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Los Alamos National Laboratory Environmental Surveillance Program Sampling and Analysis Plan for Sediment, 2009

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Prepared by the Environmental Programs Directorate

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1.0 INTRODUCTION

Monitoring of contaminants in affected environmental media at Department of Energy (DOE) sites is required under DOE Order 450.1A, Environmental Protection Program (DOE 2008). Annual monitoring of contaminants in sediments at selected locations at and near the Los Alamos National Laboratory (LANL or the Laboratory) has occurred since 1969, and results are reported in the annual Environmental Surveillance Report (e.g., Reneau and Koch 2008). This annual monitoring has been focused on active stream channel sediments, supplemented by sampling of other geomorphic settings such as floodplains, river banks, and reservoirs, to evaluate potential LANL impacts and to monitor trends in contamination over time. This monitoring is complemented by sediment sampling that occurs under other programs, including more detailed watershed-scale investigations that provide data on the nature and extent of contaminants in sediment deposits and that are used to evaluate potential human health and ecological risk (e.g., LANL 2004; LANL 2006; LANL 2008). These latter investigations are currently conducted under the March 1, 2005, Compliance Order on Consent (Consent Order) with the New Mexico Environment Department (NMED). Additional monitoring of contaminants associated with sediment is provided through sampling of storm water, which was performed under the Federal Facilities Compliance Agreement (FFCA) and Administrative Order with the U.S. Environmental Protection Agency (EPA) (EPA 2005a, 2005b) from 2005 through 2008. Beginning in 2009, storm water sampling is anticipated to be conducted under an Individual Permit (IP) with EPA (EPA 2009). These storm water analyses are also discussed in the annual Environmental Surveillance Reports. In combination, the detailed watershed-scale sediment investigations and the storm water sampling help to guide the annual surveillance sediment sampling by identifying key locations and analytical suites.

This sampling and analysis plan (SAP) presents the planned locations and analytical suites for Environmental Surveillance Program sediment samples in calendar year 2009. This SAP is based on results from surveillance sediment sampling in previous years, combined with results from other sediment investigations and storm water sampling. In addition to repeat samples from active stream channel locations, this SAP includes other samples intended to address specific questions concerning the potential environmental impacts from LANL activities. A primary focus of the sampling is to evaluate contaminants that cross or may cross the eastern, downstream, LANL boundary and potentially reach the Rio Grande, including any impacts on the Rio Grande. A secondary focus is to evaluate temporal trends in contaminant concentrations closer to sources in watersheds that have been most impacted by LANL activities.

Work presented in this SAP follows the process specified in the Quality Assurance Project Plan for the Environmental Surveillance Program Sediment Sampling Project. Sampling will occur after the 2009 summer monsoon season to evaluate the combined effects of summer floods on contaminant concentrations. Some of the potential sample locations are identified as “contingency” locations, to be sampled contingent on the occurrence of runoff in the prior year for active stream channel samples, or on the occurrence of large flood events resulting in new fine-grained sediment deposits in other settings. Subsequent to the 2009 summer monsoon season and prior to finalization of the samples table, stream gaging station records will be reviewed to identify which channels have experienced flow and which have experienced large flood events. As a preliminary guide to the recognition of large flood events (the size of which varies between canyons), Table 1 summarizes data on the size of runoff events at select gaging stations on the Pajarito Plateau (e.g., Ortiz et al. 2008). Canyons that have runoff near or exceeding the approximate 5-year discharge or stage will be visited in the field to determine the presence or absence of new fine-grained sediment deposits of sufficient thickness to sample prior to finalization of the samples table.

2.0 LOS ALAMOS CANYON WATERSHED

The nature and sources of contaminants in sediment in the Los Alamos Canyon watershed are well defined from previous studies (e.g., LANL 2004, LANL 2007a). The primary LANL sources of contaminants are in upper Los Alamos Canyon (including its tributary DP Canyon), and Pueblo Canyon (including its tributary Acid Canyon). Additional sources for contaminants in sediment are the Los Alamos townsite and the Cerro Grande burn area. Los Alamos and Pueblo Canyons have both had known transport of Laboratory-derived contaminants to the Rio Grande, and monitoring of these canyons is important for understanding off-site transport. The Los Alamos Canyon watershed also includes Barrancas, Bayo, Guaje, and Rendija Canyons, but significant contamination from Laboratory activities has not been identified in sediment in these canyons (LANL 2007a); therefore, no sampling is planned in these canyons.

2.1 Active Stream Channel Samples

Seven active channel locations that have been historically sampled in the Los Alamos Canyon watershed are considered to be sufficient to define spatial and temporal trends in contaminant concentrations in the stream beds, and are shown in Figure 1. These include DP and Los Alamos Canyons above their confluence, Acid and Pueblo Canyons above their confluence, Los Alamos and Pueblo Canyons above the eastern LANL boundary (above NM 4 and NM 502, respectively; note that the historical names for New Mexico state highways associated with sediment sampling locations are preceded by “SR” for “State Road”, and “SR” is interchangeable with “NM”), and Los Alamos Canyon above the Rio Grande (Los Alamos at Otowi). Contaminants of concern that are or may be derived from LANL sites include metals, polychlorinated biphenyls (PCBs), and radionuclides (americium-241, cesium-137, plutonium isotopes, strontium-90, tritium, and uranium isotopes). Planned sample locations and analytical suites for 2009 are shown in Table 2.

2.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Los Alamos Canyon watershed that are useful to evaluate trends in sediment contamination over time include floodplains and a sediment retention structure. Potential sample locations for these setting are shown in Figure 2. Floodplains or other areas of fine-grained sediment deposition in reach LA-3E (in Los Alamos Canyon above NM 4), reach LA-5 (in Los Alamos Canyon above the Rio Grande), and reach P-4E (in Pueblo Canyon above NM 502) are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in these areas. Two samples of fine-grained sediment would be collected in each reach for the analyte suite shown in Table 2. These areas were last sampled in September 2007 to evaluate sediment deposits resulting from record floods in August 2006 (Reneau and Koch, 2008).

A sediment retention structure, the Los Alamos Canyon low-head weir, was constructed above NM 4 in summer 2000 after the Cerro Grande fire to reduce the off-site transport of contaminants associated with sediment in post-fire floods. This site was last sampled in September 2008 as part of the Environmental Surveillance Program. Up to five samples are planned to be collected at the weir in 2009 to document trends in contaminant concentrations at this location and, in combination with volume estimates obtained from repeat surveys, to estimate the amount or inventory of contaminants accumulated behind this structure. The analytical suite includes dioxins and furans because of increases in concentrations that occurred during summer 2008 runoff events. These samples will be contingent on the occurrence of runoff events and new sediment deposits in 2009.

