site 1 than Site 2 or the Control Site and americium-241was higher at Site 2 than Site 1 or the Control Site (Biggs et al., 1997a).

13. Evaluation of Habitat Use by Rocky Mountain Elk in North-Central New Mexico Using Global Positioning System Radio Collars

In 1996, LANL initiated a study to identify habitat use in north-central New Mexico by Rocky Mountain elk (*Cervus elaphus nelsoni*) using global positioning system (GPS) radio collars. We collared 6 elk (5 cows/1 bull) in the spring of 1996 with GPS radio collars programmed to obtain locational fixes every 23 h. Between April 1, 1996, and January 7, 1997, we collected more than 1,200 fixes with an approximately 70% observation rate. GPS locational fixes of elk were interfaced with detailed vegetation maps using the Geographic Information System (GIS) to provide seasonal (calving, late summer, fall, winter) habitat use within mountainous regions of north-central New Mexico. Based on habitat use and availability analysis, use of grass/shrub and piñon-juniper habitats was generally higher than expected during most seasons and use of forested habitats (ponderosa pine, mixed conifer) was lower than expected. Most of the collared elk remained on LANL property year-round. The application of GPS collars to elk studies in north-central New Mexico is believed to be a more efficient and effective method than the use of very high-frequency radio collars (Biggs et al., 1997b).

14. Estimation of Home Range and Water Resource Use of Elk at Los Alamos National Laboratory

LANL estimated yearly and seasonal home ranges of six GPS-collared elk that occupied Laboratory land at least partially between February 1996 and September 1997, using the Program CALHOME. Seasonal home ranges varied from 903 ha to 5,004 ha during winter, 1,218 ha to 6,157 ha in spring, 2,138 ha to 7,907 ha during calving, 1,957 ha to 3,306 ha in summer, and 3021 ha to 10,160 ha in fall. Seasonal core activity areas (50%) were generally less than 500 ha. for most animals. We evaluated relative percent seasonal and yearly water source use by overlaying permanent water sources on to the GIS and calculating the number of locational fixes within a set of five distances from that source: 0.25 mi., 0.50 mi., 0.75 mi., 1.0 mi., and 2.0 miles. Cumulated use was 17%, 35%, 49%, 61%, and 90%, respectively (Biggs et al., 1997c).

15. Determination of Locational Error Associated with Global Positioning System Radio Collars in Relation to Vegetation and Topography in North-Central New Mexico

In 1996, LANL initiated a study to assess seasonal habitat use and movement patterns of Rocky Mountain elk (*Cervus elaphus nelsoni*) using GPS radio collars. As part of this study, LANL attempted to assess the accuracies of GPS (nondifferentially corrected) positions under various vegetation canopies and terrain conditions with the use of a GPS test collar. The test collar was activated every 20 min to obtain a position location and continuously uplinked to Argos satellites to transfer position data files. A Telonics, Inc. uplink receiver was used to intercept the transmission and view the results of the collar in real time. The collar was placed on a stand equivalent to the neck height of an adult elk and then the stand was placed within three different treatment categories: topographical influence (canyon and mesa tops), canopy influence (open and closed canopy), and vegetation type influence (ponderosa pine and piñon pine-juniper). The collar was kept at each location for one hour (usually obtaining three fixes). In addition, we used a hand-held GPS to obtain a position of the test collar at the same time and location. The hand-held unit was differentially corrected. Previous tests of the hand-held unit indicated that the accuracy was within two meters of an actual position. To determine locational error of the test collar within the different treatments, we made comparisons between the test collar and the hand-held GPS following correction. The overall mean locational error was 106 ± 16 m (354 ± 53 ft). There were no statistical differences in locational errors between ponderosa pine and piñon pine-juniper vegetation types, open and closed canopies, or canyons and mesa tops. Observation rate was also calculated for each treatment category. There were no statistical differences between observation rates of the three treatments (Bennett et al., 1997).

Table 6-1. Radiochemical Analyses of Soils Collected during 1997

Location	^{3}H (pCi/mL)	^{90}Sr (pCi/g dry)	^{137}Cs (pCi/g dry)	^{tot}U (µg/g dry)	^{238}Pu (pCi/g dry)	^{239,240}Pu (pCi/g dry)	^{241}Am (pCi/g dry)	Gross Alpha (pCi/g dry)	Gross Beta (pCi/g dry)	Gross Gamma (pCi/g dry)
Regional Background Stations:										
Embudo	–0.16 (0.36)[a,b]	0.61 (0.75)	0.22 (0.03)	1.54 (0.15)	0.001 (0.001)	0.012 (0.002)	0.003 (0.002)	3.4 (2.0)	2.4 (0.6)	2.2 (0.3)
Cochiti	–0.21 (0.39)	0.67 (0.63)	0.32 (0.04)	1.77 (0.18)	–0.000 (0.001)	0.013 (0.002)	0.005 (0.001)	2.0 (1.2)	2.8 (1.1)	2.2 (0.3)
Jemez	–0.10 (0.49)	1.08 (0.76)	0.22 (0.04)	2.77 (0.28)	0.000 (0.001)	0.011 (0.002)	0.010 (0.018)	2.5 (1.8)	2.4 (1.0)	3.1 (0.4)
Mean (std dev)	–0.16 (0.06)	0.79 (0.26)	0.25 (0.06)	2.03 (0.65)	0.000 (0.001)	0.012 (0.001)	0.006 (0.004)	2.6 (0.7)	2.5 (0.2)	2.5 (0.5)
RSRL[c]	1.06	0.71	0.60	3.16	0.010	0.021	0.011	6.1	6.2	4.1
SAL[d]	1,900.00[e]	4.40	5.10	29.00	27.000	24.000	22.000	– – –	– – –	– – –
Perimeter Stations:										
Otowi	–0.29 (0.30)	0.25 (1.13)	0.31 (0.04)	3.26 (0.33)	0.002 (0.001)	0.052 (0.003)	0.023 (0.002)	2.2 (1.5)	2.8 (1.1)	NA[f]
TA-8 (GT Site)	0.28 (0.37)	1.07 (0.78)	0.89 (0.10)	2.93 (0.29)	0.003 (0.001)	0.038 (0.003)	0.060 (0.011)	7.1 (2.0)	6.1 (1.5)	3.9 (0.4)
Near TA-49 (BNP)	0.03 (0.87)	1.16 (0.59)	0.57 (0.07)	5.17 (0.52)	0.002 (0.001)	0.021 (0.002)	0.012 (0.002)	2.5 (0.8)	5.1 (1.4)	3.6 (0.4)
East Airport	0.06 (0.21)	0.93 (0.70)	0.29 (0.04)	3.41 (0.34)	0.001 (0.001)	0.042 (0.003)	0.008 (0.001)	4.7 (1.5)	3.5 (1.1)	3.5 (0.4)
West Airport	0.09 (0.33)	0.86 (0.72)	0.17 (0.03)	3.43 (0.34)	0.001 (0.001)	0.049 (0.004)	0.007 (0.002)	5.2 (1.8)	3.8 (1.2)	3.3 (0.4)
North Mesa	0.64 (0.32)	1.24 (0.75)	0.35 (0.05)	3.69 (0.37)	0.001 (0.001)	0.020 (0.002)	0.005 (0.001)	8.8 (2.9)	4.6 (1.3)	3.5 (0.4)
Sportsman's Club	0.25 (0.48)	1.11 (0.80)	0.44 (0.06)	3.93 (0.39)	0.001 (0.001)	0.036 (0.003)	0.010 (0.002)	9.1 (2.8)	4.9 (0.9)	3.6 (0.4)
Tsankawi/PM-1	–0.40 (0.34)	0.93 (0.82)	0.16 (0.03)	5.15 (0.52)	0.001 (0.001)	0.005 (0.001)	0.005 (0.001)	7.1 (2.4)	2.8 (1.1)	3.9 (0.4)
White Rock (East)	0.06 (0.30)	0.99 (0.75)	0.31 (0.04)	3.15 (0.32)	–0.002 (0.001)	0.014 (0.003)	0.010 (0.002)	4.5 (1.7)	3.7 (1.2)	3.6 (0.4)
San Ildefonso	0.04 (0.30)	1.05 (0.76)	0.29 (0.04)	2.77 (0.28)	0.002 (0.001)	0.014 (0.002)	0.007 (0.001)	4.8 (1.8)	2.7 (1.0)	3.3 (0.4)
Mean (std dev)	0.08 (0.29)	0.96 (0.27)	0.38 (0.22)	3.69 (0.84)	0.001 (0.001)	0.029 (0.016)	0.015 (0.017)	5.6 (2.4)	4.0 (1.1)	3.6 (0.2)
On-Site Stations:										
TA-16 (S-Site)	–0.05 (0.24)	0.79 (0.17)	0.82 (0.07)	6.17 (0.62)	0.002 (0.001)	0.041 (0.003)	0.016 (0.002)	10.5 (2.9)	6.1 (1.5)	4.5 (0.5)
TA-21 (DP-Site)	0.19 (0.24)	0.67 (0.20)	0.14 (0.02)	3.01 (0.30)	0.010 (0.002)	0.868 (0.020)	0.065 (0.005)	10.0 (2.8)	4.5 (0.8)	2.8 (0.3)
Near TA-33	–0.12 (0.28)	0.64 (0.51)	0.30 (0.04)	2.98 (0.30)	0.000 (0.001)	0.015 (0.002)	0.007 (0.002)	3.2 (1.4)	3.3 (1.1)	3.5 (0.4)
TA-50	–0.06 (0.19)	0.51 (0.17)	0.11 (0.02)	2.75 (0.28)	0.002 (0.001)	0.032 (0.003)	0.008 (0.002)	6.1 (2.0)	4.2 (1.2)	3.2 (0.4)
TA-51	0.37 (0.21)	0.46 (0.22)	0.18 (0.02)	3.08 (0.31)	0.001 (0.001)	0.011 (0.002)	0.003 (0.001)	6.9 (2.1)	3.5 (1.1)	3.2 (0.4)
West of TA-53	0.10 (0.22)	0.69 (0.17)	0.14 (0.02)	3.06 (0.31)	0.001 (0.001)	0.016 (0.003)	0.005 (0.001)	5.2 (1.9)	7.4 (1.7)	3.4 (0.4)
East of TA-53	0.49 (0.28)	0.70 (0.13)	0.94 (0.08)	3.02 (0.30)	0.002 (0.001)	0.053 (0.003)	0.015 (0.002)	5.6 (1.9)	3.6 (1.2)	3.2 (0.4)
East of TA-54	0.46 (0.20)	0.49 (0.33)	0.43 (0.04)	2.83 (0.28)	0.004 (0.001)	0.043 (0.003)	0.014 (0.002)	6.0 (1.9)	3.6 (1.2)	3.5 (0.4)
Potrillo Drive/TA-36	0.09 (0.13)	0.76 (0.21)	0.31 (0.04)	3.05 (0.31)	–0.001 (0.001)	0.014 (0.002)	0.005 (0.001)	6.2 (2.1)	3.5 (1.2)	3.5 (0.4)
Near Test Well DT-9	0.06 (0.17)	0.70 (0.15)	0.35 (0.04)	2.53 (0.25)	0.001 (0.000)	0.010 (0.002)	0.006 (0.002)	8.2 (2.2)	4.4 (1.3)	3.2 (0.4)
R-Site Road East	–0.03 (0.15)	0.87 (0.22)	0.46 (0.05)	5.35 (0.54)	0.002 (0.001)	0.020 (0.002)	0.012 (0.002)	6.6 (2.2)	3.9 (1.2)	3.2 (0.4)
Two-Mile Mesa	0.28 (0.23)	0.49 (0.23)	0.35 (0.04)	3.23 (0.32)	–0.000 (0.000)	0.009 (0.002)	0.005 (0.001)	8.5 (2.4)	3.9 (1.2)	3.1 (0.4)
Mean (std dev)	0.15 (0.21)	0.65 (0.13)	0.38 (0.26)	3.42 (1.12)	0.002 (0.003)	0.094 (0.244)	0.013 (0.017)	6.9 (2.1)	4.3 (1.2)	3.4 (0.4)

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

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1993 to 1997 for Embudo, Cochiti, and Jemez.

[d] Los Alamos National Laboratory Screening Action Level from Fresquez et al. (1996a).

[e] Equivalent to the SAL of 260 pCi/g dry soil at 12% moisture.

[f] Not analyzed, lost in analysis, or outlier omitted.

Table 6-2. Total Recoverable Trace and Heavy Metals (μg/g dry) in Soils Collected during 1997[a]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl[c]
Regional Background Stations:												
Embudo	0.50[b]	0.40	64.0	0.20	NA[c]	1.90	NA	2.50[b]	5.20	NA	0.50[b]	0.03[b]
Cochiti	0.50[b]	0.50	64.0	0.10		1.10		2.50[b]	6.30		0.50[b]	0.03[b]
Jemez	0.50[b]	1.80	48.0	0.20		1.20		2.50[b]	6.80		0.50[b]	0.03[b]
Mean	0.50	0.90	58.7	0.17		1.40		2.50	6.10		0.50	0.03
(std dev)	(0.00)	(0.78)	(9.2)	(0.06)		(0.44)		(0.00)	(0.82)		(0.00)	(0.00)
RSRL[d]	2.09	6.05	194.0	0.74	0.20	14.78	0.02	10.96	14.42	0.20	0.62	0.84
SAL[e]	400.00	6.00	5,600.0	0.90	80.00	400.00	24.00	1,600.00	500.00		400.0	
Perimeter Stations:												
Otowi	0.50[b]	0.30	38.0	0.20		1.00		2.50[b]	5.0		0.50[b]	0.03[b]
TA-8 (GT Site)	0.50[b]	0.90	74.0	0.20		1.50		2.50[b]	11.3		0.50[b]	0.03[b]
TA-49 (BNP)	0.50[b]	1.10	111.0	0.40		1.70		2.50[b]	14.0		0.50[b]	0.06
East Airport	0.50[b]	0.70	52.0	0.30		1.10		2.50[b]	13.9		0.50[b]	0.03[b]
West Airport	0.50[b]	1.10	93.0	0.30		2.10		2.50[b]	18.7		0.50[b]	0.03[b]
North Mesa	0.50[b]	1.00	81.0	0.30		2.10		2.50[b]	9.9		0.50[b]	0.03[b]
Sportsman’s Club	0.50[b]	1.50	106.0	0.40		2.10		2.50[b]	14.8		0.50[b]	0.03[b]
Tsankawi/PM-1	0.50[b]	0.15[b]	23.0	0.30		1.00		2.50[b]	11.5		0.50[b]	0.03[b]
White Rock (East)	0.50[b]	0.60	86.0	0.50		1.30		2.50[b]	14.1		0.50[b]	0.03[b]
San Ildefonso	0.50[b]	0.50	33.0	0.20		1.00		2.50[b]	6.8		0.50[b]	0.03[b]
Mean	0.50	0.79	69.7	0.31		1.49		2.50	12.0		0.50	0.03
(std dev)	(0.00)	(0.41)	(31.3)	(0.10)		(0.48)		(0.00)	(4.0)		(0.00)	(0.01)
On-Site Stations:												
TA-16 (S-Site)	0.50[b]	0.80	160.0	0.50		1.40		2.50[b]	11.0		0.50[b]	0.07
TA-21 (DP-Site)	0.50[b]	1.10	106.0	0.40		3.20		2.50[b]	26.5		0.50[b]	0.09
Near TA-33	0.50[b]	0.60	128.0	0.50		2.60		2.50[b]	10.7		0.50[b]	0.10
TA-50	0.50[b]	1.00	109.0	0.40		3.30		2.50[b]	11.5		0.50[b]	0.11
TA-51	0.50[b]	0.90	106.0	0.30		3.10		2.50[b]	12.6		0.50[b]	0.11
West of TA-53	0.50[b]	1.00	100.0	0.40		3.30		2.50[b]	11.1		0.50[b]	0.10
East of TA-53	0.50[b]	0.80	48.0	0.40		1.80		2.50[b]	12.9		0.50[b]	0.05
East of TA-54	0.50[b]	0.50	49.0	0.30		1.40		2.50[b]	8.7		0.50[b]	0.03
Potrillo Drive/TA-36	0.50[b]	1.00	71.0	0.30		2.70		2.50[b]	10.6		0.50[b]	0.07
Near Test Well DT-9	0.50[b]	0.70	97.0	0.40		2.30		2.50[b]	10.4		0.50[b]	0.09
R-Site Road	0.50[b]	1.30	102.0	0.40		2.70		2.50[b]	12.8		0.50[b]	0.08
Two-Mile Mesa	0.50[b]	1.40	102.0	0.40		3.80		2.50[b]	12.5		0.50[b]	0.11
Mean	0.50	0.93	98.2	0.39		2.63		2.50	12.6		0.50	0.08
(std dev)	(0.00)	(0.27)	(31.1)	(0.07)		(0.78)		(0.00)	(4.5)		(0.00)	(0.03)

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[a] Analysis by EPA Method 3051 for total recoverable metals.

