APPENDIX F
ENVIRONMENTAL SAMPLE DATA

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Appendix F presents an analysis of 2001 through 2005 environmental monitoring analytical results for use in this *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (LANL SWEIS). In Appendix F these results are evaluated for the following three purposes:

- To summarize and present the 2001 through 2005 environmental sample data in a manner[1] analogous to that used in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999);

- To evaluate the effects of the Cerro Grande Fire of May 2000, at an aggregate level, on the concentration of radioisotope analytical results in groundwater, sediment, stormwater runoff, and soil samples in and around LANL (in Section F.2); and

- To provide conservative assessments of environmental concentrations of radioisotopes and chemicals (in Section F.3) for use in calculating the Offsite Resident (Los Alamos County resident), Recreational User, and Special Pathways receptor impacts presented in Appendix C, Section C.1.4.

Appendix F is not intended to replace or supplement the LANL annual Environmental Surveillance Reports (LANL 2002, 2004a, 2004b, 2005, 2006b). Those reports provide analyses of environmental measurement results along with statistical interpretation of the data and assessments of data importance. The statistical analysis in the LANL Environmental Surveillance Reports results in a determination as to whether each specific chemical or radioisotope (denoted an analyte) is conclusively present, that is, has actually been detected, in a sample. The data analysis in Appendix F is for the purposes described above and is not intended to indicate the presence of known contamination in the environment.

F.1 Environmental Monitoring Selection

Los Alamos National Laboratory (LANL) staff conducts an ongoing environmental monitoring program that encompasses locations within LANL, along the perimeter of LANL, and throughout the region of non-LANL land in the adjoining counties. This program provides an extensive set of measurements of radiological and hazardous chemical substances in the air, surface water or stormwater runoff, groundwater, sediment, and soil.

For radiological monitoring, periodic samples are obtained and measured for a wide range of radioisotopes, as well as gross alpha, beta, and gamma radiation. Monitored radioisotopes

[1] *A similar approach is used in Section F.2 as was used to average the environmental data presented in the 1999 SWEIS. This allows the 2001 through 2005 environmental data in Section F.2 to be compared with the data from 1991 through 1996 presented in the 1999 SWEIS. The statistical treatment of data and the comparison between the two time frames does not account for differences in measurement techniques or instrument accuracy.*

include americium-241, cesium-137, cobalt-60, iodine-129, neptunium-237, plutonium-238, plutonium-239, plutonium-240, potassium-40, radium-226, radium-228, sodium-22, strontium-90, technetium-99, tritium, uranium-234, uranium-235, uranium-236, and uranium-238. Radioisotope concentrations in the soil collected within and around LANL has been very low and, for the most part, has not increased over time. Soils are now sampled every 3 years. Tritium is measured in both solid and liquid samples because of its high affinity for the liquid state as tritiated water. Most of these radioisotopes have relatively long half-lives (greater than 10 years, except for cobalt-60, radium-228, and sodium-22), can have significant health impacts in sufficient quantities, and represent many of the radioisotopes that are handled, managed, and stored at LANL. They also constitute the entire range of high-energy emitters of alpha, beta, gamma, and neutron radiation.

During 2001 through 2005, radiological samples were obtained from 15 onsite canyons, as well as sites along LANL's borders. Further measurements were made of samples from the surrounding counties. These samples were used to measure radioactivity levels, and the data were subjected to statistical analysis. The data were subdivided into three principal regions of interest: Regional, Perimeter, and Onsite.

F.2 Evaluation of Los Alamos National Laboratory Environmental Sampling Data

Numerous studies and analyses have been performed on the effects of the Cerro Grande Fire at LANL. One area of major interest is the redistribution of radioisotopes in the environment in and around LANL due to this wildfire. The current measured[2] distribution of radioisotopes in the environment was used to calculate doses to special receptors as reported in Appendix C of this SWEIS. The current measured radioisotope distribution in soil, surface water or stormwater runoff, sediment, and groundwater was also used to calculate worker and public doses from a postulated wildfire accident in Appendix D.

As environmental measurements of radioisotopes in and around LANL now exist for 2001 through 2005 and the same data were developed for the *1999 SWEIS* for the years 1991 through 1996, a graphical presentation was prepared to compare the distribution for selected radioisotopes in each of the four environmental media (groundwater, sediment, soil, and surface water or stormwater runoff). Only those radioisotopes that were measured in both sets of data were presented graphically. **Figures F–1** through **F–23** present the mean measured concentration of a specific radioisotope at a specific location in or near LANL. One symbol represents the 2001 through 2005 data, while a different symbol represents the 1991 through 1996 data, resulting in a "scatter plot" for each radioisotope and medium. The use of this type of plot allows the observer to make general observations regarding any trend.

The data in these figures were based on measurements at Regional, Perimeter, and Onsite locations. Each mean measured concentration data point was calculated from annual measurements at one of the various locations. The radioisotopes of interest that were plotted are americium-241, cesium-137, plutonium-238, plutonium-239 and plutonium-240, strontium-90, and tritium. These isotopes represent relatively long half-life nuclides with potentially

[2] *In this appendix, the use of the terms measured or measurements refers to values derived from the sample analytical data in accordance with the statistical evaluation described in Section F.3.*

significant health hazards that may have been released by LANL facilities. For soil environmental data, only the mean for the composite Regional, Perimeter, and Onsite stations is presented because those are the only data available for both periods. In addition, strontium-90 data are not available for soil data from both time periods. Each sediment and soil graph also presents the LANL human health risk-based Screening Action Level (SAL) (LANL 2001) that LANL uses as a criterion for acceptable sediment and soil radioisotope mass concentration level except for tritium, which is defined as a volumetric concentration value. The SAL indicates whether further study or environmental remediation is required. These LANL SALs for sediments and soil were first developed in 2001 and are based on the U.S. Environmental Protection Agency (EPA) guidance limit of 15 millirem per year for residential, commercial, recreational, and industrial use of the land. The SAL calculation includes inhalation, ingestion, and external exposure pathways. The radionuclide SALs were calculated for a 1,000-year timeframe with no loss by erosion or leaching (LANL 2001).

The grouping of the data has changed over the years. To allow visual comparison in graphs, the data for 1991 through 1996 are related to 2001 through 2005 data as shown in **Table F–1**. **Figures F–1** through **F–6** are graphs for groundwater data for measured isotopes for the groundwater data sets as shown in Table F–1. Table F–1 also indicates the Section F.3 data tables that correspond to the 2001 through 2005 data sets.

Table F–1 Groundwater Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Alluvial Groundwater	Canyon Alluvial Groundwater Systems [a]	F–15, F–16
2	Spring from Basalt	Basalt Springs [b]	F–18
3	Main Aquifer	Regional Aquifer Wells [c]	F–10
4	Test Wells	Test Wells	F–12
5	Springs	Regional Aquifer Springs	F–14
6	Springs from Volcanics [d]	Water Gallery (2001-2003) [d]	F–18
7	San Ildefonso	San Ildefonso Pueblo	F–19
8	Intermediate Perched	Intermediate Perched Groundwater Systems [e]	F–17, F–18
9	Not Measured	Hydrogeologic Characterization Wells	F–11
10	Not Measured	Water Supply Wells	F–13
11	Not Measured	Santa Fe Water Supply Wells	F–20

[a] Canyon Alluvial Groundwater Systems encompasses Canyon Alluvial Wells and Canyon Alluvial Springs, which are separated into Table F–15 and Table F–16.

[b] Basalt springs is a subset of the Los Alamos Canyon data in Table F–18, Intermediate Perched Springs.

[c] Regional Aquifer Wells is a summation of Hydrogeologic Characterization Wells, Test Wells, and Water Supply Wells.

[d] Data from the location identified as Springs from Volcanics in 1991 through 1996 most closely correlates with data from Water Gallery (2001-2003). Water Gallery data are a subset of the Water Canyon data in Table F–18, Intermediate Perched Springs.

[e] Intermediate Perched Groundwater Systems encompasses Intermediate Perched Wells and Intermediate Perched Springs, which are separated into Table F–17 and Table F–18.

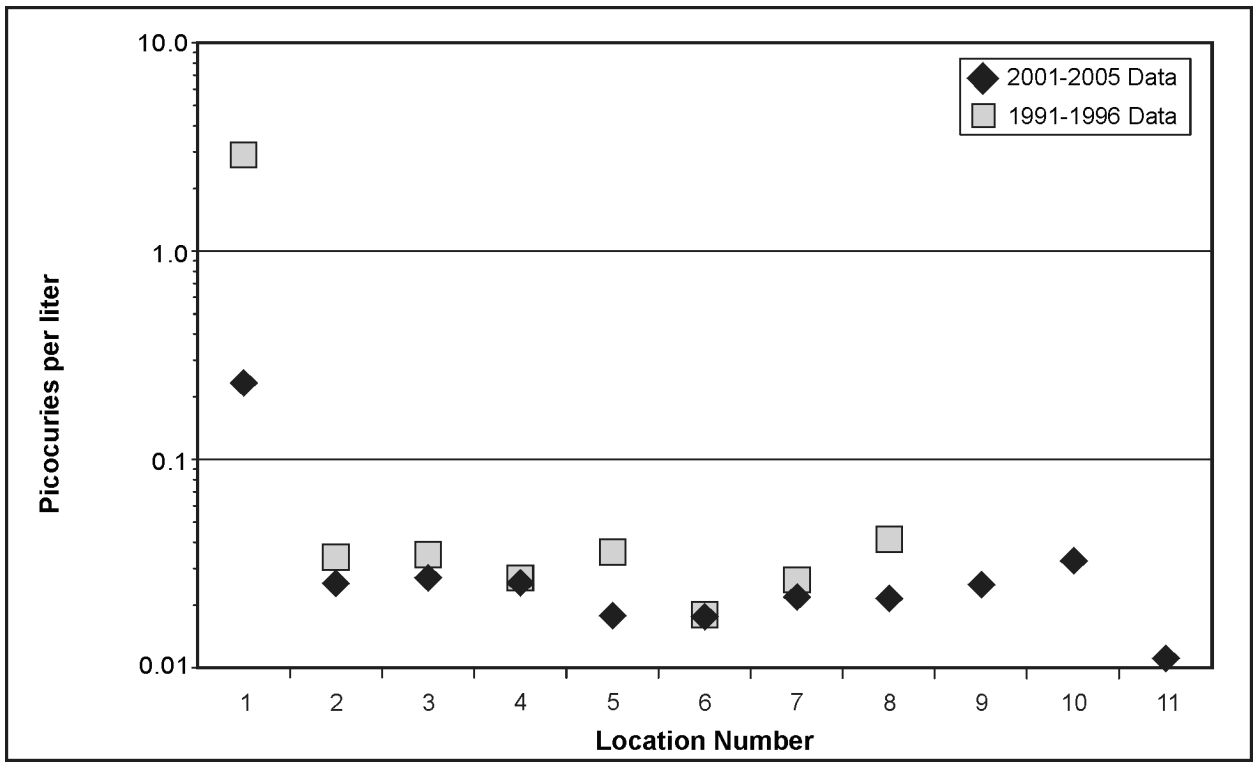

Figure F–1 Americium-241 Measured Mean Concentration Value for Groundwater

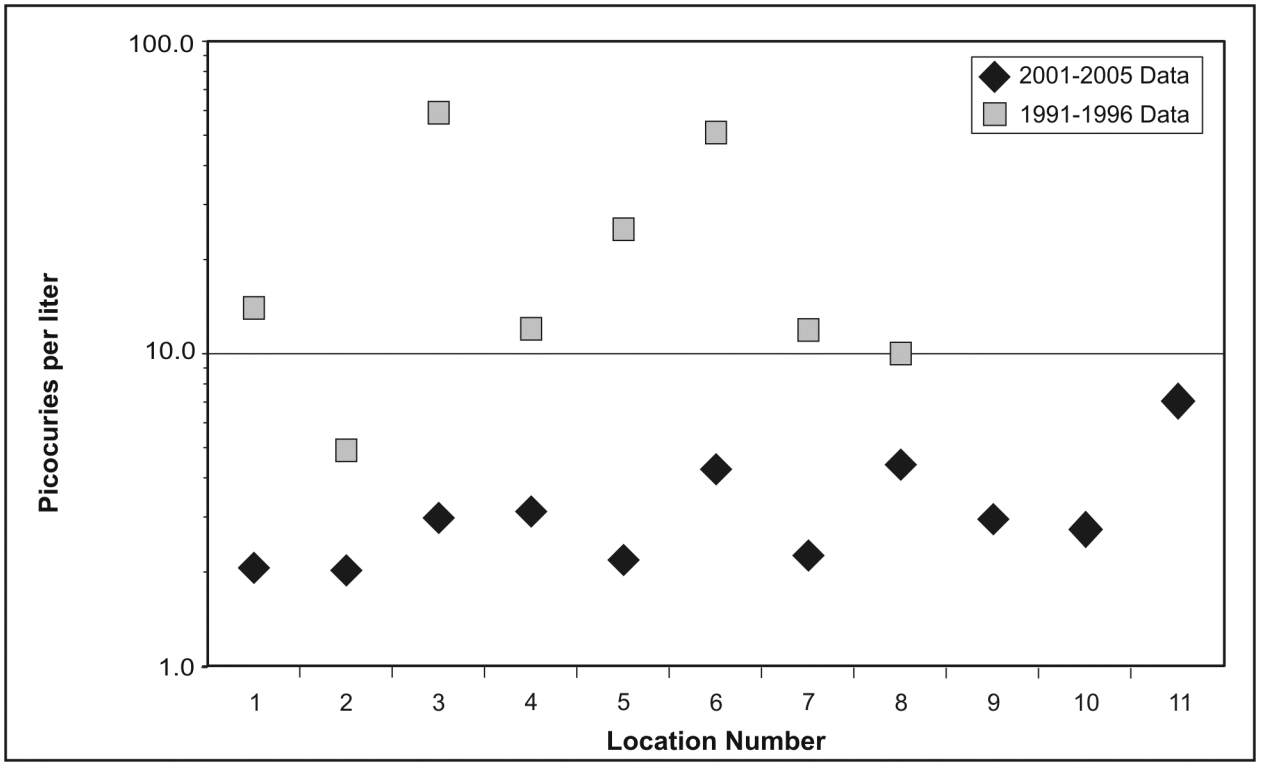

Figure F–2 Cesium-137 Measured Mean Concentration Value for Groundwater

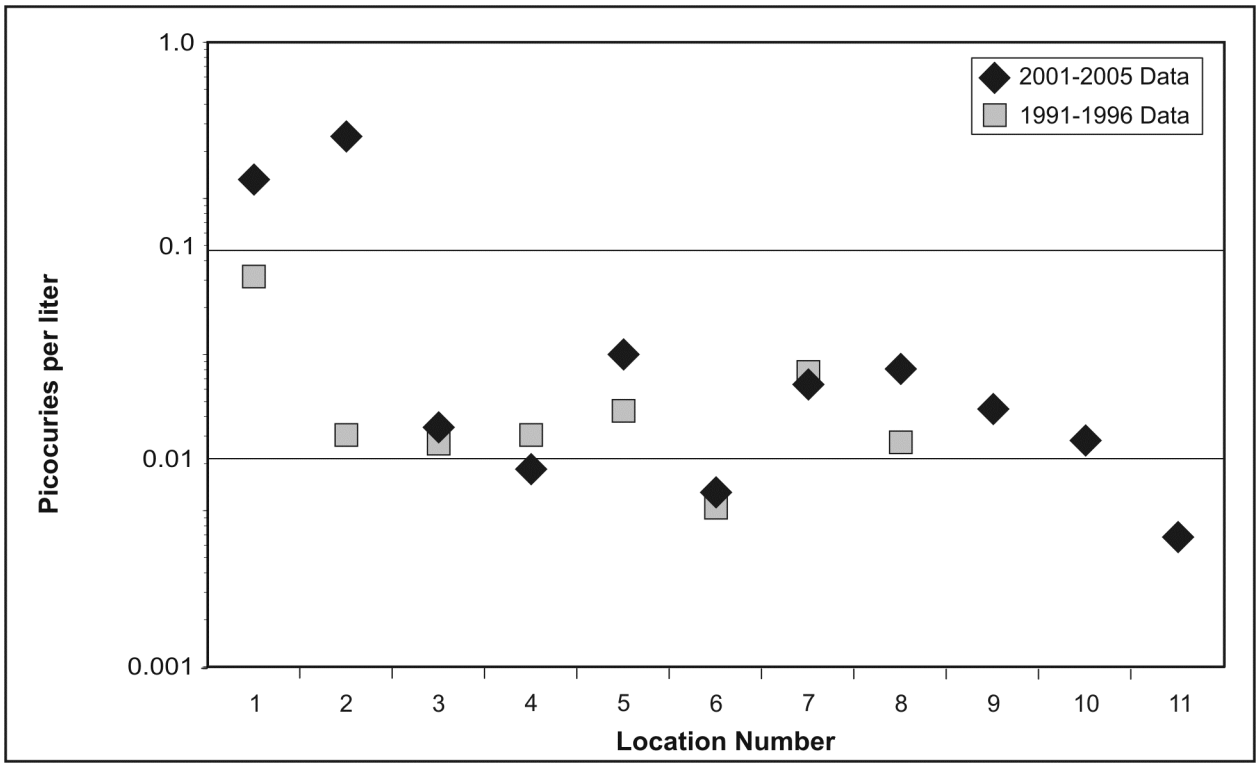

Figure F–3 Plutonium-238 Measured Mean Concentration Value for Groundwater

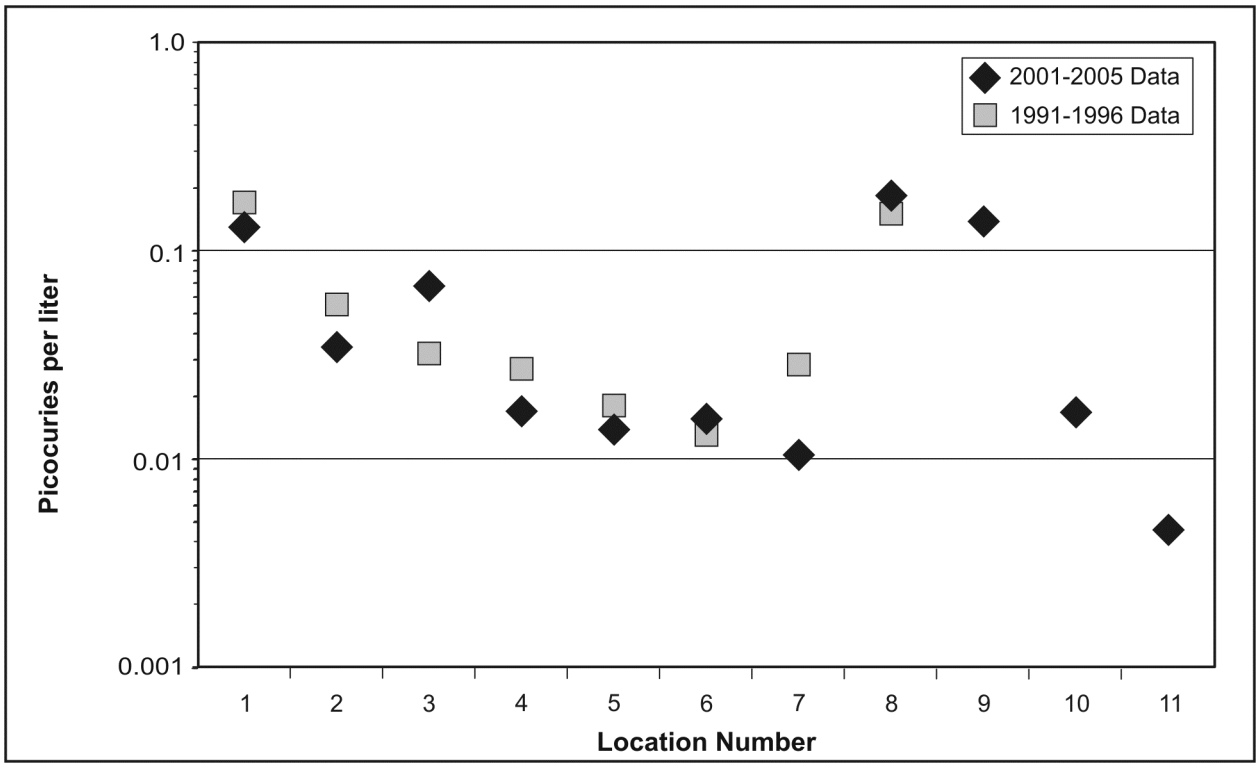

Figure F–4 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Groundwater

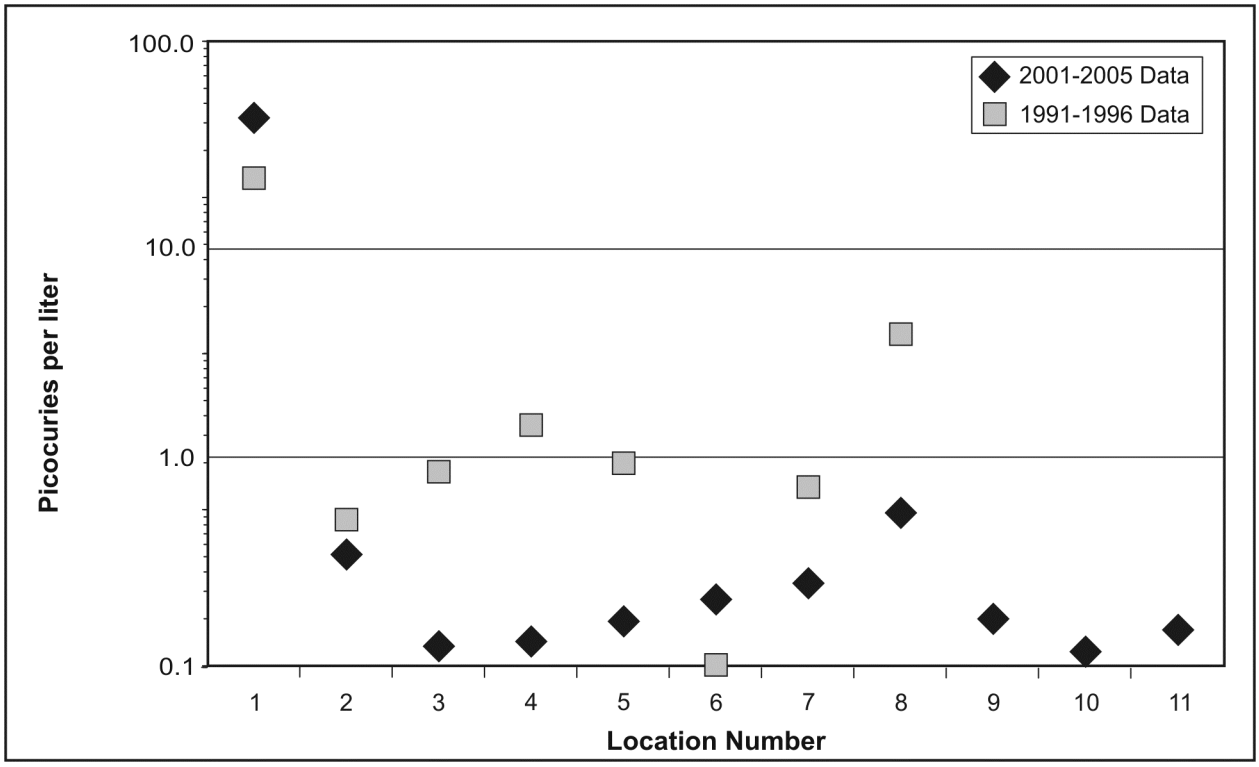

Figure F–5 Strontium-90 Measured Mean Concentration Value for Groundwater

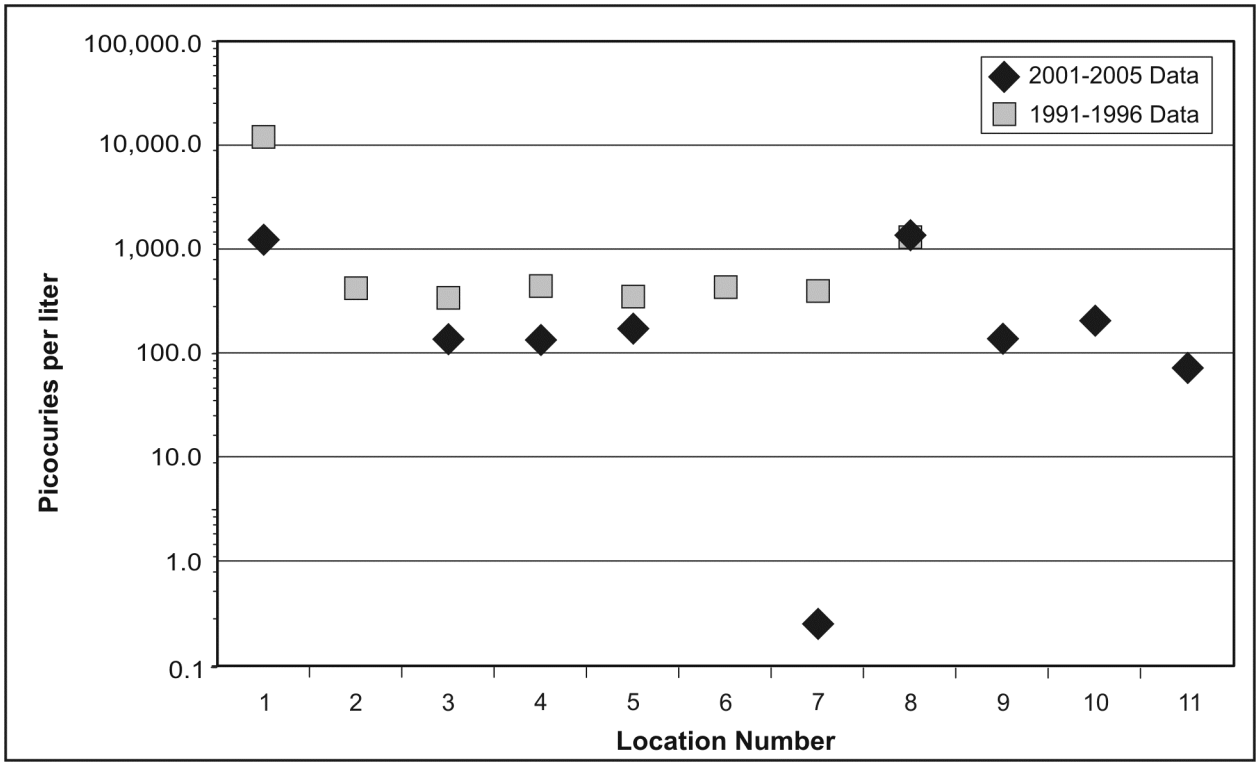

Figure F–6 Tritium Measured Mean Concentration Value for Groundwater

Figures F–7 through **F–12** are graphs for isotopes measured in sediments. The data points are in the order shown in **Table F–2**. Table F–2 also indicates the Section F.3 data table that corresponds to the 2001 through 2005 data sets. In 2001 through 2005 data, measurements in sediments were provided for Fence and Indio Canyons for some isotopes that were not considered in the 1991 through 1996 data. Plutonium-238 and tritium do not have measured values for Indio Canyon in the 2001 through 2005 data. For Bayo Canyon, strontium-90 and plutonium-239 and plutonium-240 do not have measured values in the 2001 through 2005 data.