The transport of PCBs in storm water in Los Alamos and Pueblo Canyons resulted in a requirement from NMED to mitigate the transport of contaminated sediments in these canyons (NMED 2007). The potential

impact of PCBs and other contaminants (e.g., plutonium) on the Rio Grande is also of concern to stakeholders, in part related to the planned Buckman Direct Diversion project downriver from Los Alamos Canyon. To help evaluate potential impacts on the Rio Grande, a series of fine-grained sediment samples were collected from the Rio Grande upriver and downriver of Los Alamos Canyon for isotopic plutonium and PCB congeners in December 2008, as part of the Environmental Surveillance Program. The PCB congener data allow evaluation of the congener "fingerprint" above and below LANL sources, and hence to evaluate if there is a recognizable LANL impact. To supplement the PCB congener data obtained along the Rio Grande, collection of additional sediment samples for congener analyses is planned from Los Alamos and Pueblo Canyons in 2009 to better identify the congener fingerprints in these canyons. Five samples of fine-grained sediment are planned for these analyses at the Los Alamos Canyon low-head weir, in reach LA-5E, and in reach P-4E, as shown in Table 2. The sediment retention basin above the weir is planned for excavation in 2009, and if it has not received sufficient sediment from runoff events after excavation, then the samples for PCB congeners will instead be collected upstream in reach LA-3E.

3.0 SANDIA CANYON WATERSHED

Evidence on the nature and distribution of contaminants in sediment in the Sandia Canyon watershed are provided from previous studies (e.g., LANL 2007b). The primary LANL sources of contaminants are near the headwaters of Sandia Canyon at Technical Area (TA) 03 (e.g., LANL 1999). Additional potential sources for contaminants in sediment also exist farther east, including at TA-53. A more complete evaluation of the nature and sources of contaminants in sediments in Sandia Canyon is planned for the August 2009 Sandia Canyon Investigation Report.

3.1 Active Stream Channel Samples

Three active channel locations that have been historically sampled in Sandia Canyon are considered to be sufficient to define spatial and temporal trends in contaminant concentrations in the stream bed, and are shown in Figure 1. These include locations below the wetland, above NM 4 and the eastern LANL boundary, and above the Rio Grande. Contaminants of concern that are or may be derived from LANL sites include metals, PCBs, and radionuclides. Planned sample locations and analytical suites for 2009 are shown in Table 2. Because runoff does not extend beyond the LANL boundary every year (no flow was recorded at gaging station E125 above NM 4 in 31% of the years from 1995 to 2007), sampling of the active channel at the two eastern locations is contingent on runoff occurring in 2009 prior to the sampling event. A combination of infrequent detections and historical knowledge suggests that some or all of the radionuclides may not have recognizable sources at LANL solid waste management units (SWMUs) or areas of concern (AOCs), and the analytical suite may be reduced following completion of the Sandia Canyon Investigation Report.

3.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Sandia Canyon watershed that are useful to evaluate trends in sediment contamination over time include floodplains and low-lying abandoned channel surfaces that experience overbank flooding. Potential sample locations for these settings are shown in Figure 2. Floodplains or other areas of fine-grained sediment deposition in reach S-5E (in Sandia Canyon above NM 4) are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in this reach. Two samples of fine-grained sediment would be collected in each reach for the analyte suite shown in Table 2; the analytical suite may be modified following completion of the Sandia Canyon Investigation Report and refinement of the list of LANL-derived contaminants. These areas were last sampled in June 2007 as part of the Sandia Canyon Phase 1 sediment investigation (LANL 2007b).

4.0 MORTANDAD CANYON WATERSHED

The nature and sources of contaminants in sediment in Mortandad Canyon and its tributaries above NM 4 are well defined from previous studies (e.g., LANL 2006a). The primary LANL source of contaminants is the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) that discharges into Effluent Canyon. Additional sources for contaminants in sediment are TA-35, TA-46, and runoff from developed areas in TA-03 at the head of the canyon. The nature and sources of contaminants in sediment in Cañada del Buey, a major tributary to Mortandad Canyon, are less well defined. However, extensive sampling of sediment in the Cañada del Buey watershed has been completed and will be reported in the Cañada del Buey Investigation Report, due to NMED by August 31, 2009.

4.1 Active Stream Channel Samples

Five locations along the main stream channel in Mortandad Canyon and one location in Cañada del Buey that have been historically sampled are considered to be sufficient to define spatial and temporal trends in contaminant concentrations in the primary stream beds, and are shown in Figure 1. These include Mortandad Canyon above Effluent Canyon ("Mortandad west of GS-1"), below Effluent Canyon, at well MCO-8.5 (east of the sediment traps), at the LANL boundary, and at the Rio Grande, and Cañada del Buey below Material Disposal Area (MDA) G. Contaminants of concern that are or may be derived from LANL sites include metals, PCBs, and radionuclides (americium-241, cesium-137, plutonium isotopes, strontium-90, tritium, and uranium isotopes). Planned sample locations and analytical suites for 2009 are shown in Table 2. Because runoff does not extend beyond the Mortandad Canyon sediment traps in most years, sampling of the active channel at well MCO-8.5 and at the LANL boundary are contingent on runoff occurring in 2009 prior to the sediment sampling event (flow is only known to have passed MCO-8.5 once in the last 20 years, on August 25, 2006, never passing the LANL boundary since RLWTF discharges began in 1963; LANL 2006a). Runoff has been recorded crossing the LANL boundary in Cañada del Buey every year since gaging station E230 was established in 1994, and therefore sampling at the Cañada del Buey station and downcanyon in Mortandad Canyon above the Rio Grande is planned in 2009. At the Cañada del Buey and Mortandad Canyon above the Rio Grande stations, the analytical suite may be modified following completion of the Cañada del Buey Investigation Report and refinement of the list of LANL-derived contaminants.

In addition to sample locations along the main stream channels, five locations along short tributary drainages to Cañada del Buey below MDA G at TA-54 have been historically sampled, and are shown in Figure 3. Field notes indicate that there was only evidence of recent flow at one of these locations, MDA G-8, and sampling at the other four locations will be contingent on flow occurring prior to the 2009 sampling event and producing sediment deposits of sufficient thickness to sample. Planned sample locations and analytical suites for 2009 are shown in Table 2.