[b] All less-than values were converted to one-half the concentration (Gilbert 1987).

[c] Not analyzed, lost in analysis, or an outlier that was omitted; and in the case of Cd (<1 μg/g), Hg (<20 μg/g), and Sb (<1 μg/g) results, these data were not reported because the minimum detection levels were higher than what was employed in the past.

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1994 to 1997.

[e] Los Alamos National Laboratory Screening Action Level.

Table 6-3. Radionuclides in Produce Collected from Off-Site, Perimeter, and On-Site Areas during the 1997 Growing Season[a]

Location	^{3}H (pCi/mL)		^{137}Cs (10^{-3} pCi/g dry)		^{90}Sr (10^{-3} pCi/g dry)		^{tot}U (ng/g dry)		^{238}Pu (10^{-5} pCi/g dry)		^{239,240}Pu (10^{-5} pCi/g dry)		^{241}Am (10^{-5} pCi/g dry)	
Regional Background Stations														
Española/Santa Fe/Jemez:														
Squash	–0.29	(0.62)[b,c]	40.61	(61.57)	1.3	(19.7)	NA[d]		–1.3	(2.6)	10.5	(3.9)	10.5	(3.9)
Tomato	0.25	(0.66)	6.00	(24.00)	35.0	(85.0)	NA		2.0	(2.0)	4.0	(3.0)	–5.0	(21.0)
Cucumber	–0.06	(0.64)	136.99	(206.15)	234.1	(385.7)	2.66	(1.33)	–4.0	(6.7)	13.3	(12.0)	66.5	(25.3)
Apple	0.10	(0.65)	2.52	(3.60)	2.2	(10.4)	0.36	(0.36)	3.2	(2.2)	4.0	(2.2)	2.5	(1.4)
Corn	–0.11	(0.64)	NA		127.4	(210.6)	0.64	(0.64)	–21.8	(9.0)	6.4	(14.1)	16.6	(14.1)
Collard	–0.17	(0.63)	70.0	(102.5)	15.0	(165.0)	NA		–1.3	(4.0)	6.7	(5.3)	18.6	(10.6)
Mean (std dev)	–0.05	(0.19)	51.22	(55.31)	69.2	(93.6)	1.22	(1.25)	–3.9	(9.2)	7.5	(3.7)	18.3	(25.2)
RSRL[e]	0.39		73.8		81.6		17.4		11.2		16.2		20.5	
Perimeter Stations														
Los Alamos:														
Corn	1.60	(0.74)	34.56	(51.84)	23.0	(53.8)	0.64	(0.64)	21.1	(25.0)	8.3	(23.7)	–5.1	(6.4)
Tomato	–0.13	(0.72)	39.00	(7.00)	–1.0	(18.0)	0.00	(1.00)	11.0	(10.0)	26.0	(14.0)	–50.0	(22.0)
Squash	–0.13	(0.72)	102.18	(24.89)	260.7	(203.1)	1.31	(1.31)	–5.2	(39.3)	–11.8	(43.2)	10.5	(44.5)
Peach	0.24	(0.74)	12.16	(2.28)	–6.8	(26.6)	1.52	(0.76)	62.3	(22.8)	122.4	(31.2)	13.7	(5.3)
Nectarine	0.02	(0.73)	–2.34	(18.72)	–7.0	(14.0)	0.78	(0.78)	15.6	(57.7)	73.3	(48.4)	0.0	(2.3)
Cherry	0.05	(0.73)	16.66	(3.92)	–23.5	(26.5)	0.98	(0.98)	–8.8	(8.8)	–5.9	(13.7)	–10.8	(2.9)
Apple	0.16	(0.74)	37.44	(7.92)	–9.4	(37.4)	1.44	(0.36)	9.7	(12.2)	0.7	(16.2)	–2.5	(10.8)
Peach	1.22	(0.80)	6.84	(9.88)	–19.0	(16.7)	1.52	(0.76)	4.6	(3.8)	3.8	(3.8)	20.5	(7.6)
Lettuce	3.60	(0.74)	–87.50	(60.00)	157.5	(292.5)	27.50	(2.50)	7.5	(37.5)	65.0	(47.5)	177.5	(162.5)
Mean (std dev)	0.74	(1.24)	17.67	(49.85)	41.6	(99.3)	3.97	(8.84)	13.1	(20.7)	31.3	(45.7)	17.1	(63.5)
White Rock/Pajarito Acres:														
Bean	0.00	(0.68)	–3.12	(18.72)	24.2	(29.6)	17.94	(1.56)	–5.5	(6.2)	40.6	(12.5)	52.3	(16.4)
Lettuce	–0.26	(0.66)	0.00	(60.00)	52.5	(87.5)	12.50	(2.50)	–10.0	(22.5)	117.5	(42.5)	27.5	(32.5)
Cucumber	–0.34	(0.66)	–7.98	(31.9)	53.2	(49.2)	5.32	(1.33)	–17.3	(6.7)	42.6	(18.6)	85.1	(27.9)
Squash	0.04	(0.68)	11.79	(18.34)	68.1	(51.1)	5.24	(1.31)	0.0	(3.9)	22.3	(7.9)	41.9	(26.2)
Corn	–0.40	(0.65)	3.84	(5.76)	–3.8	(21.8)	0.64	(0.64)	–1.9	(6.4)	–5.8	(9.0)	0.6	(5.1)
Tomato	0.35	(0.70)	–3.00	(24.00)	–17.0	(51.0)	2.00	(1.00)	37.0	(22.0)	21.0	(32.0)	22.0	(14.0)
Apple	0.13	(0.69)	11.16	(16.92)	6.1	(14.0)	1.44	(0.36)	3.6	(5.8)	9.7	(7.9)	13.3	(6.5)
Mean (std dev)	–0.07	(0.27)	1.81	(7.50)	26.2	(35.5)	6.44	(6.46)	–9.7	(13.9)	35.4	(39.9)	34.7	(28.1)

Table 6-3. Radionuclides in Produce Collected from Off-Site, Perimeter, and On-Site Areas during the 1997 Growing Season[a] (Cont.)

Location	^{3}H (pCi/mL)		^{137}Cs (10^{-3} pCi/g dry)		^{90}Sr (10^{-3} pCi/g dry)		^{tot}U (ng/g dry)		^{238}Pu (10^{-5} pCi/g dry)		^{239,240}Pu (10^{-5} pCi/g dry)		^{241}Am (10^{-5} pCi/g dry)	
Cochiti:														
Squash	–0.03	(0.66)	73.36	(110.04)	85.2	(187.3)	6.55	(1.31)	–17.0	(13.1)	–7.9	(17.0)	40.6	(14.4)
Cucumber	–0.07	(0.66)	15.96	(22.61)	238.1	(295.3)	2.66	(1.33)	–21.3	(21.3)	–5.3	(14.6)	53.2	(25.3)
Tomato	0.38	(0.69)	–10.00	(24.00)	0.0	(167.0)	1.00	(1.00)	–5.0	(6.0)	–2.0	(6.0)	24.0	(9.0)
Bell pepper	0.22	(0.68)	–21.17	(17.52)	–8.0	(172.3)	8.76	(0.73)	8.8	(13.9)	25.6	(20.4)	75.9	(101.5)
Apple	0.47	(0.69)	8.64	(2.16)	–3.2	(17.3)	0.36	(0.36)	0.0	(1.4)	1.1	(2.2)	1.1	(2.2)
Lettuce	–0.11	(0.66)	105.00	(155.00)	30.0	(317.5)	25.00	(2.50)	12.5	(20.0)	20.0	(25.0)	17.5	(52.5)
Mean (std dev)	0.14	(0.25)	28.63	(49.73)	57.0	(95.3)	7.39	(9.22)	–3.7	(13.6)	5.3	(14.0)	35.4	(26.9)
Pueblo of San Ildefonso:														
Apple	–0.30	(0.66)	0.72	(0.72)	5.8	(22.3)	1.08	(0.36)	–2.9	(3.6)	1.8	(3.6)	–4.3	(11.9)
Apple	–0.62	(0.64)	0.00	(8.64)	–7.9	(13.7)	0.72	(0.36)	9.7	(6.8)	–5.8	(4.7)	17.6	(13.0)
Squash	–0.30	(0.66)	7.86	(13.10)	–27.5	(159.8)	14.41	(1.31)	1.3	(7.9)	–2.6	(3.9)	–1.3	(9.2)
Corn	–0.34	(0.66)	6.40	(9.60)	–42.2	(80.0)	1.28	(0.64)	–1.3	(3.8)	–0.6	(3.8)	10.2	(8.3)
Cucumber	0.11	(0.69)	1.33	(2.66)	14.6	(155.6)	3.99	(1.33)	–31.9	(10.6)	–29.3	(22.6)	38.6	(13.3)
Tomato	0.33	(0.70)	10.00	(4.00)	–11.0	(60.0)	2.00	(1.00)	11.0	(7.0)	24.0	(9.0)	4.0	(6.0)
Mean (std dev)	–0.19	(0.34)	4.39	(4.23)	–11.4	(20.9)	3.91	(5.27)	–2.4	(15.6)	–2.1	(17.0)	10.8	(15.8)
On-Site Stations														
LANL (Mesa):														
Peach	1.63	(0.78)	20.52	(30.40)	48.6	(58.5)	0.76	(0.76)	–6.8	(8.4)	–0.8	(10.6)	32.7	(22.0)
Apple	0.31	(0.70)	66.24	(10.44)	68.4	(53.3)	2.16	(0.36)	–5.4	(11.5)	5.4	(9.0)	–32.0	(24.5)
Peach	–0.03	(0.68)	44.84	(10.64)	120.1	(69.2)	3.04	(0.76)	–11.4	(6.8)	38.8	(16.0)	29.6	(11.4)
Peach	14.60	(1.40)	26.60	(5.32)	29.6	(55.5)	2.28	(0.76)	16.0	(9.9)	12.9	(10.6)	113.2	(43.3)
Nectarine	0.12	(0.69)	–7.80	(140.40)	NA		1.56	(0.78)	–13.3	(5.5)	6.2	(12.5)	–70.2	(14.8)
Apple	0.74	(0.73)	32.76	(7.20)	46.1	(47.2)	0.72	(0.36)	4.3	(6.5)	4.3	(7.9)	51.1	(18.0)
Mean (std dev)	2.90	(5.77)	30.53	(24.78)	62.6	(35.0)	1.75	(0.92)	–2.8	(11.1)	11.1	(14.2)	20.7	(64.4)

Table 6-3. Radionuclides in Produce Collected from Off-Site, Perimeter, and On-Site Areas during the 1997 Growing Season[a] (Cont.)

Location	^{3}H (pCi/mL)		^{137}Cs (10^{-3} pCi/g dry)		^{90}Sr (10^{-3} pCi/g dry)		^{tot}U (ng/g dry)		^{238}Pu (10^{-5} pCi/g dry)		^{239,240}Pu (10^{-5} pCi/g dry)		^{241}Am (10^{-5} pCi/g dry)	
On-Site Stations														
LANL (Mortandad Canyon):														
Raspberries	0.005	(0.021)	12.3	(18.3)	105.6	(85.8)	12.6	(1.2)	84.9	(24.6)	77.7	(25.2)	54.9	(33.0)
Currants	–0.005	(0.034)	21.5	(5.0)	192.5	(58.5)	3.5	(0.5)	17.0	(5.5)	35.0	(7.5)	100.5	(27.5)
Acorns	0.174	(0.030)	2,763.0	(204.0)	460.2	(97.5)	0.6	(0.3)	5.7	(3.9)	5.1	(4.2)	15.6	(9.6)
Wild Rhubarb	0.154	(0.173)	554.4	(67.2)	2,901.6	(441.6)	36.0	(4.8)	9,866.4	(266.4)	10,603.2	(280.8)	23,992.8	(1,027.2)
Rose Hips	0.082	(0.032)	30.4	(45.6)	149.6	(63.6)	2.4	(0.4)	0.4	(4.8)	–4.0	(6.4)	5.2	(8.8)
Pinon (shoot tips)	0.001	(0.054)	34.4	(51.2)	51.2	(38.4)	20.8	(2.4)	16.0	(16.0)	18.4	(16.8)	53.6	(28.8)
Strawberries	0.092	(0.047)	492.0	(738.0)	9,421.8	(878.4)	7.8	(0.6)	764.4	(156.0)	307.8	(124.2)	654.0	(285.0)
Mean (std dev)	0.072	(0.074)	558.3	(1,000.4)	1,897.5	(3,470.6)	12.0	(12.7)	1,536.4	(3,683.6)	1,577.6	(3,981.4)	3,553.8	(9,015.7)

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[a] There are no concentration guides for produce.

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

[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[d] Not analyzed, lost in analyses, or outlier omitted.

[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on worldwide fallout data from 1993 to 1997.