Table F–2 Sediment Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Regional Stations	Regional Stations	F–21
2	Perimeter Stations	Perimeter Stations	F–21
3	Onsite Stations	Onsite Stations	F–21
4	Ancho Canyon	Ancho Canyon	F–21
5	Bayo Canyon	Bayo Canyon	F–21
6	Cañada del Buey Canyon	Cañada del Buey Canyon	F–21
7	Chaquehui Canyon	Chaquehui Canyon	F–21
8	Not Measured	Fence Canyon	F–21
9	Frijoles Canyon	Frijoles Canyon	F–21
10	Gauje Canyon	Gauje Canyon	F–21
11	Not Measured	Indio Canyon	F–21
12	Los Alamos Canyon	Los Alamos Canyon	F–21
13	Mortandad Canyon	Mortandad Canyon	F–21
14	Pajarito Canyon	Pajarito Canyon	F–21
15	Potrillo Canyon	Potrillo Canyon	F–21
16	Pueblo Canyon	Pueblo Canyon	F–21
17	Sandia Canyon	Sandia Canyon	F–21
18	Water Canyon	Water Canyon	F–21

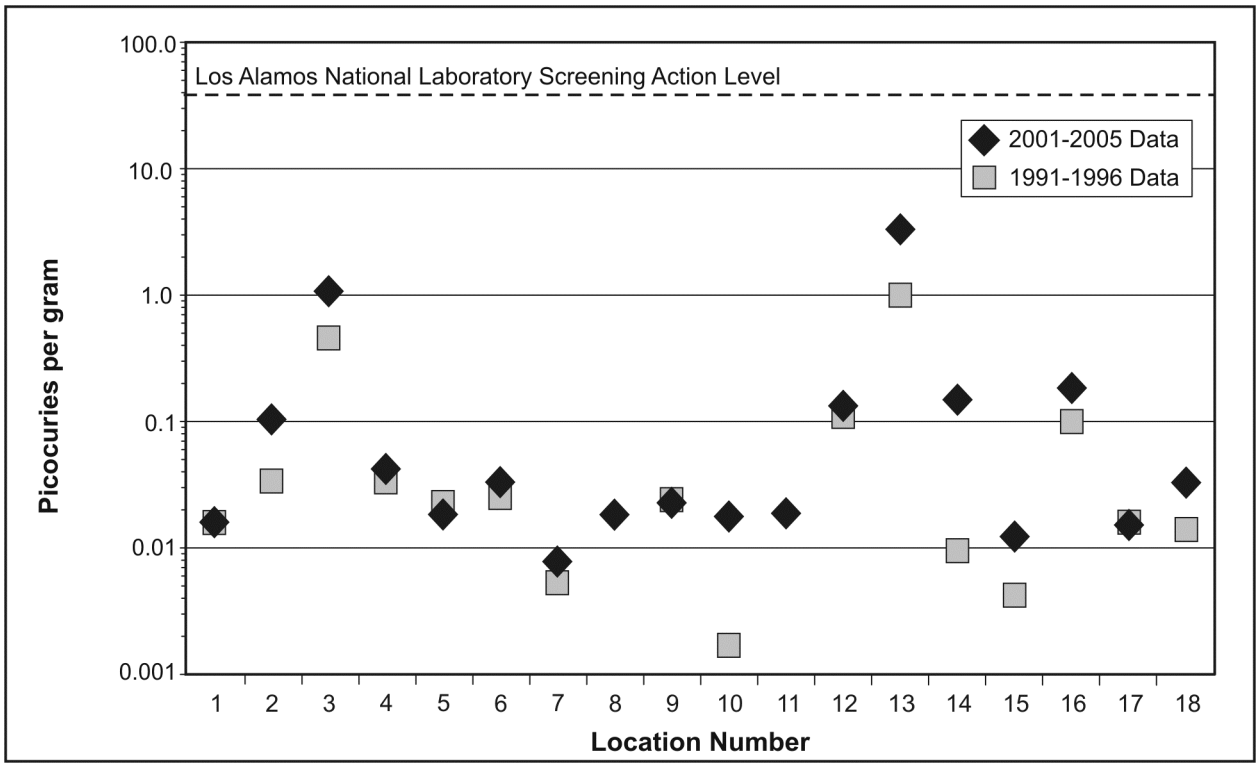

Figure F–7 Americium-241 Measured Mean Concentration Value for Sediment

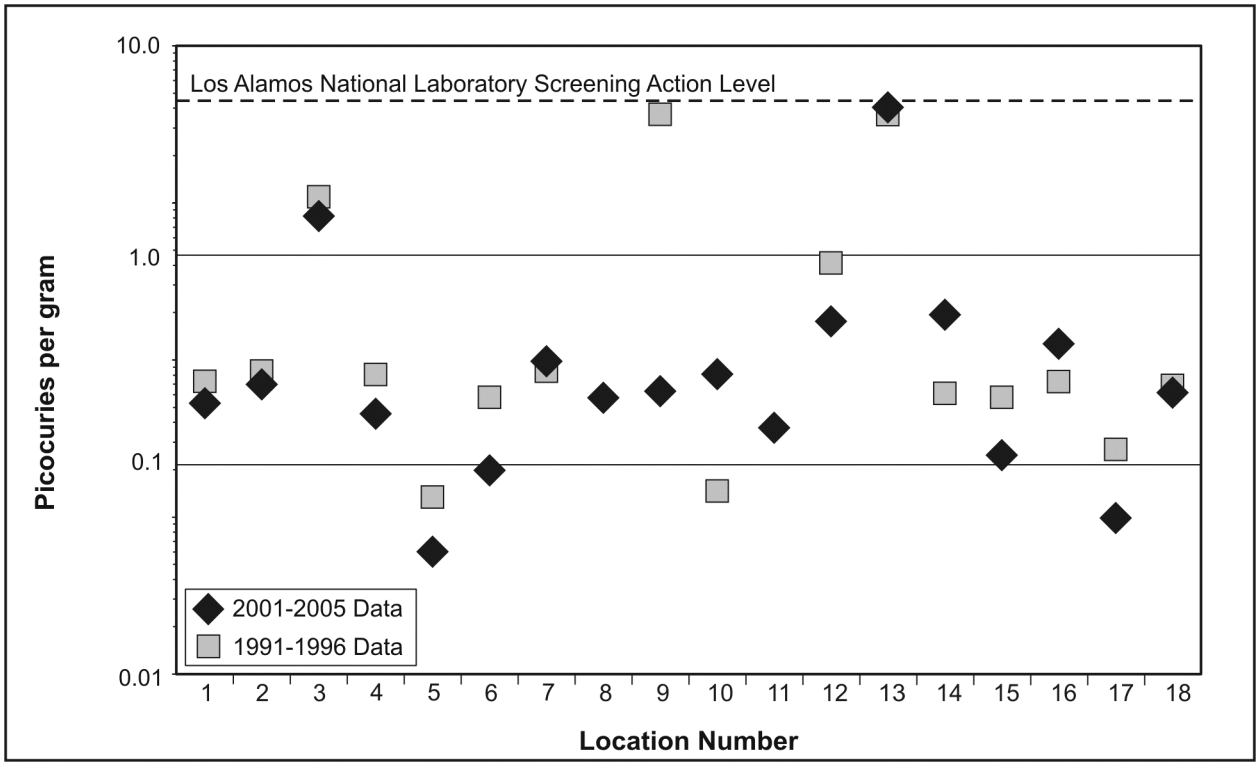

Figure F–8 Cesium-137 Measured Mean Concentration Value for Sediment

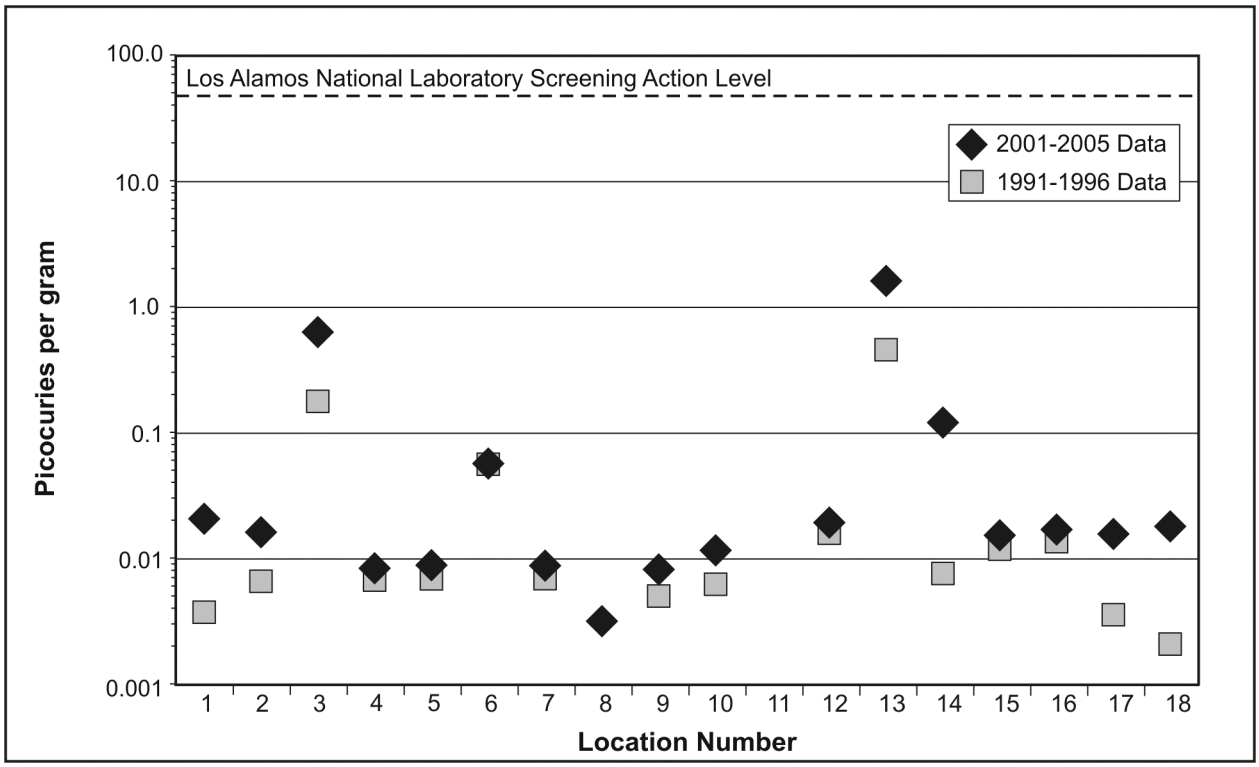

Figure F–9 Plutonium-238 Measured Mean Concentration Value for Sediment

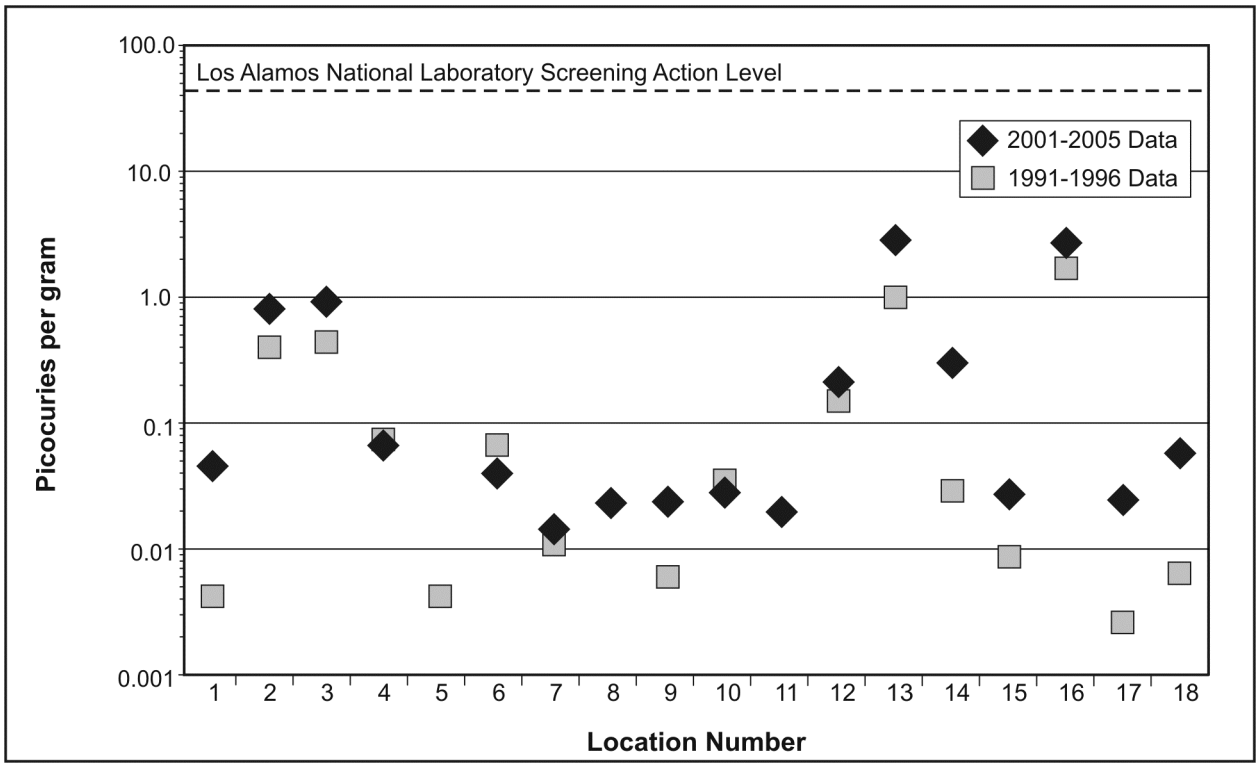

Figure F–10 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Sediment

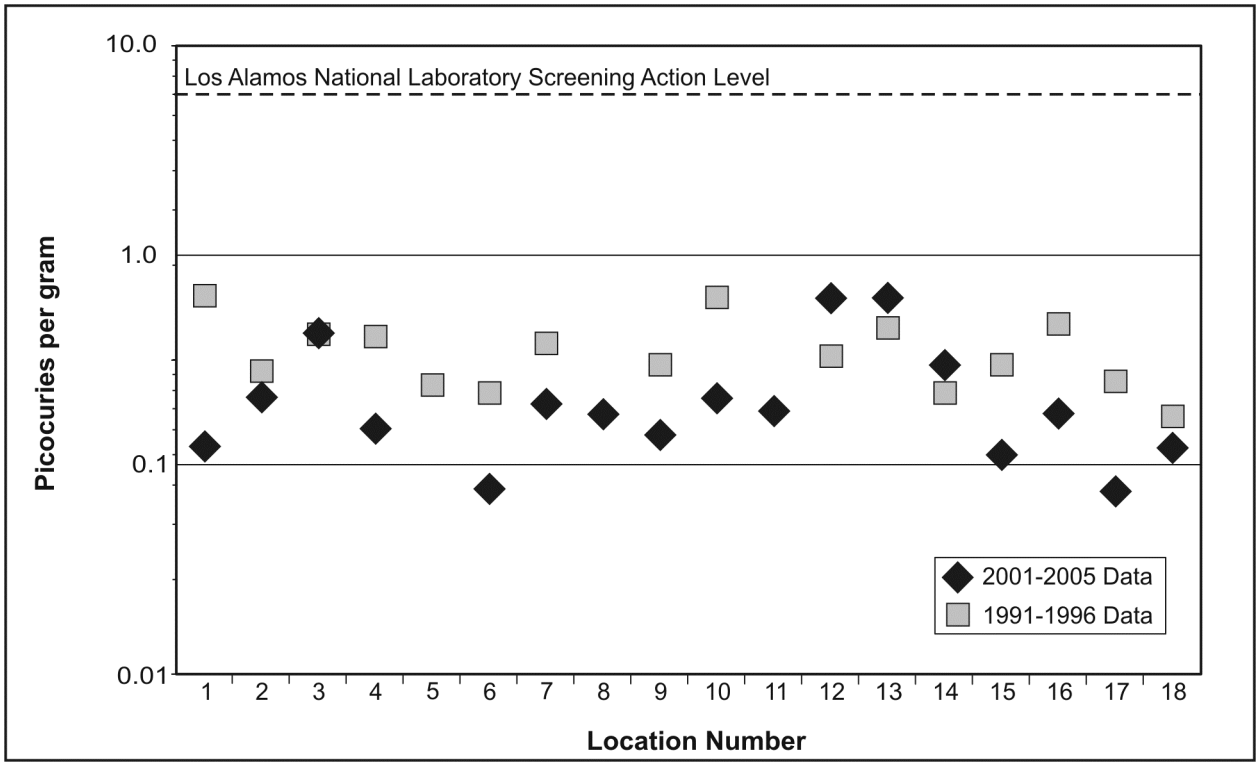

Figure F–11 Strontium-90 Measured Mean Concentration Value for Sediment

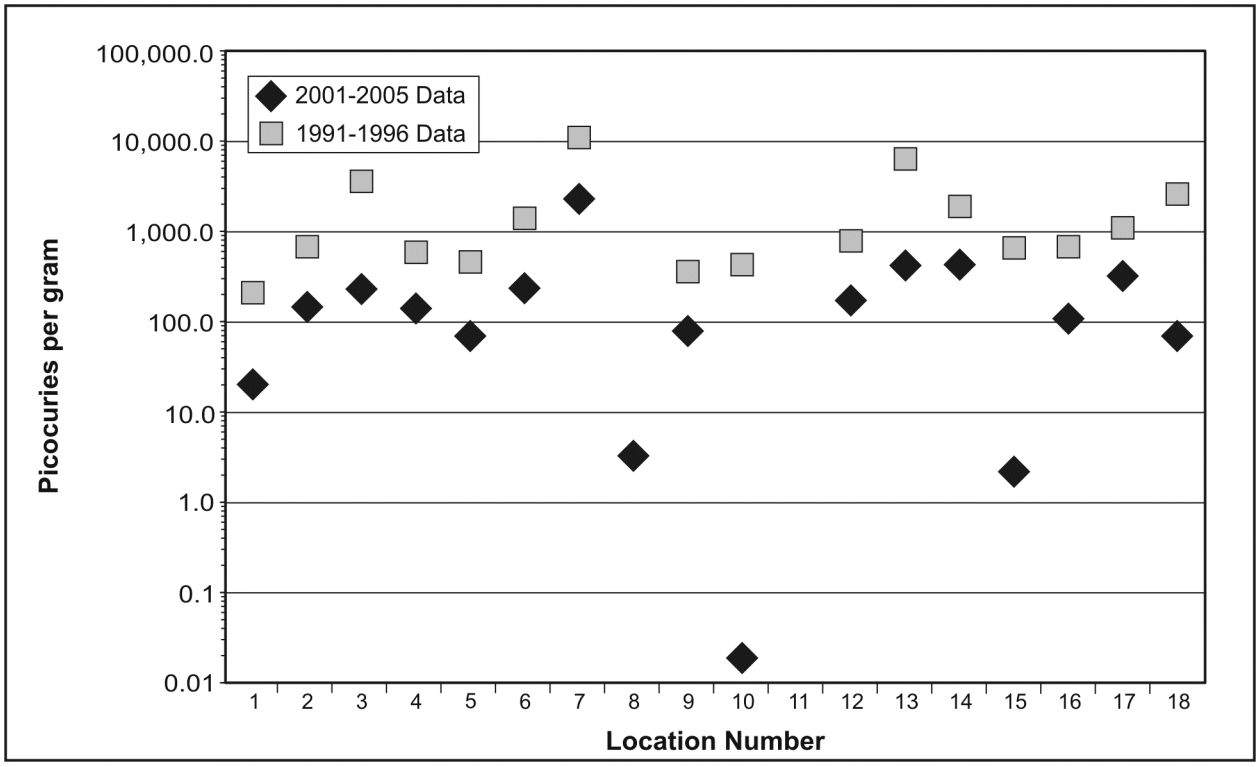

Figure F–12 Tritium Measured Mean Concentration Value for Sediment

Figures F–13 through **F–18** are graphs for stormwater runoff data for each measured isotope. Data points are in the canyon order provided in **Table F–3**. Table F–3 also indicates the Section F.3 data table that corresponds to the 2001 through 2005 data sets. The 1991 through 1996 data include Cañada del Buey and Chaquehui Canyons (unlike the 2001 through 2005 data). Cesium-137 data are not available for Chaquehui Canyon from 1991 through 1996. Plutonium-239 and plutonium-240 data are not available for Ancho Canyon from 2001 through 2005 data. Strontium-90 data are not available for Guaje Canyon from 1991 through 1996 and for Ancho Canyon for 2001 through 2005.

Table F–3 Runoff Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Regional Stations	Regional Canyons	F–22
2	Perimeter Stations	Perimeter Canyons	F–22
3	Onsite Stations	Onsite Canyons	F–22
4	Ancho Canyon	Ancho Canyon	F–22
5	Cañada del Buey Canyon	Not measured	Not applicable
6	Chaquehui Canyon	Not measured	Not applicable
7	Frijoles Canyon	Frijoles Canyon	F–22
8	Guaje Canyon	Guaje Canyon	F–22
9	Los Alamos Canyon	Los Alamos Canyon	F–22
10	Mortandad Canyon	Mortandad Canyon	F–22
11	Pajarito Canyon	Pajarito Canyon	F–22
12	Pueblo Canyon	Pueblo Canyon	F–22
13	Sandia Canyon	Sandia Canyon	F–22
14	Water Canyon	Water Canyon	F–22

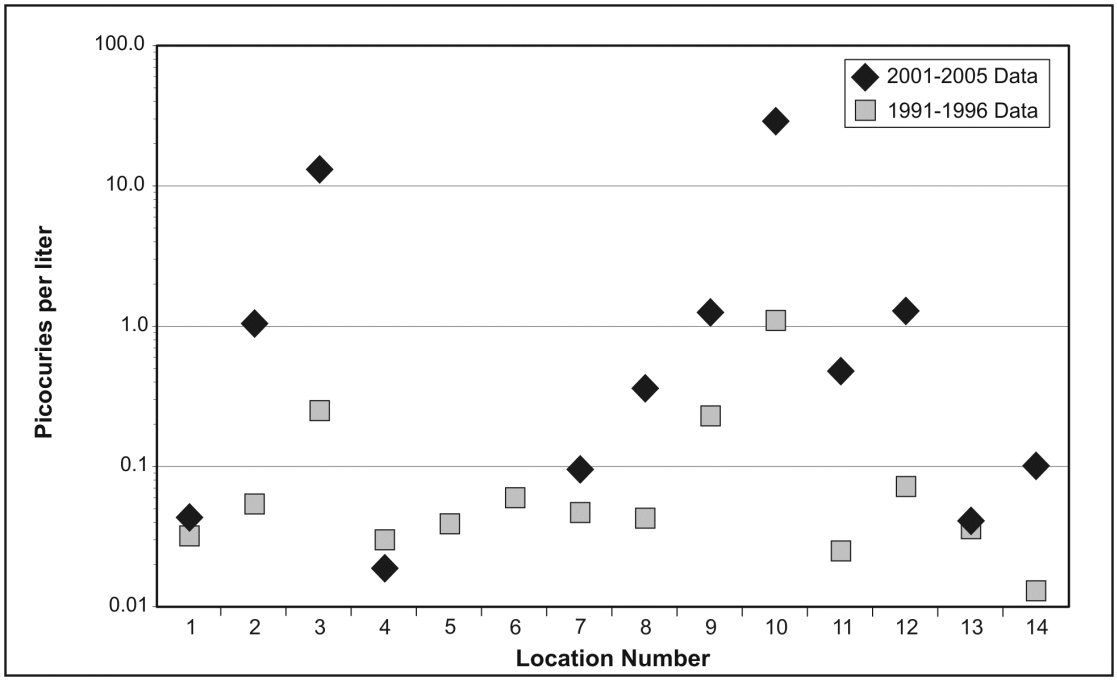

Figure F–13 Americium-241 Measured Mean Concentration Value for Runoff

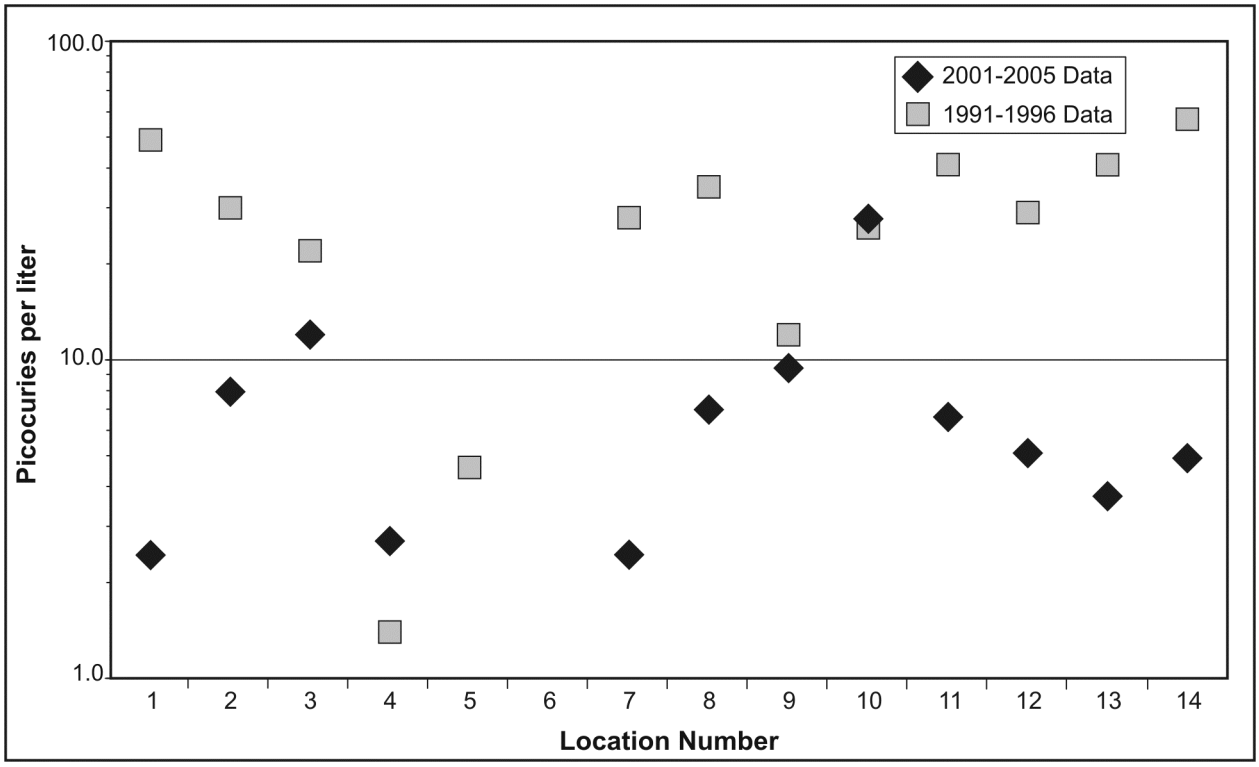

Figure F–14 Cesium-137 Measured Mean Concentration Value for Runoff

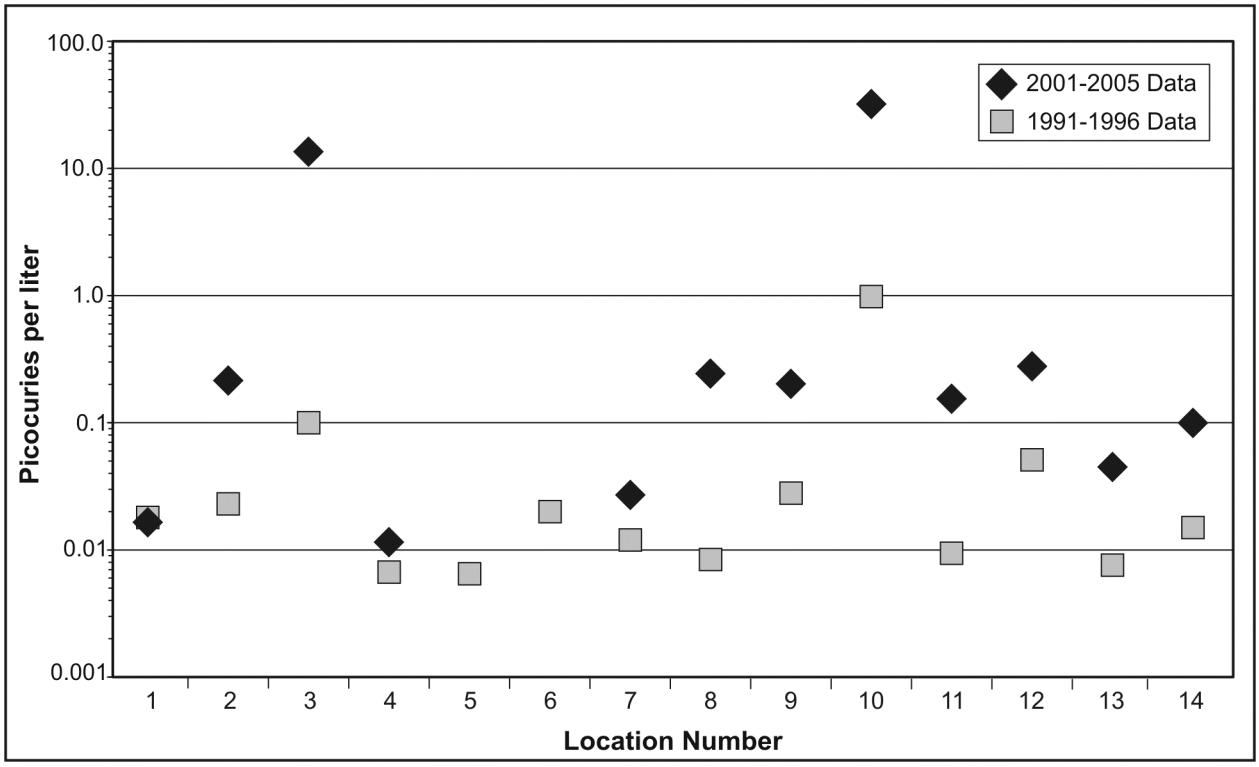

Figure F–15 Plutonium-238 Measured Mean Concentration Value for Runoff

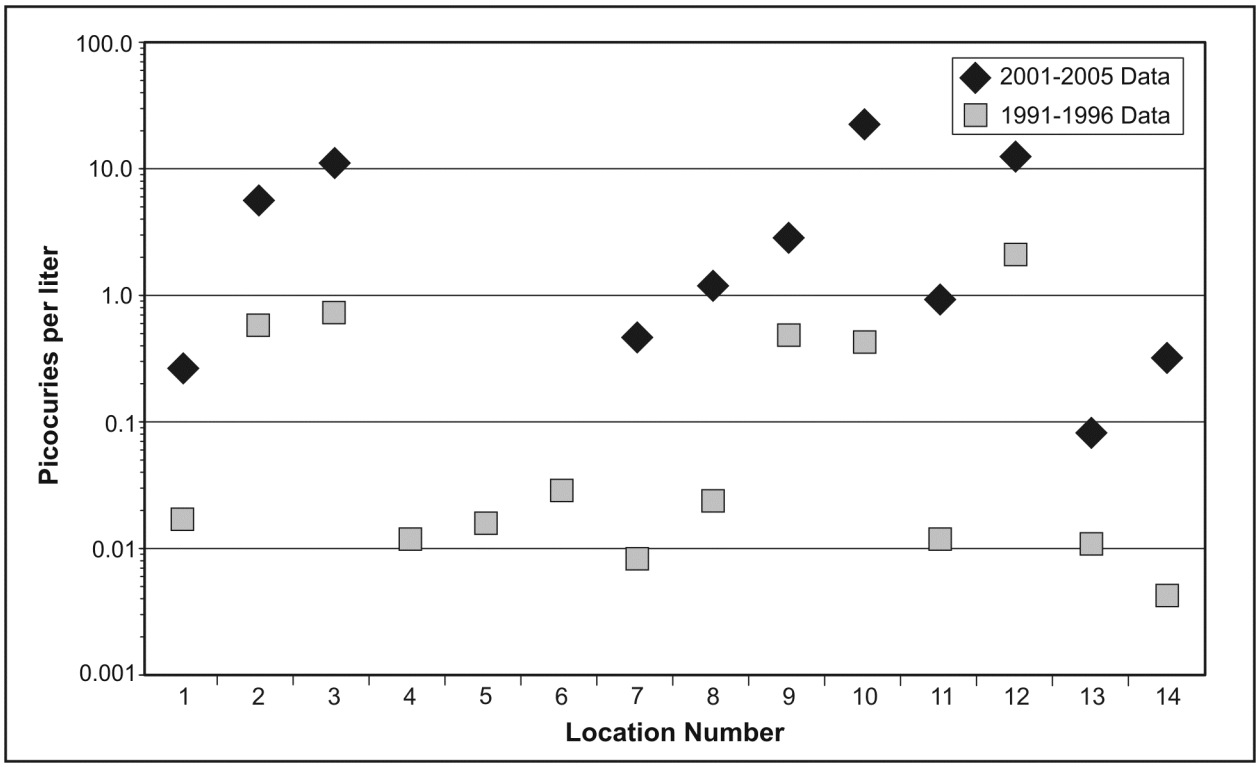

Figure F–16 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Runoff

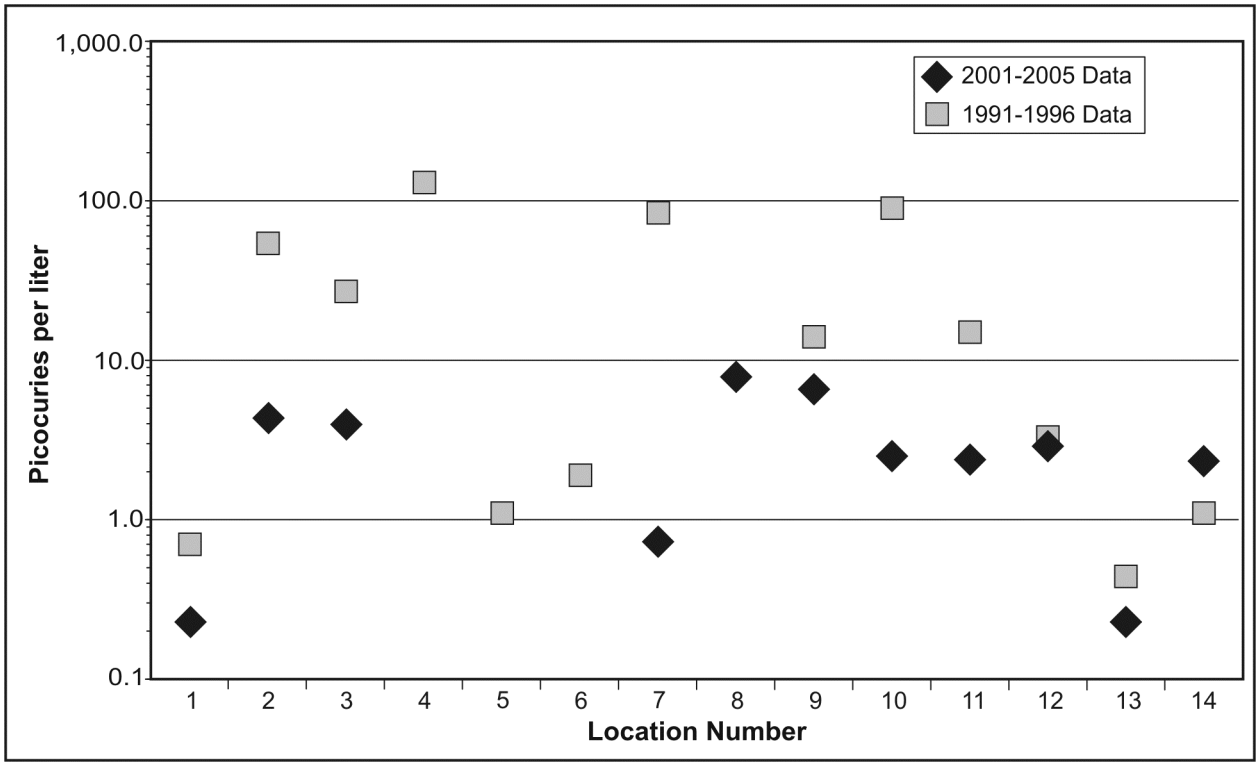

Figure F–17 Strontium-90 Measured Mean Concentration Value for Runoff

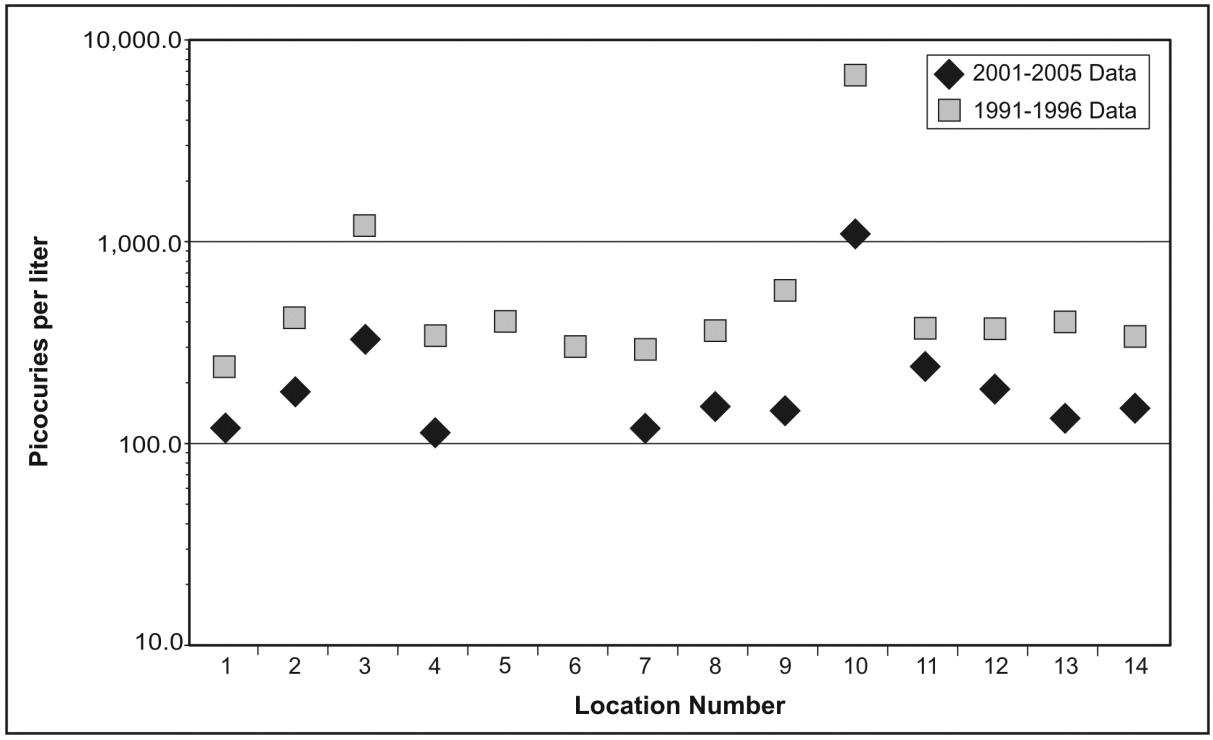

Figure F–18 Tritium Measured Mean Concentration Value for Runoff

Figures F–19 through **F–23** show graphs for soils for each measured isotope. The data are grouped into the three principal regions of interest of Regional, Perimeter, and Onsite. The corresponding data are presented in Section F.3, Table F–23.