4.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Mortandad Canyon watershed that are useful to evaluate trends in sediment contamination over time include floodplains and low-lying abandoned channel surfaces that experience overbank flooding and the Mortandad Canyon sediment traps. Potential sample locations for these setting are shown in Figure 2.

Floodplains or other areas of fine-grained sediment deposition in reach CDB-3E (in Cañada del Buey below MDA G) are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in this reach. Two samples of fine-grained sediment would be collected in this reach for the analyte suite shown in Table 2; the analytical suite may be modified following completion of the

Cañada del Buey Investigation Report and refinement of the list of LANL-derived contaminants. This reach was last sampled in September 2004 as part of an investigation at MDA G (LANL 2005).

The Mortandad Canyon sediment traps impound water and accumulate sediment after runoff events, although only the largest events flow past trap #1 and into trap #2 or trap #3. Up to three samples of fine-grained sediment would be collected from the sediment traps following significant runoff events for the analyte suite shown in Table 2. The sediment traps were last sampled in September 2007 to evaluate sediment deposits resulting from a large flood in August 2006 that filled all three traps to capacity (Reneau and Koch, 2008). Gaging station E202, in Mortandad Canyon above the sediment trap #1, had its second highest recorded discharge in 2008, exceeding the approximate 5-year return period event, but no discharge was recorded below trap #3 at gaging station E203. The traps will therefore be visited in 2009 and one or more samples will be collected if a sufficient thickness of post-2007 sediment has been deposited.

5.0 PAJARITO CANYON WATERSHED

The nature and sources of contaminants in sediment in the Pajarito Canyon watershed are well defined from previous studies (e.g., LANL 2008). The primary LANL sources of contaminants identified in sediment include TA-08 and TA-09 in the upper Pajarito Canyon watershed, TA-15 in the Threemile Canyon watershed, and TA-03 and TA-69 in the Twomile Canyon watershed. Additional sources for contaminants in sediment are the Cerro Grande burn area, and developed areas within various TAs and the White Rock townsite.

5.1 Active Stream Channel Samples

Two locations along the main stream channel in Pajarito Canyon that have been historically sampled are considered to be sufficient to define spatial and temporal trends in contaminant concentrations in the primary stream beds, and are shown in Figure 1. These include Pajarito Canyon above SR-4 and above the Rio Grande. In addition, sampling is planned at five locations along short tributary drainages to Pajarito Canyon below MDA G at TA-54 that have been historically sampled, and are shown in Figure 3. One additional location that was previously sampled, “MDA G-6 U West,” will be excluded in 2009 because contaminants in this drainage are well defined by two downstream locations, “MDA G-6 Retention Pond Lower” and “MDA G-6.” Contaminants of concern that are or may be derived from LANL sites include metals, explosive compounds, PCBs, and radionuclides (americium-241, plutonium isotopes, tritium, and uranium isotopes). Planned sample locations and analytical suites for 2009 are shown in Table 2. Runoff has been recorded crossing the LANL boundary in Pajarito Canyon every year since gaging station E250 was established in 1995, and therefore sampling at the two locations along the main Pajarito Canyon channel is planned in 2009.

5.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Pajarito Canyon watershed that are useful to evaluate trends in sediment contamination over time include wetlands and an impoundment behind a flood retention structure (FRS). Potential sample locations for these setting are shown in Figure 2.

The wetlands in reach PA-3E (Pajarito Canyon below TA-18) and reach PA-4 (in Pajarito Canyon above NM 4) are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in these reaches. Two samples of fine-grained sediment would be collected in each reach for the analyte suite shown in Table 2. The analytical suite includes dioxins and furans because there is a known upstream source for these analytes (LANL 2008). Reach PA-3E was last sampled in August 2007 to

evaluate deposits from the record flood of August 2006; reach PA-4 was not sampled then because new sediments were too thin to sample (<5 cm thick) (LANL 2008).

The Pajarito Canyon FRS was constructed below the confluence of Pajarito and Twomile Canyons in summer 2000 after the Cerro Grande fire to reduce the potential for flooding at TA-18. Water impounds here during large floods, resulting in sediment deposition that extends upstream from the confluence in both canyons. Two samples of fine-grained sediment would be collected from reach PA-2W (Pajarito Canyon above the confluence) and reach TW-4E (Twomile Canyon above the confluence) following significant runoff events that impound water in these areas for the analyte suites shown in Table 2. The analytical suite for TW-4E includes dioxins and furans because there is a known upstream source for these analytes (LANL 2008). These reaches were last sampled in August 2007 to evaluate deposits from the record floods of August 2006 (LANL, 2008).

6.0 WATER CANYON WATERSHED

The nature and distribution of contaminants in sediment in the Water Canyon watershed, including its tributaries Cañon de Valle and Fence, Indio, and Potrillo Canyons, are incompletely known because detailed investigations have not yet been conducted in many parts of the watershed. Information on potential contaminant sources and results of previous work are summarized in the South Canyons Historical Investigation Report (LANL 2006b), and additional results are presented in Environmental Surveillance Reports (e.g., Reneau and Koch, 2008). More complete evaluations of the nature and sources of contaminants in sediments in the Water Canyon watershed are planned for the Water Canyon and Cañon de Valle Investigation Report (currently due to NMED December 31, 2010) and the Potrillo and Fence Canyons Investigation Report (currently due to NMED August 31, 2011).

6.1 Active Stream Channel Samples

Six active channel locations that have been historically sampled in the Water Canyon watershed are considered to be sufficient to define spatial and temporal trends in contaminant concentrations in the stream bed, and are shown in Figure 1. These include locations in Water Canyon below the confluence with Cañon de Valle (Water at Beta), in Fence, Indio, Potrillo, and Water Canyons above NM 4, and in Water Canyon above the Rio Grande. Contaminants of concern that are or may be derived from LANL sites include metals, explosive compounds, PCBs, and radionuclides. Planned sample locations and analytical suites for 2009 are shown in Table 2. Because runoff does not extend beyond NM 4 every year in any of these canyons, sampling of the active channel at the locations near NM 4 or the Rio Grande is contingent on runoff occurring in 2009 prior to the sampling event.