Table 6-4. Total Recoverable Trace and Heavy Metals (μg/g dry) in Produce Collected during 1997[a]

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl
Regional Background Stations												
Española/Santa Fe/Jemez:												
Squash	0.50[b]	0.10	8.95	0.05[b]	0.08	0.80	0.05[b]	0.01[b]	1.1	0.50[b]	0.10[b]	0.03[b]
Tomato	0.50[b]	0.10	3.67	0.05[b]	0.03[b]	1.34	0.05[b]	6.48	3.7	0.50[b]	0.20	0.03[b]
Cucumber	0.50[b]	1.00	47.50	0.05[b]	0.10	0.78	0.05[b]	28.10	25.9	0.50[b]	0.20	0.03[b]
Apple	0.50[b]	0.05[b]	3.70	0.05[b]	0.13	0.40	0.05[b]	70.81	21.2	0.50[b]	0.10[b]	0.03[b]
Corn	0.50[b]	0.10	8.80	0.05[b]	0.03[b]	0.64	0.05[b]	3.48	5.6	0.50[b]	0.20	0.03[b]
Collard	0.50[b]	2.00	23.37	0.05[b]	0.24	1.02	0.05[b]	4.69	3.9	0.50[b]	1.30	0.61
Mean	0.50	0.56	16.00	0.05	0.10	0.83	0.05	18.93	10.2	0.50	0.35	0.13
(std dev)	(0.00)	(0.80)	(17.04)	(0.00)	(0.08)	(0.32)	(0.00)	(27.31)	(10.5)	(0.00)	(0.47)	(0.24)
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
Perimeter Stations												
Los Alamos:												
Corn	0.50[b]	0.05[b]	1.21	0.05[b]	0.03[b]	0.49	0.05[b]	6.51	16.4	0.50[b]	0.10[b]	0.03[b]
Tomato	0.50[b]	0.05[b]	6.11	0.05[b]	0.05	1.75	0.05[b]	10.11	4.5	0.50[b]	0.20	0.03[b]
Squash	0.50[b]	0.10	19.77	0.05[b]	0.03[b]	0.73	0.05[b]	1.91	3.0	0.50[b]	0.10[b]	0.03[b]
Peach	0.50[b]	0.10	4.62	0.05[b]	0.03[b]	0.74	0.05[b]	4.36	6.7	0.50[b]	0.10[b]	0.03[b]
Nectarine	0.50[b]	0.05[b]	4.45	0.05[b]	0.03[b]	1.24	0.05[b]	6.15	5.6	0.50[b]	0.10[b]	0.03[b]
Cherry	0.50[b]	0.05[b]	15.04	0.05[b]	0.03[b]	0.57	0.10	1.82	3.6	0.50[b]	0.10[b]	0.03[b]
Apple	0.50[b]	0.05[b]	5.22	0.05[b]	0.03[b]	0.29	0.05[b]	0.57	2.9	0.50[b]	0.10[b]	0.03[b]
Peach	0.50[b]	0.05[b]	1.63	0.05[b]	0.03[b]	1.51	0.05[b]	9.47	4.1	0.50[b]	0.10[b]	0.03[b]
Lettuce	0.50[b]	0.20	31.05	0.05[b]	0.19	1.63	0.05[b]	2.28	1.2	0.50[b]	0.30	0.03[b]
Mean	0.50	0.08	9.90	0.05	0.05	1.00	0.06	4.80	5.3	0.50	0.13	0.03
(std dev)	(0.00)	(0.05)	(10.06)	(0.00)	(0.05)	(0.54)	(0.02)	(3.47)	(4.5)	(0.00)	(0.07)	(0.00)
White Rock /Pajarito Acres:												
Bean	0.50[b]	0.05[b]	13.50	0.05[b]	0.05	0.55	0.05[b]	1.87	1.5	0.50[b]	0.20	0.03[b]
Lettuce	0.50[b]	0.20	62.68	0.05[b]	0.22	1.20	0.05[b]	1.16	1.9	0.50[b]	0.20	0.03[b]
Cucumber	0.50[b]	0.20	6.16	0.05[b]	0.15	0.96	0.05[b]	2.74	2.3	0.50[b]	0.40	0.03[b]
Squash	0.50[b]	0.05[b]	19.81	0.05[b]	0.03[b]	0.60	0.05[b]	3.31	1.6	0.50[b]	0.20	0.03[b]
Corn	0.50[b]	0.05[b]	1.04	0.05[b]	0.03[b]	0.47	0.05[b]	2.24	28.9	0.50[b]	0.10[b]	0.03[b]
Tomato	0.50[b]	0.05[b]	4.76	0.05[b]	0.09	3.01	0.05[b]	24.68	1.8	0.50[b]	0.20	0.03[b]
Apple	0.50[b]	0.05[b]	3.68	0.05[b]	0.03[b]	0.30	0.05[b]	1.16	7.6	0.50[b]	0.10[b]	0.03[b]
Mean	0.50	0.09	15.95	0.05	0.09	1.01	0.05	5.31	6.5	0.50	0.20	0.03
(std dev)	(0.00)	(0.07)	(21.60)	(0.00)	(0.07)	(0.93)	(0.00)	(8.58)	(10.1)	(0.00)	(0.10)	(0.00)

Table 6-4. Total Recoverable Trace and Heavy Metals (µg/g dry) in Produce Collected during 1997[a] (Cont.)

Location	Ag	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl
Cochiti/Peña Blanca/Santo Domingo:												
Squash	0.50[b]	0.05[b]	11.59	0.05[b]	0.03[b]	0.80	0.05[b]	4.20	2.6	0.50[b]	0.10[b]	0.03[b]
Cucumber	0.50[b]	0.20	7.71	0.05[b]	0.06	0.70	0.05[b]	4.11	1.6	0.50[b]	0.20	0.03[b]
Tomato	0.50[b]	0.05[b]	5.06	0.05[b]	0.12	0.70	0.05[b]	1.22	3.9	0.50[b]	0.20	0.03[b]
Bell pepper	0.50[b]	0.05[b]	2.91	0.05[b]	0.12	0.56	0.05[b]	2.21	23.6	0.50[b]	0.10[b]	0.03[b]
Apple	0.50[b]	0.05[b]	2.30	0.05[b]	0.03[b]	0.32	0.05[b]	0.47	2.5	0.50[b]	0.10[b]	0.03[b]
Lettuce	0.50[b]	0.20	27.10	0.05[b]	0.25	1.07	0.05[b]	32.65	7.9	0.50[b]	0.40	0.03[b]
Mean	0.50	0.10	9.45	0.05	0.10	0.69	0.05	7.48	7.0	0.50	0.18	0.03
(std dev)	(0.00)	(0.08)	(9.30)	(0.00)	(0.08)	(0.25)	(0.00)	(12.42)	(8.4)	(0.00)	(0.12)	(0.00)
Pueblo of San Ildefonso:												
Apple	0.50[b]	0.05[b]	1.60	0.05[b]	0.03[b]	0.59	0.05[b]	0.61	3.0	0.50[b]	0.10[b]	0.03[b]
Apple	0.50[b]	0.05[b]	22.18	0.05[b]	0.03[b]	0.83	0.05[b]	5.03	3.2	0.50[b]	0.10[b]	0.03[b]
Squash	0.50[b]	0.05[b]	14.39	0.05[b]	0.06	0.87	0.05[b]	11.63	3.6	0.50[b]	0.10[b]	0.03[b]
Corn	0.50[b]	0.05[b]	2.37	0.05[b]	0.03[b]	0.68	0.05[b]	4.59	12.2	0.50[b]	0.10[b]	0.03[b]
Cucumber	0.50[b]	0.10	9.86	0.05[b]	0.03[b]	0.78	0.05[b]	2.21	2.0	0.50[b]	0.10[b]	0.03[b]
Tomato	0.50[b]	0.10	6.90	0.05[b]	0.06	1.81	0.05[b]	5.69	13.7	0.50[b]	0.40	0.03[b]
Mean	0.50	0.07	9.55	0.05	0.04	0.93	0.05	4.96	6.3	0.50	0.15	0.03
(std dev)	(0.00)	(0.03)	(7.81)	(0.00)	(0.02)	(0.44)	(0.00)	(3.79)	(5.2)	(0.00)	(0.12)	(0.00)
On-Site Stations												
LANL:												
Peach	0.50[b]	0.05[b]	3.49	0.05[b]	0.03[b]	0.49	0.05[b]	5.65	6.2	0.50[b]	0.20	0.03[b]
Apple	0.50[b]	0.05[b]	3.84	0.05[b]	0.03[b]	0.75	0.05[b]	4.10	1.6	0.50[b]	0.20	0.16
Peach	0.50[b]	0.05[b]	3.94	0.05[b]	0.03[b]	0.49	0.10	3.97	1.9	0.50[b]	0.10[b]	0.03[b]
Peach	0.50[b]	0.05[b]	6.84	0.05[b]	0.07	0.45	0.05[b]	7.28	1.9	0.50[b]	0.10[b]	0.03[b]
Nectarine	0.50[b]	0.05[b]	5.79	0.05[b]	0.05	0.47	0.05[b]	1.85	4.5	0.50[b]	0.10[b]	0.03[b]
Apple	0.50[b]	0.05[b]	4.85	0.05[b]	0.03[b]	0.41	0.10	0.39	2.4	0.50[b]	0.10[b]	0.03[b]
Mean	0.50	0.05	4.79	0.05	0.04	0.51	0.07	3.87	3.1	0.50	0.13	0.05
(std dev)	(0.00)	(0.00)	(1.31)	(0.00)	(0.02)	(0.12)	(0.03)	(2.49)	(1.9)	(0.00)	(0.05)	(0.06

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[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 (95%) limit background concentration (mean + 2 std dev) based on data from 1994 to 1996.

Table 6-5. Radionuclides in Honey Collected from Off-Site Perimeter and Regional (Background) Beehives during 1997

		Perimeter								Regional Background		
		Los Alamos		Los Alamos		White Rock		White Rock				
Radioisotope		Venado St.		43rd St.		Monte Rey St.		Piedra Loop St.		Jemez		RSRL[d]
^{3}H	(pCi/mL)[a]	1.82	(0.80)[b]	0.35	(0.71)	1.21	(0.76)	0.60	(0.72)	0.19	(0.70)	5.25
^{137}Cs	(pCi/L)	13.2	(19.8)	10.2	(15.3)	–0.98	(19.5)[c]	11.8	(17.7)	22.0	(33.0)	305.28
^{238}Pu	(pCi/L)	0.002	(0.007)	0.001	(0.007)	–0.020	(0.020)	–0.008	(0.005)	–0.011	(0.009)	0.07
^{239}Pu	(pCi/L)	0.005	(0.009)	0.030	(0.016)	–0.035	(0.007)	0.017	(0.010)	0.047	(0.019)	0.12
^{241}Am	(pCi/L)	0.002	(0.004)	0.013	(0.006)	0.015	(0.009)	0.0062	(0.014)	0.033	(0.010)	0.05
^{90}Sr	(pCi/L)	14.00	(14.62)	1.04	(4.26)	0.10	(3.79)	–0.06	(4.58)	2.23	(3.95)	5.04
^{tot}U	(μg/L)	0.11	(0.01)	0.19	(0.02)	0.13	(0.01)	0.12	(0.01)	0.21	(0.02)	4.99

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[a] pCi/mL of honey moisture; honey contains approximately 18% water and has a density of 1,860 g/L.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

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

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from Fresquez et al., 1997.

Table 6-6. Radionuclides in Eggs Collected during 1997[a]

	Perimeter		Regional Background	
Radionuclide	Pueblo of San Ildefonso	Los Alamos Townsite	Española	RSRL[d]
^{238}Pu (pCi/L)[c]	–0.008 (0.004)[b,c]	–0.000 (0.001)	–0.002 (0.001)	0.059
^{239}Pu (pCi/L)	–0.001 (0.004)	–0.001 (0.001)	0.005 (0.002)	0.052
^{90}Sr (pCi/L)	–0.02 (0.81)	0.91 (0.90)	0.69 (0.98)	2.43
Total U (µg/L)	0.04 (0.01)	0.12 (0.01)	0.22 (0.02)	0.31
Tritium (pCi/mL)	0.29 (0.31)	0.32 (0.31)	0.25 (0.25)	0.61
^{137}Cs (pCi/L)	4.6 (6.9)	–5.6 (19.5)	3.8 (5.7)	9.1
^{241}Am (pCi/L)	0.011 (0.003)	0.013 (0.003)	0.005 (0.002)	0.045

[a] 1L is equal to approximately 24 eggs, and the density of eggs is approximately 1,135 g/L.
[b] See Appendix B for an explanation of the presence of negative values.
[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1995 to 1997.

Table 6-7. Radionuclides in Milk Collected during 1997

	Perimeter		Regional Background	
Radionuclide	Los Alamos[a]	Pojoaque Valley[b]	Albuquerque	RSRL[c]
^{238}Pu (pCi/L)	0.007 (0.003)[d]	0.002 (0.002)	–0.005 (0.003)[e]	0.011
^{239}Pu (pCi/L)	0.083 (0.010)	0.005 (0.002)	0.014 (0.007)	0.020
^{90}Sr (pCi/L)	0.04 (1.62)	–0.16 (0.88)	0.70 (1.65)	6.95
Total U (µg/L)	0.04 (0.01)	0.42 (0.04)	0.03 (0.1)	0.85
Tritium (pCi/mL)	0.31 (0.28)	0.18 (0.36)	–0.10 (0.36)	0.07
^{137}Cs (pCi/L)	20.0 (30.0)	19.8 (29.7)	6.4 (9.6)	19.0
^{131}I (pCi/L)	19.0 (28.5)	14.5 (2.4)	2.0 (3.0)	15.4

[a] Goat's milk.
[b] Cow's milk.
[c] Regional Statistical Reference Level; this is the upper (95%) limit background (mean + 2 std dev) based on data from 1994 to 1997.
[d] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.
[e] See Appendix B for an explanation of the presence of negative values.

Table 6-8. Radionuclides in Game and Nongame Fish Upstream and Downstream of Los Alamos National Laboratory during 1997

Location	^{3}H^{a} (pCi/mL)	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Game Fish							
Upstream (Abiquiu, Heron, and El Vado):							
Trout	–0.14 (0.64)[b,c]	3.85 (12.94)	2.62 (0.46)	2.31 (0.77)	–2.31 (3.08)	26.95 (6.16)	–0.77 (2.31)
Walleye	0.06 (0.66)	0.94 (14.99)	2.36 (0.35)	1.18 (1.18)	NA[d]	NA	20.06 (10.62)
Walleye	0.09 (0.66)	–7.08 (17.46)	0.59 (0.24)	1.18 (1.18)	0.00 (2.36)	10.62 (4.72)	NA
Bass	–0.24 (0.64)	0.48 (1.20)	2.04 (0.24)	2.40 (1.20)	0.00 (3.60)	16.80 (6.00)	12.00 (4.80)
Mean (std dev)	–0.06 (0.16)	–0.45 (4.66)	1.90 (0.91)	1.77 (0.68)	–0.77 (1.33)	18.2 (8.25)	10.43 (10.50)
RSRL[e]	0.20	17.00	27.70	6.50	23.6	28.3	28.90
Downstream (Cochiti):							
Blue Gill	0.10 (0.66)	0.91 (2.57)	0.91 (1.36)	NA	–1.51 (1.51)	3.02 (3.02)	12.08 (12.08)
Crappie	0.15 (0.66)	4.68 (3.78)	1.81 (0.45)	4.53 (1.51)	–3.02 (3.02)	3.02 (3.02)	12.08 (12.08)
Bass	0.07 (0.66)	1.68 (1.56)	2.04 (0.48)	4.80 (1.20)	0.00 (1.20)	7.20 (2.40)	–2.40 (4.80)
Pike	0.09 (0.66)	0.66 (1.32)	1.54 (2.31)	1.10 (1.10)	2.20 (1.10)	6.60 (2.20)	7.70 (9.90)
Pike	0.00 (0.65)	0.66 (1.43)	0.33 (0.55)	3.30 (1.10)	0.00 (1.10)	5.50 (2.20)	5.50 (3.30)
Mean (std dev)	0.08 (0.05)	1.72 (1.71)	1.33 (0.70)	3.43 (1.69)	–0.47 (1.95)	5.07 (1.97)	6.99 (5.97)
Nongame Fish							
Upstream (Abiquiu, Heron, and El Vado):							
Catfish	0.00 (0.65)	0.82 (9.02)	1.07 (0.33)	9.84 (0.82)	6.56 (2.46)	5.74 (3.28)	2.46 (4.10)
Carp	0.24 (0.67)	–0.58 (9.28)	0.93 (0.35)	22.04 (2.32)	3.48 (3.48)	11.60 (5.80)	11.60 (8.12)
Catfish	0.26 (0.67)	10.09 (14.02)	0.74 (1.15)	9.84 (0.82)	6.56 (4.92)	–0.82 (3.28)	9.84 (5.74)
Carp	0.15 (0.66)	–0.46 (7.54)	0.46 (0.58)	6.96 (1.16)	33.64 (9.28)	NA	3.48 (4.64)
Sucker	–0.02 (0.65)	2.52 (14.36)	1.01 (0.38)	3.78 (1.26)	NA	NA	15.12 (8.82)
Mean (std dev)	0.13 (0.13)	2.48 (4.43)	0.84 (0.25)	10.49 (6.92)	12.56(14.13)	5.51 (6.21)	8.50 (5.41)
RSRL[e]	0.20	13.20	26.90	16.20	9.80	19.20	16.14

Table 6-8. Radionuclides in Game and Nongame Fish Upstream and Downstream of Los Alamos National Laboratory during 1997 (Cont.)