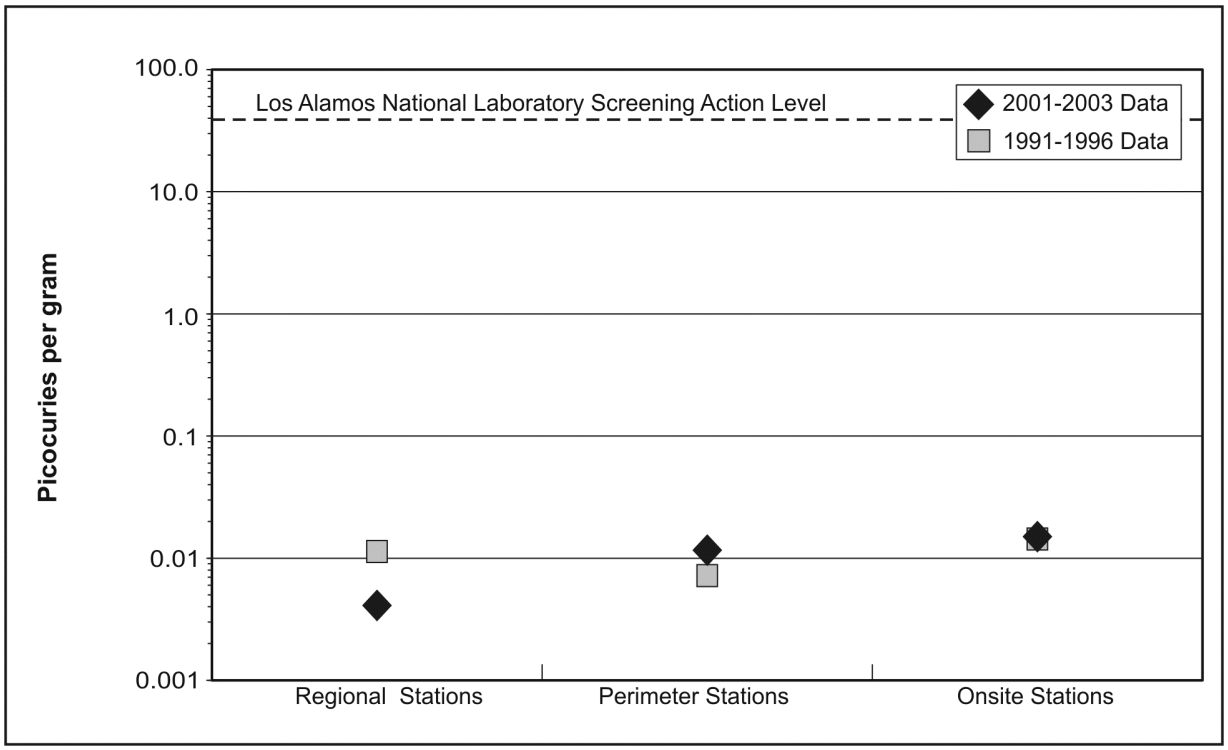

Figure F–19 Americium-241 Measured Mean Concentration Value for Soils

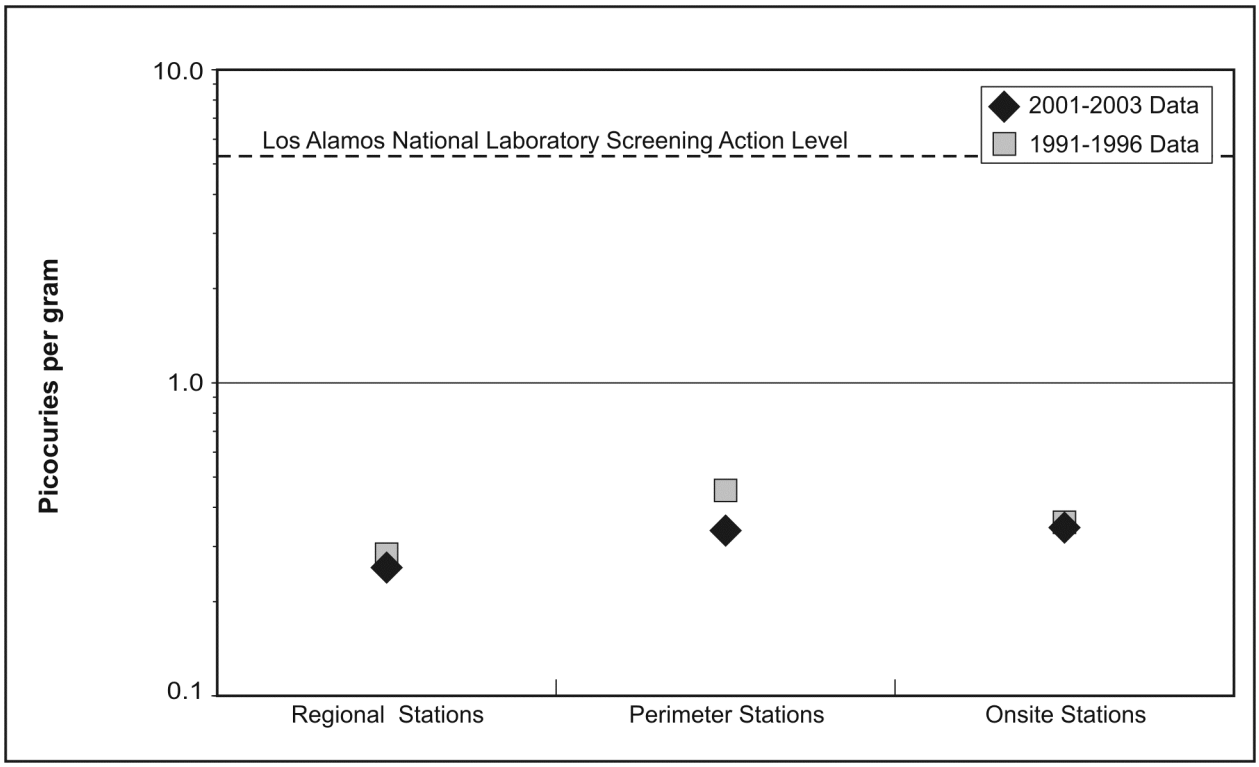

Figure F–20 Cesium-137 Measured Mean Concentration Value for Soils

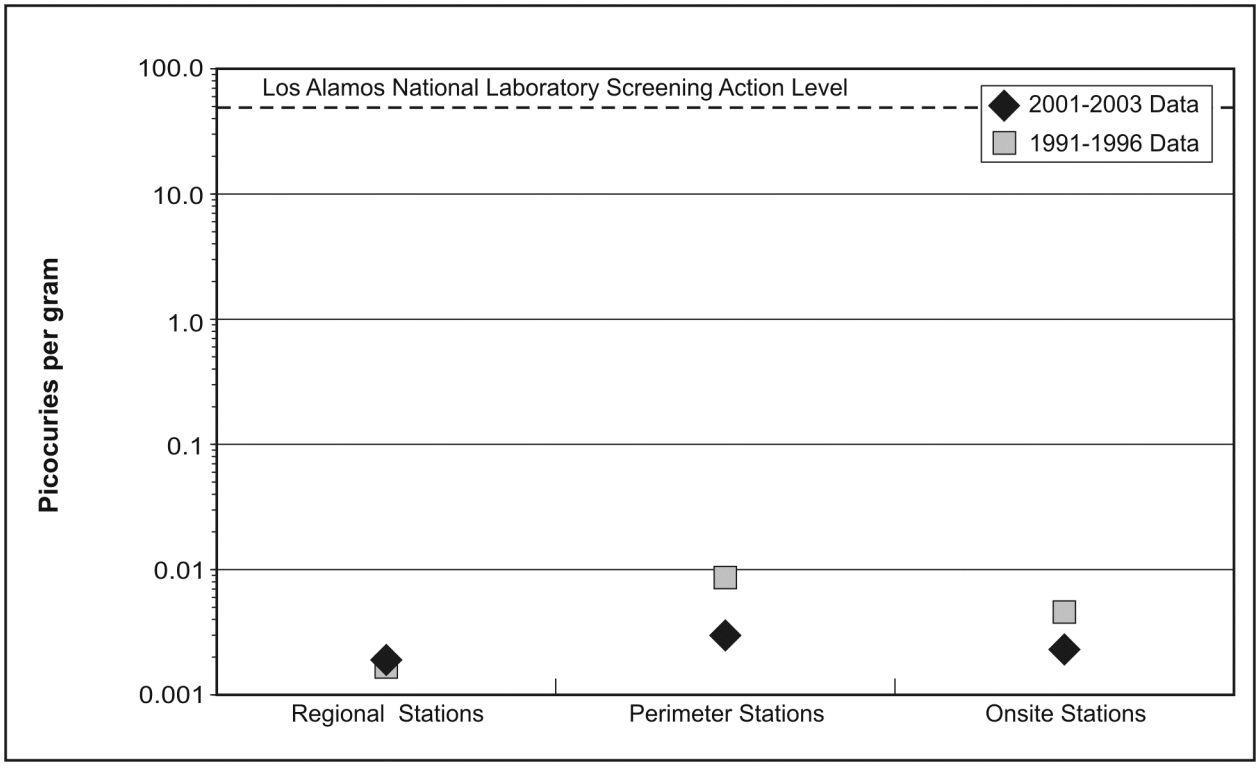

Figure F–21 Plutonium-238 Measured Mean Concentration Value for Soils

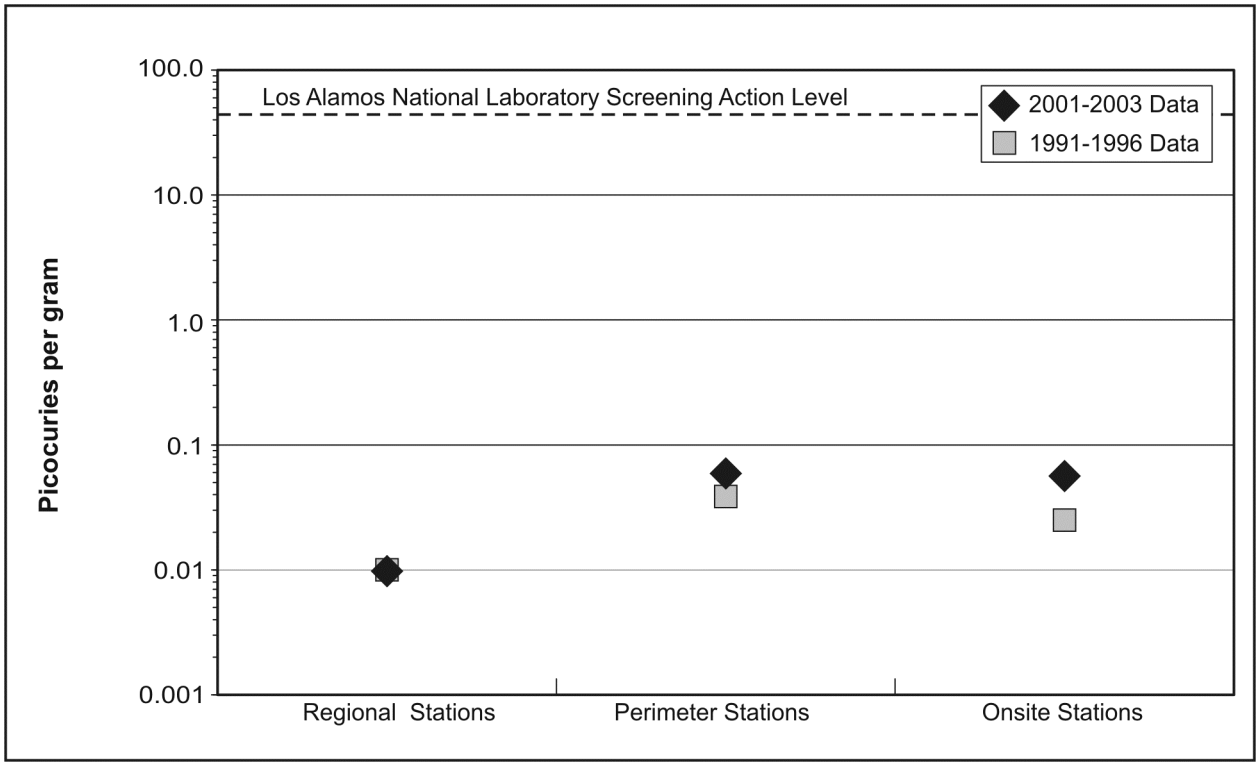

Figure F–22 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Soils

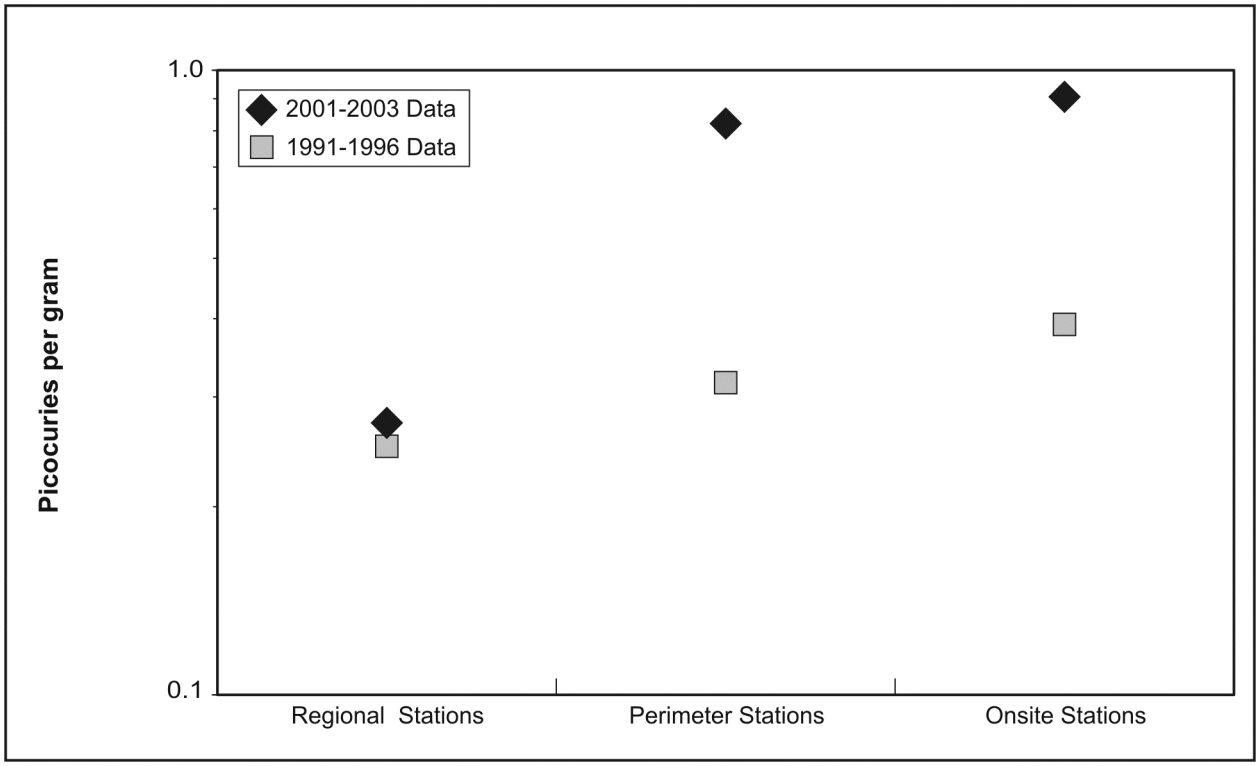

Figure F–23 Tritium Measured Mean Concentration Value for Soils

Groundwater data show a more marked shift in the transuranics toward higher concentrations in the 1991 through 1996 data than in the runoff or sediment data (see **Table F–4**). Unlike runoff and sediment, groundwater is much more slowly diluted or replenished, especially in the LANL region. Groundwater is also a potential source of drinking water for residences that use wells. In general, both transuranics and lighter radioisotopes showed higher concentrations in groundwater in the 1991 through 1996 data than in the 2001 through 2005 data. No measurements exceeded applicable (tritium and strontium-90) EPA limits for drinking water (40 CFR 141.66).

Table F–4 Comparison of Measured 2001 through 2005 Radioisotope Groundwater Data to 1991 through 1996 Data

Radioisotope	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Other than one data point, both the 1991 through 1996 data and the 2001 through 2005 data are concentrated over one order of magnitude (0.01 to 0.1 picocuries per liter). The maximum data point of about 3 picocuries per liter is from 1991 through 1996, and is much higher than the largest 2001 through 2005 data point of 0.5 picocuries per liter. Most of the 2001 through 2005 data points are slightly lower than or equal to the 1991 through 1996 data points.
Cesium-137	1991 through 1996	All 2001 through 2005 data points are significantly lower in value than the 1991 through 1996 data points by as much as a factor of 10 to 20.
Plutonium-238	Equivalent	Both data sets are closely clustered over the same two orders of magnitude. The highest 2001 through 2005 data point is about 0.45 picocuries per liter; the largest 1991 through 1996 data point is about 0.08 picocuries per liter.
Plutonium-239, Plutonium-240	Equivalent	Both sets of data show a small spread over the same two orders of magnitude.
Strontium-90	1991 through 1996	Some (six out of eight data points) of the 2001 through 2005 data are lower in value than the 1991 through 1996 data by factors of 2 to 10.
Tritium	1991 through 1996	Most of the 2001 through 2005 data points are a factor of 2 to 4 times lower in value than the comparable 1991 through 1996 data points. It should be noted that the largest mean values for the 1991 through 1996 data and the 2001 through 2005 data are smaller than the U.S. Environmental Protection Agency annual drinking water limit of 20,000 picocuries per liter (assumed to be equivalent to a total body dose of 4 millirem) (40 CFR 141.66).

In qualitatively evaluating the graphical presentation of measured radioisotope concentrations in and around LANL between the 1991 through 1996 and 2001 through 2005 periods, only general observations can be made. More specific conclusions would require much more extensive statistical and measurement methodology analysis and would only quantify results in a statistical framework, which might not convey any more information to the reader. **Table F–5** presents the assessment of the differences between the two data sets for sediment.

As previously stated, qualitative interpretation of the data presented graphically for LANL sediment radioisotope concentrations is limited by the extent of this evaluation. However, some general conclusions can be drawn (see Table F–5). Transuranic isotope concentrations all have increased from the 1991 through 1996 period to the 2001 through 2005 period, while lower atomic weight radioisotopes have decreased. Because sediments are subject to the actions of water over time, it is reasonable to assume that the lighter weight radioisotopes (strontium-90, cesium-137, and tritium) would have been preferentially carried with the rainwater and

Table F–5 Comparison of Measured 2001 through 2005 Radioisotope Sediment Data to 1991 through 1996 Data

Radioisotope	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Two 2001 through 2005 data points are about a factor of 10 times larger than the 1991 through 1996 data points. All other data points are close to each other. All data are below the LANL SAL.
Cesium-137	Equivalent	A third of the 2001 through 2005 data points are half the value of their 1991 through 1996 counterparts. Most of the data points from 2001 through 2005 are in the same range as the preponderance of 1991 through 1996 data points. All data are below the LANL SAL.
Plutonium-238	2001 through 2005	Both sets of data exhibit a similar large spread over three orders of magnitude, but 2001 through 2005 data points are greater than their 1991 through 1996 data points. All data are below the LANL SAL
Plutonium-239, Plutonium-240	2001 through 2005	Both sets of data showed a similar large spread of four orders of magnitude (from 0.001 to 10 picocuries per gram); all data are below the LANL SAL.
Strontium-90	1991 through 1996	Data points from both time periods are clustered over two orders of magnitude (from 0.01 to 1 picocurie per gram); nonetheless, all data are well below the LANL SAL. Most of the 2001 through 2005 data are lower than the 1991 through 1996 data by factors of 2 to 3. Three data points from 2001 through 2005 are greater than the 1991 through 1996 data points.
Tritium	1991 through 1996	The two sets of data are distinctly separate and are tightly confined to a narrow band. All of the 2001 through 2005 data points are a factor of 5 to 15,000 times smaller than the comparable 1991 through 1996 data points.

SAL = Screening Action Level.

surface runoff water, whereas a greater fraction of the heavier transuranics would have stayed in the sediment due to their higher density. It is also important to note that tritium is highly soluble, as tritiated water in rain and surface water. Another consideration is that the 12.2-year half-life of tritium would have resulted in the decay of a significant fraction of tritium between 1991 through 1996 and 2001 through 2005, which together represent a period of anywhere from 5 to 14 years. Assuming no dramatic changes in emissions of these measured radioisotopes from 1991 through 1996 to 2001 through 2005, the sediment data indicate that any radioactive material movement involving this sediment due to the Cerro Grande Fire was acted upon by the natural forces of rain and surface water that significantly depleted the sediment content of lighter-weight, more soluble radioisotopes.

Transuranic radioisotopes exist in larger concentrations in the 2001 through 2005 data than in the 1991 through 1996 data surface runoff; the opposite is true for all lighter radioisotopes such as tritium, strontium-90, and cesium-137 (see **Table F–6**). As in the case of sediment, the lighter radioisotopes would be transported farther by runoff than the heavier transuranic radioisotopes since the Cerro Grande Fire. As noted above, radioactive decay of tritium could also account for some of the difference in the data.

Table F–6 Comparison of Measured 2001 through 2005 Radioisotope Runoff Data to 1991 through 1996 Data

Radioisotope	*Noticeably Significant Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	2001 through 2005	The 2001 through 2005 data are spread out between four orders of magnitude, whereas the 1991 through 1996 data are spread out within two orders of magnitude (from 0.01 to 1 picocurie per liter). Most of the 2001 through 2005 data are 2 to 50 times higher than the corresponding 1991 through 1996 data points.
Cesium-137	1991 through 1996	A majority of the 2001 through 2005 data points are significantly lower than the 1991 through 1996 data points by as much as a factor of 20. Only 2 of the 11 data points from 2001 through 2005 are higher than the 1991 through 1996 data points.
Plutonium-238	2001 through 2005	The data sets exhibit a large spread over four orders of magnitude. The 1991 through 1996 data extend from 0.001 to 1 picocuries per liter and the 2001 through 2005 data extend from 0.01 to 100 picocuries per liter. Most 2001 through 2005 data points are factors of 3 to over 100 greater than the 1991 through 1996 data points.
Plutonium-239, Plutonium-240	2001 through 2005	Both sets of data showed a large spread over four orders of magnitude, but the 1991 through 1996 data are spread over a range of 0.001 to 10 picocuries per liter and the 2001 through 2005 data are spread over a range of 0.1 to 100 picocuries per liter. The 2001 through 2005 data points are 6 to 80 times greater than the 1991 through 1996 data points.
Strontium-90	1991 through 1996	A large amount (10 of 11 data points) of the 2001 through 2005 data are lower than the equivalent 1991 through 1996 data by factors of 2 to 100. No 2001 through 2005 data points exceeded 10 picocuries per liter, but seven 1991 through 1996 data points are between 10 and 200 picocuries per liter.
Tritium	1991 through 1996	All of the 2001 through 2005 data points are a factor of 2 to 10 times smaller than the comparable 1991 through 1996 data points. It should be noted that the largest mean values of less than 6,700 picocuries per liter for the 1991 through 1996 data and about 1,000 picocuries per liter for the 2001 through 2005 data are much lower than the U.S. Environmental Protection Agency drinking water limit of 20,000 picocuries per liter.

Unlike the sediment, surface runoff water, and groundwater data, the soil data show that the 2001 through 2003 measurements are at equivalent concentration for most radioisotopes to the 1991 through 1996 data (see **Table F–7**). The redistribution due to the Cerro Grande Fire of these radioisotopes, formerly present in vegetation and trees, to the soil is a possible explanation. A review of actual radiological emissions from LANL facilities' stacks from 1999 through 2005 does not show any significant increase in emissions of these radioisotopes.

Table F–7 Comparison of Measured 2001 through 2003 Radioisotope Soil Data to 1991 through 1996 Data

Radioisotope (average worldwide soil concentration)	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241 (0.01 picocuries per gram)	Equivalent	All measurement values are more than a factor of 1,000 below the LANL SAL, and Regional station data are equivalent to average worldwide concentrations.
Cesium-137 (0.4 picocuries per gram)	Equivalent	Both data sets are almost identical with the 1991 through 1996 data slightly (10 percent to 50 percent) higher. All data are a factor of 10 below the SAL and at or near the worldwide measured level.
Plutonium-238 (0.01 to 0.1 picocuries per gram)	Equivalent	The 2001 through 2003 data are lower than the comparable 1991 through 1996 data at Onsite and Perimeter stations. The data are a factor of about 10,000 times lower than the LANL SAL. Data are at or below worldwide average concentrations.
Plutonium-239, Plutonium-240 (0.01 to 0.1 picocuries per gram)	Equivalent	All measurement values are more than a factor of 400 below the LANL SAL. All measurements are at or below worldwide average levels.
Tritium	2001 through 2003	The 2001 through 2003 data are significantly higher for the Onsite and Perimeter stations by as much as a factor of 2 compared to the 1991 through 1996 data.

SAL = Screening Action Level.
Sources: ANL 2005a, 2005b, 2005c, 2005d, 2005e.

Table F–8 presents several key parameters for radioisotopes measured by LANL including typical background concentrations, EPA drinking water limits, relative solubility, and soil adhesion characteristics.

Table F–8 Key Parameters of Radioisotopes Measured in the Los Alamos National Laboratory Environment

Radioisotope	*Background Concentration (EPA Drinking Water Limit)*	*Water Solubility*	*Soil Adhesion Characteristics (LANL soil is generally sandy-loam)*
Americium-241	0.01 picocuries per gram soil	Very insoluble	Ratio of sandy soil to water adhesion equals 1,900. Ratio of loam/clay to water adhesion is greater than 1,900.
Cesium-137	0.1 to 1 picocuries per gram soil; average 0.4 picocuries per gram	Very insoluble	Ratio of sandy soil to water adhesion equals 280. Ratio of clay/loam soil to water adhesion equals 2,000 to 4,000.
Plutonium-238, Plutonium-239, Plutonium-240	0.01 to 0.1 picocuries per gram soil	Very insoluble	Radio of sediment/soil to water adhesion equals 2,000.
Strontium-90	0.1 picocuries per gram soil (36 picocuries per liter)	Soluble	Ratio of sandy soil to water adhesion equals 15. Ratio of clay soil to water adhesion equals 110.
Tritium	10 to 30 picocuries per liter surface water (20,000 picocuries per liter)	Very soluble	No adhesion to soil; chemically identical to water.

EPA = U.S. Environmental Protection Agency.
Sources: ANL 2005a, 2005b, 2005c, 2005d, 2005e.

Several general and qualitative conclusions can be drawn by examination of the graphically presented environmental surveillance data on radioisotopes in and around the LANL site.

- Most radioisotopes measured in and around LANL exist in concentrations equivalent to worldwide averages based on non-LANL atmospheric releases.

- Many monitored radioisotope concentrations in groundwater decreased after 2000.
- All 2001 through 2005 tritium data for surface water and stormwater runoff and groundwater are 10 to 100 times lower than the EPA drinking water limit.
- The largest difference in data between 1991 through 1996 and 2001 through 2005 is that the 2001 through 2005 sediment tritium concentration data are 1,000 to 100,000 times smaller than the 1991 through 1996 data.
- In general, transuranic concentrations in sediment and surface water or stormwater runoff increased after 2000, while lighter radioisotope (strontium-90, cesium-137, and tritium) concentrations in sediments and surface water or stormwater runoff decreased after 2000.
- Changes in radioisotope concentration in surface water or stormwater runoff and sediment from 1991 through 1996 to 2001 through 2005 coincide with the radioisotopes that are much more soluble in water.
- Both sets of data show tritium in surface water or stormwater runoff at LANL from all the data at concentrations 10 to 100 times greater than the worldwide average.
- Most soil radioisotope concentrations increased after 2000 (possibly attributable to the redistribution of radioisotopes in biologic material that burned during the Cerro Grande Fire).
- The 2001 through 2003 soil data show a plutonium-238 concentration about 100 times greater than the 1991 through 1996 data and 10 to 100 times greater than worldwide averages.
- All 2001 through 2003 soil data are much lower (by orders of magnitude) than the relevant LANL SAL.