6.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Water Canyon watershed that are useful to evaluate trends in sediment contamination over time include floodplains and low-lying abandoned channel surfaces that experience overbank flooding. Potential sample locations for these setting are shown in Figure 2. Floodplains or other areas of fine-grained sediment deposition in areas immediately above NM 4 are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in these areas. Two samples of fine-grained sediment would be collected in each area for the analyte suite shown in Table 2. Sampling of fine-grained sediment outside the active channels in these areas has not occurred in Fence, Indio, and Potrillo Canyons, and therefore data on a large suite of potential contaminants will be obtained. However, samples of overbank sediment in Water Canyon were collected in November 2008 as part of the Environmental Surveillance Program after a large flood that occurred in August 2008, and a smaller analytical suite is planned for Water Canyon.

7.0 ANCHO CANYON WATERSHED

The nature and distribution of contaminants in sediment in the Ancho Canyon watershed are incompletely known because detailed investigations have not yet been conducted in many parts of the watershed. Information on potential contaminant sources and results of previous work are summarized in the South Canyons Historical Investigation Report (LANL 2006b), and additional results are presented in Environmental Surveillance Reports (e.g., Reneau and Koch, 2008). More complete evaluations of the nature and sources of contaminants in sediments in the Ancho Canyon watershed are planned for the Ancho Canyon Investigation Report (currently due to NMED February 28, 2011).

7.1 Active Stream Channel Samples

Three active channel locations that have been historically sampled in the Ancho Canyon watershed are considered to be sufficient to define spatial and temporal trends in contaminant concentrations in the stream bed, and are shown in Figure 1. These include locations in main Ancho Canyon and the north fork of Ancho Canyon above their confluence (below NM 4), and in Ancho Canyon near the Rio Grande. Contaminants of concern that are or may be derived from LANL sites include metals, explosive compounds, and radionuclides. Planned sample locations and analytical suites for 2009 are shown in Table 2. Because runoff does not extend beyond the confluence every year in these channels, sampling of the active channel at these locations is contingent on runoff occurring in 2009 prior to the sampling event.

7.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Ancho Canyon watershed that are useful to evaluate trends in sediment contamination over time include floodplains and low-lying abandoned channel surfaces that experience overbank flooding. Potential sample locations for these setting are shown in Figure 2. Floodplains or other areas of fine-grained sediment deposition in areas immediately above and below the confluence of main Ancho Canyon and the north fork are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in these areas. Two samples of fine-grained sediment would be collected in each area for the analyte suite shown in Table 2*. Sampling of fine-grained sediment outside the active channels in these areas last occurred in November 2008 as part of the Environmental Surveillance Program after a large flood that occurred in August 2008.

8.0 CHAQUEHUI CANYON WATERSHED

The nature and distribution of contaminants in sediment in the Chaquehui Canyon watershed are incompletely known because detailed investigations have not yet been conducted in many parts of the watershed. Information on potential contaminant sources and results of previous work are summarized in the South Canyons Historical Investigation Report (LANL 2006b), and additional results are presented in Environmental Surveillance Reports (e.g., Reneau and Koch, 2008). More complete evaluations of the nature and sources of contaminants in sediments in the Chaquehui Canyon watershed are planned for the Chaquehui Canyon Investigation Report (currently due to NMED February 28, 2011).

8.1 Active Stream Channel Samples

One active channel location has been historically sampled in the Chaquehui Canyon watershed, near the Rio Grande. This is a non-representative location below a spring with organic-rich material dominating the stream bed, and is also in an area of differing geology than upstream, resulting in uncertainties in

background comparisons for metals. A replacement location is planned for 2009 below the confluence of main Chaquehui Canyon and the north fork of Chaquehui Canyon to provide better identification of possible LANL impacts to the stream channel. This location is shown in Figure 1. Contaminants of concern that are or may be derived from LANL sites in this watershed include metals, explosive compounds, and radionuclides. The planned analytical suite for 2009 is shown in Table 2. Because runoff does not extend beyond the confluence every year in these channels, sampling of the active channel at this location is contingent on runoff occurring in 2009 prior to the sampling event.

8.2 Other Sediment Samples

In addition to active stream channels, other geomorphic settings in the Chaquehui Canyon watershed that are useful to evaluate trends in sediment contamination over time include floodplains and low-lying abandoned channel surfaces that experience overbank flooding. Potential sample locations for these setting are shown in Figure 2. Floodplains or other areas of fine-grained sediment deposition in areas below the confluence of main Chaquehui Canyon and the north fork are planned for sampling in 2009 if significant floods occur that produce new overbank sediment deposits in these areas. Two samples of fine-grained sediment would be collected in each area for the analyte suite shown in Table 2. No prior sampling of fine-grained sediment has occurred in this area, and therefore data on a large suite of potential contaminants will be obtained.

9.0 RIO GRANDE

The nature and concentration of LANL-derived contaminants in sediment in the Rio Grande and at a downriver reservoir (Cochiti Reservoir) are evaluated by comparing data from samples collected upriver and downriver from canyons that drain LANL, in combination with data from farther west on the Pajarito Plateau. These samples have historically included a combination of river bank sediment and reservoir bottom sediment, the latter collected upriver at Abiquiu Reservoir on the Rio Chama and downriver at Cochiti Reservoir. Analyte suites have included metals, explosive compounds, PCBs, and the full suite of radionuclides identified as having potential LANL sources. One radionuclide suite sampled in recent years, isotopic thorium, is planned to be dropped in 2009 because no LANL source has been identified, and in addition concentrations along the Rio Grande are below LANL sediment background values.

In 2008 sediment sampling along the Rio Grande was enhanced by collecting five samples in each of two areas, upriver and downriver of Los Alamos Canyon (near Otowi Bridge and below White Rock), for a more limited suite that focused on key contaminants of concern in this watershed: plutonium and PCBs. The PCB analyses were obtained with the congener method (method 1668A) to allow comparison of congener fingerprints upriver and downriver from this source. The collection of five samples in each area allows examination of variations in analyte concentrations resulting from particle size variations as well as sediment deposited in different geomorphic settings and probably during different runoff events (e.g., silt and clay in low-water areas vs. higher sand bars deposited during higher flow conditions).

The enhanced sampling conducted in 2008 is planned to be expanded in 2009 to include five samples in each of four areas: Otowi Bridge (upriver from Los Alamos Canyon), Buckman (upriver from Sandia Canyon), White Rock (downriver from Mortandad Canyon), and Frijoles Canyon (downriver from all LANL drainages). The analytical suite will include all analytes included in the previous year in Abiquiu and Cochiti Reservoirs, with the exception of isotopic thorium, to provide an improved understanding of upriver baseline conditions and potential LANL impacts. Sample numbers and analytical suites are shown in Table 2. In Table 2, a sub-watershed designation of “White Rock Canyon”, indicates areas downriver of Los Alamos Canyon and potentially impacted by LANL, whereas a sub-watershed designation of “Rio Grande” indicate areas upriver of Los Alamos Canyon (background or baseline areas).