Location	^{3}H[a] (pCi/mL)	^{90}Sr (10^{-2} pCi/g dry)	^{137}Cs (10^{-2} pCi/g dry)	^{tot}U (ng/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Downstream (Cochiti):							
Sucker	0.06 (0.66)	2.65 (1.76)	2.02 (0.50)	6.30 (1.26)	0.00 (1.26)	6.30 (2.52)	11.34 (3.78)
Catfish	0.20 (0.67)	0.00 (0.90)	1.64 (0.41)	11.48 (0.82)	–1.64 (0.82)	5.74 (1.64)	2.46 (3.28)
Carp	0.14 (0.66)	0.81 (1.39)	0.46 (0.12)	30.16 (3.48)	1.16 (1.16)	4.64 (2.32)	–53.36 (10.44)
Carp	0.07 (0.66)	4.76 (6.61)	0.93 (0.23)	32.48 (3.48)	2.32 (1.16)	2.32 (2.32)	8.12 (2.32)
Carp	0.13 (0.66)	18.68 (13.46)	0.93 (0.23)	39.44 (3.48)	NA	NA	5.80 (6.96)
Mean (std dev)	0.12 (0.06)	5.38 (7.66)	1.20 (0.62)	23.97 (14.30)	0.46 (1.69)	4.75 (1.76)	–5.13 (27.16)

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[a] pCi/mL of tissue moisture.

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

[c] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[d] Not analyzed, lost in analysis, or outlier omitted.

[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from Fresquez et al. (1994c).

Table 6-9. Total Recoverable Mercury in Nongame Fish (µg/g wet) Collected during 1997

Upstream Abiquiu Reservoir		Downstream Cochiti Reservoir		RSRL[c]
0.03	(sucker)[a]	0.06	(sucker)	
0.10	(catfish)	0.10	(catfish)	
0.15	(catfish)[a]	0.30	(carp)	
0.30	(carp)	0.20	(carp)	
0.20	(carp)	0.10	(carp)	
0.16	(0.10)[b]	0.15	(0.10)[b]	0.41

[a] Less-than values were converted to one-half the concentration (Gilbert 1987).

[b] The average (std dev) of five nongame fish.

[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1991 to 1996.

Table 6-10. Radionuclides in Muscle and Bone Tissues of Elk Collected from On-Site, Perimeter, and Regional Background Areas during 1996 and 1997

Location/Date/Sample	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
LANL Elk							
TA-62/Ski Hill Road/9-13-96/Bull	0.32 (0.14)[b]	0.44 (0.44)	29.3 (6.8)	51.9 (6.6)	12.6 (3.2)	1.4 (1.4)	9.2 (2.7)
TA-18/Pajarito Road/12-2-96/Cow	0.41 (0.14)	0.44 (0.44)	15.8 (3.1)	24.2 (2.6)	0.2 (0.9)	0.4 (1.3)	2.6 (1.3)
TA-54/Pajarito Road/12-9-96/Cow	0.24 (0.14)	0.18 (0.18)	9.7 (14.5)	51.9 (5.3)	–1.8 (0.9)[c]	4.4 (2.2)	0.9 (1.3)
TA-36/Pajarito Road/1-9-97/Bull	0.22 (0.14)	0.44 (0.44)	28.2 (42.3)	100.8 (6.2)	0.2 (0.5)	2.2 (1.3)	4.4 (1.3)
San Ildefonso/Sacred Area/1-19-97/Cow	0.24 (0.14)	5.72 (0.44)	8.4 (12.3)	–8.4 (12.3)	–1.3 (1.8)	4.8 (2.2)	11.4 (5.7)
San Ildefonso/State Road 4/1-24-97/Cow	1.09 (0.14)	1.76 (0.44)	11.9 (18.1)	16.7 (12.0)	2.6 (2.7)	4.0 (2.7)	0.9 (6.6)
TA-49/State Road 4/1-27-97/Cow	0.01 (0.13)	1.76 (0.44)	4.0 (1.3)	–29.9 (18.5)	2.2 (2.7)	0.2 (2.7)	8.4 (7.5)
TA-54/Pajarito Road/3-12-97/Cow	NA[d]	NA	NA	NA	NA	NA	NA
Mean (std dev)	0.36 (0.34)	1.53 (1.96)	15.3 (9.8)	29.6 (43.3)	2.1 (4.9)	2.5 (1.9)	5.4 (4.3)
Regional Background Elk							
Coyote, NM/11-19-96/Cow	0.12 (0.14)	0.44 (0.44)	16.3 (24.7)	0.0 (2.2)	–0.4 (0.9)	–0.4 (0.2)	–0.4 (2.2)
Coyote, NM/11-20-96/Cow	0.03 (0.14)	0.88 (0.44)	48.8 (8.8)	0.0 (4.4)	–6.2 (0.9)	–2.6 (2.7)	11.4 (4.9)
Mean (std dev)	0.08 (0.06)	0.66 (0.31)	32.6 (23.0)	0.0 (0.0)	–3.3 (4.1)	–1.5 (1.6)	5.5 (8.3)
RSRL[e]	0.43	2.71	71.15	3.3	3.5	1.4	17.0
Leg Bone:							
LANL Elk							
TA-62/Ski Hill Road/9-13-96/Bull	0.23 (0.14)	5.00 (5.00)	25.0 (4.0)	1,280.0 (105.0)	45.0 (15.0)	90.0 (20.0)	75.0 (30.0)
TA-18/Pajarito Road/12-2-96/Cow	–0.06 (0.13)	5.00 (5.00)	270.0 (405.0)	1,260.0 (105.0)	–20.0 (20.0)	–20.0 (10.0)	10.0 (25.0)
TA-54/Pajarito Road/12-9-96/Cow	0.42 (0.14)	2.00 (2.00)	–40.0 (15.0)	1,090.0 (110.0)	2.0 (10.0)	80.0 (20.0)	15.0 (25.0)
TA-36/Pajarito Road/1-9-97/Bull	1.54 (0.15)	2.00 (2.00)	–15.0 (120.0)	625.0 (35.0)	–5.0 (10.0)	15.0 (10.0)	40.0 (20.0)
San Ildefonso/Sacred Area/1-19-97/Cow	–0.01 (0.13)	2.00 (2.00)	2.00 (15.0)	955.0 (130.0)	30.0 (35.0)	35.0 (35.0)	65.0 (60.0)
San Ildefonso/State Road 4/1-24-97/Cow	–0.08 (0.13)	15.0 (5.00)	2.0 (15.0)	1,375.0 (165.0)	25.0 (35.0)	25.0 (25.0)	50.0 (80.0)
TA-49/State Road 4/1-27-97/Cow	0.14 (0.14)	50.0 (5.00)	10.0 (5.0)	715.0 (110.0)	–25.0 (10.0)	10.0 (20.0)	40.0 (40.0)
TA-54/Pajarito Road/3-12-97/Cow	0.66 (0.15)	10.0 (5.00)	2.0 (120.0)	885.0 (90.0)	15.0 (20.0)	10.0 (20.0)	–25.0 (25.0)
Mean (std dev)	0.36 (0.54)	11.38(16.27)	32.0 (98.0)	1,023.0 (274.5)	8.4 (24.7)	30.6 (37.2)	33.8 (32.5)

Table 6-10. Radionuclides in Muscle and Bone Tissues of Elk Collected from On-Site, Perimeter, and Regional Background Areas during 1996 and 1997 (Cont.)

Location/Date/Sample	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Leg Bone:							
Regional Background Elk							
Coyote, NM/11-19-96/Cow	0.14 (0.14)	2.00 (2.00)	30.0 (45.0)	350.0 (40.0)	–45.0 (10.0)	–15.0 (20.0)	35.0 (20.0)
Coyote, NM/11-20-96/Cow	0.06 (0.13)	2.00 (2.00)	–25.0 (120.0)	450.0 (45.0)	35.0 (25.0)	–15.0 (15.0)	45.0 (20.0)
Mean (std dev)	0.10 (0.06)	2.00 (0.00)	2.5 (38.9)	400.0 (70.7)	–5.0 (56.6)	–15.0 (0.0)	40.0 (7.1)
RSRL[e]	0.51	4.32	54.6	2,281.7	114.8	64.7	51.6

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[a] pCi/mL of tissue moisture.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

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

[d] Not analyzed, lost in analysis, or outlier omitted.

[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1991 to 1997.

Table 6-11. Radionuclides in Muscle and Bone Tissues of Deer Collected from On-Site, Perimeter, and Regional Background Areas during 1996 and 1997

Location/Date/Sample	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
LANL Deer							
San Ildefonso/State Road 502/11-25-96/Buck	0.14 (0.13)[b]	0.45 (0.45)	21.2 (4.5)	0.9 (2.7)	–2.3 (0.9)[c]	0.2 (2.3)	7.2 (2.7)
TA-73/State Road 502/11-25-96/Buck	0.27 (0.14)	0.18 (0.18)	15.3 (3.6)	49.5 (4.1)	0.2 (0.9)	–0.9 (0.9)	2.3 (1.8)
TA-73/State Road 502/12-4-96/Doe	0.03 (0.13)	0.45 (0.45)	19.4 (3.6)	3.6 (1.4)	–1.8 (0.9)	3.2 (1.4)	1.8 (1.8)
TA-53/LANSCE Road/2-10-97/Buck	0.28 (0.14)	0.18 (0.18)	6.8 (10.0)	–19.8 (12.2)	5.9 (2.7)	6.3 (3.2)	1.6 (0.7)
Mean (std dev)	0.18 (0.12)	0.32 (0.16)	15.7 (6.4)	8.6 (29.2)	0.5 (3.8)	2.2 (3.2)	3.2 (2.6)
Regional Background Deer							
Dulce, NM/10-31-96	0.15 (0.35)	1.80 (0.45)	6.8 (2.3)	22.5 (2.7)	–0.5 (0.9)	0.5 (1.4)	18.5 (10.4)
Mean (counting uncertainty)	0.15 (0.35)	1.80 (0.45)	6.8 (2.3)	22.5 (2.7)	–0.5 (0.9)	0.5 (1.4)	18.5 (10.4)
RSRL[d]	0.86	2.42	29.0	38.3	3.72	14.8	27.5
Leg Bone:							
LANL Deer							
San Ildefonso/State Road 502/11-25-96/Buck	0.52 (0.14)	8.80 (4.40)	22.0 (35.2)	NA[e]	–4.4 (8.8)	35.2 (17.6)	22.0 (17.6)
TA-73/State Road 502/11-25-96/Buck	0.45 (0.14)	1.76 (1.75)	35.2 (52.8)	651.2 (48.4)	–66.0 (30.8)	–35.2 (4.4)	30.8 (17.6)
TA-73/State Road 502/12-4-96/Doe	0.12 (0.14)	1.76 (1.75)	88.0 (132.0)	541.2 (111.0)	26.4 (26.4)	17.6 (22.0)	61.6 (22.0)
TA-53/LANSCE Road/2-10-97/Buck	0.53 (0.13)	1.76 (1.76)	1.8 (13.2)	1,227.6 (136.0)	30.8 (17.6)	22.0 (17.6)	18.5 (7.5)
Mean (std dev)	0.41 (0.19)	3.52 (3.52)	36.8 (36.8)	806.7 (368.7)	–3.3 (44.6)	9.9 (31.0)	33.2 (19.6)
Regional Background Deer							
Dulce, NM/10-31-96	0.12 (0.13)	4.40 (4.40)	39.6 (57.2)	787.6 (57.2)	–17.6 (30.8)	1.8 (17.6)	92.4 (30.8)
Mean (counting uncertainty)	0.12 (0.13)	4.40 (4.40)	39.6 (57.2)	787.6 (57.2)	–17.6 (30.8)	1.8 (17.6)	92.4 (30.8)
RSRL[d]	0.57	6.23	61.8	1,028.3	14.5	2.68	116.5

[a] pCi/mL of tissue moisture.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

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

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1991 to 1997.

[e] Not analyzed, lost in analysis, or outlier omitted.

Table 6-12. Radionuclides in Muscle and Bone of a Free Range Steer Collected from the Pueblo of San Ildefonso Lands during 1997

Tissue/Location	^{3}H[a] (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Muscle:							
San Ildefonso	0.11 (0.14)[b]	1.48 (0.37)	8.9 (2.6)	31.5 (11.1)	–2.2 (1.5)[c]	2.6 (1.5)	5.9 (4.8)
Regional Background[d]	0.32 (0.72)	1.11 (0.37)	30.7 (46.3)	–8.9 (23.7)	3.0 (7.0)	–12.2 (4.8)	11.5 (3.7)
RSRL[e]	1.76	1.85	123.3	38.5	17.0	–2.6	18.9
Leg Bone:							
San Ildefonso	–0.09 (0.13)	35.00 (5.00)	0.0 (15.0)	1,530.0 (210.0)	0.0 (20.0)	15.0 (20.0)	0.0 (80.0)
Regional Background	–0.52 (0.69)	5.00 (5.00)	25.0 (35.0)	1,250.0 (350.0)	–35.0 (160.0)	–75.0 (95.0)	125.0 (95.0)
RSRL[e]	0.86	15.00	95.0	1,950.0	285.0	115.0	315.0

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[a] pCi/mL of tissue moisture.

[b] (±1 one counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

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

[d] Background from El Rito, NM.

[e] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from current year.

Table 6-13. Radionuclides in Navajo Tea (Cota) Collected from Regional and Perimeter Locations during 1997

	^{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)
Regional Background:							
Española	–0.08 (0.33)[a,b]	–1.26 (6.04)	0.008 (0.009)	0.022 (0.012)	15.4 (23.1)	0.82 (0.08)	0.063 (0.019)
RSRL[c]	0.05	1.73	0.015	0.043	17.1	1.28	0.287
Perimeter:							
San Ildefonso	–0.36 (0.22)	2.49 (5.85)	0.048 (0.017)	0.037 (0.016)	12.2 (18.3)	0.71 (0.07)	0.049 (0.017)
Los Alamos Townsite	0.07 (0.13)	0.60 (2.98)	0.018 (0.012)	0.031 (0.013)	6.2 (9.3)	0.86 (0.09)	0.058 (0.019)
White Rock/ Pajarito Acres	0.14 (0.15)	–2.63 (6.65)	0.027 (0.017)	0.018 (0.014)	17.8 (26.7)	0.94 (0.09)	0.018 (0.011)
On-Site:							
LANL (Mortandad Canyon)		7.05 (4.63)	0.039 (0.017)	0.041 (0.018)	8.6 (12.9)	0.68 (0.07)	0.033 (0.012)

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

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

[c] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on data from 1994 to 1997.

Table 6-14. Radionuclides in Piñon Shoot Tips (Vegetation) Collected from Regional Background, Perimeter, and On-Site Areas during the 1997 Growing Season[a]

Location	^{3}H (pCi/mL)	^{tot}U (ng/g dry)	^{137}Cs (10^{-3} pCi/g dry)	^{90}Sr (10^{-3} pCi/g dry)	^{238}Pu (10^{-5} pCi/g dry)	^{239}Pu (10^{-5} pCi/g dry)	^{241}Am (10^{-5} pCi/g dry)
Regional Background:							
Española/Santa Fe/Jemez	0.00 (0.66)	3.2 (0.8)	–4.8 (144.0)[b]	–116.8 (2,472.8)	15.2 (11.2)	37.6 (14.4)	16.8 (19.2)
RSRL[c]	1.32	4.8	283.2	4,828.8	37.6	66.4	55.2
Perimeter:							
Los Alamos Townsite	0.70 (0.70)	0.0 (0.8)	18.4 (28.0)	–124.0 (2,632.0)	–5.6 (6.4)	16.8 (10.4)	36.0 (18.4)
White Rock/Pajarito Acres	0.38 (0.68)	12.8 (1.6)	20.8 (31.2)	–157.6 (2,905.6)	6.4 (11.2)	32.0 (12.8)	56.8 (17.6)
Pueblo of San Ildefonso	0.26 (0.67)	177.6 (17.6)	2.4 (4.0)	86.4 (2,489.6)	10.4 (7.2)	32.0 (10.4)	34.4 (16.8)

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[a] These are the shoot tips of the piñon tree and are not piñon nuts.