These aforementioned observations are based on a qualitative assessment of plots of mean measured radioisotope concentration data. Differences in measurement technique or instrument accuracy between the 1991 through 1996 data and the 2001 through 2005 data are not accounted for, nor are differences in LANL stack emissions from 1991 through 2005 incorporated. This evaluation has not accounted for other radioisotopes or hazardous chemicals. Spatial variations in measured concentrations are not included in this assessment.

F.3 Environmental Sample Data

Groundwater, sediment, and stormwater runoff data are collected and analyzed for individual canyons. Soil data are grouped under three regions of interest: regional locations, perimeter locations, and onsite locations. The measured values of radioisotope and radioactivity that are presented are derived from environmental surveillance analytical data. Groundwater, sediment, stormwater runoff, and soil values from annual environmental surveillance data tables are used to calculate "Detected per ESR," "Used in This SWEIS," "Analyzed," "Minimum," "Mean," "Standard Deviation," "Maximum," and "95 percent Upper Confidence Limit (UCL)" values.

Analytical data are identified in a number of categories in this appendix. The "Analyzed" value is the total number of samples for which analyses were performed for a particular isotope or chemical. The "Detected per ESR" value is the number of analyzed samples that are determined

to have detectable contamination as reported in the LANL environmental surveillance reports. The "Used in This SWEIS" value is the number of analyzed samples, in accordance with the guidanceprocess below, that are used in the following statistical analysis. The "Minimum" value is the smallest, positive measured analytical result for an isotope or chemical. The "Maximum" value is the greatest measured analytical result for an isotope or chemical. The "Mean" value is the average of the "Used in This SWEIS" samples for an isotope or chemical. The "Standard Deviation" value is a statistical measure of the amount by which each sample deviates from the mean. The "95 Percent UCL" value is a statistical representation of the concentration of a specific measured radioisotope, radioactivity, or chemical that is equal to or greater than 95 percent of all the expected measured values assuming a normal distribution.

Measurement of each parameter involves obtaining a known sample volume or mass, transporting it to an analytical laboratory, and subjecting the sample to the detection of a specific type and energy of radiation, which is detected and counted by an instrument for a set time. Each radioisotope has a unique set of radiation emission energies that identifies it just as fingerprints identify each human individual. A chemical or isotope is considered to be detected if it exceeds the lowest concentration that can be measured in a sample and reported with 99 percent confidence. It depends on the sample matrix, the instrument used, and the operator skill. For purposes of this SWEIS, the analytical results were evaluated in accordance with the following process:

- Any "Analyzed" sample for which the analytical result is less than zero is eliminated from further consideration.

- An "Analyzed" sample (in the following tables) for which the analytical result plus two standard deviations exceeds the instrument's minimum detectable activity is "Used in This SWEIS."

In applying the above process, analytical results below the instrument's minimum detectable activity are included as part of the conservative assessment approach to data treatment in this SWEIS, but will not be continued in future SWEIS updates. Future data treatments will include only those analytical results exceeding the minimum detectable activity.

The following process is then applied to the analytical results that are identified as "Used in This SWEIS."

- A minimum of two data values is required to calculate and present a Mean, Minimum, and Maximum value.

- A minimum of three data values is required to calculate and present a Standard Deviation and 95 Percent UCL value.

- The 95 Percent UCL value is calculated by first calculating the Mean and Standard Deviation on the Mean of the Used in This SWEIS data, then adding two Standard Deviations to the Mean Value.

Measured concentrations are in terms of picocuries per liter (pCi/L), picocuries per gram (pCi/g), micrograms per gram (μg/g) or micrograms per liter (μg/L) depending on whether the sample

medium is solid or liquid and whether the parameter is measured in terms of radioactivity or mass.

The numbers of groundwater, sediment, surface water or stormwater runoff, and soil data samples from 2001 through 2005 that meet the criteria for "Used in This SWEIS" are shown in **Table F–9**. Table F–9 also shows the numbers of samples with "Detected" activity. The statistical analysis of measured samples (LANL 2002, 2004a, 2004b, 2005, 2006b) is presented in **Tables F–10** through **F–20** for groundwater (2001 to 2005), **Table F–21** for sediments (2001 to 2005), **Table F–22** for surface water or stormwater runoff (2001 to 2005), and **Table F–23** for soil (2001 to 2003). The most recent soil survey data available at the time of this analysis was from 2003.

The LANL environmental surveillance program uses statistical criteria to determine whether a particular radioisotope is actually detected in a sample. For a radioisotope to be detected, the sample measurement (the number of radioactive emissions counted in a given time period by a detector) must be equal to or greater than the minimum detectable activity and also must be equal to or greater than three times the total propagated uncertainty, which accounts for both the measurement instrumentation uncertainty as well as the sample background uncertainty. These criteria, which have been used for groundwater, sediment, surface water, and soil from 2001 through 2005, provide a high degree of confidence (99.7 percent) that a measurement result classified as detected is actually present in the sample. This is not the case for a number of the values indicated as "Used in This SWEIS." The number of detected measurements for each analyte, as reported in the Environmental Surveillance Reports, is presented in Tables F–10 through F–23 under the column heading of "Detected per ESR". The number of usable measurements for the purpose of this SWEIS is delineated under the column "Used in This SWEIS" in Tables F–10 through F–23. The number of usable measurements for each analyte is equal or greater than the LANL detected measurements because of the different method that was used in the SWEIS to select measurements. The method used in this SWEIS allows comparison with the environmental surveillance data presented in the *1999 SWEIS* (DOE 1999) which used a similar statistical approach to select usable measurements from the 1991 through 1996 environmental surveillance data. A usable measurement (Used in This SWEIS) in Tables F–10 through F–23 does not indicate that the analyte actually exists in the sample at a level greater than the analytical instrument was able to detect, but only that the measurement met the previously described guidance. There is a large difference between the number of environmental samples analyzed that are reported as detected and the number of samples that are reported as "Used in This SWEIS" for uranium. Uranium is a naturally occurring element in the LANL environment. The criterion for detected samples eliminates uranium concentrations below the 5 microcuries per gram whereas the "Used in This SWEIS" data do not screen out background uranium concentrations in environmental samples and therefore results in a higher number of numerical values. Only the usable measurements were used to develop the mean values and 95 percent UCL values shown in Tables F–10 through F–23. The 95 percent UCL values are used in Appendix C of this SWEIS to estimate human health impacts.

Table F–9 Number of Detectable Radiological Data Samples at Los Alamos National Laboratory Exceeding Analytical Thresholds

Radioisotope	Number of Samples Exceeding Analytical Thresholds (2001 through 2005)							
	Groundwater		Sediment		Surface Water or Stormwater Runoff		Soil (2001 through 2003)	
	Detected per ESR	Used in This SWEIS	Detected per ESR	Used in This SWEIS	Detected per ESR	Used in This SWEIS	Detected per ESR	Used in This SWEIS
Americium-241	84	237	132	353	63	499	75	75
Cesium-137	14	134	82	570	0	273	76	76
Plutonium-238	25	135	77	246	23	325	61	61
Plutonium-239, Plutonium-240	37	132	212	363	78	483	76	76
Strontium-90	133	328	33	231	45	518	73	73
Tritium	105	190	11	201	15	303	71	71
Uranium-234	47	675	23	599	37	693	51	51
Uranium-235, Uranium-236	3	414	4	508	3	546	–	–
Uranium-238	19	635	1	599	34	706	51	51

ESR = Environmental Surveillance Reports.

Table F–10 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Aquifer Wells Composite [a]									
Americium-241	pCi/L	7	64	311	0.002	0.027	0.009	0.157	0.03
Cesium-137	pCi/L	4	45	322	0.021	2.97	1.84	16.3	3.51
Cobalt-60	pCi/L	2	30	198	0.264	2.1	0.545	7.83	2.3
Iodine-129	pCi/L	0	5	37	0.339	0.562	0.167	0.794	0.709
Neptunium-237	pCi/L	0	29	166	2.02	12.2	0.622	28.4	12.4
Plutonium-238	pCi/L	0	28	310	0.0	0.014	0.009	0.038	0.017
Plutonium-239, Plutonium-240	pCi/L	4	26	310	0.0	0.068	0.068	0.601	0.094
Potassium-40	pCi/L	5	168	198	0.47	31.1	3.04	105	31.5
Radium-226	pCi/L	26	57	79	0.123	0.42	0.12	1.17	0.451
Sodium-22	pCi/L	0	11	198	1.04	1.99	0.028	2.74	2
Strontium-90	pCi/L	8	122	447	0.004	0.123	0.045	0.434	0.131
Technetium-99	pCi/L	1	11	48	1.27	2.44	1.23	5.24	3.17
Tritium	pCi/L	17	50	216	0.0	136	81.3	874	158
Uranium-234	pCi/L	0	265	306	0.009	0.473	0.111	2.66	0.486
Uranium-235, Uranium-236	pCi/L	0	138	307	0.005	0.043	0.023	0.181	0.047
Uranium-238	pCi/L	0	253	307	0.008	0.205	0.105	1.53	0.218
Uranium (calculated)	µg/L	0	333	342	0.01	0.627	0.131	4.6	0.641
Uranium (measured)	µg/L	0	80	80	0.02	0.63	0.038	3.46	0.639
Gross Alpha	pCi/L	4	134	285	0.173	1.55	0.567	14.5	1.65

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	0	234	284	0.504	3.38	0.499	15.6	3.44
Gross Gamma	pCi/L	0	84	258	44.1	141	29.1	1,920	147

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite includes data from Hydrogeologic Characterization Wells (Table F–11), Test Wells (Table F–12), Water Supply Wells (Table F–13). The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–11 Radiochemical Statistical Analysis of Groundwater – Hydrogeologic Characterization Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Hydrogeologic Characterization Wells [a] Composite									
Americium-241	pCi/L	4	30	193	0.002	0.025	0.009	0.047	0.029
Cesium-137	pCi/L	0	23	196	0.251	2.95	1.61	14.6	3.6
Cobalt-60	pCi/L	2	21	147	0.264	2.07	0.517	7.83	2.29
Iodine-129	pCi/L	0	5	37	0.339	0.562	0.167	0.794	0.709
Neptunium-237	pCi/L	0	14	114	5.24	10.1	0.553	21	10.4
Plutonium-238	pCi/L	0	4	197	0.006	0.017	0.017	0.038	0.034
Plutonium-239, Plutonium-240	pCi/L	4	6	197	0.011	0.138	0.09	0.601	0.21
Potassium-40	pCi/L	5	124	147	0.471	35.7	10.8	105	37.6
Radium-226	pCi/L	15	29	37	0.149	0.437	0.146	1.17	0.49
Sodium-22	pCi/L	0	10	147	1.04	1.94	0.095	2.74	2
Strontium-90	pCi/L	4	45	191	0.078	0.167	0.02	0.434	0.172
Technetium-99	pCi/L	1	11	48	1.27	2.44	1.23	5.24	3.17
Tritium	pCi/L	4	20	94	63.4	137	32.2	523	151
Uranium-234	pCi/L	0	161	193	0.009	0.392	0.144	2.66	0.414
Uranium-235, Uranium-236	pCi/L	0	86	194	0.016	0.047	0.011	0.164	0.049
Uranium-238	pCi/L	0	151	194	0.01	0.215	0.061	1.53	0.225
Uranium (calculated)	µg/L	0	235	244	0.01	0.486	0.153	4.6	0.506
Uranium (measured)	µg/L	0	46	46	0.02	0.627	0.065	2.03	0.646
Gross Alpha	pCi/L	3	74	157	0.268	1.92	0.91	14.5	2.13
Gross Beta	pCi/L	0	122	157	0.504	3.8	0.795	15.6	3.94
Gross Gamma	pCi/L	0	52	167	44.1	158	66.7	1,920	177
Ancho Canyon [b]									
Americium-241	pCi/L	0	0	8	–	–	–	–	–
Cesium-137	pCi/L	0	1	8	–	2.03	–	–	–
Cobalt-60	pCi/L	0	3	8	0.801	2.09	1.15	3	3.39
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	8	–	15.1	–	–	–
Plutonium-238	pCi/L	0	0	8	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	8	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Potassium-40	pCi/L	0	7	8	15.1	33.2	14.7	55.8	44.1
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	8	–	–	–	–	–
Strontium-90	pCi/L	1	1	8	–	0.228	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	4	–	122	–	–	–
Uranium-234	pCi/L	0	8	8	0.058	0.236	0.23	0.618	0.395
Uranium-235, Uranium-236	pCi/L	0	2	8	0.03	0.031	–	0.033	–
Uranium-238	pCi/L	0	7	8	0.047	0.163	0.16	0.398	0.281
Uranium (calculated)	µg/L	0	8	8	0.083	0.4	0.406	1.1	0.682
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	5	8	0.873	2.33	1.33	4.28	3.49
Gross Beta	pCi/L	0	8	8	2.35	4.52	1.81	6.44	5.77
Gross Gamma	pCi/L	0	3	8	73.5	92.7	20.3	114	116
Cañada del Buey [b]									
Americium-241	pCi/L	0	13	57	0.002	0.025	0.01	0.039	0.03
Cesium-137	pCi/L	0	7	60	1.24	2.89	1.39	7.29	3.91
Cobalt-60	pCi/L	0	4	33	0.304	0.95	0.914	1.75	1.85
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	33	5.24	12.3	5.71	21	17.3
Plutonium-238	pCi/L	0	1	58	–	0.038	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	2	58	0.025	0.026	–	0.026	–
Potassium-40	pCi/L	1	31	33	4.2	42.5	16.6	103	48.3
Radium-226	pCi/L	0	7	8	0.216	0.373	0.188	0.752	0.512
Sodium-22	pCi/L	0	2	33	1.7	2.12	–	2.53	–
Strontium-90	pCi/L	0	8	56	0.099	0.147	0.018	0.248	0.16
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	1	4	30	77	247	241	523	483
Uranium-234	pCi/L	0	42	58	0.009	0.361	0.171	2.1	0.413
Uranium-235, Uranium-236	pCi/L	0	21	58	0.016	0.042	0.02	0.129	0.05
Uranium-238	pCi/L	0	38	58	0.01	0.218	0.109	1.31	0.253
Uranium (calculated)	µg/L	0	55	58	0.01	0.471	0.398	3.8	0.577
Uranium (measured)	µg/L	0	14	14	0.02	0.494	0.089	2.03	0.541
Gross Alpha	pCi/L	0	23	56	0.35	1.82	0.468	3.55	2.01
Gross Beta	pCi/L	0	36	56	1.18	4.94	0.972	10.3	5.26
Gross Gamma	pCi/L	0	21	61	49.2	217	134	1,920	274
Los Alamos Canyon [b]									
Americium-241	pCi/L	1	7	27	0.019	0.029	0.006	0.047	0.033
Cesium-137	pCi/L	0	5	29	0.251	2.65	2.336	5.51	4.7
Cobalt-60	pCi/L	0	2	16	3.14	5.49	–	7.83	–
Iodine-129	pCi/L	0	1	5	–	0.524	–	–	–
Neptunium-237	pCi/L	0	0	12	–	–	–	–	–
Plutonium-238	pCi/L	0	2	26	0.006	0.013	–	0.019	–

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Plutonium-239, Plutonium-240	pCi/L	1	2	26	0.011	0.031	–	0.051	–
Potassium-40	pCi/L	0	10	16	6.41	31.4	17.2	73.4	42.1
Radium-226	pCi/L	2	8	10	0.316	0.415	0.14	1.17	0.512
Sodium-22	pCi/L	0	1	16	–	2.74	–	–	–
Strontium-90	pCi/L	2	10	25	0.124	0.164	0.039	0.278	0.188
Technetium-99	pCi/L	0	0	5	–	–	–	–	–
Tritium	pCi/L	0	4	12	63.4	94.2	3.57	120	97.7
Uranium-234	pCi/L	0	21	26	0.036	0.496	0.304	1.72	0.626
Uranium-235, Uranium-236	pCi/L	0	16	27	0.016	0.057	0.025	0.137	0.070
Uranium-238	pCi/L	0	20	27	0.024	0.293	0.214	0.962	0.386
Uranium (calculated)	µg/L	0	21	23	0.019	0.642	0.401	3	0.813
Uranium (measured)	µg/L	0	5	5	0.02	0.78	0.229	1.8	0.981
Gross Alpha	pCi/L	1	16	23	0.268	2.28	2.21	13.5	3.37
Gross Beta	pCi/L	0	19	23	1.08	3.48	1.08	6.79	3.97
Gross Gamma	pCi/L	0	4	25	66.6	137	91.5	243	227
Mortandad Canyon [b]									
Americium-241	pCi/L	0	4	42	0.011	0.012	0.001	0.014	0.014
Cesium-137	pCi/L	0	3	42	1.26	2.53	1.19	3.62	3.88
Cobalt-60	pCi/L	1	6	39	0.576	1.61	0.7	2.42	2.17
Iodine-129	pCi/L	0	3	14	0.339	0.55	0.229	0.79	0.81
Neptunium-237	pCi/L	0	5	27	5.44	6.75	2.01	10.3	8.52
Plutonium-238	pCi/L	0	0	44	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	1	44	–	0.601	–	–	–
Potassium-40	pCi/L	3	36	39	0.471	33.2	13.2	92	37.5
Radium-226	pCi/L	7	9	12	0.162	0.389	0.258	0.926	0.558
Sodium-22	pCi/L	0	3	39	1.04	1.48	0.381	1.71	1.91
Strontium-90	pCi/L	1	10	43	0.079	0.183	0.051	0.434	0.215
Technetium-99	pCi/L	1	6	25	1.27	2.56	1.42	5.24	3.7
Tritium	pCi/L	1	6	22	88.4	139	48.3	210	178
Uranium-234	pCi/L	0	39	42	0.051	0.336	0.126	0.892	0.376
Uranium-235, Uranium-236	pCi/L	0	21	42	0.028	0.046	0.005	0.084	0.048
Uranium-238	pCi/L	0	38	42	0.07	0.169	0.061	0.395	0.189
Uranium (calculated)	µg/L	0	43	43	0.05	0.491	0.137	1.1	0.532
Uranium (measured)	µg/L	0	8	8	0.315	0.394	0.04	0.463	0.422
Gross Alpha	pCi/L	1	11	30	0.647	1.59	1.33	14.5	2.37
Gross Beta	pCi/L	0	26	30	0.504	2.29	1.98	14.1	3.05
Gross Gamma	pCi/L	0	11	31	44.1	157	85.8	778	207
Pajarito Canyon [b]									
Americium-241	pCi/L	2	2	16	0.008	0.019	–	0.031	–
Cesium-137	pCi/L	0	2	16	1.08	7.84	–	14.6	–
Cobalt-60	pCi/L	0	0	16	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	16	6.7	13	–	19.2	–
Plutonium-238	pCi/L	0	0	16	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	16	–	–	–	–	–
Potassium-40	pCi/L	0	11	16	10.9	28.1	13.3	49.3	35.9
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	1	16	–	2.01	–	–	–
Strontium-90	pCi/L	0	2	16	0.088	0.17	–	0.252	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	8	–	–	–	–	–
Uranium-234	pCi/L	0	12	16	0.061	0.317	0.193	0.582	0.426
Uranium-235, Uranium-236	pCi/L	0	5	16	0.033	0.043	0.011	0.061	0.053
Uranium-238	pCi/L	0	12	16	0.033	0.162	0.089	0.269	0.212
Uranium (calculated)	µg/L	0	16	16	0.05	0.294	0.301	0.98	0.442
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	1	6	16	0.574	1.76	1.86	5.37	3.25
Gross Beta	pCi/L	0	13	16	1.52	3.55	2.08	8.67	4.68
Gross Gamma	pCi/L	0	8	16	45.5	77.3	29.8	139	98
Potrillo Canyon [b]									
Americium-241	pCi/L	0	1	9	–	0.035	–	–	–
Cesium-137	pCi/L	0	2	9	1.77	2.39	–	3	–
Cobalt-60	pCi/L	0	1	9	–	0.264	-	-	-
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	9	–	–	–	–	–
Plutonium-238	pCi/L	0	0	11	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	1	11	–	0.163	–	–	–
Potassium-40	pCi/L	0	6	9	3.25	26.1	12.8	60.3	36.3
Radium-226	pCi/L	0	2	3	0.149	0.176	–	0.202	–
Sodium-22	pCi/L	0	2	9	1.87	2.23	–	2.58	–
Strontium-90	pCi/L	0	4	9	0.167	0.215	0.061	0.282	0.275
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	5	–	67.7	–	–	–
Uranium-234	pCi/L	0	9	9	0.215	0.476	0.012	0.918	0.484
Uranium-235, Uranium-236	pCi/L	0	4	9	0.035	0.077	0.025	0.104	0.102
Uranium-238	pCi/L	0	9	9	0.076	0.237	0.013	0.669	0.245
Uranium (calculated)	µg/L	0	9	9	0.26	0.628	0.1	1.44	0.693
Uranium (measured)	µg/L	0	8	8	0.02	0.678	0.225	1.89	0.834
Gross Alpha	pCi/L	0	4	9	0.924	2.39	1.16	4.99	3.53
Gross Beta	pCi/L	0	8	9	1.11	3.27	1.2	6.34	4.1
Gross Gamma	pCi/L	0	0	9	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Pueblo Canyon [b]									
Americium-241	pCi/L	0	0	7	–	–	–	–	–
Cesium-137	pCi/L	0	0	7	–	–	–	–	–
Cobalt-60	pCi/L	0	1	7	–	2.19	–	–	–
Iodine-129	pCi/L	0	0	7	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	7	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	7	–	–	–	–	–
Potassium-40	pCi/L	0	5	7	22.8	30.3	4.44	33.7	34.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	7	–	–	–	–	–
Strontium-90	pCi/L	0	1	7	–	0.121	–	–	–
Technetium-99	pCi/L	0	2	7	2.18	3.13	–	4.07	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Uranium-234	pCi/L	0	6	7	0.493	0.638	0.129	0.846	0.741
Uranium-235, Uranium-236	pCi/L	0	2	7	0.048	0.053	–	0.057	–
Uranium-238	pCi/L	0	6	7	0.183	0.261	0.04	0.289	0.293
Uranium (calculated)	µg/L	0	13	13	0.05	0.689	0.246	1.1	0.823
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	0	–	–	–	–	–
Gross Beta	pCi/L	0	0	0	–	–	–	–	–
Gross Gamma	pCi/L	0	0	0	–	–	–	–	–
Sandia Canyon [b]									
Americium-241	pCi/L	1	3	21	0.016	0.02	0.005	0.025	0.025
Cesium-137	pCi/L	0	3	19	1.08	3.31	2.16	2.48	5.75
Cobalt-60	pCi/L	0	2	13	2.4	2.4	–	2.4	–
Iodine-129	pCi/L	0	1	7	–	0.634	–	–	–
Neptunium-237	pCi/L	0	1	7	–	9.68	–	–	–
Plutonium-238	pCi/L	0	1	21	–	0.03	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	21	–	–	–	–	–
Potassium-40	pCi/L	1	12	13	6.5	38	25	105	52.2
Radium-226	pCi/L	2	3	4	0.208	0.48	0.269	0.745	0.784
Sodium-22	pCi/L	0	1	13	–	2.04	–	–	–
Strontium-90	pCi/L	0	9	21	0.078	0.128	0.044	0.247	0.156
Technetium-99	pCi/L	0	3	7	1.36	1.73	0.590	2.41	2.4
Tritium	pCi/L	0	4	10	110	111	0.0	112	–
Uranium-234	pCi/L	0	18	21	0.016	0.713	0.274	2.66	0.839
Uranium-235, Uranium-236	pCi/L	0	14	21	0.017	0.06	0.017	0.164	0.069
Uranium-238	pCi/L	0	16	21	0.022	0.404	0.09	1.53	0.448
Uranium (calculated)	µg/L	0	23	27	0.05	1.19	0.246	4.6	1.29
Uranium (measured)	µg/L	0	7	7	0.051	1.1	0.058	1.64	1.15

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Alpha	pCi/L	0	9	13	0.614	1.36	0.32	2.49	1.57
Gross Beta	pCi/L	0	10	13	1.32	4.23	2.19	15.6	5.59
Gross Gamma	pCi/L	0	3	15	70.2	114	61.3	220	183
Water Canyon [b]									
Americium-241	pCi/L	0	0	6	–	–	–	–	–
Cesium-137	pCi/L	0	0	6	–	–	–	–	–
Cobalt-60	pCi/L	1	2	6	3.12	4.81	–	6.5	–
Iodine-129	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	0	6	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	6	–	–	–	–	–
Potassium-40	pCi/L	0	6	6	10.6	20.4	9.86	37.2	28.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	6	–	–	–	–	–
Strontium-90	pCi/L	0	0	6	–	–	–	–	–
Technetium-99	pCi/L	0	0	4	–	–	–	–	–
Tritium	pCi/L	0	0	3	–	–	–	–	–
Uranium-234	pCi/L	0	6	6	0.048	0.225	0.09	0.297	0.298
Uranium-235, Uranium-236	pCi/L	0	1	6	–	0.031	–	–	–
Uranium-238	pCi/L	0	5	6	0.121	0.135	0.012	0.151	0.145
Uranium (calculated)	µg/L	0	47	47	0.05	0.234	0.187	0.54	0.288
Uranium (measured)	µg/L	0	4	4	0.046	0.388	0.278	0.727	0.66
Gross Alpha	pCi/L	0	0	2	–	–	–	–	–
Gross Beta	pCi/L	0	2	2	1.89	1.97	–	2.04	–
Gross Gamma	pCi/L	0	2	2	94.1	102	–	109	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–12 Radiochemical Statistical Analysis of Groundwater – Test Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Test Wells [a] Composite									
Americium-241	pCi/L	1	17	54	0.003	0.026	0.008	0.066	0.03
Cesium-137	pCi/L	3	12	60	0.132	3.12	2	16.3	4.25
Cobalt-60	pCi/L	0	3	25	1.71	2.84	1.14	3.99	4.13
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	7	26	8.51	13.45	2.04	21.2	15

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Plutonium-238	pCi/L	0	12	53	0.0	0.009	0.005	0.015	0.012
Plutonium-239, Plutonium-240	pCi/L	0	8	53	0.005	0.017	0.009	0.027	0.023
Potassium-40	pCi/L	0	22	25	1.91	30.1	5.67	68	32.5
Radium-226	pCi/L	4	11	16	0.173	0.496	0.087	0.904	0.548
Sodium-22	pCi/L	0	1	25	–	2.06	–	–	–
Strontium-90	pCi/L	3	26	71	0.004	0.129	0.07	0.238	0.156
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	6	19	50	0.0	133	70.7	303	165
Uranium-234	pCi/L	0	45	53	0.035	0.562	0.139	2.14	0.602
Uranium-235, Uranium-236	pCi/L	0	16	53	0.006	0.067	0.046	0.181	0.089
Uranium-238	pCi/L	0	43	53	0.008	0.254	0.141	1.18	0.296
Uranium (calculated)	µg/L	0	49	49	0.011	0.649	0.064	3.6	0.666
Uranium (measured)	µg/L	0	20	20	0.02	0.491	0.235	3.46	0.593
Gross Alpha	pCi/L	0	24	52	0.173	1.37	0.49	4.73	1.56
Gross Beta	pCi/L	0	45	52	0.708	2.34	0.535	5.75	2.5
Gross Gamma	pCi/L	0	14	44	52.3	88.4	42.9	271	111
Ancho Canyon [b]									
Americium-241	pCi/L	1	7	28	0.003	0.029	0.011	0.066	0.036
Cesium-137	pCi/L	0	3	25	1.9	4.52	3.59	7.06	8.59
Cobalt-60	pCi/L	0	1	12	–	2.82	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	13	8.51	9.89	1.96	13.1	12.1
Plutonium-238	pCi/L	0	5	27	0.0	0.006	0.005	0.009	0.01
Plutonium-239, Plutonium-240	pCi/L	0	5	27	0.005	0.016	0.01	0.027	0.024
Potassium-40	pCi/L	0	11	12	11.3	33.1	1.08	57.7	33.7
Radium-226	pCi/L	3	4	6	0.22	0.61	0.286	0.904	0.89
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	1	10	28	0.004	0.124	0.07	0.233	0.167
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	7	22	0.0	154	148	303	263
Uranium-234	pCi/L	0	23	27	0.086	0.271	0.069	0.644	0.299
Uranium-235, Uranium-236	pCi/L	0	6	27	0.027	0.043	0.006	0.054	0.048
Uranium-238	pCi/L	0	22	27	0.021	0.098	0.048	0.31	0.118
Uranium (calculated)	µg/L	0	27	27	0.011	0.322	0.116	0.67	0.365
Uranium (measured)	µg/L	0	10	10	0.02	0.28	0.04	0.547	0.305
Gross Alpha	pCi/L	0	10	24	0.173	0.858	0.499	1.9	1.17
Gross Beta	pCi/L	0	19	24	0.8	1.61	0.411	2.97	1.79
Gross Gamma	pCi/L	0	5	22	52.3	81.5	15.9	99.2	95.5

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	4	11	0.01	0.015	0.009	0.028	0.024
Cesium-137	pCi/L	3	5	14	0.132	4.36	4.91	16.3	8.66
Cobalt-60	pCi/L	0	1	5	–	3.99	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	5	–	–	–	–	–
Plutonium-238	pCi/L	0	3	11	0.0	0.007	0.007	0.015	0.015
Plutonium-239, Plutonium-240	pCi/L	0	2	11	0.012	0.02	–	0.027	–
Potassium-40	pCi/L	0	3	5	10.6	25.6	6.4	31.5	32.8
Radium-226	pCi/L	0	2	5	0.173	0.399	–	0.625	–
Sodium-22	pCi/L	0	1	5	–	2.06	–	–	–
Strontium-90	pCi/L	0	5	14	0.057	0.133	0.085	0.226	0.207
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	9	53.1	84.8	44.8	117	136
Uranium-234	pCi/L	0	9	11	0.049	0.209	0.191	0.444	0.333
Uranium-235, Uranium-236	pCi/L	0	0	11	–	–	–	–	–
Uranium-238	pCi/L	0	8	11	0.02	0.062	0.067	0.18	0.108
Uranium (calculated)	µg/L	0	9	9	0.041	0.283	0.247	0.55	0.444
Uranium (measured)	µg/L	0	4	4	0.02	0.337	0.413	0.629	0.742
Gross Alpha	pCi/L	0	3	12	0.381	0.63	0.217	0.774	0.876
Gross Beta	pCi/L	0	11	12	0.708	2.53	1.17	5.26	3.22
Gross Gamma	pCi/L	0	5	7	55	69.2	13.3	99.8	80.9
Mortandad Canyon [b]									
Americium-241	pCi/L	0	1	4	–	0.009	–	–	–
Cesium-137	pCi/L	0	2	8	2.16	2.23	–	2.3	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	2	9.62	15.4	–	21.2	–
Plutonium-238	pCi/L	0	1	4	–	0.0	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	2	2	28.8	31.2	–	33.6	–
Radium-226	pCi/L	0	1	1	–	0.268	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	3	11	0.004	0.132	0.119	0.238	0.266
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	7	0.0	40.5	–	80.9	–
Uranium-234	pCi/L	0	4	4	0.264	0.377	0.042	0.412	0.418