The enhanced sampling of sediment along the Rio Grande in 2009 will be a substitute for sampling of Abiquiu and Cochiti Reservoirs. It is expected that the reservoirs will be sampled in subsequent years.

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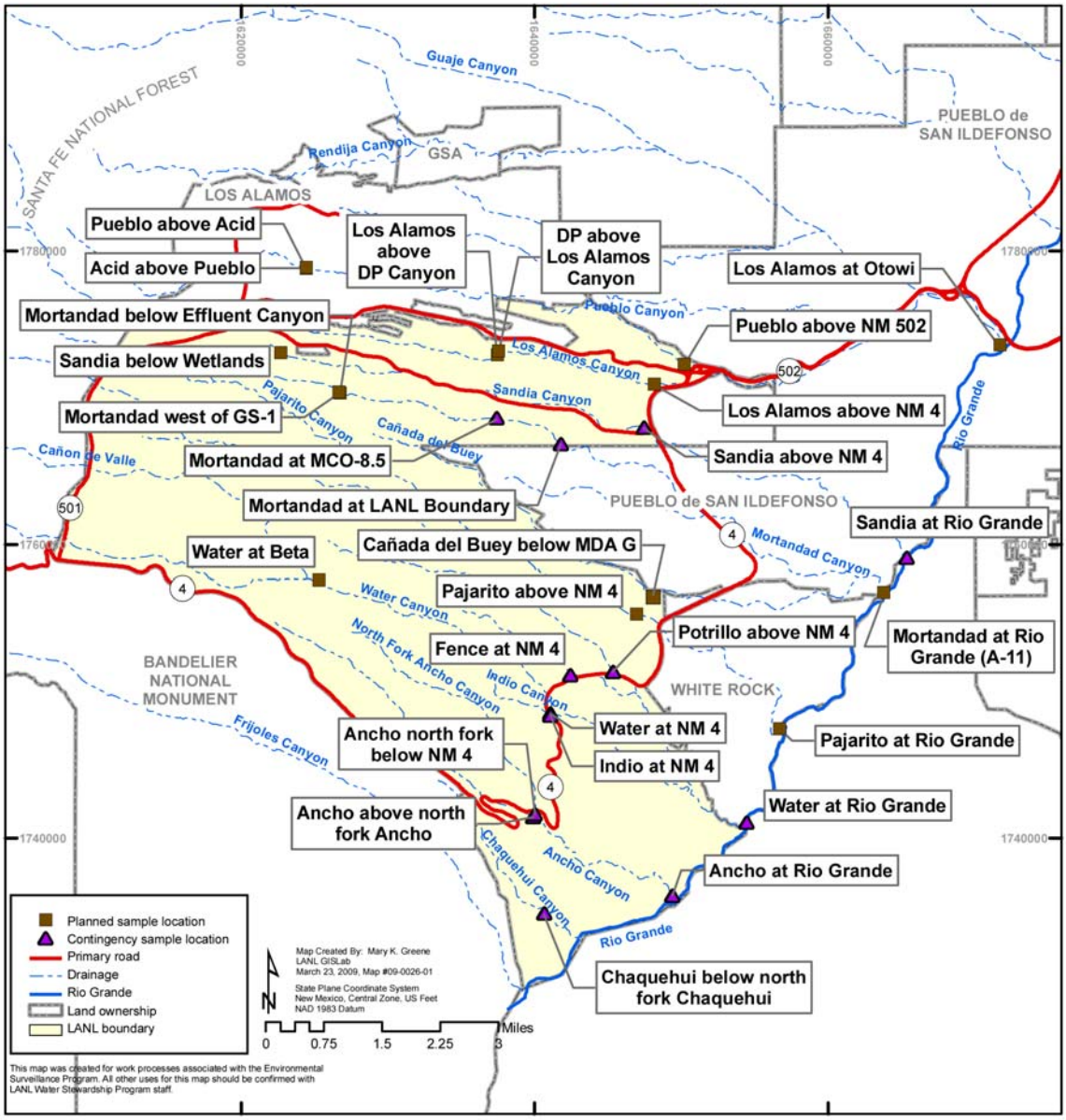

Figure 1 Map of active channel sample locations in canyons at or downstream from LANL