[b] (±1 counting uncertainty); values are the uncertainty of the analytical results at the 65% confidence level.

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

[d] Regional Statistical Reference Level; this is the upper (95%) limit background concentration (mean + 2 std dev) based on present data.

E. Figures

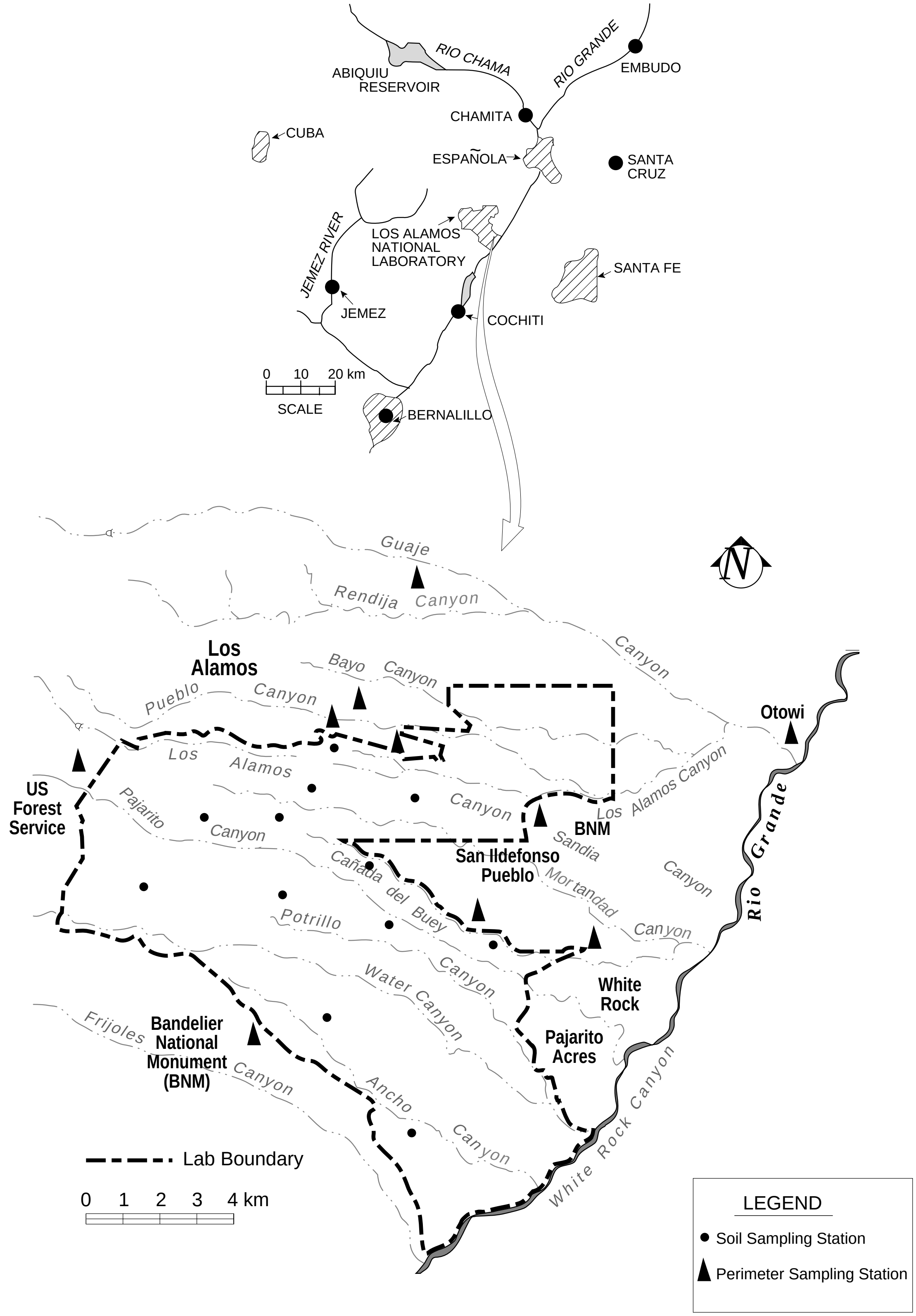

Figure 6-1. Off-site regional (top) and perimeter and on-site (bottom) Laboratory soil sampling locations.

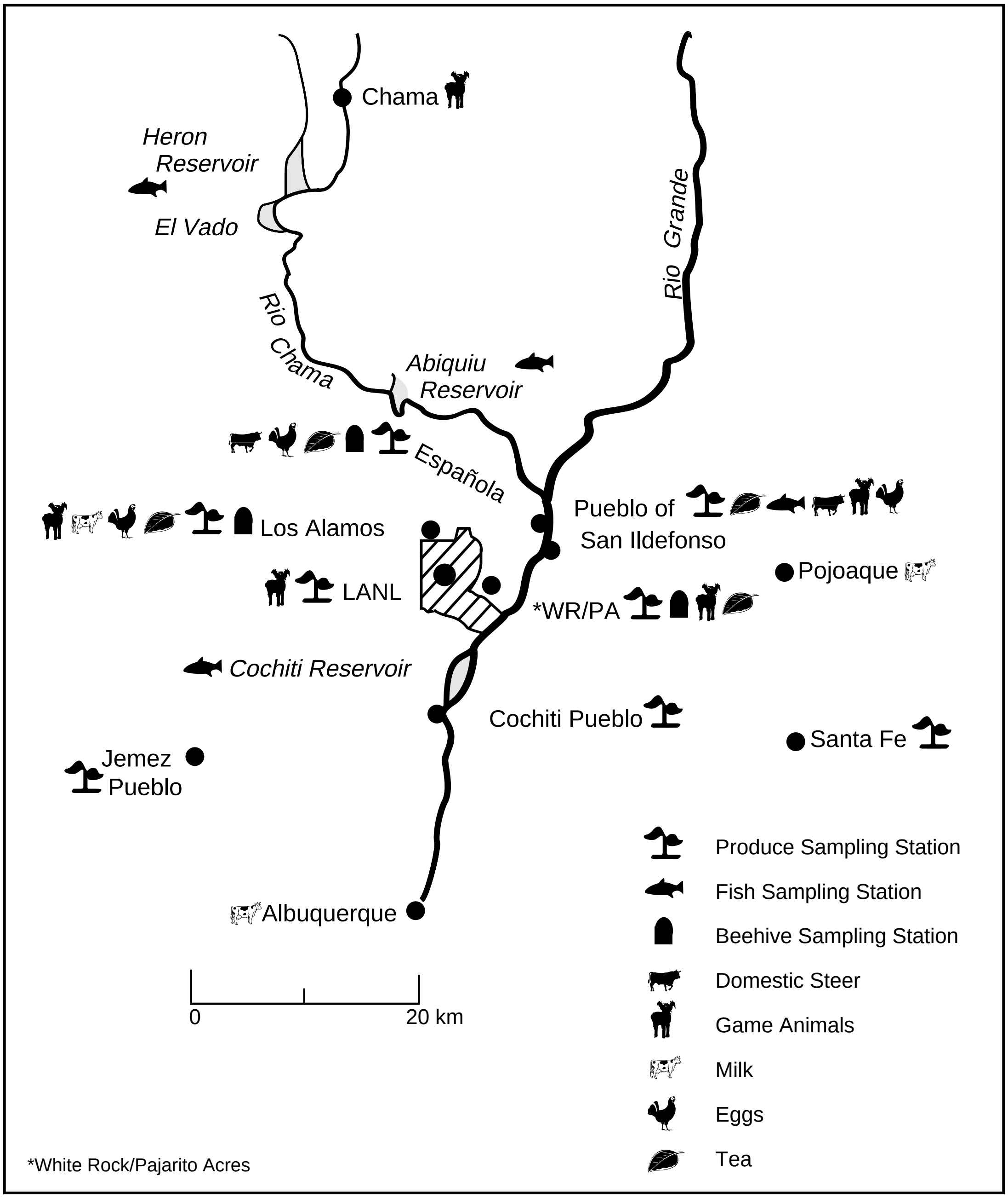

Figure 6-2. Produce, fish, milk, eggs, tea, domestic and game animals, and beehive sampling locations. (Map denotes general locations only.)

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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, or foodstuffs are available. Los Alamos National Laboratory (LANL or the Laboratory) operations are conducted in accordance with directives for compliance with environmental standards. These directives are contained in Department of Energy (DOE) Orders 5400.1, "General Environmental Program;" 5400.5, "Radiation Protection of the Public and the Environment;" 5480.1, "Environmental Protection, Safety, and Health Protection Standards;" 5480.11, "Requirements for Radiation Protection for Occupational Workers;" 5484.1, "Environmental Radiation Protection, Safety, and Health Protection Information Reporting Requirements," Chap. III, "Effluent and Environmental Monitoring Program Requirements" and 231.1, "Environmental Safety and Health Reporting."

Radiation Standards. DOE regulates radiation exposure to the public and the worker by limiting the radiation dose that can be received during routine Laboratory operations. Because some radionuclides remain in the body and result in exposure long after intake, DOE requires consideration of the dose commitment caused by inhalation, ingestion, or absorption of such radionuclides. This evaluation involves integrating the dose received from radionuclides over a standard period of time. For this report, 50-yr dose commitments were calculated using the DOE dose factors from DOE 1988a and DOE 1988b. The dose factors 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 per year. The PDLs and the DOE dose factors are based on recommendations in ICRP (1988) and the National Council on Radiation Protection and Measurements (NCRP 1987).

The EDE is the hypothetical whole-body dose that would result in the same risk of radiation-induced cancer or genetic disorder as a given exposure to an individual organ. It is the sum of the individual organ doses, weighted to account for the sensitivity of each organ to radiation-induced damage. The weighting factors are taken from the recommendations of the ICRP. The EDE includes doses from both internal and external exposure.

Radionuclide concentrations in air or water are compared to DOE's Derived Concentration Guides (DCGs) to evaluate potential impacts to members of the public. The DCGs for air are the radionuclide concentrations in air, which, if inhaled continuously for an entire year would give a dose of 100 mrem. Similarly, the DCGs for water are those concentrations in water, which if consumed at a maximum rate of 730 liters per year, would give a dose of 100 mrem per year. Derived air concentrations (DACs) were developed for protection of workers and are the air concentrations, which, if inhaled throughout a "work year" would give the limiting allowed dose to the worker. The DCGs and DACs are shown in Table A-2.

Nonradioactive Air Quality Standards. Federal and state ambient air quality standards for nonradioactive pollutants are shown in Table A-3.

National Pollutant Discharge Elimination System. Table A-4 presents a summary of the outfalls, the types of monitoring required under National Pollutant Discharge Elimination System (NPDES), and the limits established for sanitary and industrial outfalls. Table A-5 presents NPDES annual water quality parameters for all outfalls.

Drinking Water Standards. For chemical constituents in drinking water, regulations and standards are issued by EPA and adopted by the New Mexico Environment Department (NMED) as part of the New Mexico Drinking Water Regulations (Table A-6) (NMEIB 1995). EPA's secondary drinking water standards, which are not included in the New Mexico Drinking Water Regulations and are not enforceable, relate to contaminants in drinking water that primarily affect aesthetic qualities associated with public acceptance of drinking water (EPA 1989b). There may be health effects associated with considerably higher concentrations of these contaminants.

Radioactivity in drinking water is regulated by EPA regulations contained in 40 CFR 141 (EPA 1989b) and New Mexico Drinking Water Regulations, Sections 206 and 207 (NMEIB 1995). These regulations provide that combined radium-226 and radium-228 may not exceed 5 pCi per liter. Gross alpha activity (including radium-226, but excluding radon and uranium) may not exceed 15 pCi per liter.

A screening level of 5 pCi per liter for gross alpha is established to determine when analysis specifically for radium isotopes is necessary. In this report, plutonium concentrations are compared with both the EPA gross alpha standard for drinking water (Table A-6) and the DOE guides calculated for the DCGs applicable to drinking water (Table A-2).

For man-made beta- and photon-emitting radionuclides, EPA drinking water standards are limited to concentrations that would result in doses not exceeding 4 mrem per year, calculated according to a specified procedure. In addition, DOE Order 5400.5 requires that persons consuming water from DOE-operated public water supplies do not receive an EDE greater than 4 mrem per year. DCGs for drinking water systems based on this requirement are in Table A-2.

Surface Water Standards. Concentrations of radionuclides in surface water samples may be compared to either the DOE DCGs (Table A-2) or the New Mexico Water Quality Control Commission (NMWQCC) stream standard, which references the state's radiation protection regulations. However, New Mexico radiation levels are in general two orders of magnitude greater than DOE's DCGs for public dose, so only the DCGs will be discussed here. The concentrations of nonradioactive constituents may be compared with the NMWQCC Livestock Watering and Wildlife Habitat stream standards (NMWQCC 1995). (See Tables A-7 and A-8.) The NMWQCC groundwater standards can also be applied in cases where discharges may affect groundwater.

Organic Analysis of Surface and Groundwaters: Methods and Analytes. Organic analyses of surface waters, groundwaters, and sediments are made using SW-846 methods as shown in Table A-9. This table shows the number of analytes included in each analytical suite. The specific compounds analyzed in each suite are listed in Tables A-10 through A-13.

Table A-1. Department of Energy Public Dose Limits for External and Internal Exposures

	Effective Dose Equivalent[a] at Point of Maximum Probable Exposure
Exposure of Any Member of the Public[b]	
All Pathways	100 mrem/yr[c]
Air Pathway Only[d]	10 mrem/yr
Drinking Water	4 mrem/yr
Occupational Exposure[b]	
Stochastic Effects	5 rem (annual EDE[e])
Nonstochastic Effects	
Lens of eye	15 rem (annual EDE[e])
Extremity	50 rem (annual EDE[e])
Skin of the whole body	50 rem (annual EDE[e])
Organ or tissue	50 rem (annual EDE[e])
Unborn Child	
Entire gestation period	0.5 rem (annual EDE[e])

[a] As used by DOE, effective dose equivalent (EDE) includes both the EDE from external radiation and the committed EDE to individual tissues from ingestion and inhalation during the calendar year.

[b] In keeping with DOE policy, exposures must be limited to as small a fraction of the respective annual dose limits as practicable. DOE's PDL applies to exposures from routine Laboratory operation, excluding contributions from cosmic, terrestrial, and global fallout; self-irradiation; and medical diagnostic sources of radiation. Routine operation means normal, planned operation and does not include actual or potential accidental or unplanned releases. Exposure limits for any member of the general public are taken from DOE Order 5400.5 (DOE 1990). Limits for occupational exposure are taken from 10 CFR 835 Occupational Radiation Protection.

[c] Under special circumstances and subject to approval by DOE, this limit on the EDE may be temporarily increased to 500 mrem per year, provided the dose averaged over a lifetime does not exceed the principal limit of 100 mrem per year.

[d] This level is from EPA's regulations issued under the Clean Air Act, (40 CFR 61, Subpart H) (EPS 1989a).