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	2	4	0.038	0.044	–	0.049	–
Uranium-238	pCi/L	0	4	4	0.023	0.125	0.089	0.194	0.212
Uranium (calculated)	µg/L	0	4	4	0.39	0.486	0.083	0.6	0.567
Uranium (measured)	µg/L	0	5	5	0.52	0.66	0.167	0.845	0.806
Gross Alpha	pCi/L	0	3	4	0.96	1.08	0.132	1.22	1.23
Gross Beta	pCi/L	0	3	4	2.36	2.7	0.445	3.01	3.2
Gross Gamma	pCi/L	0	0	5	–	–	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	5	11	0.015	0.024	0.009	0.04	0.032
Cesium–137	pCi/L	0	2	13	0.971	1.5	–	2.03	–
Cobalt-60	pCi/L	0	1	6	–	1.71	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	6	15.5	18.3	–	21.1	–
Plutonium-238	pCi/L	0	3	11	0.0	0.009	0.007	0.014	0.017
Plutonium-239, Plutonium-240	pCi/L	0	1	11	–	0.005	–	–	–
Potassium-40	pCi/L	0	6	6	1.91	24.6	15.5	68	37.1
Radium-226	pCi/L	1	4	4	0.176	0.411	0.16	0.629	0.568
Sodium-22	pCi/L	0	0	6	–	–	–	–	–
Strontium-90	pCi/L	2	8	18	0.017	0.099	0.08	0.19	0.155
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	4	7	12	53.4	151	33.6	208	176
Uranium-234	pCi/L	0	9	11	0.035	1.74	0.441	2.14	2.03
Uranium-235, Uranium-236	pCi/L	0	8	11	0.006	0.098	0.073	0.181	0.148
Uranium-238	pCi/L	0	9	11	0.008	0.832	0.441	1.18	1.12
Uranium (calculated)	µg/L	0	9	9	0.018	2.19	0.715	3.6	2.66
Uranium (measured)	µg/L	0	1	1	–	3.46	–	–	–
Gross Alpha	pCi/L	0	8	12	0.429	2.38	0.818	4.73	2.95
Gross Beta	pCi/L	0	12	12	1.85	3.44	0.672	5.75	3.82
Gross Gamma	pCi/L	0	4	10	53.9	98	70	271	167

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–13 Radiochemical Statistical Analysis of Groundwater – Water Supply Wells

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Water Supply Wells [a] Composite									
Americium-241	pCi/L	2	17	64	0.003	0.033	0.03	0.157	0.047
Cesium-137	pCi/L	1	10	66	0.021	2.73	2.59	15.2	4.33
Cobalt-60	pCi/L	0	6	26	1.35	2.12	0.502	3.53	2.52
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	8	26	2.02	13.3	3.77	28.4	15.9
Plutonium-238	pCi/L	0	12	60	0.004	0.012	0.001	0.019	0.013
Plutonium-239, Plutonium-240	pCi/L	0	12	60	0.0	0.017	0.014	0.031	0.024
Potassium-40	pCi/L	0	22	26	0.47	27.3	5.88	63.9	29.8
Radium-226	pCi/L	7	17	26	0.123	0.338	0.124	0.671	0.397
Sodium-22	pCi/L	0	0	26	–	–	–	–	–
Strontium-90	pCi/L	1	51	185	0.035	0.116	0.043	0.272	0.127
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	7	11	72	60.8	204	180	874	311
Uranium-234	pCi/L	0	59	60	0.13	0.523	0.082	1.29	0.544
Uranium-235, Uranium-236	pCi/L	0	36	60	0.005	0.048	0.017	0.142	0.054
Uranium-238	pCi/L	0	59	60	0.017	0.226	0.11	0.642	0.254
Uranium (calculated)	µg/L	0	49	49	0.025	0.82	0.053	1.78	0.835
Uranium (measured)	µg/L	0	14	14	0.02	0.849	0.547	1.77	1.14
Gross Alpha	pCi/L	1	36	76	0.528	1.48	0.669	9.09	1.69
Gross Beta	pCi/L	0	67	75	0.872	3.43	0.77	8.93	3.61
Gross Gamma	pCi/L	0	18	47	48.4	114	39.6	355	132
Cañada del Buey [b]									
Americium-241	pCi/L	0	0	3	–	–	–	–	–
Cesium-137	pCi/L	0	2	3	0.021	1.04	–	2.05	–
Cobalt-60	pCi/L	0	1	1	–	1.35	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	1	–	–	–	–	–
Plutonium-238	pCi/L	0	1	3	–	0.017	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	1	1	–	26.6	–	–	–
Radium-226	pCi/L	0	1	1	–	0.242	–	–	–
Sodium-22	pCi/L	0	0	1	–	–	–	–	–
Strontium-90	pCi/L	1	2	7	0.085	0.154	–	0.224	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	3	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.213	0.247	0.031	0.275	0.283

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	1	3	–	0.035	–	–	–
Uranium-238	pCi/L	0	3	3	0.019	0.094	0.066	0.144	0.169
Uranium (calculated)	µg/L	0	2	2	0.37	0.39	–	0.41	–
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	1	3	–	1.94	–	–	–
Gross Beta	pCi/L	0	3	3	1.14	3.33	2.48	6.03	6.14
Gross Gamma	pCi/L	0	2	2	54.1	72.3	–	90.5	–
Guaje Canyon [b]									
Americium-241	pCi/L	0	5	29	0.006	0.018	0.0	0.032	0.018
Cesium-137	pCi/L	0	3	29	1.61	2.80	1.18	3.97	4.14
Cobalt-60	pCi/L	0	2	12	2.36	2.95	–	3.53	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	12	12.2	12.6	–	13	–
Plutonium-238	pCi/L	0	5	29	0.004	0.013	0.008	0.019	0.02
Plutonium-239, Plutonium-240	pCi/L	0	4	29	0.0	0.017	0.02	0.031	0.036
Potassium-40	pCi/L	0	10	12	0.47	30.1	5.19	40	33.3
Radium-226	pCi/L	5	9	12	0.139	0.355	0.11	0.608	0.427
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	0	24	83	0.035	0.108	0.046	0.272	0.127
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	7	8	30	67.8	257	255	874	434
Uranium-234	pCi/L	0	28	29	0.254	0.415	0.043	0.627	0.431
Uranium-235, Uranium-236	pCi/L	0	19	29	0.005	0.038	0.009	0.068	0.042
Uranium-238	pCi/L	0	28	29	0.019	0.198	0.098	0.347	0.235
Uranium (calculated)	µg/L	0	24	24	0.025	0.661	0.074	1.05	0.69
Uranium (measured)	µg/L	0	7	7	0.02	0.589	0.284	0.858	0.799
Gross Alpha	pCi/L	0	15	36	0.528	0.955	0.378	1.84	1.15
Gross Beta	pCi/L	0	31	36	1.32	2.72	0.743	6.25	2.98
Gross Gamma	pCi/L	0	9	25	48.4	91.2	18.1	123	103
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	0	4	–	–	–	–	–
Cesium-137	pCi/L	0	0	5	–	–	–	–	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	2	5.77	10.7	–	15.6	–
Plutonium-238	pCi/L	0	1	4	–	0.017	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	1	4	–	0.016	–	–	–
Potassium-40	pCi/L	0	2	2	31.1	33.8	–	36.4	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Radium-226	pCi/L	1	1	2	–	0.349	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	4	15	0.067	0.086	0.019	0.104	0.104
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	6	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.516	0.585	0.053	0.641	0.638
Uranium-235, Uranium-236	pCi/L	0	2	4	0.031	0.063	–	0.095	–
Uranium-238	pCi/L	0	4	4	0.028	0.211	0.125	0.31	0.334
Uranium (calculated)	µg/L	0	3	3	0.74	0.814	0.108	0.937	0.935
Uranium (measured)	µg/L	0	1	1	–	0.784	–	–	–
Gross Alpha	pCi/L	0	3	5	1.02	1.28	0.304	1.49	1.62
Gross Beta	pCi/L	0	5	5	2.66	3.7	0.952	4.94	4.54
Gross Gamma	pCi/L	0	1	3	–	120	–	–	–
Mortandad Canyon [b]									
Americium-241	pCi/L	1	2	5	0.012	0.085	–	0.157	–
Cesium-137	pCi/L	1	1	5	–	15.2	–	–	–
Cobalt-60	pCi/L	0	1	2	–	2.52	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	2	–	17.4	–	–	–
Plutonium-238	pCi/L	0	0	4	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	1	2	–	16.6	–	–	–
Radium-226	pCi/L	0	2	2	0.23	0.306	–	0.382	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	3	13	0.115	0.135	0.028	0.194	0.166
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	6	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.228	0.332	0.076	0.391	0.407
Uranium-235, Uranium-236	pCi/L	0	2	4	0.039	0.041	–	0.044	–
Uranium-238	pCi/L	0	4	4	0.019	0.143	0.086	0.218	0.227
Uranium (calculated)	µg/L	0	3	3	0.43	0.487	0.05	0.521	0.544
Uranium (measured)	µg/L	0	1	1	–	0.553	–	–	–
Gross Alpha	pCi/L	0	1	5	–	0.665	–	–	–
Gross Beta	pCi/L	0	5	5	1.71	2.69	0.963	4.01	3.53
Gross Gamma	pCi/L	0	0	3	–	–	–	–	–
Pajarito Canyon [b]									
Americium-241	pCi/L	0	3	5	0.016	0.031	0.008	0.059	0.041
Cesium-137	pCi/L	0	2	5	1.53	1.71	–	1.88	–
Cobalt-60	pCi/L	0	1	2	–	2.59	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	2	–	28.4	–	–	–
Plutonium-238	pCi/L	0	1	4	–	0.01	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	1	4	–	0.003	–	–	–
Potassium-40	pCi/L	0	2	2	20.9	42.4	–	63.9	–
Radium-226	pCi/L	0	1	2	–	0.466	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	5	16	0.073	0.1	0.007	0.11	0.106
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	7	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.13	0.201	0.054	0.257	0.253
Uranium-235, Uranium-236	pCi/L	0	2	4	0.018	0.025	–	0.033	–
Uranium-238	pCi/L	0	4	4	0.017	0.076	0.039	0.099	0.115
Uranium (calculated)	µg/L	0	3	3	0.266	0.296	0.028	0.320	0.328
Uranium (measured)	µg/L	0	1	1	–	0.236	–	–	–
Gross Alpha	pCi/L	0	1	5	–	1.03	–	–	–
Gross Beta	pCi/L	0	4	5	0.872	2.08	1.17	3.55	3.23
Gross Gamma	pCi/L	0	1	3	–	281	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	1	4	8	0.018	0.055	0.057	0.121	0.111
Cesium-137	pCi/L	0	0	7	–	–	–	–	–
Cobalt-60	pCi/L	0	0	3	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	3	–	2.02	–	–	–
Plutonium-238	pCi/L	0	2	7	0.012	0.015	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	3	7	0.002	0.006	0.004	0.009	0.01
Potassium-40	pCi/L	0	3	3	3.3	27.6	15	38.2	44.5
Radium-226	pCi/L	0	1	3	–	0.123	–	–	–
Sodium-22	pCi/L	0	0	3	–	–	–	–	–
Strontium-90	pCi/L	0	4	19	0.06	0.074	0.004	0.09	0.078
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	7	60.8	79.7	–	98.5	–
Uranium-234	pCi/L	0	7	7	0.753	0.891	0.108	1.04	0.971
Uranium-235, Uranium-236	pCi/L	0	4	7	0.027	0.101	0.064	0.142	0.163
Uranium-238	pCi/L	0	7	7	0.044	0.409	0.245	0.594	0.591
Uranium (calculated)	µg/L	0	6	6	1.33	1.5	0.079	1.56	1.56
Uranium (measured)	µg/L	0	2	2	1.72	1.75	–	1.77	–
Gross Alpha	pCi/L	0	6	8	0.691	1.62	0.604	2.21	2.1

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	0	8	8	2.46	3.74	0.632	6.1	4.18
Gross Gamma	pCi/L	0	2	4	91.3	104	–	116	–
Sandia Canyon [b]									
Americium-241	pCi/L	0	3	10	0.003	0.023	0.021	0.037	0.046
Cesium-137	pCi/L	0	2	12	0.322	1.59	–	2.85	–
Cobalt-60	pCi/L	0	1	4	–	1.76	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	4	–	11.8	–	–	–
Plutonium-238	pCi/L	0	2	9	0.01	0.010	–	0.011	–
Plutonium-239, Plutonium-240	pCi/L	0	3	9	0.0	0.008	0.011	0.016	0.02
Potassium-40	pCi/L	0	3	4	8.37	12.4	3.28	21.1	16.1
Radium-226	pCi/L	1	2	4	0.234	0.453	–	0.671	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	9	32	0.05	0.106	0.052	0.178	0.14
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	13	–	96.4	–	–	–
Uranium-234	pCi/L	0	9	9	0.595	0.957	0.125	1.29	1.04
Uranium-235, Uranium-236	pCi/L	0	6	9	0.047	0.078	0.015	0.125	0.09
Uranium-238	pCi/L	0	9	9	0.039	0.336	0.2	0.642	0.467
Uranium (calculated)	µg/L	0	8	8	0.860	1.18	0.234	1.78	1.34
Uranium (measured)	µg/L	0	2	2	0.931	1.35	–	1.77	–
Gross Alpha	pCi/L	1	9	14	0.696	2.24	1.16	9.09	3
Gross Beta	pCi/L	0	11	13	2.47	5.57	1.55	8.93	6.48
Gross Gamma	pCi/L	0	3	7	81.7	167	73.1	355	249

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–14 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Springs

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Aquifer Springs [a] Composite									
Americium-241	pCi/L	3	25	119	0.005	0.018	0.004	0.037	0.02
Cesium-137	pCi/L	0	15	120	1.21	2.18	0.738	3.98	2.55
Cobalt-60	pCi/L	0	3	61	0.353	1.82	1.61	3.55	3.65
Iodine-129	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/L	0	11	62	2.71	14	4.43	29.6	16.6
Plutonium-238	pCi/L	2	12	118	0.0	0.032	0.019	0.074	0.042
Plutonium-239, Plutonium-240	pCi/L	0	7	118	0.005	0.014	0.005	0.021	0.018
Potassium-40	pCi/L	3	43	61	0.4	30.5	1.33	65.4	30.9
Radium-226	pCi/L	5	18	28	0.118	1.22	1.11	3.45	1.73
Sodium-22	pCi/L	0	2	61	2.04	2.44	–	2.84	–
Strontium-90	pCi/L	2	22	113	0.056	0.162	0.028	0.3	0.174
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	17	25	117	54.8	171	113	588	216
Uranium-234	pCi/L	7	107	117	0.044	1.04	0.412	7.22	1.12
Uranium-235, Uranium-236	pCi/L	0	68	116	0.009	0.077	0.03	0.552	0.084
Uranium-238	pCi/L	0	107	117	0.019	0.563	0.28	4.4	0.616
Uranium (calculated)	µg/L	0	111	112	0.008	1.76	0.553	11.8	1.86
Uranium (measured)	µg/L	0	67	67	0.02	3.98	2.98	19.6	4.7
Gross Alpha	pCi/L	9	65	118	0.625	2.87	0.957	11.5	3.1
Gross Beta	pCi/L	0	96	117	0.649	3.36	1.32	17.0	3.63
Gross Gamma	pCi/L	0	27	104	50.4	198	67.9	1,420	224
Sandia Canyon [b]									
Americium-241	pCi/L	1	1	9	–	0.035	–	–	–
Cesium-137	pCi/L	0	1	9	–	3.17	–	–	–
Cobalt-60	pCi/L	0	0	5	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	29.6	–	–	–
Plutonium-238	pCi/L	0	2	9	0.002	0.005	–	0.007	–
Plutonium-239, Plutonium-240	pCi/L	0	0	9	–	–	–	–	–
Potassium-40	pCi/L	0	3	5	30.3	41	2.48	48.1	43.8
Radium-226	pCi/L	1	2	2	0.381	1.32	–	2.25	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	1	2	9	0.114	0.127	–	0.14	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	3	9	122	194	88.8	293	294
Uranium-234	pCi/L	0	8	9	0.264	0.589	0.239	0.99	0.754
Uranium-235, Uranium-236	pCi/L	0	4	9	0.031	0.118	0.106	0.193	0.222
Uranium-238	pCi/L	0	8	9	0.042	0.279	0.163	0.634	0.392
Uranium (calculated)	µg/L	0	8	8	0.05	0.862	0.256	1.21	1.04
Uranium (measured)	µg/L	0	1	1	–	0.62	–	–	–
Gross Alpha	pCi/L	0	5	9	0.839	1.13	0.196	1.62	1.3
Gross Beta	pCi/L	0	8	9	1.8	3.21	1.22	4.85	4.06

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Gamma	pCi/L	0	2	7	105	237	–	369	–
White Rock Canyon and Rio Grande [b]									
Americium-241	pCi/L	2	24	110	0.005	0.018	0.004	0.037	0.02
Cesium-137	pCi/L	0	14	111	1.21	2.14	0.738	3.98	2.53
Cobalt-60	pCi/L	0	3	56	0.353	1.82	1.61	3.55	3.65
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	10	57	2.71	12.6	6.33	28.2	16.6
Plutonium-238	pCi/L	2	10	109	0.0	0.032	0.018	0.074	0.044
Plutonium-239, Plutonium-240	pCi/L	0	7	109	0.005	0.014	0.005	0.021	0.018
Potassium-40	pCi/L	3	40	56	0.4	29.8	1.28	65.4	30.2
Radium-226	pCi/L	4	16	26	0.118	1.16	1.02	3.45	1.66
Sodium-22	pCi/L	0	2	56	2.04	2.44	–	2.84	–
Strontium-90	pCi/L	1	20	104	0.056	0.167	0.035	0.3	0.182
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	15	22	108	54.8	182	124	588	234
Uranium-234	pCi/L	7	99	108	0.044	1.07	0.438	7.22	1.16
Uranium-235, Uranium-236	pCi/L	0	64	107	0.009	0.078	0.031	0.552	0.085
Uranium-238	pCi/L	0	99	108	0.019	0.586	0.293	4.4	0.644
Uranium (calculated)	µg/L	0	103	104	0.008	1.83	0.585	11.8	1.94
Uranium (measured)	µg/L	0	66	66	0.02	4.01	2.94	19.6	4.72
Gross Alpha	pCi/L	9	60	109	0.625	3.03	1.1	11.5	3.31
Gross Beta	pCi/L	0	88	108	0.649	3.39	1.35	17	3.67
Gross Gamma	pCi/L	0	25	97	50.4	193	65.3	1,420	218

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–15 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Wells [a]

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Canyon Alluvial Wells [a] Composite									
Americium-241	pCi/L	72	109	152	0.0	0.422	0.402	3.98	0.497
Cesium-137	pCi/L	7	35	149	0.0	3.46	1.82	16.5	4.06
Cobalt-60	pCi/L	0	9	80	1.03	2.16	0.142	4.29	2.25
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	11	80	1.39	11.7	1.79	20.9	12.8

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	21	65	151	0.0	0.422	0.432	2.19	0.528
Plutonium-239, Plutonium-240	pCi/L	30	67	151	0.0	0.239	0.157	1.96	0.277
Potassium-40	pCi/L	10	70	80	0.535	41.7	12.5	154	44.6
Radium-226	pCi/L	39	49	51	0.137	0.803	0.441	2.27	0.927
Sodium-22	pCi/L	1	31	80	1.47	3.8	0.367	6.48	3.93
Strontium-90	pCi/L	107	121	149	0.1	17.4	5	81.6	18.3
Technetium-99	pCi/L	19	19	23	6.25	12.8	4.8	23.1	14.9
Tritium	pCi/L	56	74	108	84.2	2,200	441	8,770	2,300
Uranium-234	pCi/L	0	134	152	0.014	0.515	0.212	3.24	0.55
Uranium-235, Uranium-236	pCi/L	0	92	152	0.0	0.059	0.017	0.222	0.063
Uranium-238	pCi/L	0	131	152	0.0	0.248	0.084	1.53	0.263
Uranium (calculated)	µg/L	0	163	166	0.0	0.821	0.481	28.5	0.895
Uranium (measured)	µg/L	0	64	64	0.02	0.475	0.228	1.6	0.531
Gross Alpha	pCi/L	11	107	150	0.512	2.85	0.758	19.3	3
Gross Beta	pCi/L	79	142	148	1.93	51.2	15.5	262	53.8
Gross Gamma	pCi/L	0	41	118	55	201.7	133	2,340	242
Los Alamos Canyon [b]									
Americium-241	pCi/L	9	29	51	0.0	0.035	0.014	0.273	0.04
Cesium-137	pCi/L	1	11	50	0.0	2.62	1.67	4.9	3.6
Cobalt-60	pCi/L	0	3	14	1.32	1.8	0.371	2.06	2.22
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	14	6.62	10	0.007	13.4	10
Plutonium-238	pCi/L	3	20	51	0.0	0.103	0.142	0.313	0.165
Plutonium-239, Plutonium-240	pCi/L	2	21	51	0.0	0.023	0.01	0.103	0.027
Potassium-40	pCi/L	3	13	14	0.535	46.5	41.1	154	68.9
Radium-226	pCi/L	9	14	14	0.137	0.589	0.397	1.78	0.797
Sodium-22	pCi/L	0	0	14	–	–	–	–	–
Strontium-90	pCi/L	38	44	50	0.1	15.29	2.94	71.5	16.2
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	14	26	40	84.2	173	40.89	399	189
Uranium-234	pCi/L	0	41	51	0.017	0.227	0.194	1.39	0.286
Uranium-235, Uranium-236	pCi/L	0	25	51	0.007	0.056	0.048	0.222	0.075
Uranium-238	pCi/L	0	38	51	0.009	0.084	0.049	0.243	0.1
Uranium (calculated)	µg/L	0	43	44	0.01	0.239	0.08	1.12	0.263
Uranium (measured)	µg/L	0	30	30	0.02	0.234	0.064	0.653	0.257
Gross Alpha	pCi/L	0	22	49	0.512	1.3	0.453	3.08	1.49
Gross Beta	pCi/L	22	45	49	3.19	36.2	7.6	107	38.4
Gross Gamma	pCi/L	0	12	31	55	410	528	2,340	709

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Mortandad Canyon [b]									
Americium-241	pCi/L	62	64	69	0.012	0.728	0.651	3.98	0.888
Cesium-137	pCi/L	5	19	68	0.8	5	3.26	16.5	6.47
Cobalt-60	pCi/L	0	5	54	1.03	2.78	1.21	4.29	3.84
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	6	54	9.34	12.87	2.09	20	14.5
Plutonium-238	pCi/L	18	34	68	0.01	0.601	0.611	2.19	0.807
Plutonium-239, Plutonium-240	pCi/L	19	29	68	0.01	0.436	0.385	1.96	0.576
Potassium-40	pCi/L	5	47	54	3.1	33.5	3.2	77	34.4
Radium-226	pCi/L	24	27	29	0.242	1.02	0.436	2.27	1.18
Sodium-22	pCi/L	1	31	54	1.47	3.80	0.367	6.48	3.93
Strontium-90	pCi/L	53	57	69	0.214	31	11.1	81.6	33.8
Technetium-99	pCi/L	19	19	23	6.25	12.78	4.8	23.1	14.9
Tritium	pCi/L	42	44	45	108	4,240	1,420	8,770	4,660
Uranium-234	pCi/L	0	67	69	0.088	1.04	0.392	3.24	1.13
Uranium-235, Uranium-236	pCi/L	0	60	69	0.025	0.072	0.016	0.212	0.076
Uranium-238	pCi/L	0	67	69	0.044	0.432	0.102	1.53	0.456
Uranium (calculated)	µg/L	0	49	49	0.0	1.5	0.55	28.5	1.66
Uranium (measured)	µg/L	0	25	25	0.529	0.927	0.093	1.6	0.964
Gross Alpha	pCi/L	10	62	67	0.777	4.01	1.87	12.4	4.47
Gross Beta	pCi/L	56	66	67	4.97	104	33.4	262	111
Gross Gamma	pCi/L	0	23	66	59.1	146	92.1	1,480	184
Pajarito Canyon [b]									
Americium-241	pCi/L	0	7	12	0.005	0.037	0.02	0.058	0.052
Cesium-137	pCi/L	1	1	12	–	9.39	–	–	–
Cobalt-60	pCi/L	0	0	5	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	20.9	–	–	–
Plutonium-238	pCi/L	0	6	12	0.0	0.004	0.01	0.024	0.012
Plutonium-239, Plutonium-240	pCi/L	0	5	12	0.005	0.01	0.006	0.02	0.015
Potassium-40	pCi/L	1	4	5	10.2	34.3	19.7	53.9	53.7
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	2	6	11	0.197	0.344	0.075	0.491	0.404
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	6	161	180	–	199	–
Uranium-234	pCi/L	0	10	12	0.014	0.272	0.205	1.08	0.399
Uranium-235, Uranium-236	pCi/L	0	3	12	0.0	0.045	0.039	0.069	0.089

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-238	pCi/L	0	9	12	0.0	0.209	0.146	0.869	0.305
Uranium (calculated)	µg/L	0	12	13	0.0	0.553	0.335	2.62	0.743
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	8	12	0.807	1.5	0.607	3.07	1.92
Gross Beta	pCi/L	0	12	12	1.93	6.19	0.045	12.9	6.21
Gross Gamma	pCi/L	0	1	5	–	76.9	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	7	14	0.014	0.025	0.01	0.04	0.033
Cesium-137	pCi/L	0	2	13	0.577	0.635	–	0.693	–
Cobalt-60	pCi/L	0	1	5	–	1.11	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	1.39	–	–	–
Plutonium-238	pCi/L	0	4	14	0.004	0.023	0.021	0.045	0.044
Plutonium-239, Plutonium-240	pCi/L	9	11	14	0.03	0.114	0.062	0.276	0.15
Potassium-40	pCi/L	1	5	5	3.66	21.9	9.34	42.5	30.1
Radium-226	pCi/L	4	6	6	0.202	0.556	0.102	1.04	0.637
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	14	14	14	0.275	0.777	0.346	1.42	0.958
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	11	115	130	–	145	–
Uranium-234	pCi/L	0	13	14	0.053	0.189	0.117	0.407	0.253
Uranium-235, Uranium-236	pCi/L	0	2	14	0.013	0.03	–	0.046	–
Uranium-238	pCi/L	0	14	14	0.02	0.11	0.075	0.278	0.15
Uranium (calculated)	µg/L	0	10	10	0.061	0.35	0.256	0.83	0.508
Uranium (measured)	µg/L	0	9	9	0.109	0.201	0.121	0.31	0.28
Gross Alpha	pCi/L	0	8	14	0.718	1.3	0.389	2.97	1.57
Gross Beta	pCi/L	0	14	14	4.9	12.8	4.69	19.5	15.2
Gross Gamma	pCi/L	0	4	11	63.1	97.8	30.2	156	127
Water Canyon [b]									
Americium-241	pCi/L	0	0	2	–	–	–	–	–
Cesium-137	pCi/L	0	0	2	–	–	–	–	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	0	2	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	2	–	–	–	–	–
Potassium-40	pCi/L	0	1	2	–	31.1	–	–	–
Radium-226	pCi/L	2	2	2	0.45	0.74	–	1.03	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Strontium-90	pCi/L	0	0	2	–	–	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	0	2	–	–	–	–	–
Uranium-235, Uranium-236	pCi/L	0	0	2	–	–	–	–	–
Uranium-238	pCi/L	0	0	2	–	–	–	–	–
Uranium (calculated)	µg/L	0	46	46	0.027	1.37	3.28	16.6	2.32
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	2	2	0.766	0.882	–	0.998	–
Gross Beta	pCi/L	0	2	2	2.45	3.04	–	3.63	–
Gross Gamma	pCi/L	0	1	2	–	1,070	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Canyon Alluvial Wells (Table F–15) and Canyon Alluvial Springs (Table F–16).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–16 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Springs

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Canyon Alluvial Wells [a] Composite									
Americium-241	pCi/L	1	6	14	0.011	0.046	0.039	0.091	0.077
Cesium-137	pCi/L	0	4	15	0.044	0.666	0.803	2.39	1.45
Cobalt-60	pCi/L	0	2	12	1.4	2	–	2.6	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	12	3.74	10.6	–	17.5	–
Plutonium-238	pCi/L	0	2	14	0.013	0.016	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	4	14	0.007	0.02	0.01	0.026	0.029
Potassium-40	pCi/L	1	8	12	7.71	35.6	20.3	49.9	49.6
Radium-226	pCi/L	2	3	4	0.36	0.505	0.138	0.602	0.661
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	5	8	14	0.101	68.5	42.1	115	97.7
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	5	9	105	276	160	455	416
Uranium-234	pCi/L	0	7	14	0.067	0.392	0.246	0.977	0.574
Uranium-235, Uranium-236	pCi/L	0	5	14	0.011	0.045	0.048	0.104	0.087
Uranium-238	pCi/L	0	10	14	0.028	0.073	0.03	0.14	0.092
Uranium (calculated)	µg/L	0	12	12	0.05	0.183	0.088	0.3	0.233

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (measured)	µg/L	0	3	3	0.119	0.168	0.07	0.22	0.247
Gross Alpha	pCi/L	0	10	14	0.248	2.04	1.44	3.88	2.93
Gross Beta	pCi/L	5	12	14	3.37	97.2	96.2	228	152
Gross Gamma	pCi/L	0	8	13	53.3	78.8	1.19	138	79.7
Los Alamos Canyon [b]									
Americium-241	pCi/L	1	5	5	0.017	0.048	0.037	0.091	0.08
Cesium-137	pCi/L	0	2	5	0.044	0.398	–	0.753	–
Cobalt-60	pCi/L	0	1	2	–	1.4	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	2	5	0.013	0.016	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	4	5	0.007	0.02	0.01	0.026	0.029
Potassium-40	pCi/L	0	2	2	29.7	29.8	–	29.9	–
Radium-226	pCi/L	1	1	2	–	0.602	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	5	5	5	60.5	83.8	27.4	115	108
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	2	3	349	402	–	455	–
Uranium-234	pCi/L	0	5	5	0.378	0.599	0.326	0.977	0.885
Uranium-235, Uranium-236	pCi/L	0	5	5	0.011	0.045	0.048	0.104	0.087
Uranium-238	pCi/L	0	5	5	0.028	0.081	0.051	0.14	0.125
Uranium (calculated)	µg/L	0	3	3	0.09	0.176	0.122	0.262	0.314
Uranium (measured)	µg/L	0	1	1	–	0.119	–	–	–
Gross Alpha	pCi/L	0	4	5	1.43	2.8	0.953	3.88	3.73
Gross Beta	pCi/L	5	5	5	123	161	52.8	228	207
Gross Gamma	pCi/L	0	1	3	–	104	–	–	–
Pajarito Canyon [b]									
Americium-241	pCi/L	0	1	9	–	0.011	–	–	–
Cesium-137	pCi/L	0	2	10	0.382	1.39	–	2.39	–
Cobalt-60	pCi/L	0	1	10	–	2.6	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	10	3.74	10.6	–	17.5	–
Plutonium-238	pCi/L	0	0	9	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	9	–	–	–	–	–
Potassium-40	pCi/L	1	6	10	7.71	33.8	22.7	49.9	52
Radium-226	pCi/L	1	2	2	0.36	0.407	–	0.454	–
Sodium-22	pCi/L	0	0	10	–	–	–	–	–
Strontium-90	pCi/L	0	3	9	0.101	0.131	0.033	0.166	0.168
Technetium-99	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Tritium	pCi/L	0	3	6	105	125	28.6	146	158
Uranium-234	pCi/L	0	2	9	0.067	0.07	–	0.073	–
Uranium-235, Uranium-236	pCi/L	0	0	9	–	–	–	–	–
Uranium-238	pCi/L	0	5	9	0.048	0.081	0.006	0.109	0.086
Uranium (calculated)	µg/L	0	9	9	0.05	0.189	0.092	0.3	0.249
Uranium (measured)	µg/L	0	2	2	0.215	0.218	–	0.22	–
Gross Alpha	pCi/L	0	6	9	0.248	0.756	0.231	1.97	0.941
Gross Beta	pCi/L	0	7	9	3.37	5.76	0.158	9.09	5.88
Gross Gamma	pCi/L	0	7	10	53.3	76.8	1.67	138	78.1