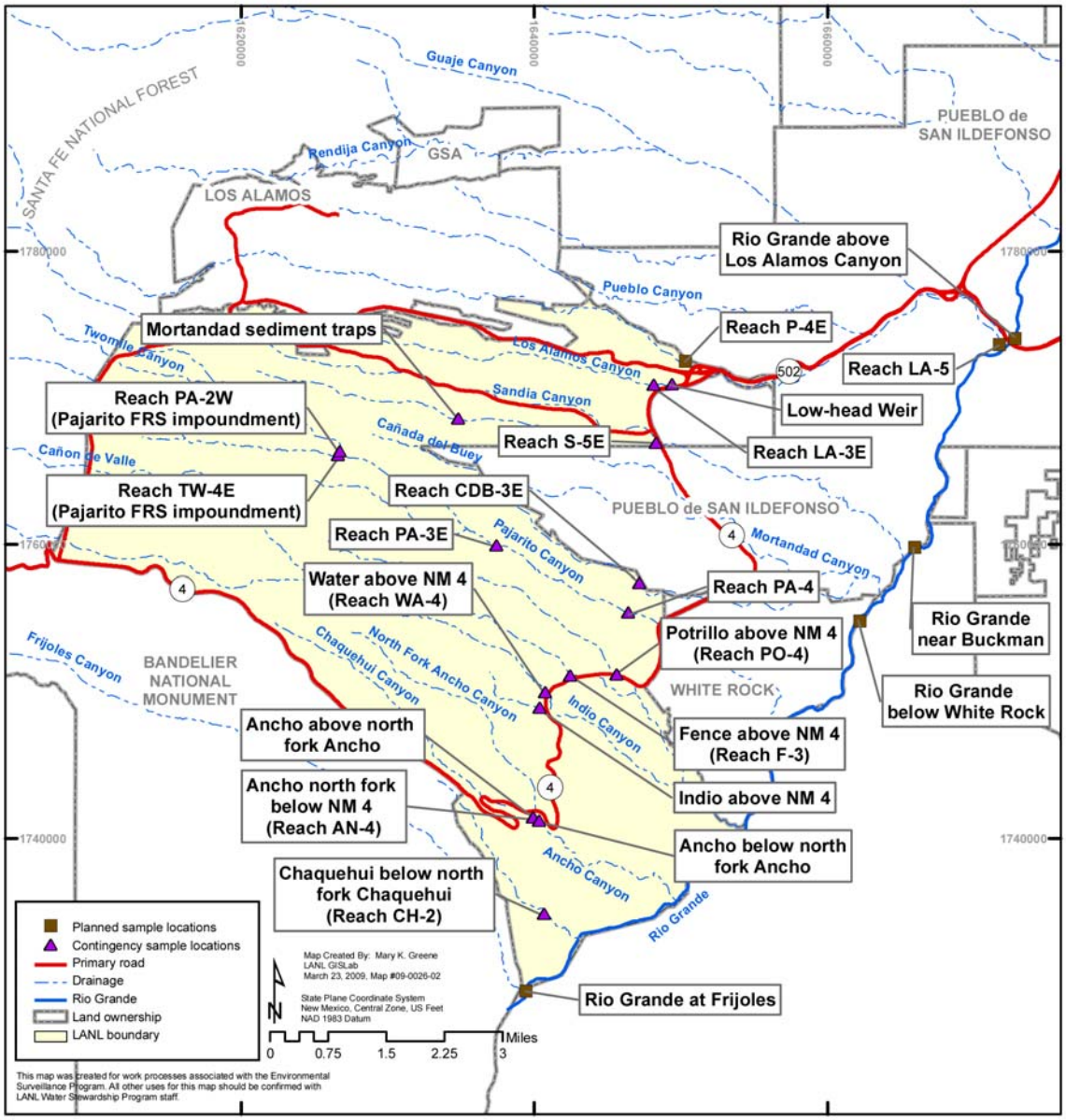

Figure 2 **Map of sample locations for fine-grained sediment in canyons at or downstream from LANL and along the Rio Grande**

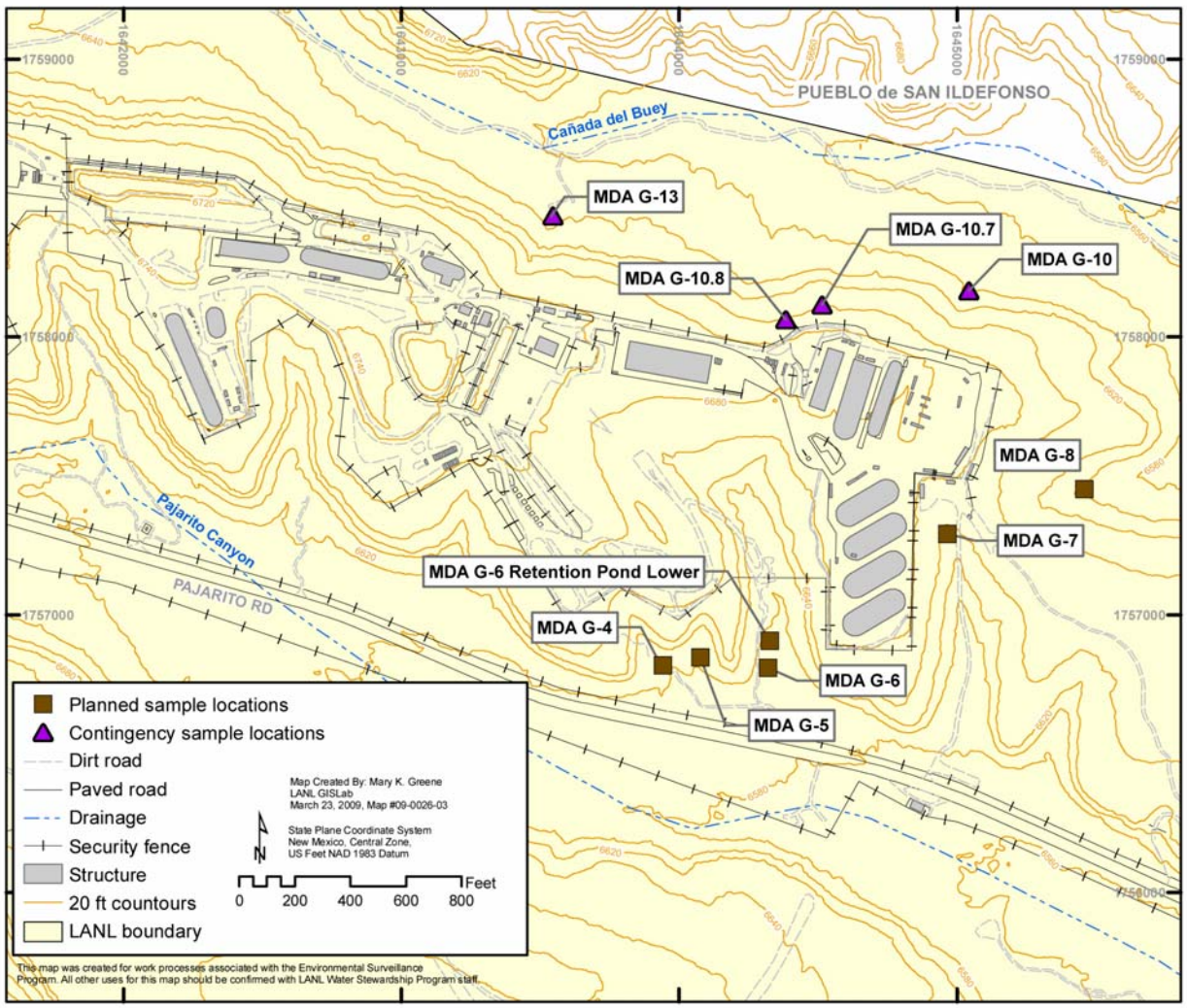

Figure 3 Map of sample locations along drainages below MDA G at TA-54

Table 1
Summary of Runoff Events Recorded at Select Stream Gages Downstream from LANL SWMUs and AOCs