[e] Annual EDE is the EDE received in a year.

Table A-2. Department of Energy's Derived Concentration Guides for Water and Derived Air Concentrations[a]

Nuclide	f_1[b]	DCGs for Water Ingestion in Uncontrolled Areas (pCi/L)	DCGs for Drinking Water Systems (pCi/L)	DCGs for Air Inhalation by the Public (μCi/mL)	Class[b]	DACs for Occupational Exposure (μCi/mL)
^{3}H	—	2,000,000	80,000	1×10^{-7}[c]	—	2×10^{-5}[c]
^{7}Be	5×10^{-3}	1,000,000	40,000	4×10^{-8}	Y	8×10^{-6}
^{89}Sr	2×10^{-5}	20,000	800	3×10^{-10}	Y	6×10^{-8}
^{90}Sr[b]	1×10^{-6}	1,000	40	9×10^{-12}	Y	2×10^{-9}
^{137}Cs	1×10^{0}	3,000	120	4×10^{-10}	D	7×10^{-8}
^{234}U	5×10^{-2}	500	20	9×10^{-14}	Y	2×10^{-11}
^{235}U	5×10^{-2}	600	24	1×10^{-13}	Y	2×10^{-11}
^{238}U	5×10^{-2}	600	24	1×10^{-13}	Y	2×10^{-11}
^{238}Pu	1×10^{-3}	40	1.6	3×10^{-14}	W	3×10^{-12}
^{239}Pu[b]	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}
^{240}Pu	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}
^{241}Am	1×10^{-3}	30	1.2	2×10^{-14}	W	2×10^{-12}

[a] Guides for uncontrolled areas are based on DOE's public dose limit for the general public (DOE 1990); those for occupational exposure are based on radiation protection standards in 10 CFR 835. Guides apply to concentrations in excess of those occurring naturally or that are due to worldwide fallout.

[b] Gastrointestinal tract absorption factors (f_1) and lung retention classes (Class) are taken from ICRP30 (ICRP 1988). Codes: Y = year, D = day, W = week.

[c] Tritium in the HTO form.

Table A-3. National (40 CFR 50) and New Mexico (20 NMAC 2.03) Ambient Air Quality Standards

Pollutant	Averaging Time	Unit	New Mexico Standard	Federal Standards Primary	Federal Standards Secondary
Sulfur dioxide	Annual	ppm	0.02	0.030[a]	
	24 hours	ppm	0.10	0.14[b]	
	3 hours	ppm			0.5[b]
Hydrogen sulfide	1 hour	ppm	0.010[b]		
Total reduced sulfur	1/2 hour	ppm	0.003[b]		
Total suspended particulates	Annual	µg/m^3	60		
	30 days	µg/m^3	90		
	7 days	µg/m^3	110		
	24 hours	µg/m^3	150		
PM_{10}[c]	Annual	µg/m^3		50	50
	24 hours	µg/m^3		150	150
$PM_{2.5}$[d]	Annual	µg/m^3		15[e]	15[e]
	24 hours	µg/m^3		65[e]	65[e]
Carbon monoxide	8 hours	ppm	8.7	9[b]	
	1 hour	ppm	13.1	35[b]	
Ozone	1 hour	ppm		0.12	0.12
	8 hours	ppm		0.08	0.08
Nitrogen dioxide	Annual	ppm	0.05	0.053	0.053
	24 hours	ppm	0.10		
Lead and its compounds	Calendar quarter	µg/m^3		1.5	1.5

[a] Not to be exceeded in a calendar year.

[b] Not to be exceeded more than once in a calendar year.

[c] Particles ≤10 µm in diameter.

[d] Particles ≤2.5 µm in diameter.

[e] Applicable when the changes to the NM State Implementation Plan are approved by EPA.

Table A-4. Limits Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary and Industrial Outfall Discharges for 1997

Discharge Category	Permit Parameter		Daily Average		Daily Maximum	
Sanitary						
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	colonies/100 mL	500	colonies/100 mL
	pH		6.0–9.0 s.u.		6.0–9.0 s.u.	
	Flow[e]		Report		Report	

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
Industrial						
001 Power Plant	1	Monthly	TSS	30	100	mg/L
			Free available CL_2	0.2	0.5	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
02A Boiler Blowdown	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	s.u.
03A Treated Cooling Water	20	Every 3 months	TSS	30	100	mg/L
			Free available Cl	0.2	0.5	mg/L
			Total P	20	40	mg/L
			Total As	0.04	0.04	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
04A Noncontact Cooling Water	19	Every 3 months	pH	6.0–9.0	6.0–9.0	s.u.
			Total residual CL_2	Report[f]	Report	mg/L
051 Radioactive Liquid Waste Treatment Facility (TA-50)	1	Variable: weekly to monthly	COD[g]	94	156	lb/day
			TSS	18.8	62.6	lb/day
			Total Cd	0.06	0.30	lb/day
			Total Cr	0.19	0.38	lb/day
			Total Cu	0.63	0.63	lb/day
			Total Fe	1.0	2.0	lb/day
			Total Pb	0.06	0.15	lb/day
			Total Hg	0.003	0.09	lb/day
			Total Zn	0.62	1.83	lb/day
			TTO[h]	1.0	1.0	mg/L
			Total Ni	Report	Report	mg/L
			Total N	Report	Report	mg/L
			NO_3-NO_2	Report	Report	mg/L
			Ammonia (as N)[f]	Report	Report	mg/L

Table A-4. (Cont.)

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
051 (Cont.)			pH	6.0–9.0	6.0–9.0	s.u.
			COD	125	125	mg/L
			^{226}Ra and ^{228}Ra	30.0	30.0	pCi/L
05A High Explosive Wastewater	11	Every 3 months	Oil & Grease	15	15	mg/L
			COD	125	125	mg/L
			TSS	30.0	45.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.
06A Photo Wastewater	10	Every 3 months	Total Ag	0.5	1.0	mg/L
			pH	6.0–9.0	6.0–9.0	s.u.

[a] Biochemical oxygen demand.
[b] Not applicable.
[c] Total suspended solids.
[d] Logarithmic mean.
[e] Discharge volumes are reported to EPA but are not subject to limits.
[f] Concentrations are reported to EPA but are not subject to limits.
[g] Chemical oxygen demand.
[h] Total toxic organics.

Note: Sampling frequency for sanitary outfall varies from once a week to once every 3 months, depending on the parameter.

Table A-5. Annual Water Quality Parameters Established by National Pollutant Discharge Elimination System Permit No. NM0028355 for Sanitary and Industrial Outfall Discharges for 1997

Discharge Category	Number of Outfalls	Sampling Frequency	Permit Parameter	Daily Average	Daily Maximum	Unit of Measurement
All Outfall Categories: Annual Water Quality Parameters	65	Annually	Total Al	5.0	5.0	mg/L
			Total As	0.04	0.04	mg/L
			Total B	5.0	5.0	mg/L
			Total Cd	0.2	0.2	mg/L
			Total Cr	5.1	5.1	mg/L
			Total Co	1.0	1.0	mg/L
			Total Cu	1.6	1.6	mg/L
			Total Pb	0.4	0.4	mg/L
			Total Hg	0.01	0.01	mg/L
			Total Se	0.05	0.05	mg/L
			Total V	0.1	0.1	mg/L
			Total Zn	95.4	95.4	mg/L
			^{226} Ra and ^{228}Ra	30.0	30.0	pCi/L
			^{3}H[a]	3,000,000	3,000,000	pCi/L

[a] When accelerator produced.

Table A-6. Safe Drinking Water Act Maximum Contaminant Levels in the Water Supply for Radiochemicals, Inorganic Chemicals, and Microbiological Constituents

ContaminantsLevel	
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[b]
	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
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.

[b] The proposed MCL for radon was withdrawn by the EPA on August 6, 1997.

Table A-7. Livestock Watering Standards[a]

Livestock Contaminant	Concentration	
Dissolved Al	5	mg/L
Dissolved As	0.2	mg/L
Dissolved B	5	mg/L
Dissolved Cd	0.05	mg/L
Dissolved Cr	1	mg/L
Dissolved Co	1	mg/L
Dissolved Cu	0.5	mg/L
Dissolved Pb	0.1	mg/L
Total Hg	0.01	mg/L
Dissolved Se	0.05	mg/L
Dissolved V	0.1	mg/L
Dissolved Zn	25	mg/L
^{226}Ra and ^{228}Ra	30	pCi/L
^{3}H	20,000	pCi/L
Gross alpha	15	pCi/L

[a] NMWQCC 1995.

Table A-8. Wildlife Habitat Stream Standards[a]

The following narrative standard shall apply:

1. Except as provided below in Paragraph 2 of this section, no discharge shall contain any substance, including, but not limited to selenium, DDT, PCBs, and dioxin, at a level which, when added to background concentrations, can lead to bioaccumulation to toxic levels in any animal species. In the absence of site-specific information, this requirement shall be interpreted as establishing a stream standard of 2 µg per liter for total recoverable selenium and of 0.012 µg per liter for total mercury.
2. The discharge of substances that bioaccumulate in excess of levels specified above in Paragraph 1, is allowed if, and only to the extent that, the substances are present in the intake waters which are diverted and utilized prior to discharge, and then only if the discharger utilizes best available treatment technology to reduce the amount of bioaccumulating substances which are discharged.
3. Discharges to waters which are designated for wildlife habitat uses, but not for fisheries uses, shall not contain levels of ammonia or chlorine in amounts which reduce biological productivity and/or species diversity to levels below those which occur naturally, and in no case shall contain chlorine in excess of 1 mg per liter nor ammonia in excess of levels 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% the amount present in the intake waters which are diverted and utilized prior to the discharge, unless the discharger has taken steps (an approved program to require industrial pretreatment or a corrosion program) appropriate to reduce influent concentration to the extent practicable.

[a] NMWQCC 1995.

Table A-9. Organic Analytical Methods

Test	SW-846 Method	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] Polychlorinated biphenyls.

[c] High-explosive.

Table A-10. Volatile Organic Compounds

	Limit of Quantitation
Analytes	Water (μg/L)
Acetone	20
Benzene	5
Bromobenzene	5
Bromochloromethane	5
Bromodichloromethane	5
Bromoform	5
Bromomethane	10
Butanone [2-]	20
Butylbenzene [n-]	5
Butylbenzene [sec-]	5
Butylbenzene [tert-]	5
Carbon disulfide	5
Carbon tetrachloride	5
Chlorobenzene	5
Chlorodibromomethane	5
Chloroethane	10
Chloroform	5
Chloromethane	10
Chlorotoluene [o-]	5
Chlorotoluene [p-]	5
Dibromo-3-chloropropane [1,2]	10
Dibromoethane [1,2-]	5
Dibromomethane	5
Dichlorobenzene [m-] (1,3)	5
Dichlorobenzene [o-] (1,2)	5
Dichlorobenzene [p-] (1,4)	5
Dichlorodifluoromethane	10
Dichloroethane [1,1-]	5
Dichloroethane [1,2-]	5
Dichloroethene [1,1-]	5
Dichloroethene [trans-1,2-]	5

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

	Limit of Quantitation
Analytes	**Water (µg/L)**
Dichloropropane [1,2-]	5
Dichloropropane [1,3-]	5
Dichloropropane [2,2-]	5
Dichloropropene [1,1-]	5
Dichloropropene [cis-1,3-]	5
Dichloropropene [trans-1,3-]	5
Ethylbenzene	5
Hexachlorobutadiene	10
Hexanone [2-]	20
Isopropylbenzene	5
Isopropyltoluene [4-]	5
Methyl iodide	5
Methyl-2-pentanone [4-]	20
Methylene chloride	5
Naphthalene	10
Propylbenzene	5
Styrene	5
Tetrachloroethane [1,1,1,2-]	5
Tetrachloroethane [1,1,2,2-]	5
Tetrachloroethylene	5
Toluene	5
Trichloro-1,2,2-trifloroethane [1,1,2-]	5
Trichlorobutadiene [1,2,3-]	10
Trichlorobutadiene [1,2,4-]	10
Trichloroethane [1,1,1-]	5
Trichloroethane [1,1,2-]	5
Trichloroethene	5
Trichlorofluoromethane	5
Trichloropropane [1,2,3-]	5
Trimethylbenzene [1,2,4-]	5
Trimethylbenzene [1,3,5-]	5
Vinyl chloride	10
Xylene (o)	5
Xylene (x+p)	5
Xylenes (o + m + p) [Mixed-]	5

Table A-11. Semivolatile Organic Compounds

	Limit of Quantitation	
Analytes	**Water (µg/L)**	**Sediments (mg/kg-avg)**
Acenaphthene	10	0.38
Acenaphthylene	10	0.38
Aniline	10	0.38
Anthracene	10	0.38
Azobenzene	10	0.38
Benzidine [m-]	50	1.95
Benzo[a]anthracene	10	0.38
Benzo[a]pyrene	10	0.38
Benzo[b]fluoranthene	10	0.38
Benzo[g,h,i]perylene	10	0.38
Benzo[k]fluoranthene	10	0.38
Benzoic acid	50	1.95
Benzyl alcohol	10	0.38
Bis(2-chloroethoxy)methane	10	0.38
Bis(2-chloroethyl)ether	10	0.38
Bis(2-chloroisopropyl)ether	10	0.38
Bis(2-ethylhexyl)phthalate	10	0.38
Bromophenylphenyl ether [4-]	10	0.38
Butyl benzyl phthalate	10	0.38
Chloro-3-methylphenol [4-]	10	0.38
Chloroaniline [4-]	10	0.38
Chloronaphthalene [2-]	10	0.38
Chlorophenol [o-]	10	0.38
Chlorophenylphenyl ether [4-]	10	0.38
Chrysene	10	0.38
Di-n-butyl phthalate	10	0.38
Di-n-octyl phthalate	10	0.38
Dibenzo[a,h]anthracene	10	0.38
Dibenzofuran	10	0.38
Dichlorobenzene (1,2) [o-]	10	0.38
Dichlorobenzene (1,3) [m-]	10	0.38
Dichlorobenzene (1,4) [p-]	10	0.38
Dichlorobenzidine [3,3'-]	20	0.66
Dichlorophenol [2,4-]	10	0.38
Diethyl phthalate	10	0.38
Dimethyl phthalate	10	0.38
Dimethylphenol [2,4-]	10	0.38
Dinitrophenol [2,4-]	50	1.95
Dinitrotoluene [2,4-]	10	0.38
Dinitrotoluene [2,6-]	10	0.38
Fluoranthene	10	0.38
Fluorene	10	0.38
Hexachlorobenzene	10	0.38
Hexachlorobutadiene	50	1.95

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

	Limit of Quantitation	
Analytes	**Water (µg/L)**	**Sediments (mg/kg-avg)**
Hexachlorocyclopentadiene	10	0.38
Hexachloroethane	10	0.38
Indeno[1,2,3-cd]pyrene	10	0.38
Isophorone	10	0.38
Methyl-4,6-dinitrophenol [2-]	50	1.95
Methylnaphthalene [2-]	10	0.38
Methylphenol [2-]	10	0.38
Methylphenol [4-]	10	0.38
Naphthalene	10	0.38
Nitroaniline [2-]	20	0.66
Nitroaniline [3-]	20	0.66
Nitroaniline [4-]	20	0.66
Nitrobenzene	10	0.38
Nitrophenol [2-]	10	0.38
Nitrophenol [4-]	50	1.95
Nitrosodi-n-propylamine [N-]	10	0.38
Nitrosodimethylamine [N-]	10	0.38
Nitrosodiphenylamine [N-]	10	0.38
Pentachlorophenol	50	1.95
Phenanthrene	10	0.38
Phenol	10	0.38
Picoline [2-]	10	0.38
Pyrene	10	1.95
Pyridine	10	0.38
Trichlorobenzene [1,2,4-]	10	0.38
Trichlorophenol [2,4,5-]	10	0.38
Trichlorophenol [2,4,6-]	10	0.38

Table A-12. Polychlorinated Biphenyls

Analytes	Detection Limits Water (μg/L)	 Sediments (mg/kg)
Aroclor 1016	0.5	0.25
Aroclor 1221	0.5	0.25
Aroclor 1232	0.5	0.25
Aroclor 1242	0.5	0.25
Aroclor 1248	0.5	0.25
Aroclor 1254	0.5	0.25
Aroclor 1260	0.5	0.25
Aroclor 1262	0.5	0.25

Table A-13. High-Explosives Analytes

Analytes	Limit of Quantitation Water (μg/L	 Sediments (mg/kg)
HMX	0.5	0.5
RDX	0.5	0.5
1,3,5-TNB	0.5	0.5
1,3-DNB	0.5	0.5
Tetryl	0.5	0.5
Nitrobenzene	0.5	0.5
2,4,6-TNT	0.5	0.5
4-A-2,6-DNT	0.5	0.5
2,6-DNT	0.5	0.5
2,4-DNT	0.5	0.5
2-NT	0.5	0.5
4-NT	0.5	0.5
3-NT	0.5	0.5

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 be 0.00002.