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Canyon Alluvial Wells (Table F–15) and Canyon Alluvial Springs (Table F–16).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–17 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Intermediate Perched Wells [a] Composite									
Americium-241	pCi/L	0	12	77	0.012	0.02	0.005	0.033	0.023
Cesium-137	pCi/L	2	11	77	0.395	6.11	2.06	7.39	7.33
Cobalt-60	pCi/L	0	10	60	1.22	3.31	1.88	6.48	4.48
Iodine-129	pCi/L	0	1	8	–	0.818	–	–	–
Neptunium-237	pCi/L	0	12	50	5.79	13.9	1.14	30.1	14.6
Plutonium-238	pCi/L	1	8	77	0.0	0.024	0.027	0.111	0.043
Plutonium-239, Plutonium-240	pCi/L	2	8	77	0.014	0.333	0.611	3.65	0.756
Potassium-40	pCi/L	5	51	60	1.26	289	353	19,000	386
Radium-226	pCi/L	10	21	31	0.137	0.743	0.608	3.28	1
Sodium-22	pCi/L	0	3	60	1.2	5.62	5.57	9.56	11.9
Strontium-90	pCi/L	2	14	78	0.091	0.776	1.28	10.3	1.45
Technetium-99	pCi/L	9	11	22	2.34	4.26	1.61	7.86	5.21
Tritium	pCi/L	15	24	61	78.7	2,650	4,340	23,500	4,380
Uranium-234	pCi/L	1	55	73	0.046	8.22	15.6	1,210	12.3
Uranium-235, Uranium-236	pCi/L	2	32	75	0.017	0.791	1.49	53.3	1.31
Uranium-238	pCi/L	1	55	75	0.031	8.45	16.4	1,210	12.8
Uranium (calculated)	µg/L	0	69	73	0.0	0.543	0.356	6.9	0.627
Uranium (measured)	µg/L	0	41	41	0.02	0.54	0.015	2.97	0.545

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Alpha	pCi/L	0	26	67	0.574	1.48	0.423	4.04	1.64
Gross Beta	pCi/L	3	51	67	0.829	4.78	2.59	42.6	5.49
Gross Gamma	pCi/L	0	26	63	45.6	121	73.8	1,560	149
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	2	21	0.022	0.023	–	0.024	–
Cesium-137	pCi/L	2	6	22	1.29	5.95	2.5	7.39	7.95
Cobalt-60	pCi/L	0	3	17	2.43	4.09	2.34	6.48	6.73
Iodine-129	pCi/L	0	1	4	–	0.818	–	–	–
Neptunium-237	pCi/L	0	3	11	13	19.3	8.2	25.1	28.6
Plutonium-238	pCi/L	0	2	20	0.012	0.012	–	0.012	–
Plutonium-239, Plutonium-240	pCi/L	0	2	20	0.04	1.85	–	3.65	–
Potassium-40	pCi/L	2	16	17	1.68	970	1,340	19,000	1,630
Radium-226	pCi/L	4	7	10	0.143	0.453	0.197	0.592	0.599
Sodium-22	pCi/L	0	1	17	–	9.56	–	–	–
Strontium-90	pCi/L	2	6	22	0.091	1.82	2.93	10.3	4.16
Technetium-99	pCi/L	1	1	7	–	2.34	–	–	–
Tritium	pCi/L	4	11	15	117	186	7.04	348	190
Uranium-234	pCi/L	1	16	20	0.048	40.8	70.4	1,210	75.3
Uranium-235, Uranium-236	pCi/L	2	12	20	0.018	3.01	5.16	53.3	5.93
Uranium-238	pCi/L	1	15	20	0.09	45.2	78.1	1,210	84.8
Uranium (calculated)	µg/L	0	15	17	0.019	1.012	1.21	6.9	1.62
Uranium (measured)	µg/L	0	12	12	0.02	0.322	0.075	0.785	0.365
Gross Alpha	pCi/L	0	6	16	0.735	1.55	1.11	4.04	2.44
Gross Beta	pCi/L	1	12	16	2.8	5.89	1.91	23.9	6.97
Gross Gamma	pCi/L	0	6	16	45.6	84.5	34.6	146	112
Mortandad Canyon [b]									
Americium-241	pCi/L	0	1	16	–	0.033	–	–	–
Cesium-137	pCi/L	0	2	16	0.395	1.19	–	1.99	–
Cobalt-60	pCi/L	0	5	16	1.22	1.82	0.634	2.8	2.38
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	16	8.91	12.9	3.53	15.6	16.9
Plutonium-238	pCi/L	0	0	16	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	16	–	–	–	–	–
Potassium-40	pCi/L	1	14	16	3.48	22.9	13.1	47.8	29.7
Radium-226	pCi/L	4	6	8	0.302	1.43	1.36	3.28	2.51
Sodium-22	pCi/L	0	1	16	–	2.17	–	–	–
Strontium-90	pCi/L	0	1	16	–	0.22	–	–	–
Technetium-99	pCi/L	8	10	11	2.63	4.45	1.56	7.86	5.42
Tritium	pCi/L	9	9	9	4,310	12,000	5,610	23,500	15,700
Uranium-234	pCi/L	0	16	16	0.096	0.26	0.142	0.441	0.33

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	8	16	0.028	0.043	0.015	0.069	0.054
Uranium-238	pCi/L	0	16	16	0.032	0.114	0.065	0.219	0.146
Uranium (calculated)	µg/L	0	8	8	0.12	0.33	0.157	0.5	0.438
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	3	16	1.12	1.81	0.599	2.2	2.49
Gross Beta	pCi/L	0	15	16	1.01	4.8	4.25	14.7	6.95
Gross Gamma	pCi/L	0	5	16	57.9	86.5	37.7	151	120
Pajarito Canyon [b]									
Americium-241	pCi/L	0	0	4	–	–	–	–	–
Cesium-137	pCi/L	0	1	4	–	2.89	–	–	–
Cobalt-60	pCi/L	0	1	4	–	2.34	–	–	–
Iodine-129	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	4	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	3	4	15.7	41.6	27.9	71.1	73.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	1	4	–	0.176	–	–	–
Technetium-99	pCi/L	0	0	4	–	–	–	–	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Uranium-234	pCi/L	0	3	4	0.233	0.248	0.013	0.257	0.262
Uranium-235, Uranium-236	pCi/L	0	1	4	–	0.050	–	–	–
Uranium-238	pCi/L	0	3	4	0.108	0.13	0.021	0.15	0.154
Uranium (calculated)	µg/L	0	7	7	0.05	0.294	0.11	0.36	0.376
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	0	–	–	–	–	–
Gross Beta	pCi/L	0	0	0	–	–	–	–	–
Gross Gamma	pCi/L	0	0	0	–	–	–	–	–
Potrillo Canyon [b]									
Americium-241	pCi/L	0	0	3	–	–	–	–	–
Cesium-137	pCi/L	0	0	3	–	–	–	–	–
Cobalt-60	pCi/L	0	1	3	–	2.44	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	3	–	–	–	–	–
Plutonium-238	pCi/L	0	0	3	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	2	3	10.6	24.8	-	38.9	-
Radium-226	pCi/L	0	0	1	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Sodium-22	pCi/L	0	0	3	–	–	–	–	–
Strontium-90	pCi/L	0	0	3	–	–	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.228	0.276	0.068	0.332	0.353
Uranium-235, Uranium-236	pCi/L	0	2	3	0.021	0.057	–	0.093	–
Uranium-238	pCi/L	0	3	3	0.105	0.124	0.027	0.171	0.154
Uranium (calculated)	µg/L	0	3	3	0.24	0.284	0.055	0.322	0.346
Uranium (measured)	µg/L	0	3	3	0.027	0.204	0.098	0.273	0.314
Gross Alpha	pCi/L	0	1	3	–	3.51	–	–	–
Gross Beta	pCi/L	0	1	3	–	0.829	–	–	–
Gross Gamma	pCi/L	0	0	3	–	–	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	4	9	0.015	0.022	0.007	0.029	0.029
Cesium-137	pCi/L	0	2	8	6.58	6.84	–	7.1	–
Cobalt-60	pCi/L	0	0	4	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	4	–	–	–	–	–
Plutonium-238	pCi/L	1	4	10	0.0	0.026	0.034	0.111	0.059
Plutonium-239, Plutonium-240	pCi/L	1	2	10	0.033	0.036	–	0.039	–
Potassium-40	pCi/L	0	3	4	45.5	57.8	17	69.8	77
Radium-226	pCi/L	1	3	4	0.23	0.364	0.188	0.765	0.577
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	2	9	0.093	0.178	–	0.263	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	3	13	78.7	711	554	1,110	1,340
Uranium-234	pCi/L	0	7	8	0.046	0.936	0.453	1.83	1.27
Uranium-235, Uranium-236	pCi/L	0	5	8	0.019	0.105	0.045	0.153	0.144
Uranium-238	pCi/L	0	6	8	0.034	0.688	0.234	1.12	0.875
Uranium (calculated)	µg/L	0	6	6	0.0	1.41	1.23	3.08	2.4
Uranium (measured)	µg/L	0	5	5	0.02	2.3	0.455	2.97	2.7
Gross Alpha	pCi/L	0	3	8	2.3	2.67	0.473	3.2	3.2
Gross Beta	pCi/L	0	6	8	1.45	8.53	1.76	12.6	9.93
Gross Gamma	pCi/L	0	3	6	79	89.1	17.2	109	109
Sandia Canyon [b]									
Americium-241	pCi/L	0	0	13	–	–	–	–	–
Cesium-137	pCi/L	0	0	13	–	–	–	–	–
Cobalt-60	pCi/L	0	0	8	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	4	8	8.16	14.4	10.5	30.1	24.7

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	0	0	13	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	13	–	–	–	–	–
Potassium-40	pCi/L	1	6	8	10	45.6	16.5	103	58.8
Radium-226	pCi/L	0	5	6	0.137	0.239	0.061	0.288	0.292
Sodium-22	pCi/L	0	0	8	–	–	–	–	–
Strontium-90	pCi/L	0	1	13	–	0.099	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	13	–	170	–	–	–
Uranium-234	pCi/L	0	2	13	0.306	0.306	–	0.306	–
Uranium-235, Uranium-236	pCi/L	0	1	13	–	0.031	–	–	–
Uranium-238	pCi/L	0	3	13	0.052	0.125	0.035	0.15	0.165
Uranium (calculated)	µg/L	0	11	13	0.006	0.109	0.051	0.446	0.14
Uranium (measured)	µg/L	0	11	11	0.026	0.195	0.022	0.557	0.208
Gross Alpha	pCi/L	0	4	13	0.627	0.986	0.076	1.17	1.06
Gross Beta	pCi/L	0	8	13	1.47	2.27	0.185	3.49	2.4
Gross Gamma	pCi/L	0	10	13	46.3	323	430	1,560	590
Water Canyon [b]									
Americium-241	pCi/L	0	5	11	0.012	0.018	0.003	0.022	0.021
Cesium-137	pCi/L	0	0	11	–	–	–	–	–
Cobalt-60	pCi/L	0	0	8	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	8	5.79	9.45	–	13.1	–
Plutonium-238	pCi/L	0	2	11	0.007	0.012	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	1	4	11	0.014	0.032	0.024	0.059	0.055
Potassium-40	pCi/L	1	7	8	1.26	33.1	7.35	53.9	38.5
Radium-226	pCi/L	0	0	2	–	–	–	–	–
Sodium-22	pCi/L	0	1	8	–	1.2	–	–	–
Strontium-90	pCi/L	0	3	11	0.134	0.158	0.033	0.183	0.195
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	9	–	–	–	–	–
Uranium-234	pCi/L	0	8	9	0.052	0.263	0.155	0.733	0.370
Uranium-235, Uranium-236	pCi/L	0	3	11	0.017	0.055	0.045	0.086	0.105
Uranium-238	pCi/L	0	9	11	0.031	0.143	0.128	0.455	0.227
Uranium (calculated)	µg/L	0	19	19	0.05	0.28	0.201	0.74	0.37
Uranium (measured)	µg/L	0	10	10	0.02	0.425	0.013	0.706	0.434
Gross Alpha	pCi/L	0	9	11	0.574	1.41	0.547	3.09	1.77

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	2	9	11	1.05	7.05	9.85	42.6	13.5
Gross Gamma	pCi/L	0	2	9	71.2	92.1	–	113	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Intermediate Perched Wells (Table F–17) and Intermediate Perched Springs (Table F–18).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–18 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Springs

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Intermediate Perched Springs [a] Composite									
Americium-241	pCi/L	0	9	30	0.012	0.023	0.006	0.034	0.027
Cesium-137	pCi/L	0	4	31	0.847	2.72	1.64	4.25	4.32
Cobalt-60	pCi/L	0	1	22	–	2.45	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	22	6.33	14.4	5.79	33.4	19.5
Plutonium-238	pCi/L	1	2	30	0.003	0.03	–	0.058	–
Plutonium-239, Plutonium-240	pCi/L	2	4	30	0.018	0.034	0.013	0.045	0.047
Potassium-40	pCi/L	3	18	22	4.34	24.8	1.29	56.6	25.4
Radium-226	pCi/L	4	8	10	0.154	0.563	0.403	1.31	0.843
Sodium-22	pCi/L	0	1	22	–	2.89	–	–	–
Strontium-90	pCi/L	3	11	33	0.066	0.313	0.213	0.611	0.438
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	22	70	93.6	14.7	104	110
Uranium-234	pCi/L	0	23	31	0.031	0.328	0.23	0.673	0.422
Uranium-235, Uranium-236	pCi/L	0	9	31	0.011	0.045	0.039	0.113	0.071
Uranium-238	pCi/L	0	19	31	0.022	0.22	0.136	0.425	0.281
Uranium (calculated)	µg/L	0	69	69	0.023	0.559	0.439	1.31	0.663
Uranium (measured)	µg/L	0	10	10	0.02	0.626	0.364	1.4	0.852
Gross Alpha	pCi/L	0	15	31	0.595	1.23	0.725	2.51	1.59
Gross Beta	pCi/L	0	28	31	0.796	7.04	5.23	15.7	8.98
Gross Gamma	pCi/L	0	11	29	61.7	99	15.3	293	108
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	4	9	0.014	0.026	0.007	0.034	0.033
Cesium-137	pCi/L	0	2	9	1.13	2.02	–	2.91	–
Cobalt-60	pCi/L	0	1	3	–	2.45	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/L	0	0	3	–	–	–	–	–
Plutonium-238	pCi/L	1	2	9	0.003	0.03	–	0.058	–
Plutonium-239, Plutonium-240	pCi/L	2	4	9	0.018	0.034	0.013	0.045	0.047
Potassium-40	pCi/L	0	3	3	9.04	24.8	13.7	34.5	40.3
Radium-226	pCi/L	0	2	3	0.154	0.216	–	0.278	–
Sodium-22	pCi/L	0	1	3	–	2.89	–	–	–
Strontium-90	pCi/L	2	4	10	0.119	0.340	0.221	0.611	0.556
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	8	–	–	–	–	–
Uranium-234	pCi/L	0	8	10	0.237	0.442	0.197	0.673	0.579
Uranium-235, Uranium-236	pCi/L	0	5	10	0.016	0.054	0.039	0.113	0.089
Uranium-238	pCi/L	0	8	10	0.148	0.283	0.126	0.425	0.371
Uranium (calculated)	µg/L	0	8	8	0.023	0.794	0.372	1.31	1.05
Uranium (measured)	µg/L	0	3	3	0.02	0.883	0.748	1.34	1.73
Gross Alpha	pCi/L	0	5	9	0.628	1.37	0.784	2.51	2.05
Gross Beta	pCi/L	0	8	9	1.43	8.33	5.05	15.7	11.8
Gross Gamma	pCi/L	0	4	8	61.7	81.7	12.1	93.3	93.6
Pajarito Canyon [b]									
Americium-241	pCi/L	0	4	18	0.012	0.02	0.001	0.025	0.021
Cesium-137	pCi/L	0	1	19	–	0.847	–	–	–
Cobalt-60	pCi/L	0	0	19	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	19	6.33	14.4	5.79	33.4	19.5
Plutonium-238	pCi/L	0	0	18	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	18	–	–	–	–	–
Potassium-40	pCi/L	3	15	19	4.34	25.3	1.15	56.6	25.9
Radium-226	pCi/L	4	6	7	0.374	0.964	0.367	1.31	1.26
Sodium-22	pCi/L	0	0	19	–	–	–	–	–
Strontium-90	pCi/L	0	5	19	0.066	0.154	0.07	0.252	0.215
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	12	70	93.6	14.7	104	110
Uranium-234	pCi/L	0	12	18	0.05	0.099	0.022	0.191	0.111
Uranium-235, Uranium-236	pCi/L	0	2	18	0.017	0.029	–	0.041	–
Uranium-238	pCi/L	0	9	18	0.032	0.076	0.011	0.141	0.083
Uranium (calculated)	µg/L	0	18	18	0.028	0.14	0.059	0.428	0.168
Uranium (measured)	µg/L	0	7	7	0.058	0.368	0.478	1.4	0.722
Gross Alpha	pCi/L	0	10	19	0.595	0.907	0.023	1.25	0.922
Gross Beta	pCi/L	0	18	19	0.796	3.31	0.341	5.1	3.47

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Gamma	pCi/L	0	6	18	64.3	136	90	293	208
Water Canyon [b]									
Americium-241	pCi/L	0	1	3	–	0.02	–	–	–
Cesium-137	pCi/L	0	1	3	–	4.25	–	–	–
Cobalt-60	pCi/L	0	0	0	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	3	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	0	0	–	–	–	–	–
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	0	–	–	–	–	–
Strontium-90	pCi/L	1	2	4	0.166	0.279	–	0.392	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.031	0.056	0.028	0.087	0.088
Uranium-235, Uranium-236	pCi/L	0	2	3	0.011	0.018	–	0.026	–
Uranium-238	pCi/L	0	2	3	0.022	0.025	–	0.028	–
Uranium (calculated)	µg/L	0	43	43	0.023	0.192	0.186	0.65	0.248
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	3	–	–	–	–	–
Gross Beta	pCi/L	0	2	3	1.99	2.24	–	2.49	–
Gross Gamma	pCi/L	0	1	3	–	101	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Intermediate Perched Wells (Table F–17) and Intermediate Perched Springs (Table F–18).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–19 Radiochemical Statistical Analysis of Groundwater – San Ildefonso Pueblo Water Supply Wells [a]

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	1	11	46	0.005	0.022	0.009	0.034	0.027
Cesium-137	pCi/L	1	6	46	0.575	2.22	2.11	6.4	3.91
Cobalt-60	pCi/L	0	3	17	1.62	2.11	0.427	2.42	2.59
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	17	9.11	11.2	–	13.3	–
Plutonium-238	pCi/L	0	17	62	0.0	0.023	0.029	0.044	0.037

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-239, Plutonium-240	pCi/L	0	14	62	0.0	0.01	0.009	0.017	0.015
Potassium-40	pCi/L	2	14	17	0.971	29.1	3.11	63.3	30.7
Radium-226	pCi/L	4	10	16	0.14	0.737	0.567	2.18	1.09
Sodium-22	pCi/L	0	3	17	2.7	3.26	0.788	4.86	4.15
Strontium-90	pCi/L	6	20	59	0.051	0.247	0.121	1.69	0.3
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	4	44	52.8	88.9	24.3	116	113
Uranium-234	pCi/L	18	38	43	0.022	5.342	0.815	13	5.6
Uranium-235, Uranium-236	pCi/L	0	33	44	0.021	0.297	0.110	0.909	0.335
Uranium-238	pCi/L	6	36	44	0.087	3.11	0.557	8.23	3.29
Uranium (calculated)	µg/L	0	33	35	0.017	8.67	1.66	24.8	9.23
Uranium (measured)	µg/L	0	12	12	0.02	8.35	0.526	24.3	8.65
Gross Alpha	pCi/L	20	33	44	0.324	7.47	3.23	19.7	8.58
Gross Beta	pCi/L	0	34	44	1.47	5.34	2	18.4	6.01
Gross Gamma	pCi/L	0	8	37	50.2	97.9	45.9	184	130

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–20 Radiochemical Statistical Analysis of Groundwater – Santa Fe Water Supply Wells [a]

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	0	1	18	–	0.011	–	–	–
Cesium-137	pCi/L	0	14	28	0.018	7.03	6.77	14.2	10.6
Cobalt-60	pCi/L	0	2	6	1.41	1.64	–	1.87	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	6	9.84	10.4	0.057	10.8	10.4
Plutonium-238	pCi/L	0	1	18	–	0.004	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	2	18	0.0	0.005	–	0.009	–
Potassium-40	pCi/L	2	5	6	12	30.6	7.05	61.1	36.8
Radium-226	pCi/L	5	6	8	0.557	2.3	0.842	3.96	2.97
Sodium-22	pCi/L	0	1	6	–	1.59	–	–	–
Strontium-90	pCi/L	0	10	35	0.081	0.147	0.047	0.226	0.176
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	5	17	0.125	71.5	51.5	123	117
Uranium-234	pCi/L	21	46	47	0.005	20.6	18.2	97.2	25.9

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	1	37	40	0.003	1.44	1.26	7.79	1.85
Uranium-238	pCi/L	12	24	26	2.03	21.3	18.7	84.8	28.8
Uranium (calculated)	µg/L	0	21	22	0.0	70.3	53	255	93
Uranium (measured)	µg/L	0	4	4	6.41	14.3	5.36	18.4	19.5
Gross Alpha	pCi/L	16	16	17	6.31	33.3	33.2	192	49.5
Gross Beta	pCi/L	3	16	17	0.167	11.3	4.94	51.5	13.7
Gross Gamma	pCi/L	0	0	16	–	–	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–21 Radiochemical Statistical Analysis of Sediment from 2001 through 2005

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Stations									
Americium-241	pCi/g	0	41	91	0.002	0.015	0.005	0.116	0.017
Cesium-137	pCi/g	7	86	88	0.015	0.196	0.084	1.09	0.213
Cobalt-60	pCi/g	0	6	25	0.018	0.054	0.033	0.087	0.08
Neptunium-237	pCi/g	0	24	25	0.096	0.703	0.186	1.21	0.777
Plutonium-238	pCi/g	1	25	92	0.0	0.021	0.023	0.118	0.03
Plutonium-239, Plutonium-240	pCi/g	3	43	92	0.0	0.045	0.032	0.450	0.055
Potassium-40	pCi/g	0	25	25	13.8	19.7	0.94	32.9	20
Sodium-22	pCi/g	0	0	25	–	–	–	–	–
Strontium-90	pCi/g	2	27	93	0.043	0.122	0.02	0.247	0.13
Tritium	pCi/L	1	4	15	80.6	160	113	465	271
Tritium	pCi/g	0	12	35	0.032	0.081	0.027	0.135	0.097
Uranium-234	pCi/g	0	91	91	0.282	0.863	0.106	1.74	0.885
Uranium-235, Uranium-236	pCi/g	0	79	91	0.022	0.075	0.01	0.174	0.077
Uranium-238	pCi/g	0	91	91	0.295	0.858	0.128	1.65	0.884
Uranium (calculated)	µg/g	0	51	51	0.1	1.48	1.15	4.48	1.79
Gross Alpha	pCi/g	13	90	90	2.85	13.5	1.3	30.9	13.8
Gross Beta	pCi/g	13	90	90	12.2	24.2	0.838	36.7	24.3
Gross Gamma	pCi/g	0	55	56	3.87	7.96	1.61	25.8	8.39
Perimeter Stations									
Americium-241	pCi/g	15	115	225	0.0	0.104	0.079	3.08	0.118
Cesium-137	pCi/g	8	211	228	0.0	0.237	0.172	3.16	0.26
Cobalt-60	pCi/g	0	5	86	0.02	0.036	0.002	0.056	0.038

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	86	86	0.091	0.606	0.008	2.04	0.608
Plutonium-238	pCi/g	4	80	224	0.0	0.016	0.007	0.325	0.018
Plutonium-239, Plutonium-240	pCi/g	34	120	224	0.0	0.774	0.377	12.5	0.841
Potassium-40	pCi/g	0	86	86	13.7	26.8	1.57	35	27.1
Sodium-22	pCi/g	0	11	85	0.013	0.035	0.008	0.106	0.039
Strontium-90	pCi/g	0	89	223	0.031	0.21	0.080	3.24	0.226
Tritium	pCi/L	4	27	52	0.0	804	189	2,300	875
Tritium	pCi/g	0	42	169	0.0	14.1	27.4	145	22.4
Uranium-234	pCi/g	2	227	227	0.05	0.903	0.068	2.71	0.912
Uranium-235, Uranium-236	pCi/g	0	185	227	0.0	0.078	0.02	0.414	0.08
Uranium-238	pCi/g	0	227	227	0.056	0.878	0.072	2.66	0.887
Uranium (calculated)	µg/g	0	148	148	0.09	1.95	1.46	7.51	2.19
Gross Alpha	pCi/g	13	230	230	2	13.1	1.44	38.2	13.2
Gross Beta	pCi/g	22	230	230	15.2	32.8	3.04	63.3	33.2
Gross Gamma	pCi/g	0	181	182	1.46	9.2	2.13	145	9.51
Onsite Stations									
Americium-241	pCi/g	117	197	288	0.004	1.07	0.231	13.7	1.1
Cesium-137	pCi/g	67	273	280	0.005	1.54	0.625	28.6	1.61
Cobalt-60	pCi/g	0	11	89	0.021	0.055	0.008	0.137	0.06
Neptunium-237	pCi/g	0	89	89	0.157	0.659	0.039	1.61	0.667
Plutonium-238	pCi/g	72	141	285	0.0	0.638	0.25	11.5	0.679
Plutonium-239, Plutonium-240	pCi/g	175	200	285	0.003	0.919	0.223	13.4	0.95
Potassium-40	pCi/g	0	89	89	18.1	28	0.448	33.8	28.1
Sodium-22	pCi/g	0	6	89	0.022	0.055	0.038	0.082	0.086
Strontium-90	pCi/g	31	115	286	0.024	0.414	0.056	2.64	0.425
Tritium	pCi/L	71	74	81	82.5	1,450	430	9,930	1,550
Tritium	pCi/g	11	74	194	0.0	0.719	0.472	5.1	0.826
Uranium-234	pCi/g	21	281	281	0.042	0.874	0.081	1.91	0.883
Uranium-235, Uranium-236	pCi/g	4	244	281	0.011	0.081	0.03	0.214	0.084
Uranium-238	pCi/g	1	281	281	0.037	0.901	0.083	2.16	0.911
Uranium (calculated)	µg/g	0	188	188	0.11	1.99	1.5	6.51	2.2
Gross Alpha	pCi/g	154	274	275	1.7	16.7	2.43	59.3	17
Gross Beta	pCi/g	268	276	276	6.64	37.6	2.91	74.3	37.9
Gross Gamma	pCi/g	0	199	202	1.48	10.5	1.5	36.6	10.7
Ancho Canyon [a]									
Americium-241	pCi/g	7	21	50	0.0	0.042	0.039	0.239	0.059
Cesium-137	pCi/g	6	47	47	0.013	0.175	0.086	0.724	0.2
Cobalt-60	pCi/g	0	1	21	–	0.021	–	–	–