Gage	Gage Name	Period of Record	Maximum Recorded Discharge (cfs) or Stage (ft)	Year of Maximum	Approximate 5-Year Discharge (cfs) or Stage (ft)*	% of Years with no Recorded Flow
E042	Los Alamos Canyon above SR 4	1995-2008	240 cfs	2006	160 cfs	0%
E060	Pueblo Canyon above SR 502	1994-2008	1930 cfs	2006	582 cfs	0%
E125	Sandia Canyon above SR 4	1995-2008	59 cfs	2006	13 cfs	25%
E202	Mortandad Canyon Above Sediment Traps	1997-2008	292 cfs	2006	6.4 cfs	25%
E203	Mortandad Canyon Below Sediment Traps	1997-2008	220 cfs	2006	0	83%
E204	Mortandad Canyon at LANL boundary	1994-2008	0	-	0	100%
E230	Cañada del Buey above SR 4	1994-2008	210 cfs	1999	112 cfs	0%
E243	Pajarito above Twomile	2002-2008	272 cfs	2005	116 cfs	0%
E244	Two Mile above Pajarito	2002-2008	628 cfs	2006	517 cfs	14%
E250	Pajarito Canyon above SR 4	1995-2008	206 cfs	2006	26 cfs	0%
E264	Indio Canyon at SR 4	2007-2008	0.03 cfs	2007	0.01 cfs	0%
E265	Water Canyon below SR 4	1995-2008	274 cfs	2000	72 cfs	14%
E267	Potrillo Canyon above SR 4	1995-2008	63 cfs	1995	37 cfs	7%
E267.5	Fence Canyon	2004	2.1 ft	2004	2.1 ft	0%
E273	Ancho above North Fork	2001-2005	5.1 ft	**	5.1 ft	0%
E274	North Fork Ancho	2001-2008	2.8 ft	2008	1.7 ft	25%
E275	Ancho Canyon below SR 4	1995-2008	537 cfs	2008	520 cfs	7%
E338	Chaquehui Canyon	2002-2008	4.1 ft	2007	4.1 ft	33%
E340	North Fork Chaquehui Canyon	2001-2008	1.0 ft	2003 + 2006	1.0 ft	25%

* Approximate 5-year discharge or stage is the value equaled or exceeded in 20% of the years of record, excluding 2000 and 2001 in watersheds affected by the Cerro Grande fire (characterized by anomalous hydrologic conditions). (Stages have arbitrary datums, and do not indicate flood depth.)

** The same peak stage was recorded in several years at E273, indicating an inability at this station to resolve differences between the larger flow events.

Table 2
Planned and Contingency Sediment Sample Locations and Analytic Suites for 2009

Watershed	Sub-watershed	Location Name	Canyon-Based Sample Prefix	Target Analyte List Metals	Explosive Compounds (NMED List)	PCBs by Aroclor Method	PCB Congeners	Dioxins and Furans	Am-241 (by alpha spec-troscopy)	Gamma Spectroscopy Radionuclides	Iso Pu	Iso U	Sr-90	Tritium	Particle Size	Sample #	Notes
Active stream channels, Pajarito Plateau																	
Los Alamos	Acid	Acid above Pueblo	CAPU	1	-	1	-	-	1	1	1	1	1	1	1	1	
Los Alamos	DP	DP above Los Alamos Canyon	CALA	1	-	1	-	-	1	1	1	1	1	1	1	1	
Los Alamos	Los Alamos	Los Alamos above DP Canyon	CALA	1	-	1	-	-	1	1	1	1	1	1	1	1	
Los Alamos	Los Alamos	Los Alamos above SR-4	CALA	1	-	1	-	-	1	1	1	1	1	1	1	1	
Los Alamos	Los Alamos	Los Alamos at Otowi	CALA	1	-	1	-	-	1	1	1	1	1	1	1	1	
Los Alamos	Pueblo	Pueblo above Acid	CAPU	1	-	1	-	-	-	-	-	-	-	-	1	1	
Los Alamos	Pueblo	Pueblo above SR-502	CAPU	1	-	1	-	-	1	1	1	1	1	1	1	1	
Mortandad	Cañada del Buey	Cañada del Buey below MDA G	CACB	1	-	1	-	-	1	1	1	1	-	1	1	1	***
Mortandad	Cañada del Buey	MDA G-8	CACB	1	-	-	-	-	1	-	1	1	-	1	1	1	
Mortandad	Mortandad	Mortandad at Rio Grande (A-11)	CAMO	1	-	1	-	-	1	1	1	1	-	1	1	1	***
Mortandad	Mortandad	Mortandad below Effluent Canyon	CAMO	1	-	1	-	-	1	1	1	1	1	1	1	1	
Mortandad	Mortandad	Mortandad west of GS-1	CAMO	1	-	1	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	MDA G-4	CAPA	1	-	-	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	MDA G-5	CAPA	1	-	1	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	MDA G-6	CAPA	1	-	1	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	MDA G-6 Retention Pond Lower	CAPA	1	-	1	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	MDA G-7	CAPA	1	-	1	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	Pajarito above SR-4	CAPA	1	1	1	-	-	1	-	1	1	-	1	1	1	
Pajarito	Pajarito	Pajarito at Rio Grande	CAPA	1	1	1	-	-	1	-	1	1	-	1	1	1	
Sandia	Sandia	Sandia below Wetlands	CASA	1	-	1	-	-	-	1	1	1	1	1	1	1	**
Water	Water	Water at Beta	CAWA	1	1	1	-	-	-	-	1	1	-	-	1	1	
Supplemental sampling of sediment deposits, Pajarito Plateau																	
Los Alamos	Los Alamos	Low-head weir or reach LA-3E	CALA	-	-	-	5	-	-	-	-	-	-	-	5	5	
Los Alamos	Los Alamos	Reach LA-5E	CALA	-	-	-	5	-	-	-	-	-	-	-	5	5	
Los Alamos	Pueblo	Reach P-4E	CAPU	-	-	-	5	-	-	-	-	-	-	-	5	5	
Sediment sample locations along Rio Grande and Rio Chama																	
Rio Grande	Rio Chama	Abiquiu Reservoir	CABG	-	-	-	-	-	-	-	-	-	-	-	-	-	****
Rio Grande	Rio Grande	Rio Grande above Los Alamos Canyon	CABG	5	5	-	5	-	5	5	5	5	5	5	5	5	
Rio Grande	White Rock Canyon	Cochiti Reservoir	CAWR	-	-	-	-	-	-	-	-	-	-	-	-	-	****
Rio Grande	White Rock Canyon	Rio Grande above Buckman	CAWR	5	5	-	5	-	5	5	5	5	5	5	5	5	
Rio Grande	White Rock Canyon	Rio Grande below White Rock	CAWR	5	5	-	5	-	5	5	5	5	5	5	5	5	
Rio Grande	White Rock Canyon	Rio Grande above Frijoles Canyon	CAWR	5	5	-	5	-	5	5	5	5	5	5	5	5	
Total planned samples				**41**	**23**	**19**	**35**	**0**	**38**	**30**	**40**	**40**	**28**	**39**	**56**	**56**	