Table B-2 presents conversion factors for converting SI units into US Customary Units. Table B-3 presents abbreviations for common measurements.

Data Handling of Radiochemical Samples

Measurements of radiochemical samples require that analytical or instrumental backgrounds be subtracted to obtain net values. Thus, net values are sometimes obtained that are lower than the minimum detection limit of the analytical technique. Consequently, individual measurements can result in values of positive or negative numbers. Although a negative value does not represent a physical reality, a valid long-term average of many measurements can be obtained only if the very small and negative values are included in the population calculations (Gilbert 1975).

For individual measurements, uncertainties are reported as one standard deviation. The standard deviation is estimated from the propagated sources of analytical error.

Standard deviations for the station and group (off-site regional, off-site perimeter, and on-site) means are calculated using the following equation:

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

where

c_i = 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 one standard deviation (1*s*) for the station and group means.

Tables

Table B-1. Prefixes Used with SI (Metric) Units

Prefix	Factor	Symbol
mega	1 000 000 or 10^6	M
kilo	1 000 or 10^3	k
centi	0.01 or 10^{-2}	c
milli	0.001 or $10^{-}3$	m
micro	0.000001 or 10^{-6}	μ
nano	0.000000001 or 10^{-9}	n
pico	0.000000000001 or 10^{-12}	p
femto	0.000000000000001 or 10^{-15}	f
atto	0.000000000000000001 or 10^{-18}	a

Table B-2. Approximate Conversion Factors for Selected SI (Metric) Units

Multiply SI (Metric) Unit	by	to Obtain US Customary Unit
celsius (°C)	9/5 + 32	fahrenheit (°F)
centimeters (cm)	0.39	inches (in.)
cubic meters (m^3)	35.3	cubic feet (ft^3)
hectares (ha)	2.47	acres
grams (g)	0.035	ounces (oz)
kilograms (kg)	2.2	pounds (lb)
kilometers (km)	0.62	miles (mi)
liters (L)	0.26	gallons (gal.)
meters (m)	3.28	feet (ft)
micrograms per gram (µg/g)	1	parts per million (ppm)
milligrams per liter (mg/L)	1	parts per million (ppm)
square kilometers (km^2)	0.386	square miles (mi^2)

Table B-3. Common Measurement Abbreviations and Measurement Symbols

aCi	attocurie
Bq	becquerel
Btu/yr	British thermal unit per year
Ci	curie
cm^3/s	cubic centimeters per second
cpm/L	counts per minute per liter
fCi/g	femtocurie per gram
ft	foot
ft^3/min	cubic feet per minute
ft^3/s	cubic feet per second
kg	kilogram
kg/h	kilogram per hour
lb/h	pound per hour
lin ft	linear feet
m^3/s	cubic meter per second
µCi/L	microcurie per liter
µCi/mL	microcurie per milliliter
µg/g	microgram per gram
µg/m^3	microgram per cubic meter
mL	milliliter
mm	millimeter
µm	micrometer
µmho/cm	micro mho per centimeter
mCi	millicurie
mg	milligram
mR	milliroentgen

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

m/s	meters per second
mrad	millirad
mrem	millirem
mSv	millisievert
nCi	nanocurie
nCi/dry g	nanocurie per dry gram
nCi/L	nanocurie per liter
ng/m^3	nanogram per cubic meter
pCi/dry g	picocurie per dry gram
pCi/g	picocurie per gram
pCi/L	picocurie per liter
pCi/m^3	picocurie per cubic meter
pCi/mL	picocurie per milliliter
pg/g	picogram per gram
pg/m^3	picogram per cubic meter
PM$_{10}$	small particulate matter (less than 10 µm diameter)
PM$_{2.5}$	small particulate matter (less than 2.5 µm diameter)
R	roentgen
s, ST or σ	standard deviation
s.u.	standard unit
sq ft (ft^2)	square feet
TU	tritium unit
>	greater than
<	less than
≥	greater than or equal to
≤	less than or equal to
±	plus or minus
~	approximately

Reference

Gilbert 1975: R. O. Gilbert, “Recommendations Concerning the Computation and Reporting of Counting Statistics for the Nevada Applied Ecology Group,” Batelle Pacific Northwest Laboratories report BNWL-B-368 (September 1975).

Description of Technical Areas and Their Associated Programs

Locations of the technical areas (TAs) operated by the Laboratory in Los Alamos County are shown in Figure 1-2. The main programs conducted at each of the areas are listed in this Appendix.

TA-0: The Laboratory has about 180,000 sq ft of leased space for training, support, architectural engineering design, and unclassified research and development in the Los Alamos 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 and was removed from the nuclear facilities list. The reactor will be transferred to the institution for placement into the decontamination and decommissioning (D&D) program beginning in 2006.

TA-3, Core Area: The Administration Complex contains the Director's office, administrative offices, and support facilities. Laboratories for several divisions are in this main TA of the Laboratory. Other buildings house central computing facilities, chemistry and materials science laboratories, 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.

TA-5, Beta Site: This site contains some physical support facilities such as an electrical substation, test wells, several archaeological sites, and environmental monitoring and buffer areas.

TA-6, Two-Mile Mesa Site: The site is mostly undeveloped and contains gas cylinder staging and vacant buildings pending disposal.

TA-8, GT Site (or Anchor Site West): This is a dynamic testing site operated as a service facility for the entire Laboratory. It maintains capability in all modern nondestructive testing techniques for ensuring quality of material, ranging from test weapons components to high-pressure dies and molds. Principal tools include radiographic techniques (x-ray machines with potentials up to 1,000,000 V and a 24-MeV betatron), radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.

TA-9, Anchor Site East: At this site, fabrication feasibility and physical properties of explosives are explored. New organic compounds are investigated for possible use as explosives. Storage and stability problems are also studied.

TA-11, K Site: Facilities are located here for testing explosives components and systems, including vibration testing and drop testing, under a variety of extreme physical environments. The facilities are arranged so that testing may be controlled and observed remotely and so that devices containing explosives or radioactive materials, as well as those containing nonhazardous materials, may be tested.

TA-14, Q Site: This dynamic testing site is used for running various tests on relatively small explosive charges for fragment impact tests, explosives sensitivities, and thermal responses.

TA-15, R Site: This is the home of PHERMEX (the pulsed high-energy radiographic machine emitting x-rays) a multiple-cavity electron accelerator capable of producing a very large flux of x-rays for weapons development testing. It is also the site where DARHT (the dual-axis radiographic hydrotest facility) is being constructed. This site is also used for the investigation of weapons functioning and systems behavior in nonnuclear tests, principally through electronic recordings.

TA-16, S Site: Investigations at this site include development, engineering design, prototype manufacture, and environmental testing of nuclear weapons warhead systems. TA-16 is the site of the Weapons Engineering Tritium Facility for tritium handled in gloveboxes. Development and testing of high explosives, plastics, and adhesives, and research on process development for manufacture of items using these and other materials are accomplished in extensive facilities.

TA-18, Pajarito Laboratory Site: This is a nuclear facility that studies both static and dynamic behavior of multiplying assemblies of nuclear materials. The Category I quantities of special nuclear materials (SNM) are used to support a wide variety of programs such as Stockpile Management, Stockpile Stewardship, Emergency Response, Nonproliferation, Safeguards, etc. Experiments near critical are operated by remote control using low-power reactors called critical assemblies. The machines are housed in buildings known as kivas and are used primarily to provide a controlled means of assembling a critical amount of fissionable material so that the effects of various shapes, sizes, and configurations can be studied. These machines are also used as a large-quantity source of fission neutrons for experimental purposes. In addition, this facility provides the capability to perform hands-on training and experiments with SNM in various configurations below critical.

TA-21, DP Site: This site has two primary research areas: DP West and DP East. DP West has been in the D&D program since 1992, and six buildings have been demolished. The programs conducted at DP West, primarily in inorganic and biochemistry, were relocated during 1997, and the remainder of the site was scheduled for D&D in future years. DP East is a tritium research site.

TA-22, TD Site: This site is used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with initiating high explosives and research in rapid shock-induced reactions.

TA-28, Magazine Area A: This is an explosives storage area.

TA-33, HP Site: An old, high-pressure, tritium-handling facility located here is being phased out. An intelligence technology group and the National Radio Astronomy Observatory's Very Large Baseline Array Telescope are located at this site.

TA-35, Ten Site: This site is divided into five facility management units. Work here includes nuclear safeguards research and development that are concerned with techniques for nondestructive detection, identification, and analysis of fissionable isotopes. Research is also done on reactor safety, laser fusion, optical sciences, pulsed-power systems, high-energy physics, tritium fabrication, metallurgy, ceramic technology, and chemical plating.

TA-36, Kappa Site: Phenomena of explosives, such as detonation velocity, are investigated at this dynamic testing site.

TA-37, Magazine Area C: This is an explosives storage area.

TA-39, Ancho Canyon Site: The behavior of nonnuclear weapons is studied here, primarily by photographic techniques. Investigations are also made into various phenomenological aspects of explosives, interactions of explosives, explosions involving other materials, shock wave physics, equation state measurements, and pulsed-power systems design.

TA-40, DF Site: This site is used in the development of special detonators to initiate high-explosive systems. Fundamental and applied research in support of this activity includes investigating phenomena associated with the physics of explosives.

TA-41, W Site: Personnel at this site engage primarily in engineering design and development of nuclear components, including fabrication and evaluation of test materials for weapons.

TA-43, Health Research Laboratory: This site is adjacent to the Los Alamos Medical Center in the 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 houses 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 Bandelier National Monument and past use in high-explosive and radioactive materials experiments. The Hazardous Devices Team Training Facility is located here.

TA-50, Waste Management Site: This site is divided into two facility management units, which include managing the industrial liquid and radioactive liquid waste received from Laboratory technical areas and activities that are part of the waste treatment technology effort.

TA-51, Environmental Research Site: Research and experimental studies on the long-term impact of radioactive waste on the environment and types of waste storage and coverings are studied at this site.

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

TA-53, Los Alamos Neutron Science Center: The Los Alamos Neutron Science Center, including the linear proton accelerator, the Manuel Lujan Jr. Neutron Scattering Center, and a medical isotope production facility are located at this TA. Also located at TA-53 are the Accelerator Production of Tritium Project Office, including the Low-Energy Demonstration Accelerator, and R&D activities in accelerator technology and high-power microwaves.

TA-54, Waste Disposal Site: This site is divided into two facility management units for 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.

TA-57, Fenton Hill Site: This site is located about 28 miles west of Los Alamos on the southern edge of the Valles Caldera in the Jemez Mountains and was the location of the Laboratory’s now decommissioned Hot Dry Rock geothermal project. The site is used for the testing and development of downhole well-logging instruments and other technologies of interest to the energy industry. The high elevation and remoteness of the site make Fenton Hill a choice location for astrophysics experiments. A gamma ray observatory is located at the site.

TA-58: This site is reserved for multiuse experimental sciences requiring close functional ties to programs currently located at TA-3.

TA-59, Occupational Health Site: Occupational health and safety and environmental management activities are conducted at this site. Emergency management offices are also located here.

TA-60, Sigma Mesa: This area contains physical support and infrastructure facilities, including the Test Fabrication Facility and Rack Assembly and the Alignment Complex.

TA-61, East Jemez Road: This site is used for physical support and infrastructure facilities, including the Los Alamos County sanitary landfill.

TA-62: This site is reserved for multiuse experimental science, public and corporate interface, and environmental research and buffer zones.

TA-63: This is a major growth area at the Laboratory with expanding environmental and waste management functions and facilities. This area contains physical support facilities operated by Johnson Controls Northern New Mexico.

TA-64: This is the site of the Central Guard Facility and headquarters for the Laboratory Hazardous Materials Response Team.

TA-66: This site is used for industrial partnership activities.

TA-67: This is a dynamic testing area that contains significant archeological sites.

TA-68: This is a dynamic testing area that contains archeological and environmental study areas.

TA-69: This undeveloped TA serves as an environmental buffer for the dynamic testing area.

TA-70: This undeveloped TA serves as an environmental buffer for the high-explosives test area.

TA-71: This undeveloped TA serves as an environmental buffer for the high-explosives test area.

TA-72: This is the site of the Protective Forces Training Facility.

TA-73: This area is the Los Alamos Airport.

TA-74, Otowi Tract: This large area, bordering the Pueblo of San Ildefonso on the east, is isolated from most of the Laboratory and contains significant concentrations of archeological sites and an endangered species breeding area. This site also contains Laboratory water wells and future well fields.

activation mixed fission	Activation products are formed when a substance is struck by protons or neutrons. The atoms of the original substance are converted to another element that is unstable and, therefore, radioactive.
activation products	Radioactive products generated as a result of neutrons and other subatomic particles interacting with materials such as air, construction materials, or impurities in cooling water. These activation products are usually distinguished, for reporting purposes, from fission products.
albedo dosimeters	Albedo dosimeters are used to measure neutrons around TA-18. They use a neutron-sensitive polyethylene phantom that is used to capture neutron backscatter to simulate the human body.
alpha particle	A positively charged particle (identical to the helium nucleus) composed of two protons and two neutrons that are emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.
ambient air	The surrounding atmosphere as it exists around people, plants, and structures. It is not considered to include the air immediately adjacent to emission sources.
aquifer	A saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.
artesian well	A well in which the water rises above the top of the water-bearing bed.
background radiation	Ionizing radiation from sources other than the Laboratory. This radiation may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; worldwide fallout; and radiation from medical diagnostic procedures.
beta particle	A negatively charged particle (identical to the electron) that is emitted during decay of certain radioactive atoms. Most beta particles are stopped by 0.6 cm of aluminum.
biota	The types of animal and plant life found in an area.
blank sample	A control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. The measured value or signals in blanks for the analyte is believed to be caused by artifacts and should be subtracted from the measured value. This process yields a net amount of the substance in the sample.
blind sample	A control sample of known concentration in which the expected values of the constituent are unknown to the analyst.
BOD	Biochemical (biological) oxygen demand. A measure of the amount of oxygen in biological processes that breaks down organic matter in water; a measure of the organic pollutant load. It is used as an indicator of water quality.