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Neptunium-237	pCi/g	0	21	21	0.157	0.502	0.294	1.33	0.628
Plutonium-238	pCi/g	2	9	48	0.001	0.009	0.007	0.019	0.013
Plutonium-239, Plutonium-240	pCi/g	16	22	48	0.006	0.064	0.06	0.665	0.089
Potassium-40	pCi/g	0	21	21	18.1	26.7	1.88	31.4	27.5
Sodium-22	pCi/g	0	1	21	–	0.022	–	–	–
Strontium-90	pCi/g	5	20	50	0.054	0.149	0.022	0.375	0.158
Tritium	pCi/L	3	5	7	85.6	368	399	1,610	718
Tritium	pCi/g	1	17	41	0.0	12.4	22.7	134	23.2
Uranium-234	pCi/g	0	47	47	0.281	0.758	0.144	1.59	0.799
Uranium-235, Uranium-236	pCi/g	0	40	47	0.017	0.066	0.024	0.147	0.073
Uranium-238	pCi/g	0	47	47	0.225	0.845	0.204	2.01	0.903
Uranium (calculated)	µg/g	0	37	37	0.09	2.03	1.53	6.04	2.52
Gross Alpha	pCi/g	15	47	47	1.7	11	3.18	22.5	11.9
Gross Beta	pCi/g	37	47	47	12.4	29.3	6.3	42	31.1
Gross Gamma	pCi/g	0	42	43	4.88	7.84	1.2	16.7	8.2
Bayo Canyon [b]									
Americium-241	pCi/g	0	4	11	0.007	0.018	0.013	0.049	0.031
Cesium-137	pCi/g	0	9	11	0.012	0.038	0.011	0.09	0.046
Cobalt-60	pCi/g	0	0	4	–	–	–	–	–
Neptunium-237	pCi/g	0	4	4	0.383	0.525	0.083	0.583	0.606
Plutonium-238	pCi/g	0	2	11	0.0	0.01	-	0.02	-
Plutonium-239, Plutonium-240	pCi/g	0	0	11	–	–	–	–	–
Potassium-40	pCi/g	0	4	4	24.5	25.6	0.66	28.3	26.2
Sodium-22	pCi/g	0	2	4	0.013	0.019	–	0.024	–
Strontium-90	pCi/g	0	0	10	–	–	–	–	–
Tritium	pCi/L	1	2	2	139	325	–	510	–
Tritium	pCi/g	0	1	7	–	0.003	–	–	–
Uranium-234	pCi/g	0	11	11	0.625	0.959	0.24	1.3	1.1
Uranium-235, Uranium-236	pCi/g	0	11	11	0.031	0.084	0.043	0.144	0.11
Uranium-238	pCi/g	0	11	11	0.597	0.989	0.262	1.41	1.14
Uranium (calculated)	µg/g	0	8	8	0.22	2.27	1.81	4.23	3.52
Gross Alpha	pCi/g	2	10	10	5.78	10.7	3.03	16.8	12.6
Gross Beta	pCi/g	2	10	10	23	30.3	4.42	36.5	33.1
Gross Gamma	pCi/g	0	10	10	5.96	8.39	2.3	13.6	9.82
Cañada del Buey Canyon [c]									
Americium-241	pCi/g	2	6	11	0.018	0.035	0.013	0.083	0.045
Cesium-137	pCi/g	0	12	12	0.017	0.094	0.052	0.293	0.123
Cobalt-60	pCi/g	0	0	5	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	5	5	0.163	0.432	0.302	0.879	0.697
Plutonium-238	pCi/g	0	6	11	0.0	0.059	0.057	0.140	0.105
Plutonium-239, Plutonium-240	pCi/g	1	8	11	0.013	0.04	0.009	0.075	0.047
Potassium-40	pCi/g	0	5	5	26.5	28.6	0.271	31.5	28.9
Sodium-22	pCi/g	0	0	5	–	–	–	–	–
Strontium-90	pCi/g	0	2	12	0.057	0.077	–	0.096	–
Tritium	pCi/L	2	2	2	943	977	–	1,010	–
Tritium	pCi/g	0	7	9	0.0	0.025	0.02	0.053	0.04
Uranium-234	pCi/g	0	11	11	0.675	0.977	0.115	1.39	1.05
Uranium-235, Uranium-236	pCi/g	0	9	11	0.027	0.096	0.09	0.414	0.155
Uranium-238	pCi/g	0	11	11	0.59	0.928	0.096	1.44	0.984
Uranium (calculated)	µg/g	0	6	6	0.27	1.89	1.41	2.97	3.02
Gross Alpha	pCi/g	1	12	12	10	17.7	2.81	24.1	19.3
Gross Beta	pCi/g	2	12	12	15.8	39	10.8	63.3	45.1
Gross Gamma	pCi/g	0	9	9	6.2	8.25	1.39	10.7	9.16
Chaquehui Canyon [b]									
Americium-241	pCi/g	0	2	4	0.003	0.008	–	0.013	–
Cesium-137	pCi/g	1	4	4	0.128	0.312	0.291	0.746	0.597
Cobalt-60	pCi/g	0	0	2	–	–	–	–	–
Neptunium-237	pCi/g	0	2	2	0.635	0.796	–	0.956	–
Plutonium-238	pCi/g	0	1	4	–	0.009	–	–	–
Plutonium-239, Plutonium-240	pCi/g	1	3	4	0.008	0.015	0.006	0.02	0.021
Potassium-40	pCi/g	0	2	2	13.7	17.5	–	21.3	–
Sodium-22	pCi/g	0	0	2	–	–	–	–	–
Strontium-90	pCi/g	0	3	4	0.113	0.195	0.08	0.272	0.285
Tritium	pCi/L	1	1	1	–	2,300	–	–	–
Tritium	pCi/g	0	0	3	–	–	–	–	–
Uranium-234	pCi/g	1	4	4	1.03	1.55	0.761	2.67	2.29
Uranium-235, Uranium-236	pCi/g	0	4	4	0.058	0.086	0.035	0.135	0.12
Uranium-238	pCi/g	0	4	4	0.884	1.35	0.517	2.07	1.85
Uranium (calculated)	µg/g	0	3	3	0.34	3.27	2.94	6.211	6.6
Gross Alpha	pCi/g	2	4	4	7.19	17.8	8.87	26.1	26.5
Gross Beta	pCi/g	2	4	4	23.7	32	8.17	42.9	40
Gross Gamma	pCi/g	0	3	3	7.16	8.01	1	9.11	9.14
Fence Canyon [c]									
Americium-241	pCi/g	1	4	8	0.014	0.018	0.005	0.032	0.023
Cesium-137	pCi/g	1	8	8	0.044	0.208	0.209	0.574	0.353
Cobalt-60	pCi/g	0	1	4	–	0.026	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	4	4	0.6	0.928	0.229	1.09	1.15
Plutonium-238	pCi/g	0	1	8	–	0.003	–	–	–
Plutonium-239, Plutonium-240	pCi/g	1	2	8	0.016	0.023	–	0.03	–
Potassium-40	pCi/g	0	4	4	25.7	26.3	0.801	27.1	27.1
Sodium-22	pCi/g	0	0	4	–	–	–	–	–
Strontium-90	pCi/g	0	2	8	0.163	0.174	–	0.185	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	2	6	1.46	3.28	–	5.1	–
Uranium-234	pCi/g	0	8	8	0.683	0.98	0.062	1.12	1.02
Uranium-235, Uranium-236	pCi/g	0	8	8	0.055	0.09	0.04	0.199	0.118
Uranium-238	pCi/g	0	8	8	0.743	1.023	0.059	1.27	1.06
Uranium (calculated)	µg/g	0	6	6	0.32	2.14	1.57	3.8	3.4
Gross Alpha	pCi/g	0	8	8	4.86	18.6	8.71	28.1	24.6
Gross Beta	pCi/g	2	8	8	20.7	35.1	9.97	46.3	42
Gross Gamma	pCi/g	0	6	7	7.9	10.4	1.2	11.4	11.4
Frijoles Canyon [a]									
Americium-241	pCi/g	2	5	16	0.016	0.022	0.005	0.026	0.027
Cesium-137	pCi/g	1	16	16	0.057	0.224	0.147	0.685	0.296
Cobalt-60	pCi/g	0	0	3	–	–	–	–	–
Neptunium-237	pCi/g	0	3	3	0.266	0.433	0.237	0.889	0.701
Plutonium-238	pCi/g	0	3	15	0.0	0.008	0.01	0.019	0.02
Plutonium-239, Plutonium-240	pCi/g	5	7	15	0.009	0.024	0.004	0.053	0.026
Potassium-40	pCi/g	0	3	3	17.6	27.6	5.94	31.8	34.3
Sodium-22	pCi/g	0	1	3	–	0.024	–	–	–
Strontium-90	pCi/g	0	7	15	0.059	0.138	0.002	0.223	0.14
Tritium	pCi/L	0	1	5	–	92.3	–	–	–
Tritium	pCi/g	1	2	11	0.031	72.5	–	145	–
Uranium-234	pCi/g	0	16	16	0.376	1.11	0.297	2.1	1.25
Uranium-235, Uranium-236	pCi/g	0	15	16	0.02	0.072	0.018	0.13	0.081
Uranium-238	pCi/g	0	16	16	0.43	1.08	0.259	2.14	1.21
Uranium (calculated)	µg/g	0	10	10	0.18	2.24	2	6.42	3.48
Gross Alpha	pCi/g	9	17	17	9.44	14.3	2.27	21.7	15.4
Gross Beta	pCi/g	15	17	17	18.4	31.9	4.86	42.6	34.2
Gross Gamma	pCi/g	0	12	12	1.46	8.71	1.84	13.2	9.75
Guaje Canyon [b]									
Americium-241	pCi/g	0	9	17	0.006	0.018	0.009	0.039	0.023
Cesium-137	pCi/g	3	14	18	0.013	0.27	0.232	0.883	0.392
Cobalt-60	pCi/g	0	0	9	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	9	9	0.175	0.657	0.129	1.12	0.741
Plutonium-238	pCi/g	0	4	17	0.003	0.012	0.006	0.021	0.018
Plutonium-239, Plutonium-240	pCi/g	6	9	17	0.005	0.027	0.019	0.055	0.039
Potassium-40	pCi/g	0	9	9	24.3	28.2	1.39	33.1	29.2
Sodium-22	pCi/g	0	1	8	–	0.106	–	–	–
Strontium-90	pCi/g	0	6	18	0.13	0.207	0.07	0.396	0.263
Tritium	pCi/L	1	1	3	–	797	–	–	–
Tritium	pCi/g	0	2	9	0.014	0.019	–	0.024	–
Uranium-234	pCi/g	1	17	17	0.563	1.15	0.262	2.01	1.27
Uranium-235, Uranium-236	pCi/g	0	13	17	0.047	0.113	0.045	0.338	0.137
Uranium-238	pCi/g	0	17	17	0.623	1.14	0.207	1.75	1.24
Uranium (calculated)	µg/g	0	10	10	0.23	2.2	1.65	3.8	3.22
Gross Alpha	pCi/g	6	17	17	6.24	14	2.78	23	15.5
Gross Beta	pCi/g	9	17	17	24.1	33.2	5.03	53	35.6
Gross Gamma	pCi/g	0	15	15	6.29	9.85	1.63	15.7	10.7
Indio Canyon [c]									
Americium-241	pCi/g	0	2	5	0.011	0.019	–	0.027	–
Cesium-137	pCi/g	0	5	5	0.085	0.151	0.063	0.235	0.206
Cobalt-60	pCi/g	0	0	2	–	–	–	–	–
Neptunium-237	pCi/g	0	2	2	0.277	0.299	–	0.321	–
Plutonium-238	pCi/g	0	0	5	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/g	0	4	5	0.012	0.02	0.006	0.025	0.025
Potassium-40	pCi/g	0	2	2	25.2	28.1	–	31	–
Sodium-22	pCi/g	0	1	2	–	0.082	–	–	–
Strontium-90	pCi/g	0	1	6	–	0.18	–	–	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	0	4	–	–	–	–	–
Uranium-234	pCi/g	0	5	5	0.517	0.896	0.282	1.22	1.14
Uranium-235, Uranium-236	pCi/g	0	5	5	0.036	0.081	0.051	0.155	0.125
Uranium-238	pCi/g	0	5	5	0.501	0.925	0.303	1.27	1.19
Uranium (calculated)	µg/g	0	3	3	0.24	1.64	1.47	3.17	3.3
Gross Alpha	pCi/g	1	5	5	3.76	12.6	7.04	18.7	18.7
Gross Beta	pCi/g	2	5	5	18.5	33.3	9.31	43.2	41.5
Gross Gamma	pCi/g	0	4	4	5.7	7.44	1.77	9.9	9.17
Los Alamos Canyon [a]									
Americium-241	pCi/g	31	37	57	0.01	0.133	0.059	0.376	0.152
Cesium-137	pCi/g	14	55	55	0.023	0.484	0.165	1.96	0.528
Cobalt-60	pCi/g	0	1	18	–	0.02	–	–	–

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Neptunium-237	pCi/g	0	18	18	0.321	0.589	0.124	1.15	0.647
Plutonium-238	pCi/g	5	22	57	0.0	0.02	0.007	0.053	0.023
Plutonium-239, Plutonium-240	pCi/g	47	48	57	0.013	0.212	0.067	1.26	0.231
Potassium-40	pCi/g	0	18	18	22.7	27.3	0.636	31.3	27.6
Sodium-22	pCi/g	0	0	18	–	–	–	–	–
Strontium-90	pCi/g	3	23	58	0.066	0.622	0.237	3.24	0.719
Tritium	pCi/L	7	12	16	0.0	426	603	3,030	767
Tritium	pCi/g	4	19	41	0.002	1.94	3.04	6.46	3.3
Uranium-234	pCi/g	0	56	56	0.334	0.822	0.1	1.39	0.849
Uranium-235, Uranium-236	pCi/g	0	49	56	0.018	0.07	0.036	0.152	0.08
Uranium-238	pCi/g	0	56	56	0.338	0.785	0.092	1.48	0.809
Uranium (calculated)	µg/g	0	38	38	0.16	1.56	1.12	4.29	1.92
Gross Alpha	pCi/g	24	57	57	4.05	12.1	2.15	29.9	12.7
Gross Beta	pCi/g	51	57	57	16.9	34.3	3.68	49.5	35.2
Gross Gamma	pCi/g	0	41	42	2.09	8.41	0.408	17	8.53
Mortandad Canyon [a]									
Americium-241	pCi/g	46	56	76	0.002	3.32	0.605	13.7	3.48
Cesium-137	pCi/g	28	65	73	0.005	5.22	2.57	28.6	5.84
Cobalt-60	pCi/g	0	7	24	0.023	0.07	0.006	0.137	0.074
Neptunium-237	pCi/g	0	24	24	0.162	0.71	0.12	1.57	0.758
Plutonium-238	pCi/g	47	53	74	0.002	1.61	0.597	11.5	1.77
Plutonium-239, Plutonium-240	pCi/g	42	53	74	0.003	2.85	0.694	13.4	3.03
Potassium-40	pCi/g	0	24	24	21.7	28.9	0.11	33.8	29
Sodium-22	pCi/g	0	5	24	0.02	0.027	0.005	0.032	0.031
Strontium-90	pCi/g	15	47	72	0.024	0.625	0.238	2.64	0.693
Tritium	pCi/L	14	18	21	226	1,860	317	5,940	2,000
Tritium	pCi/g	3	18	49	0.0	6.62	12.8	96.1	12.5
Uranium-234	pCi/g	16	75	75	0.042	0.857	0.233	1.91	0.91
Uranium-235, Uranium-236	pCi/g	2	61	75	0.019	0.081	0.033	0.214	0.09
Uranium-238	pCi/g	0	75	75	0.037	0.868	0.231	2.16	0.921
Uranium (calculated)	µg/g	0	48	48	0.11	1.98	1.55	6.51	2.42
Gross Alpha	pCi/g	44	71	71	2.18	21.5	4.49	59.3	22.5
Gross Beta	pCi/g	65	71	71	21.4	43.4	3.29	74.3	44.1
Gross Gamma	pCi/g	0	55	56	5.12	16.5	6.96	145	18.4
Pajarito Canyon [a]									
Americium-241	pCi/g	26	73	95	0.0	0.149	0.096	3.08	0.171
Cesium-137	pCi/g	7	94	96	0.005	0.521	0.29	5.87	0.579
Cobalt-60	pCi/g	0	2	33	0.049	0.052	–	0.054	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	33	33	0.252	0.803	0.151	1.61	0.855
Plutonium-238	pCi/g	15	57	96	0.0	0.12	0.047	1.31	0.132
Plutonium-239, Plutonium-240	pCi/g	50	74	96	0.002	0.299	0.147	3.81	0.333
Potassium-40	pCi/g	0	33	33	20.5	27.7	0.742	35	28
Sodium-22	pCi/g	0	1	33	–	0.043	–	–	–
Strontium-90	pCi/g	6	28	97	0.031	0.299	0.148	1.14	0.354
Tritium	pCi/L	27	27	32	197	2,070	530	9,930	2,270
Tritium	pCi/g	1	32	61	0.003	7.0	11.8	103	11.1
Uranium-234	pCi/g	4	95	95	0.31	0.921	0.077	1.69	0.937
Uranium-235, Uranium-236	pCi/g	1	85	95	0.0	0.079	0.029	0.196	0.085
Uranium-238	pCi/g	0	95	95	0.221	0.915	0.087	1.86	0.933
Uranium (calculated)	µg/g	0	61	61	0.13	2.12	1.62	5.53	2.53
Gross Alpha	pCi/g	31	95	95	2.37	16.8	1.7	34.4	17.2
Gross Beta	pCi/g	46	95	95	17.9	38.5	2.69	62.3	39.1
Gross Gamma	pCi/g	0	62	62	4.73	9.99	0.778	19.1	10.2
Potrillo Canyon [c]									
Americium-241	pCi/g	0	2	7	0.012	0.013	–	0.014	–
Cesium-137	pCi/g	0	7	7	0.024	0.111	0.069	0.207	0.162
Cobalt-60	pCi/g	0	0	3	–	–	–	–	–
Neptunium-237	pCi/g	0	3	3	0.368	0.508	0.198	0.755	0.732
Plutonium-238	pCi/g	0	1	7	–	0.016	–	–	–
Plutonium-239, Plutonium-240	pCi/g	0	1	7	–	0.027	–	–	–
Potassium-40	pCi/g	0	3	3	25.3	27.3	2.76	30.1	30.4
Sodium-22	pCi/g	0	0	3	–	–	–	–	–
Strontium-90	pCi/g	0	2	6	0.107	0.112	–	0.116	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	1	6	–	2.18	–	–	–
Uranium-234	pCi/g	0	7	7	0.364	0.766	0.256	1.09	0.956
Uranium-235, Uranium-236	pCi/g	0	7	7	0.033	0.084	0.05	0.153	0.121
Uranium-238	pCi/g	0	7	7	0.419	0.833	0.257	1.1	1.02
Uranium (calculated)	µg/g	0	5	5	0.33	1.41	1.12	2.61	2.39
Gross Alpha	pCi/g	1	6	6	3.59	12.1	5	16.3	16.1
Gross Beta	pCi/g	1	7	7	18.2	33.1	10.7	45.2	41
Gross Gamma	pCi/g	0	6	6	1.48	6.46	1.57	8.43	7.71
Pueblo Canyon [a]									
Americium-241	pCi/g	15	29	35	0.011	0.184	0.18	1.32	0.25
Cesium-137	pCi/g	4	36	37	0.0	0.378	0.348	2.11	0.491
Cobalt-60	pCi/g	0	0	13	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	13	13	0.261	0.709	0.032	1.51	0.726
Plutonium-238	pCi/g	4	18	35	0.005	0.018	0.01	0.046	0.022
Plutonium-239, Plutonium-240	pCi/g	27	30	35	0.015	2.7	1.37	12.5	3.19
Potassium-40	pCi/g	0	13	13	26	29.1	0.493	33.1	29.4
Sodium-22	pCi/g	0	1	13	–	0.021	–	–	–
Strontium-90	pCi/g	0	23	34	0.051	0.175	0.056	0.386	0.199
Tritium	pCi/L	1	6	7	160	325	–	544	–
Tritium	pCi/g	0	3	27	0.006	0.254	0.351	0.818	0.65
Uranium-234	pCi/g	0	35	35	0.343	1.08	0.245	2.32	1.16
Uranium-235, Uranium-236	pCi/g	0	29	35	0.012	0.086	0.021	0.149	0.093
Uranium-238	pCi/g	0	35	35	0.391	0.993	0.126	2.03	1.04
Uranium (calculated)	µg/g	0	23	23	0.13	1.93	1.39	4.47	2.5
Gross Alpha	pCi/g	3	36	36	3.13	15.4	3.54	28.3	16.6
Gross Beta	pCi/g	9	36	36	23.5	33.7	4.41	46	35.1
Gross Gamma	pCi/g	0	29	29	5.17	9.35	1.01	12.9	9.72
Sandia Canyon [a]									
Americium-241	pCi/g	0	11	30	0.002	0.015	0.005	0.022	0.018
Cesium-137	pCi/g	0	22	29	0.004	0.056	0.004	0.139	0.057
Cobalt-60	pCi/g	0	3	10	0.024	0.028	0.001	0.031	0.029
Neptunium-237	pCi/g	0	10	10	0.223	0.826	0.178	2.04	0.937
Plutonium-238	pCi/g	3	10	30	0.0	0.015	0.006	0.044	0.019
Plutonium-239, Plutonium-240	pCi/g	2	11	30	0.0	0.025	0.012	0.043	0.032
Potassium-40	pCi/g	0	10	10	21.4	27.6	0.707	34.8	28
Sodium-22	pCi/g	0	1	10	–	0.023	–	–	–
Strontium-90	pCi/g	0	6	27	0.042	0.074	0.027	0.111	0.096
Tritium	pCi/L	2	4	6	108	543	596	1,270	1,130
Tritium	pCi/g	0	2	24	0.053	0.374	–	0.696	–
Uranium-234	pCi/g	1	30	30	0.05	0.952	0.46	2.71	1.12
Uranium-235, Uranium-236	pCi/g	1	23	30	0.012	0.084	0.045	0.246	0.103
Uranium-238	pCi/g	1	30	30	0.056	0.933	0.479	2.66	1.11
Uranium (calculated)	µg/g	0	19	19	0.14	2.16	1.7	7.51	2.92
Gross Alpha	pCi/g	7	26	27	4.26	12.9	4.11	25.9	14.5
Gross Beta	pCi/g	15	27	27	6.64	33.4	4.56	52.9	35.1
Gross Gamma	pCi/g	0	26	26	5.08	9	0.758	17.3	9.3
Water Canyon [a]									
Americium-241	pCi/g	2	42	68	0.004	0.033	0.016	0.155	0.038
Cesium-137	pCi/g	10	66	66	0.007	0.22	0.102	1.14	0.245
Cobalt-60	pCi/g	0	1	16	–	0.056	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	16	16	0.091	0.455	0.159	0.955	0.533
Plutonium-238	pCi/g	0	23	68	0.0	0.018	0.023	0.166	0.027
Plutonium-239, Plutonium-240	pCi/g	11	39	68	0.003	0.057	0.041	0.721	0.07
Potassium-40	pCi/g	0	16	16	24.5	28.3	0.725	32.9	28.7
Sodium-22	pCi/g	0	3	16	0.022	0.03	0.011	0.04	0.042
Strontium-90	pCi/g	2	30	68	0.044	0.12	0.034	0.285	0.133
Tritium	pCi/L	17	22	24	82.5	217	172	541	289
Tritium	pCi/g	1	8	68	0.0	2.13	2.20	6.59	3.66
Uranium-234	pCi/g	0	68	48	0.314	0.742	0.045	1.31	0.752
Uranium-235, Uranium-236	pCi/g	0	53	68	0.016	0.071	0.016	0.17	0.075
Uranium-238	pCi/g	0	68	68	0.273	0.786	0.09	1.74	0.808
Uranium (calculated)	µg/g	0	39	39	0.11	1.77	1.29	4.58	2.18
Gross Alpha	pCi/g	21	69	69	2.53	12.2	2.72	26.9	12.9
Gross Beta	pCi/g	32	69	69	8.22	33.1	2.62	50.5	33.7
Gross Gamma	pCi/g	0	42	42	5.45	7.98	0.94	12	8.27

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, pCi/g = picocuries per gram, µg/L = micrograms per liter.

[a] Canyon sampling stations are at both onsite and perimeter locations.

[b] Perimeter Stations. Canyon sampling stations are at perimeter locations.

[c] Canyon sampling stations are at onsite locations.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–22 Radiochemical Statistical Analysis of Runoff from 2001 through 2005

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Stations									
Americium-241	pCi/L	0	6	34	0.003	0.043	0.045	0.116	0.08
Cesium-137	pCi/L	0	5	31	0.54	2.44	1.28	3.75	3.56
Cobalt-60	pCi/L	0	2	19	1.25	1.28	–	1.3	–
Neptunium-237	pCi/L	0	0	19	–	–	–	–	–
Plutonium-238	pCi/L	0	3	35	0.018	0.029	0.017	0.049	0.049
Plutonium-239, Plutonium-240	pCi/L	0	12	35	0.0	0.267	0.368	1.0	0.475
Potassium-40	pCi/L	0	16	19	7.19	42.5	27.5	90.2	56
Radium-226	pCi/L	0	3	5	0.245	1.77	2.56	4.72	4.66
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	1	19	–	2.51	–	–	–
Strontium-90	pCi/L	0	14	34	0.093	0.227	0.171	0.694	0.316
Tritium	pCi/L	0	5	24	74.8	118	21.5	199	137
Uranium-234	pCi/L	0	36	36	0.271	7.97	13.9	108	12.5

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium-235, Uranium-236	pCi/L	0	33	36	0.025	0.689	1.26	9.55	1.12
Uranium-238	pCi/L	0	36	36	0.173	7.85	14.5	111	12.6
Uranium (calculated)	µg/L	0	26	26	0.0	2.43	2.24	12.5	3.29
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	4	31	34	0.736	17.6	26.9	235	27.1
Gross Beta	pCi/L	0	34	34	1.34	32.3	51.9	298	49.7
Gross Gamma	pCi/L	0	10	29	59.3	201	202	499	326
Perimeter Stations									
Americium-241	pCi/L	25	139	215	0.005	1.05	0.378	11.6	1.11
Cesium-137	pCi/L	3	81	207	0.0	7.95	1.9	68.1	8.36
Cobalt-60	pCi/L	0	36	149	0.517	3.6	3.09	13.5	4.61
Neptunium-237	pCi/L	0	44	149	0.141	11.2	6	28.8	13
Plutonium-238	pCi/L	3	84	214	0.0	0.231	0.098	2.84	0.252
Plutonium-239, Plutonium-240	pCi/L	23	144	214	0.0	5.65	3.81	106	6.27
Potassium-40	pCi/L	0	137	148	1	69.4	67.3	327	80.7
Radium-226	pCi/L	0	10	15	0.161	0.365	0.069	0.6	0.407
Radium-228	pCi/L	0	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	0	8	149	0.216	2.37	0.347	3.56	2.61
Strontium-90	pCi/L	14	151	208	0.062	4.32	1.66	35.1	4.59
Tritium	pCi/L	2	90	182	50.9	179	58.1	1,410	191
Uranium-234	pCi/L	10	188	211	0.038	8.14	5.45	88.9	8.92
Uranium-235, Uranium-236	pCi/L	1	155	211	0.008	0.732	0.337	7.28	0.785
Uranium-238	pCi/L	8	188	211	0.022	8.37	5.46	91.9	9.15
Uranium (calculated)	µg/L	0	171	172	0.0	5.9	4.79	135	6.62
Uranium (measured)	µg/L	0	89	89	0.03	2.05	3.5	13.5	2.78
Gross Alpha	pCi/L	9	167	212	0.548	189	124	3,070	208
Gross Beta	pCi/L	8	201	212	0.636	251	189	4,630	278
Gross Gamma	pCi/L	0	16	61	57.6	186	148	1,110	259
Onsite Stations									
Americium-241	pCi/L	38	356	542	0.0	13.1	24.8	583	15.7
Cesium-137	pCi/L	3	188	498	0.0	12	5.81	104	12.9
Cobalt-60	pCi/L	0	66	289	0.033	4	3.54	10.7	4.84
Neptunium-237	pCi/L	0	75	287	1.96	12.1	7.75	40.3	13.9
Plutonium-238	pCi/L	20	240	531	0.0	13.7	28.5	685	17.3
Plutonium-239, Plutonium-240	pCi/L	55	330	531	0.0	11.1	17	775	13
Potassium-40	pCi/L	0	266	288	0.0	78.4	112	709	91.8
Radium-226	pCi/L	0	28	36	0.123	0.349	0.302	1.45	0.461

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Radium-228	pCi/L	0	5	6	0.537	1.55	0.994	2.83	2.42
Sodium-22	pCi/L	0	13	289	0.814	2.84	1.11	4.32	3.44
Strontium-90	pCi/L	31	355	502	0.052	3.95	1.28	78.8	4.08
Tritium	pCi/L	13	209	370	54.4	326	139	12,900	345
Uranium-234	pCi/L	27	472	506	0.013	10.6	3.67	354	10.9
Uranium-235, Uranium-236	pCi/L	2	360	513	0.0	0.947	0.218	65.5	0.97
Uranium-238	pCi/L	26	485	515	0.015	13.8	6.85	2,220	14.4
Uranium (calculated)	µg/L	0	465	465	0.0	7.62	8.54	249	8.4
Uranium (measured)	µg/L	0	212	212	0.025	7.05	22.8	238	10.1
Gross Alpha	pCi/L	26	411	495	0.193	162	91.4	2,600	171
Gross Beta	pCi/L	20	469	488	0.809	199	129	5,370	211
Gross Gamma	pCi/L	0	74	175	55	180	74.8	1,990	197
Ancho Canyon [b]									
Americium-241	pCi/L	0	2	7	0.017	0.019	–	0.021	–
Cesium-137	pCi/L	0	2	6	2.47	2.7	–	2.93	–
Cobalt-60	pCi/L	0	1	5	–	2.42	–	–	–
Neptunium-237	pCi/L	0	1	5	–	13.9	–	–	–
Plutonium-238	pCi/L	0	1	7	–	0.01	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	7	–	–	–	–	–
Potassium-40	pCi/L	0	2	5	15.8	29.5	–	43.2	–
Radium-226	pCi/L	0	0	1	–	–	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	0	0	6	–	–	–	–	–
Tritium	pCi/L	0	1	5	–	112	–	–	–
Uranium-234	pCi/L	0	7	7	0.061	0.117	0.034	0.171	0.142
Uranium-235, Uranium-236	pCi/L	0	0	7	–	–	–	–	–
Uranium-238	pCi/L	0	6	7	0.037	0.054	0.008	0.103	0.06
Uranium (calculated)	µg/L	0	8	8	0.09	9.48	16.1	33.5	20.7
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	1	7	–	1.19	–	–	–
Gross Beta	pCi/L	0	3	7	1.11	1.89	0.392	2.12	2.34
Gross Gamma	pCi/L	0	1	6	–	78.3	–	–	–
Frijoles Canyon [b]									
Americium-241	pCi/L	0	5	16	0.018	0.095	0.098	0.542	0.181
Cesium-137	pCi/L	0	2	15	1.5	2.45	–	3.39	–
Cobalt-60	pCi/L	0	3	11	1.46	1.83	0.53	2.44	2.43
Neptunium-237	pCi/L	0	4	11	12.1	12.6	5.33	22.2	17.82
Plutonium-238	pCi/L	0	2	16	0.046	0.052	–	0.057	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-239, Plutonium-240	pCi/L	0	4	16	0.0	0.467	0.87	1.77	1.32
Potassium-40	pCi/L	0	8	11	2.49	22.3	15.3	43.2	32.8
Radium-226	pCi/L	0	1	3	–	0.161	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	11	–	–	–	–	–
Strontium-90	pCi/L	1	4	16	0.062	0.726	0.939	3.63	1.65
Tritium	pCi/L	0	7	16	58.3	118	47.3	219	153
Uranium-234	pCi/L	0	12	15	0.038	0.207	0.187	1.37	0.313
Uranium-235, Uranium-236	pCi/L	0	4	15	0.046	0.07	0.027	0.098	0.096
Uranium-238	pCi/L	0	12	15	0.027	0.166	0.219	1.39	0.29
Uranium (calculated)	µg/L	0	10	10	0.057	0.119	0.048	0.19	0.149
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	7	16	0.548	10	14.6	47.3	20.8
Gross Beta	pCi/L	0	15	16	0.636	9.91	13.1	128	16.6
Gross Gamma	pCi/L	0	3	13	57.6	68.5	15.3	92.6	85.8
Guaje Canyon [a]									
Americium-241	pCi/L	6	20	32	0.018	0.361	0.239	1.52	0.466
Cesium-137	pCi/L	3	20	30	0.0	6.98	3.2	15.8	8.39
Cobalt-60	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	4	–	–	–	–	–
Plutonium-238	pCi/L	0	8	32	0.065	0.361	0.011	0.699	0.369
Plutonium-239, Plutonium-240	pCi/L	7	18	32	0.012	1.2	1.32	3.93	1.81
Potassium-40	pCi/L	0	3	4	30.6	65.1	55.4	178	128
Radium-226	pCi/L	0	2	2	0.486	0.543	–	0.6	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	12	28	31	0.212	7.84	5.14	26.8	9.74
Tritium	pCi/L	2	6	16	84.3	151	24.2	268	171
Uranium-234	pCi/L	8	31	34	0.039	30.9	26.4	354	40.2
Uranium-235, Uranium-236	pCi/L	1	27	33	0.0	1.82	1.28	15.2	2.3
Uranium-238	pCi/L	7	30	33	0.033	27.2	25.1	334	36.2
Uranium (calculated)	µg/L	0	28	28	0.059	13.3	17.4	137	19.7
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	7	25	31	0.9	343	385	3,070	494
Gross Beta	pCi/L	6	30	30	2.29	446	576	5,370	652
Gross Gamma	pCi/L	0	7	19	85.2	334	546	1,110	739

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Los Alamos Canyon [b]									
Americium-241	pCi/L	9	92	121	0.0	1.26	1.1	16.1	1.48
Cesium-137	pCi/L	0	51	115	0.685	9.43	2.86	68.1	10.2
Cobalt-60	pCi/L	0	22	80	0.033	2.97	1.46	5.87	3.58
Neptunium-237	pCi/L	0	27	80	3.41	11.6	5.79	26.7	13.8
Plutonium-238	pCi/L	2	62	117	0.0	0.212	0.09	1.4	0.235
Plutonium-239, Plutonium-240	pCi/L	23	90	117	0.002	2.87	0.592	19.6	2.99
Potassium-40	pCi/L	0	77	80	0.0	69.8	67.5	277	84.9
Radium-226	pCi/L	0	7	8	0.205	0.35	0.084	0.542	0.412
Radium-228	pCi/L	0	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	0	4	80	2.45	3.09	0.363	3.56	3.45
Strontium-90	pCi/L	0	92	113	0.115	6.55	4.37	78.8	7.44
Tritium	pCi/L	0	60	102	50.9	144	49.4	400	156
Uranium-234	pCi/L	2	104	115	0.048	6.09	4.87	149	7.03
Uranium-235, Uranium-236	pCi/L	0	92	115	0.017	0.567	0.216	6.04	0.611
Uranium-238	pCi/L	0	104	115	0.022	6.09	4.89	147	7.03
Uranium (calculated)	µg/L	0	122	122	0.02	8.23	5.63	102	9.23
Uranium (measured)	µg/L	0	66	66	0.03	2.71	4.43	21.6	3.78
Gross Alpha	pCi/L	2	94	114	0.575	120	107	848	142
Gross Beta	pCi/L	0	108	114	1.58	130	132	1,140	155
Gross Gamma	pCi/L	0	6	13	70.8	226	428	814	568
Mortandad Canyon [b]									
Americium-241	pCi/L	17	94	137	0.009	28.9	48.3	583	38.7
Cesium-137	pCi/L	3	53	125	0.22	27.5	24.2	104	34
Cobalt-60	pCi/L	0	22	98	1.13	1.88	1.92	7.99	2.68
Neptunium-237	pCi/L	0	32	98	1.98	12.1	8.2	40.3	14.9
Plutonium-238	pCi/L	11	84	132	0.0	32.4	64.5	685	46.2
Plutonium-239, Plutonium-240	pCi/L	19	89	133	0.0	22.5	44.3	608	31.7
Potassium-40	pCi/L	0	86	98	0.055	72.9	88.5	630	91.6
Radium-226	pCi/L	0	17	20	0.167	0.285	0.229	1.45	0.394
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	6	98	0.814	2.35	0.913	4.13	3.09
Strontium-90	pCi/L	9	87	128	0.1	2.5	2.42	43.9	3
Tritium	pCi/L	3	52	80	78	1,090	1,042	12,900	1,370
Uranium-234	pCi/L	4	118	124	0.03	3.76	4.74	55	4.62
Uranium-235, Uranium-236	pCi/L	0	95	124	0.0	0.354	0.484	4.6	0.451
Uranium-238	pCi/L	2	119	125	0.015	4	5.18	67.2	4.93
Uranium (calculated)	µg/L	0	64	64	0.018	3.93	4.32	45.8	4.99

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Uranium (measured)	µg/L	0	35	35	0.079	3.46	8.45	48.3	6.25
Gross Alpha	pCi/L	4	107	125	0.605	148	150	2,290	176
Gross Beta	pCi/L	2	119	123	1.6	120	109	2,210	139
Gross Gamma	pCi/L	0	20	54	58.4	335	266	1,990	451
Pajarito Canyon [b]									
Americium-241	pCi/L	9	134	214	0.004	0.479	0.425	10.1	0.551
Cesium-137	pCi/L	0	61	192	1.21	6.62	3.1	46.8	7.4
Cobalt-60	pCi/L	0	24	104	0.495	4.34	3.9	10.7	5.9
Neptunium-237	pCi/L	0	26	102	2.42	11.3	8.83	28	14.6
Plutonium-238	pCi/L	5	85	212	0.0	0.167	0.116	0.985	0.192
Plutonium-239, Plutonium-240	pCi/L	11	123	212	0.002	0.931	0.931	7.65	1.1
Potassium-40	pCi/L	0	97	103	4.31	79.2	117	709	102
Radium-226	pCi/L	0	5	8	0.14	0.312	0.16	0.566	0.453
Radium-228	pCi/L	0	4	4	0.537	1.68	1.1	2.83	2.76
Sodium-22	pCi/L	0	7	104	1.87	3	1.24	4.32	3.92
Strontium-90	pCi/L	11	133	197	0.052	2.37	1.71	71.9	2.66
Tritium	pCi/L	6	93	160	62.9	238	45.9	1,980	248
Uranium-234	pCi/L	14	181	198	0.013	9.5	5.05	331	10.2
Uranium-235, Uranium-236	pCi/L	2	129	206	0.0	1.16	0.878	65.5	1.31
Uranium-238	pCi/L	17	195	207	0.02	20.8	29	2,220	24.9
Uranium (calculated)	µg/L	0	170	170	0.0	6.24	9.65	249	7.69
Uranium (measured)	µg/L	0	88	88	0.03	7.75	29	238	13.8
Gross Alpha	pCi/L	10	158	194	0.193	121	73.5	1,630	132
Gross Beta	pCi/L	9	180	190	0.809	145	102	3,160	160
Gross Gamma	pCi/L	0	29	55	55	118	51.8	430	137
Pueblo Canyon [b]									
Americium-241	pCi/L	19	75	102	0.013	1.30	0.951	67.3	1.52
Cesium-137	pCi/L	0	42	97	0.0	5.1	3.17	28.3	6.06
Cobalt-60	pCi/L	0	13	66	2.21	5.44	5.08	13.5	8.2
Neptunium-237	pCi/L	0	15	66	0.141	10.5	4.01	24.5	12.6
Plutonium-238	pCi/L	3	43	99	0.0	0.282	0.31	5.55	0.375
Plutonium-239, Plutonium-240	pCi/L	16	84	99	0.009	12.5	11.55	775	15
Potassium-40	pCi/L	0	65	65	3.67	81	78	343	99.9
Radium-226	pCi/L	0	4	5	0.274	0.31	0.004	0.352	0.314
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	2	66	0.216	0.938	–	1.66	–
Strontium-90	pCi/L	2	82	96	0.086	2.88	3.12	21.3	3.56
Tritium	pCi/L	0	38	74	57.4	183	112	1,410	219
Uranium-234	pCi/L	2	93	97	0.038	8.86	9.64	88.9	10.8

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	85	97	0.008	0.621	0.623	7.28	0.754
Uranium-238	pCi/L	1	93	97	0.066	8.68	9.8	91.9	10.7
Uranium (calculated)	µg/L	0	46	47	0.004	12.6	10.5	81.8	15.7
Uranium (measured)	µg/L	0	27	27	0.03	2.24	3.66	11.5	3.62
Gross Alpha	pCi/L	2	88	97	0.61	163	180	1,800	201
Gross Beta	pCi/L	2	96	97	1.54	267	320	3,010	331
Gross Gamma	pCi/L	0	9	25	58.4	152	137	820	241
Sandia Canyon [b]									
Americium-241	pCi/L	0	20	56	0.01	0.041	0.014	0.111	0.047
Cesium-137	pCi/L	0	10	57	1.62	3.74	1.71	9.61	4.8
Cobalt-60	pCi/L	0	9	39	1.04	3.39	1.38	5.63	4.29
Neptunium-237	pCi/L	0	11	39	1.96	13.7	0.387	22.9	13.9
Plutonium-238	pCi/L	0	9	57	0.025	0.051	0.011	0.097	0.058
Plutonium-239, Plutonium-240	pCi/L	0	20	57	0.005	0.083	0.034	0.331	0.097
Potassium-40	pCi/L	0	37	39	1.32	58.6	88.5	420	87.1
Radium-226	pCi/L	0	1	2	–	0.176	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	2	39	2.1	2.22	–	2.33	–
Strontium-90	pCi/L	0	24	55	0.09	0.227	0.091	0.831	0.264
Tritium	pCi/L	2	26	49	54.4	132	49.4	533	151
Uranium-234	pCi/L	1	55	57	0.022	2.24	1.71	69.1	2.69
Uranium-235, Uranium-236	pCi/L	0	39	57	0.019	0.201	0.17	4.83	0.254
Uranium-238	pCi/L	1	51	57	0.045	2.36	1.79	70.9	2.85
Uranium (calculated)	µg/L	0	65	65	0.018	1.55	1.39	17.7	1.89
Uranium (measured)	µg/L	0	39	39	0.04	0.998	1.23	4	1.38
Gross Alpha	pCi/L	2	44	55	0.428	52.2	64.8	877	71.3
Gross Beta	pCi/L	1	54	55	3.41	43.3	27.9	524	50.8
Gross Gamma	pCi/L	0	7	27	82.8	139	65.7	343	188
Water Canyon [b]									
Americium-241	pCi/L	3	53	72	0.0	0.101	0.079	1.18	0.122
Cesium-137	pCi/L	0	27	65	0.0	4.92	2.57	15	5.89
Cobalt-60	pCi/L	0	8	28	0.857	3	1.52	8.3	4.05
Neptunium-237	pCi/L	0	3	28	7.05	12.1	4.54	15.9	17.2
Plutonium-238	pCi/L	2	28	69	0.0	0.111	0.038	0.549	0.125
Plutonium-239, Plutonium-240	pCi/L	2	43	69	0.0	0.323	0.281	3.15	0.407
Potassium-40	pCi/L	0	25	28	1.26	105	197	511	183
Radium-226	pCi/L	0	1	1	–	0.245	–	–	–
Radium-228	pCi/L	0	1	2	–	1.06	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Sodium-22	pCi/L	0	0	28	–	–	–	–	–
Strontium-90	pCi/L	10	54	65	0.14	2.32	1.99	16.9	2.85
Tritium	pCi/L	2	15	49	88.4	148	24.9	231	161
Uranium-234	pCi/L	6	56	67	0.049	13.6	9.4	79	16
Uranium-235, Uranium-236	pCi/L	0	42	67	0.009	0.934	0.583	4.86	1.11
Uranium-238	pCi/L	6	60	67	0.019	16.4	13.8	82.1	19.9
Uranium (calculated)	µg/L	0	123	123	0.0	14.5	20	190	18
Uranium (measured)	µg/L	0	46	46	0.025	13	25.9	93.4	20.5
Gross Alpha	pCi/L	8	51	65	0.463	150	105	1,660	179
Gross Beta	pCi/L	8	62	65	1.26	234	173	2,990	278
Gross Gamma	pCi/L	0	8	23	93.1	300	228	496	455

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Canyon sampling stations are at perimeter locations.

[b] Canyon sampling stations are at both onsite and perimeter locations.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–23 Radiochemical Statistical Analysis of Soils from 2001 through 2003

Measured Radiochemical		2001 through 2003						
		Detected per ESR	Used In This SWEIS	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Stations								
Americium-241	pCi/g	10	10	0.0	0.004	0.002	0.009	0.005
Cesium-137	pCi/g	10	10	0.06	0.257	0.105	0.65	0.322
Plutonium-238	pCi/g	5	5	0.0	0.002	0.002	0.004	0.004
Plutonium-239, Plutonium-240	pCi/g	10	10	0.001	0.01	0.005	0.029	0.013
Strontium-90	pCi/g	10	10	0.05	0.156	0.041	0.26	0.181
Tritium	pCi/mL	10	10	0.0	0.273	0.237	0.94	0.419
Uranium-234	pCi/g	7	7	0.55	0.729	0.246	1.2	0.911
Uranium-235	pCi/g	7	7	0.033	0.056	0.022	0.077	0.073
Uranium-238	pCi/g	7	7	0.59	0.74	0.263	1.2	0.935
Uranium (calculated)	pCi/g	6	6	1.7	2.2	0.240	2.7	2.39
Gross Alpha	pCi/g	6	6	3.7	4.48	1.1	6.1	5.37
Gross Beta	pCi/g	6	6	3.7	4.55	0.436	5.01	4.9
Gross Gamma	pCi/g	6	6	6	7.33	1	8	8.13
Perimeter Stations								
Americium-241	pCi/g	29	29	0.001	0.012	0.003	0.058	0.013
Cesium-137	pCi/g	30	30	0.09	0.337	0.023	0.84	0.346
Plutonium-238	pCi/g	24	24	0.0	0.003	0.001	0.011	0.004
Plutonium-239, Plutonium-240	pCi/g	30	30	0.008	0.059	0.023	0.53	0.067

Measured Radiochemical		2001 through 2003						
		Detected per ESR	Used In This SWEIS	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Strontium-90	pCi/g	29	29	0.01	0.174	0.008	0.45	0.177
Tritium	pCi/mL	25	25	0.01	0.822	0.551	3	1.04
Uranium-234	pCi/g	20	20	0.6	1.12	0.439	2.25	1.31
Uranium-235	pCi/g	20	20	0.033	0.081	0.041	0.188	0.099
Uranium-238	pCi/g	20	20	0.54	1.12	0.454	2.32	1.32
Uranium (calculated)	pCi/g	20	20	2.1	3.93	1.36	9.3	4.53
Gross Alpha	pCi/g	20	20	1.93	5.41	1.97	7.9	6.27
Gross Beta	pCi/g	20	20	2.38	4.91	1.83	7.7	5.71
Gross Gamma	pCi/g	20	20	9	11.3	3.17	20	12.7
Onsite Stations								
Americium-241	pCi/g	36	36	0.002	0.015	0.008	0.2	0.018
Cesium-137	pCi/g	36	36	0.03	0.345	0.061	0.9	0.365
Plutonium-238	pCi/g	32	32	0.0	0.002	0.0	0.006	0.002
Plutonium-239, Plutonium-240	pCi/g	36	36	0.002	0.056	0.032	0.8	0.067
Strontium-90	pCi/g	34	34	0.0	0.142	0.038	0.38	0.154
Tritium	pCi/mL	36	36	0.1	0.907	0.724	4	1.14
Uranium-234	pCi/g	24	24	0.75	1.08	0.345	1.8	1.22
Uranium-235	pCi/g	24	24	0.044	0.069	0.03	0.152	0.081
Uranium-238	pCi/g	24	24	0.77	1.15	0.364	1.87	1.3
Uranium (calculated)	pCi/g	24	24	2.41	3.51	0.997	6	3.91
Gross Alpha	pCi/g	24	24	3.59	5.54	1.32	8.1	6.07
Gross Beta	pCi/g	24	24	2.9	4.7	1.39	8.1	5.26
Gross Gamma	pCi/g	24	24	10	11.6	1.54	14	12.2

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/mL = picocuries per milliliter, pCi/g = picocuries per gram.
Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–24 presents EPA and EPA-equivalent maximum contaminant levels (MCLs) (Title 40 *Code of Federal Regulations* [CFR], Part 141) for comparison between the groundwater, surface water or stormwater runoff concentrations presented in the above tables. The regulations at 40 CFR Part 141 only apply to drinking water systems.

Table F–24 Benchmark Concentrations for Analyzed Radionuclides for Groundwater, Surface Water, or Stormwater Runoff [a]

Constituent	Benchmark Concentration	
Americium-241	picocuries per liter	15 [b]
Cesium-137	picocuries per liter	93 [c]
Cobalt-60	picocuries per liter	173 [c]
Neptunium-237	picocuries per liter	15 [b]
Plutonium-238	picocuries per liter	15 [b]
Plutonium-239	picocuries per liter	15 [b]
Plutonium-240	picocuries per liter	15 [b]

Constituent	*Benchmark Concentration*	
Potassium-40	picocuries per liter	251 [c]
Radium-226, Radium-228	picocuries per liter	5 [b]
Sodium-22	picocuries per liter	407 [c]
Strontium-90	picocuries per liter	8 [b]
Tritium	picocuries per liter	20000 [b]
Uranium-234	micrograms per liter	30 [b]
Uranium-235	micrograms per liter	30 [b]
Uranium-236	micrograms per liter	30 [b]
Uranium-238	micrograms per liter	30 [b]
Uranium Total	picocuries per liter	10 [d]
Gross Alpha	picocuries per liter	15 [b]
Gross Beta	millirem per year	4 [b]
Gross Gamma	millirem per year	4 [b]

[a] Similar values are available for soils and sediments, but this would require more detailed analysis of agricultural and recreational use at a particular location.
[b] EPA maximum contaminant levels (40 CFR Part 141).
[c] EPA-equivalent maximum contaminant levels. Published value calculated to yield an annual dose equivalent of 4 millirem per year to the total body using Federal Guidance Report 11 dose factors.
[d] Calculated using sum of fractions rule and isotopic distribution for naturally occurring uranium.

The LANL environmental surveillance program also includes chemicals and elements, that are periodically measured at Regional, Perimeter, and Onsite stations. Samples of soil, sediment, surface water and groundwater were all measured for these chemicals and elements which are listed in **Tables F–25 and F–26** (LANL 2002, 2004a, 2004b, 2005, 2006b).

Table F–25 Chemicals Measured in the Los Alamos National Laboratory Environmental Surveillance Program

Chemical	*Chemical*	*Chemical*
Acenaphthene	2-Chloronaphthalene	Isophorone
Acenaphthylene	2-Chlorophenol	Isopropylbenzene
Acetone	Chrysene	4-Isopropyltoluene
4-Amino-2,6-dinitrotoluene	2,4-D	Methylene Chloride
2-Amino-4,6-dinitrotoluene	2,4-DB	2-Methylnaphthalene
Aniline	4,4'-DDD	2-Methylphenol
Anthracene	4,4'-DDE	4-Methylphenol
Aroclor-1016 (PCB)	4,4'-DDT	Naphthalene
Aroclor-1242 (PCB)	Dibenzofuran	3-Nitroaniline
Aroclor-1254 (PCB)	1,2-Dichlorobenzene	4-Nitroaniline
Aroclor-1260 (PCB)	1,3-Dichlorobenzene	Nitrobenzene
Azobenzene	1,4-Dichlorobenzene	N-Nitrosodimethylamine
Benzo(a)anthracene	3,3'-Dichlorobenzidine	N-Nitroso-di-n-propylamine
Benzo(a)pyrene	Dieldrin	1,2,3,4,6,7,8,9-Octachlorodibenzodioxin
Benzo(b)fluoranthene	Diethylphthalate	Pentachlorophenol
Benzo(g,h,i)perylene	Dimethyl Phthalate	Perchlorate
Benzo(k)fluoranthene	Di-n-butylphthalate	Phenanthrene
Benzoic Acid	Di-n-octylphthalate	Phenol
Benzyl Alcohol	2,4-Dinitrotoluene	Pyrene

Chemical	*Chemical*	*Chemical*
delta-BHC	1,4-Dioxane	Pyridine
Bis(2-chloroethoxy)methane	Endrin	RDX
Bis(2-ethylhexyl)phthalate	Ethylbenzene	Styrene
Bromodichloromethane	Fluoranthene	2,3,7,8-Tetrachlorodibenzofuran
Bromoform	Fluorene	Tetrachloroethene
2-Butanone	Heptachlor	Toluene
Butylbenzylphthalate	Heptachlor Epoxide	Trichloroethene
Carbazole	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	1,1,1-Trichloroethane
4-Chloroaniline	Hexachlorobenzene	2,4,6-Trichlorophenol
Chlorodibromomethane	2-Hexanone	1,3,5-Trinitrobenzene
Chloroform	HMX	2,4,6-Trinitrotoluene
Chloromethane	Indeno(1,2,3-cd)pyrene	

PCB = polychlorinated biphenyls.

Table F–26 Elements Measured in the Los Alamos National Laboratory Environmental Surveillance Program

Element	*Element*	*Element*
Silver	Chromium	Antimony
Aluminum	Copper	Selenium
Arsenic	Iron	Tin
Boron	Mercury	Strontium
Barium	Manganese	Thallium
Beryllium	Molybdenum	Vanadium
Cadmium	Nickel	Zinc
Cobalt	Lead	

Measured environmental concentrations of the chemicals and elements listed in Tables F–25 and F–26 did not exceed EPA or New Mexico Environment Department standards with the following exceptions of perchlorate, hexavalent chromium, polychlorinated biphenyls (PCBs), and 1,4-dioxane. The number of "Detected per ESR" and "Used in This SWEIS" data points for these four chemicals are identical because the ESR source for these chemicals only reported data that were considered detected.

Perchlorate is a chemical of particular interest that has a high propensity to enter the groundwater. Perchlorate is used in rocket solid propellant, fireworks, lubricating oils, paint production, explosives, fabrics, and dye fixers. Perchlorate is formed naturally in the upper atmosphere and may also be created from fertilizers, mineral weathering, or electrochemical reactions. Perchlorate is soluble in water and has been shown to disrupt thyroid function and influence thyroid tumor formation if ingested in sufficient quantities. There is no Federal EPA MCL or MCL goal for perchlorate in drinking water. The EPA, however, has established a No Observed Effect Level (NOEL) of 23 parts per billion or 23 micrograms per liter for perchlorate, based on a daily oral exposure of 0.0007 milligram per kilogram per day for a 154-pound (70-kilogram) adult consuming 0.53 gallons (2 liters) of water per day. The EPA Drinking Water

Equivalent Level is 24.5 Micrograms per liter. The State of New Mexico has established an interim groundwater screening level of 1 part per billion or 1 microgram per liter. Between 2002 and 2005, 903 detectable sample measurements of perchlorate were made in groundwater samples at the environmental monitoring stations. A statistical analysis of these measurements is presented in **Table F–27**. Measured mean values of perchlorate at most LANL locations were below both the EPA NOEL and New Mexico screening limit. Only Mortandad and Pueblo Canyons exceeded the New Mexico limit, and only Mortandad Canyon exceeded the EPA NOEL (USACHPPM 2006, EPA 2006a, LANL 2006b, NAS 2005, NMAC 2006).

Hexavalent chromium, also known as chromium (VI), is one of three forms of the element chromium that occurs naturally, but can also be artificially produced. Hexavalent chromium is also a chemical of particular interest that is soluble in water and therefore has a high propensity to enter groundwater. Hexavalent chromium has been shown to damage or irritate the respiratory system and is identified by the EPA as a known carcinogen if inhaled in sufficient quantities. The EPA MCL for hexavalent chromium in drinking water is 100 micrograms per liter. The State of New Mexico has established a groundwater standard of 50 micrograms per liter for hexavalent chromium. Both the EPA and State of New Mexico hexavalent chromium water concentration limits are based on the measurement of filtered groundwater samples.

Table F–27 Statistical Analysis of Perchlorate in Groundwater (micrograms per liter)

Measured Radiochemical	*2002 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	16	16	0.05	0.431	0.457	0.958	0.654
Guaje Canyon	32	32	0.05	0.623	0.552	1.45	0.814
Los Alamos	92	92	0.05	0.953	0.693	13.8	1.1
Mortandad Canyon	273	273	0.05	32.8	5.74	256	33.4
Pajarito Canyon	81	81	0.05	0.561	0.594	1.45	0.691
Pueblo Canyon	76	76	0.05	1.95	0.571	5.02	2.07
Sandia Canyon	63	63	0.05	0.642	0.471	2.17	0.759
Water Canyon	106	106	0.05	0.724	0.633	1.45	0.845
White Rock Canyon	164	164	0.05	0.751	0.762	12	0.868

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

Measured hexavalent chromium concentrations in groundwater samples in and around LANL were significantly higher for unfiltered water than for filtered water. This has been attributed to drilling equipment and well-casing materials, which are composed of steel compounds that contain hexavalent chromium and to the presence of chromium-bearing minerals in aquifer materials. Between 2001 and 2005, 1,020 detectable sample measurements of hexavalent chromium were made in groundwater at the environmental monitoring stations. A statistical analysis of these filtered sample measurements is presented in **Table F–28**. Measured mean values for hexavalent chromium at all LANL locations from 2001 through 2005 were below both the EPA MCL and the New Mexico standard (EPA 2006b, LANL 2006b, NMAC 2006).

Table F–28 Statistical Analysis of Hexavalent Chromium in Filtered Groundwater Samples (micrograms per liter)

Measured Radiochemical	*2001 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	8	8	1	1.75	0.542	2.4	2.13
Guaje Canyon	0	0	–	–	–	–	–
Los Alamos	63	63	0.503	2.25	0.243	16.7	2.31
Mortandad Canyon	92	92	0.503	7.04	11.9	404	9.48
Pajarito Canyon	46	46	0.503	1.21	0.444	3.7	1.34
Pueblo Canyon	18	18	0.503	1.08	1.07	4.9	1.57
Sandia Canyon	8	8	1	13.1	9.18	21.2	19.4
Water Canyon	89	89	0.52	1.53	0.699	10.5	1.67
White Rock Canyon	82	82	0.503	2.86	0.338	5.01	2.93
San Ildefonso	0	0	–	–	–	–	–
Santa Fe	0	0	–	–	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

In 2005, chromium concentrations between 375 and 404 micrograms per liter were detected in Well R-28 in the regional aquifer below Mortandad Canyon. Additional sampling in 2006 indicated that chromium contamination was found in the regional aquifer in a limited area beneath Sandia and Mortandad Canyons and in perched groundwater beneath Mortandad Canyon. Chromium contamination was not detected in water supply wells. In recognition of these results, the LANL contractor has prepared an *Interim Measures Work Plan for Chromium Contamination in Groundwater* in 2006 (LANL 2006a). The goals of the Work Plan were to:

- Determine the primary sources of chromium contamination and the nature of operations associated with the releases;
- Characterize the present-day spatial distribution of chromium and related constituents;
- Collect data to evaluate the geochemical, physical, and hydrologic processes that govern chromium transport; and
- Collect and evaluate data to help guide subsequent investigations and remedy selection.

These activities were conducted and completed in the summer and fall of 2006 and the results were summarized in an interim measures investigation report to provide a basis for follow-on work (LANL 2006c). This report found that the main source of hexavalent chromium was chromium-treated cooling water from a TA-3 power plant at the head of Sandia Canyon during its operations between 1956 and 1972. Other sources of chromium were identified as past facility discharges into Mortandad Canyon and Los Alamos Canyon. Sampling data from one regional groundwater well in Sandia Canyon and one regional groundwater well in Mortandad Canyon contain clear evidence of LANL-derived chromium contamination. Additional data collection from other regional groundwater monitoring wells is needed to further assess the extent of LANL-derived chromium contamination. Recommendations included additional data collection on chromium and other chemicals for use in risk assessments and the selection of corrective action remedies.

PCBs are a family of 209 chlorinated hydrocarbon compounds that were produced in the U.S. until 1997. PCBs are chemicals of particular interest because they decompose slowly and can exist and cycle between air, water, and soil. PCBs were at one time used in flame retardants, inks, adhesives, dyes, paints, fluorescent lighting fixtures, electrical transformers, electrical capacitors, and other electrical equipment. PCBs have a strong affinity for airborne particles, sediments, and soil, but do not typically migrate to groundwater. PCBs also have the potential to accumulate in fish and animals. PCBs have been shown to cause skin conditions and damage the liver and have been identified by the EPA as a known carcinogen if inhaled or ingested in sufficient quantities. The EPA MCL for PCBs in drinking water is 0.5 micrograms per liter. The State of New Mexico has established a groundwater standard of 1 microgram per liter for PCBs.

Between 2004 and 2005, four detectable sample measurements of PCBs were made in groundwater at these stations. These measurements are presented in **Table F–29**. The PCB contamination was detected only once in each of four sampling stations; no PCBs were detected in any other groundwater samples collected from the four stations. These single occurrences may indicate that the samples in which PCBs were detected are not representative of the groundwater. Despite the detection of PCBs in stormwater runoff within the LANL site boundaries, available data show no discernible impacts on PCB concentrations in the Rio Grande. Three independent types of measures showed that PCB concentrations downstream of LANL to the Cochiti Reservoir were indistinguishable from concentrations upstream of LANL. Mean total PCB concentrations in fish from Abiquiu reservoir were statistically similar to mean total PCB concentrations in fish from the Cochiti Reservoir. The statistical similarity in PCBs upstream and downstream of LANL has also been shown for dissolved water concentrations. Additionally, sampling of Rio Grande surface water by the New Mexico Environment Department and LANL showed whole water concentrations of PCBs were similar upstream and downstream of LANL. These results indicated that there are other sources of PCBs in the Rio Grande. A preliminary analysis indicated that PCB concentrations greater than 0.1 nanogram per liter can be ascribed to background fallout levels of PCBs. This is within the magnitude of some values measured in the Rio Grande water column. Measured mean value of PCBs at LANL locations was below both the EPA MCL and the New Mexico standard (EPA 2006d, LANL 2006b, NMAC 2006).

Table F–29 Statistical Analysis of Polychlorinated Biphenyl in Groundwater (micrograms per liter)

Measured Radiochemical	***2004 to 2005***						
	Detected per ESR	***Used In This SWEIS***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Ancho Canyon	1	1	–	0.44	–	–	–
Los Alamos Canyon	2	2	0.059	0.061	–	0.063	–
White Rock Canyon	1	1	–	0.17	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

1,4-Dioxane, also known as diethylene oxide and glycol ethylene ether is the name of an industrial solvent used in paints, varnishes, lacquers, cleaning and detergent preparations. It is of particular interest because it mixes readily with water and migrates rapidly in soil. It does not degrade and can exist and cycle between air, water, and soil. 1,4-Dioxane has been shown to damage the liver and kidneys and has been identified by the EPA as a probable carcinogen if inhaled or ingested in sufficient quantities. There is no EPA MCL for 1,4-dioxane in drinking

water; however, the EPA Region 6 cancer risk level of 1 in 100,000 for 1,4-dioxane is 61 micrograms per liter and is applicable to LANL groundwater measurements in accordance with the Consent Order. In 2005, a total of seven detectable sample measurements of 1,4-dioxane were made in groundwater at Mortandad Canyon stations. A statistical analysis of these measurements was collated and is presented in **Table F–30**. Measured mean values of 1,4-dioxane at these LANL locations were above the EPA 1 in 100,000 cancer risk level (EPA 2006c, HHS 2006, LANL 2006b, NMAC 2006).

Table F–30 Statistical Analysis of 1,4-Dioxane in Groundwater (micrograms per liter)

Measured Radiochemical	*2004 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Mortandad Canyon	7	7	21.6	40.3	16.1	56.4	52.3

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

F.4 References

ANL (Argonne National Laboratory), 2005a, "Human Health Fact Sheet, Americium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005b, "Human Health Fact Sheet, Plutonium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005c, "Human Health Fact Sheet, Cesium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005d, "Human Health Fact Sheet, Strontium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005e, "Human Health Fact Sheet, Tritium (Hydrogen-3)," Environmental Science Division, Argonne, Illinois, August.

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

EPA (U.S. Environmental Protection Agency), 2006a, "Integrated Risk Information System" *Perchlorate and Perchlorate Salts*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/1007.htm), February 13.

EPA (U.S. Environmental Protection Agency), 2006b, "Integrated Risk Information System," *Chromium (VI) (CASRN 18540-29-9)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0144.htm), November 30.

EPA (U.S. Environmental Protection Agency), 2006c, "Integrated Risk Information System," *1,4-Dioxane (CASRN 123-91-1)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0326.htm), November 30.

EPA (U.S. Environmental Protection Agency), 2006d, "Integrated Risk Information System," *Polychlorinated biphenyls (PCBs) (CASRN 1336-36-3)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0294.htm), November 30.

HHS (U.S. Department of Health and Human Services), 2006, *Toxicological Profile for 1,4-Dioxane*, Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine/Toxicology Branch, Atlanta, Georgia, July.

LANL (Los Alamos National Laboratory), 2001, *Derivation and Use of Radionuclide Screening Action Levels*, LA-UR-01-990, Environmental Restoration Project, Los Alamos, New Mexico, March 29.

LANL (Los Alamos National Laboratory), 2002, *Environmental Surveillance at Los Alamos during 2001*, LA-13979-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2004b, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006a, *Interim Measures Work Plan for Chromium Contamination in Groundwater*, LA-UR-06-1961, Environmental Stewardship Division, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006b, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006c, *Interim Measures Investigation Report for Chromium Contamination in Groundwater*, LA-UR-06-8372, Los Alamos, New Mexico, November.

NAS (National Academy of Sciences), 2005, "Report Assesses Health Implications of Perchlorate Exposure," Available at http://www4.nationalacademies.org/news.nsf/isbn/0309095689?OpenDocument, January 10.

NMAC (New Mexico Administrative Code), 2006, "Title 20 Environmental Protection, Chapter 6 Water Quality, Part 2 Ground and Surface Water Protection," Water Quality Control Commission, November 8.

USACHPPM (U.S. Army Center for Health Promotion and Preventive Medicine), 2006, "Perchlorate in Drinking Water," Publication No. 31-003-0502, *Readiness thru Health*, Aberdeen Proving Ground, Maryland, Available at http://chppm-www.apgea.army.mil/dwater, February 13.