CAA	Clean Air Act. The federal law that authorizes the Environmental Protection Agency (EPA) to set air quality standards and to assist state and local governments to develop and execute air pollution prevention and control programs.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Also known as Superfund, this law authorizes the federal government to respond directly to releases of hazardous substances that may endanger health or the environment. The EPA is responsible for managing Superfund.
CFR	Code of Federal Regulations. A codification of all regulations developed and finalized by federal agencies in the *Federal Register*.
COC	Chain-of-Custody. A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition.
contamination	(1) Substances introduced into the environment as a result of people's activities, regardless of whether the concentration is a threat to health (see pollution). (2) The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.
controlled area	Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.
Ci	Curie. Unit of radioactivity. One Ci equals 3.70×10^{10} nuclear transformations per second.
cosmic radiation	High-energy particulate and electromagnetic radiations that originate outside the earth's atmosphere. Cosmic radiation is part of natural background radiation.
CWA	Clean Water Act. The federal law that authorizes the EPA to set standards designed to restore and maintain the chemicals, physical, and biological integrity of the nation's waters.
DOE	US Department of Energy. The federal agency that sponsors energy research and regulates nuclear materials used for weapons production.
dose	A term denoting the quantity of radiation energy absorbed.
EDE	Effective dose equivalent. The hypothetical whole-body dose that would give the same risk of cancer mortality and serious genetic disorder as a given exposure but that may be limited to a few organs. The effective dose equivalent is equal to the sum of individual organ doses, each weighted by degree of risk that the organ dose carries. For example, a 100 mrem dose to the lung, which has a weighting factor of 0.12, gives an effective dose that is equivalent to $100 \times 0.12 = 12$ mrem. CEDE: committed effective dose equivalent TEDE: total effective dose equivalent

maximum individual dose	The greatest dose commitment, considering all potential routes of exposure from a facility's operation, to an individual at or outside the Laboratory boundary where the highest dose rate occurs. It takes into account shielding and occupancy factors that would apply to a real individual.
population dose	The sum of the radiation doses to individuals of a population. It is expressed in units of person-rem. (For example, if 1,000 people each received a radiation dose of 1 rem, their population dose would be 1,000 person-rem.)
whole body dose	A radiation dose commitment that involves exposure of the entire body (as opposed to an organ dose that involves exposure to a single organ or set of organs).
EA	Environmental Assessment. A report that identifies potentially significant environmental impacts from any federally approved or funded project that may change the physical environment. If an EA shows significant impact, an Environmental Impact Statement is required.
effluent	A liquid waste discharged to the environment.
EIS	Environmental Impact Statement. A detailed report, required by federal law, on the significant environmental impacts that a proposed major federal action would have on the environment. An EIS must be prepared by a government agency when a major federal action that will have significant environmental impacts is planned.
emission	A gaseous waste discharged to the environment.
environmental compliance	The documentation that the Laboratory complies with the multiple federal and state environmental statutes, regulations, and permits that are designed to ensure environmental protection. This documentation is based on the results of the Laboratory's environmental monitoring and surveillance programs.
environmental monitoring	The sampling of contaminants in liquid effluents and gaseous emissions from Laboratory facilities, either by directly measuring or by collecting and analyzing samples in a laboratory.
environmental surveillance	The sampling of contaminants in air, water, sediments, soils, foodstuffs, and plants and animals, either by directly measuring or by collecting and analyzing samples in a laboratory.
EPA	Environmental Protection Agency. The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure protection of human health and the environment.
exposure	A measure of the ionization produced in air by x-ray or gamma ray radiation. (The unit of exposure is the roentgen).

external radiation	Radiation originating from a source outside the body.
gallery	An underground collection basin for spring discharges.
gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other electromagnetic radiation (such as microwaves, visible light, and radiowaves) has longer wavelengths (lower energy) and cannot cause ionization.
GENII	Computer code used to calculate doses from all pathways (air, water, foodstuffs, and soil).
gross alpha	The total amount of measured alpha activity without identification of specific radionuclides.
gross beta	The total amount of measured beta activity without identification of specific radionuclides.
groundwater	Water found beneath the surface of the ground. Groundwater usually refers to a zone of complete water saturation containing no air.
^3H	Tritium.
half-life, radioactive	The time required for the activity of a radioactive substance to decrease to half its value by inherent radioactive decay. After two half-lives, one-fourth of the original activity remains (1/2 × 1/2), after three half-lives, one-eighth (1/2 × 1/2 × 1/2), and so on.
hazardous waste	Wastes exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or yielding toxic constituents in a leaching test. In addition, EPA has listed as hazardous other wastes that do not necessarily exhibit these characteristics. Although the legal definition of hazardous waste is complex, the term generally refers to any waste that EPA believes could pose a threat to human health and the environment if managed improperly. Resource Conservation and Recovery Act (RCRA) regulations set strict controls on the management of hazardous wastes.
hazardous waste constituent	The specific substance in a hazardous waste that makes it hazardous and therefore subject to regulation under Subtitle C of RCRA.
HSWA	Hazardous and Solid Waste Amendments of 1984 to RCRA. These amendments to RCRA greatly expanded the scope of hazardous waste regulation. In HSWA, Congress directed EPA to take measures to further reduce the risks to human health and the environment caused by hazardous wastes.
hydrology	The science dealing with the properties, distribution, and circulation of natural water systems.
internal radiation	Radiation from a source within the body as a result of deposition of radionuclides in body tissues by processes such as ingestion, inhalation, or implantation. Potassium-40, a naturally occurring radionuclide, is a major source of internal radiation in living organisms. Also called self-irradiation.

ionizing radiation	Radiation possessing enough energy to remove electrons from the substances through which it passes. The primary contributors to ionizing radiation are radon, cosmic and terrestrial sources, and medical sources such as x-rays and other diagnostic exposures.
isotopes	Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons. Isotopes of an element have similar chemical behaviors but can have different nuclear behaviors. • 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).
LLW	Low-level waste. The level of radioactive contamination in LLW is not strictly defined. Rather, LLW is defined by what it is not. It does not include nuclear fuel rods, wastes from processing nuclear fuels, transuranic (TRU) waste, or uranium mill tailings.
MCL	Maximum contaminant level. Maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system (see Appendix A and Table A-6). The MCLs are specified by the EPA.
MEI	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 CAA; they set limits for such pollutants as beryllium and radionuclides.

nonhazardous waste	Chemical waste regulated under the Solid Waste Act, Toxic Substances Control Act, and other regulations, including asbestos, PCB, infectious wastes, and other materials that are controlled for reasons of health, safety, and security.
NPDES	National Pollutant Discharge Elimination System. This federal program, under the Clean Water Act, requires permits for discharges into surface waterways.
nuclide	A species of atom characterized by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, number of neutrons, and energy content; or alternately, by the atomic number, mass number, and atomic mass. To be a distinct nuclide, the atom must be capable of existing for a measurable length of time.
outfall	The location where wastewater is released from a point source into a receiving body of water.
PCB	Polychlorinated biphenyls. A family of organic compounds used since 1926 in electric transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCB are extremely persistent in the environment because they do not break down into new and less harmful chemicals. PCB are stored in the fatty tissues of humans and animals through the bioaccumulation process. EPA banned the use of PCB, with limited exceptions, in 1976.
PDL	Public Dose Limit. The new term for Radiation Protection Standards, a standard for external and internal exposure to radioactivity as defined in DOE Order 5400.5 (see Appendix A and Table A-1).
perched groundwater	A groundwater body above a slow-permeablity rock or soil layer that is separated from an underlying main body of groundwater by a vadose zone.
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]).
point source	An identifiable and confined discharge point for one or more water pollutants, such as a pipe, channel, vessel, or ditch.
ppb	Parts per billion. A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or ng/mL. Also used to express the weight/weight ratio as ng/g or µg/kg.
ppm	Parts per million. A unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L. Also used to express the weight/weight ratio as µg/g or mg/kg.

QA	Quality assurance. Any action in environmental monitoring to ensure the reliability of monitoring and measurement data. Aspects of quality assurance include procedures, interlaboratory comparison studies, evaluations, and documentation.
QC	Quality control. The routine application of procedures within environmental monitoring to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.
rad	Radiation absorbed dose. The rad is a unit for measuring energy absorbed in any material. Absorbed dose results from energy being deposited by the radiation. It is defined for any material. It applies to all types of radiation and does not take into account the potential effect that different types of radiation have on the body. 1 rad = 1,000 millirad (mrad)
radionuclide	An unstable nuclide capable of spontaneous transformation into other nuclides through changes in its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.
RESRAD	A computer modeling code designed to model radionuclide transport in the environment.
RCRA	Resource Conservation and Recovery Act of 1976. RCRA is an amendment to the first federal solid waste legislation, the Solid Waste Disposal Act of 1965. In RCRA, Congress established initial directives and guidelines for EPA to regulate hazardous wastes.
release	Any discharge to the environment. Environment is broadly defined as water, land, or ambient air.
rem	Roentgen equivalent man. The rem is a unit for measuring dose equivalence. It is the most commonly used unit and pertains only to people. The rem takes into account the energy absorbed (dose) and the biological effect on the body (quality factor) 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 internal radiation source; the natural decay chains of uranium-235, uranium-238, or thorium-232; or cosmic-ray-induced radionuclides in the soil.
TLD	Thermoluminescent dosimeter. A material (the Laboratory uses lithium fluoride) that emits a light signal when heated to approximately 300°C. This light is proportional to the amount of radiation (dose) to which the dosimeter was exposed.
TRU	Transuranic waste. Waste contaminated with long-lived transuranic elements in concentrations within a specified range established by DOE, EPA, and Nuclear Regulatory Agency. These are elements shown above uranium on the chemistry periodic table, such as plutonium, americium, and neptunium, which have activities greater than 100 nanocuries per gram.
TSCA	Toxic Substances Control Act. TSCA is intended to provide protection from substances manufactured, processed, distributed, or used in the United States. A mechanism is required by the act for screening new substances before they enter the marketplace and for testing existing substances that are suspected of creating health hazards. Specific regulations may also be promulgated under this act for controlling substances found to be detrimental to human health or to the environment.
tuff	Rock formed from compacted volcanic ash fragments.
uncontrolled area	An area beyond the boundaries of a controlled area (see controlled area in this glossary).
unsaturated zone	See vadose zone in this glossary.
UST	Underground storage tank. A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10% or more of the volume of the tank system is below the surface of the ground.
vadose zone	The partially saturated or unsaturated region above the water table that does not yield water for wells. Water in the vadose zone is held to rock or soil particles by capillary forces and much of the pore space is filled with air.

water table	The water level surface below the ground at which the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer would fill with water.
water year	October through September.
watershed	The region draining into a river, a river system, or a body of water.
wetland	A lowland area, such as a marsh or swamp, that is inundated or saturated by surface water or groundwater sufficient to support hydrophytic vegetation typically adapted for life in saturated soils.
wind rose	A diagram that shows the frequency and intensity of wind from different directions at a particular place.
worldwide fallout	Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

Acronyms and Abbreviations

AA-2	Internal Assessment Group (LANL)
AEC	Atomic Energy Commission
AIP	Agreement in Principle
AIRFA	American Indian Religious Freedom Act
AIRNET	Air Monitoring Network
AL	Albuquerque Operations Office (DOE)
AO	Administrative Order
AQCR	Air Quality Control Regulation (New Mexico)
ARPA	Archeological Resources Protection Act
BEIR	biological effects of ionizing radiation
BOD	biochemical/biological oxygen demand
BTEX	total aromatic hydrocarbon
Btu	British thermal unit
CAA	Clean Air Act
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
COE	Army Corps of Engineers
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
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act

Acronyms and Abbreviations

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
GENII	Generation II
GIS	geographic information system
G/MAP	gaseous/mixed air activation products
GPS	global positioning system
GWPMPP	Groundwater Protection Management Program Plan
HAZWOPER	hazardous waste operations (training class)
HE	high-explosive
HEWTP	High-Explosive Wastewater Treatment Plant
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
JCNNM	Johnson Controls Northern New Mexico
JENV	JCNM Environmental Laboratory
LAAO	Los Alamos Area Office (DOE)
LANSCE	Los Alamos Neutron Science Center
LANL	Los Alamos National Laboratory (or the Laboratory)
LEDA	Low-Energy Demonstration Accelerator
LLW	low-level radioactive waste
LLMW	low-level mixed waste
LOQ	limit of quantitation
MAP	Mitigation Action Plan
MCL	maximum contaminant level
MDA	minimum detectable amount

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
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 biphenyls
PDL	public dose limit
PHERMEX	Pulsed high-energy radiographic machine emitting x-rays
ppb	parts per billion
ppm	parts per million
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
RCRA	Resource Conservation and Recovery Act
RD&D	research, development, and demonstration
RESRAD	residual radioactive material computer code
RLWTF	Radioactive Liquid Waste Treatment Facility (LANL)
RSRL	regional statistical reference level
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 Plant (LANL)
TA	Technical Area
TDS	total dissolved solids
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
TLDNET	thermoluminescent dosimeter network
TRI	toxic chemical release inventory
TRU	transuranic waste
TRPH	total recoverable petroleum hydrocarbon
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTHM	trihalomethane
TWISP	Transuranic Waste Inspectable Storage Project (LANL)
UC	University of California
USFS	United States Forest Service
USGS	United States Geological Survey
UST	underground storage tank
VAP	vaporous activation products
VOC	volatile organic compound
WASTENET	Waste Management Areas Network (for air monitoring)
WM	Waste Management (LANL)
WSC	Waste Stream Characterization
WWW	World Wide Web

Elemental and Chemical Nomenclature

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

Standard UC-902 (Environmental Sciences) and UC-707 (Health and Safety) Distribution

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- Office of Policy & Assistance
- Office of Research, Development, and Testing Facilities
- Albuquerque Area Office
- Los Alamos Area Office
- Environmental Measurements Laboratory
- Idaho Operations Office
- Nevada Operations Office
- Oak Ridge Operations Office
- Savannah River Operations Office

US Department of Energy Contractors

- Argonne National Laboratory
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- Brookhaven National Laboratory
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- Lawrence Livermore National Laboratory
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- Pantex Plant
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- Sandia National Laboratories, California

State of New Mexico

- Office of the Governor
- NM Health Department
- NM Environment Department
- NM Environment Improvement Board
- NM Oil Conservation Division
- NM Energy, Minerals, & Natural Resources Department
- NM State Engineer's Office
- Scientific Laboratory Division

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  - President's Council, Office of the President
  - Environment, Health, and Safety Office
- **Environmental Protection Agency**
- **NM Congressional Delegation**
- **Elected Official**
- **County of Los Alamos**
- **NM Office of Indian Affairs**
- **Indian Pueblo Governors, Northern NM**
  - Pueblo of Cochiti
  - Pueblo of Jemez
  - Pueblo of Nambé
  - Pueblo of Picuris
  - Pueblo of Pojoaque
  - Pueblo of San Ildefonso
- **Indian Pueblo Governors, Northern NM (Cont.)**
  - Pueblo of San Juan
  - Pueblo of Santa Clara
  - Pueblo of Santo Domingo
  - Pueblo of Taos
  - Pueblo of Tesuque
- **Eight Northern Indian Pueblo Council**
  - Pueblo Office of Environmental Protection
- **Bureau of Indian Affairs**
- **National Park Service**
- **Bandelier National Monument**
- **US Fish and Wildlife Service**
- **US Geological Survey**
- **Concerned Citizens for Nuclear Safety**
- **Los Alamos Study Group**
- **Responsive Environmental Action League**
- **Johnson Controls, Inc.**
- **Libraries**
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  - Mesa Public Library, White Rock Branch
  - UNM-LA, Los Alamos, NM
  - Santa Fe Public Library, Santa Fe, NM
  - New Mexico State Library, Santa Fe, NM
- **Media**
  - The Monitor, Los Alamos, NM
  - The New Mexican, Santa Fe, NM
  - The Reporter, Santa Fe, NM
  - The Rio Grande Sun, Española, NM
  - The Taos News, Taos, NM
  - Albuquerque Journal, Albuquerque, NM
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