Table 2 (continued)

Watershed	Sub-watershed	Location Name	Canyon-Based Sample Prefix	Target Analyte List Metals	Explosive Compounds (NMED List)	PCBs by Aroclor Method	PCB Congeners	Dioxins and Furans	Am-241 (by alpha spec-troscopy)	Gamma Spectroscopy Radionuclides	Iso Pu	Iso U	Sr-90	Tritium	Particle Size	Sample #	Notes
Contingency locations along active stream channels, Pajarito Plateau; sample only if runoff event occurs in summer 2009 before sampling event (locations that do not flow every year)																	
Ancho	Ancho	Ancho above north fork Ancho	CAAN	1	-	-	-	-	-	-	1	1	-	-	1	1	
Ancho	Ancho	Ancho at Rio Grande	CAAN	1	1	-	-	-	-	-	1	1	-	1	1	1	
Ancho	Ancho	Ancho north fork below SR-4	CAAN	1	1	-	-	-	-	-	-	1	-	1	1	1	
Chaquehui	Chaquehui	Chaquehui below north fork Chaquehui	CACH	1	1	-	-	-	-	-	-	1	-	1	1	1	*****
Mortandad	Cañada del Buey	MDA G-10	CACB	1	-	-	-	-	1	-	1	1	-	1	1	1	
Mortandad	Cañada del Buey	MDA G-10.7	CACB	1	-	-	-	-	1	-	1	1	-	1	1	1	
Mortandad	Cañada del Buey	MDA G-10.8	CACB	1	-	-	-	-	1	-	1	1	-	1	1	1	
Mortandad	Cañada del Buey	MDA G-13	CACB	1	-	-	-	-	1	-	1	1	-	1	1	1	
Mortandad	Mortandad	Mortandad at LANL Boundary	CAMO	1	-	1	-	-	1	1	1	1	1	1	1	1	
Mortandad	Mortandad	Mortandad at MCO-8.5	CAMO	1	-	1	-	-	1	1	1	1	1	1	1	1	
Sandia	Sandia	Sandia above SR-4	CASA	1	-	1	-	-	-	1	1	1	1	1	1	1	**
Sandia	Sandia	Sandia at Rio Grande	CASA	1	-	1	-	-	-	1	1	1	1	1	1	1	**
Water	Fence	Fence at SR-4	CAFÉ	1	1	-	-	-	-	-	-	1	-	-	1	1	
Water	Indio	Indio at SR-4	CAIN	1	1	-	-	-	-	-	-	1	-	-	1	1	
Water	Potrillo	Potrillo above SR-4	CAPO	1	1	-	-	-	-	-	-	1	-	-	1	1	
Water	Water	Water at Rio Grande	CAWA	1	1	1	-	-	-	-	1	1	-	-	1	1	
Water	Water	Water at SR-4	CAWA	1	1	1	-	-	-	-	1	1	-	-	1	1	
Total contingency locations, active stream channels, Pajarito Plateau				**17**	**8**	**6**	**0**	**0**	**6**	**4**	**12**	**17**	**4**	**11**	**17**	**17**	
Contingency locations on floodplains and miscellaneous sites Pajarito Plateau; provisionally planned for no samples in 2009 (sampling dependent on occurrence of large flood event) *																	
Ancho	Ancho	Ancho above north fork Ancho	CAAN	2	2	-	-	-	-	-	2	2	-	2	2	2	
Ancho	Ancho	Ancho below north fork Ancho	CAAN	2	2	-	-	-	-	-	2	2	-	2	2	2	
Ancho	Ancho	Ancho north fork below SR-4 (reach AN-4)	CAAN	2	2	-	-	-	-	-	2	2	-	2	2	2	
Chaquehui	Chaquehui	Chaquehui below north fork Chaquehui (reach CH-2)	CACH	2	2	2	-	-	2	2	2	2	2	2	2	2	*****
Los Alamos	Los Alamos	Low-head Weir	CALA	5	-	-	-	5	5	5	5	5	5	5	5	5	
Los Alamos	Los Alamos	Reach LA-3E	CALA	2	-	2	-	-	2	2	2	2	2	2	2	2	
Los Alamos	Los Alamos	Reach LA-5E	CALA	2	-	2	-	-	2	2	2	2	2	2	2	2	
Los Alamos	Pueblo	Reach P-4E	CAPU	2	-	2	-	-	2	2	2	2	2	2	2	2	
Mortandad	Cañada del Buey	Reach CDB-3E	CACB	2	-	2	-	-	2	2	2	2	-	2	2	2	***
Mortandad	Mortandad	Sediment traps	CAMO	3	-	3	-	-	3	3	3	3	3	3	3	3	
Pajarito	Pajarito	Reach PA-2W (Pajarito FRS impoundment)	CAPA	2	2	2	-	-	2	-	2	2	-	2	2	2	
Pajarito	Pajarito	Reach PA-3E	CAPA	2	2	2	-	2	2	-	2	2	-	2	2	2	
Pajarito	Pajarito	Reach PA-4	CAPA	2	2	2	-	2	2	-	2	2	-	2	2	2	
Pajarito	Twomile	Reach TW-4E (Pajarito FRS impoundment)	CATW	2	2	2	-	2	2	-	2	2	-	2	2	2	
Sandia	Sandia	Reach S-5E	CASA	2	-	2	-	-	2	2	2	2	2	2	2	2	**
Water	Fence	Fence above NM 4 (reach F-3)	CAFÉ	2	2	2	-	-	2	2	2	2	2	2	2	2	
Water	Indio	Indio above NM 4	CAIN	2	2	2	-	-	2	2	2	2	2	2	2	2	
Water	Potrillo	Potrillo above NM 4 (reach PO-4)	CAPO	2	2	2	-	-	2	2	2	2	2	2	2	2	
Water	Water	Water above NM 4 (reach WA-4)	CAWA	2	2	2	-	-	-	-	2	2	-	-	2	2	
Total contingency locations, floodplains and miscellaneous sites, Pajarito Plateau				**42**	**24**	**31**	**0**	**11**	**34**	**26**	**42**	**42**	**24**	**40**	**42**	**42**	

= Number of samples or analyses planned for 2009; does not include QA duplicate locations, 10% of total, to be chosen with random number generator following finalization of samples table after 2009 monsoon season

- = No analyses planned for 2009.

* Sample only if large flood occurs in summer 2009 before sampling event (e.g., ≥5-year event that produces fine-grained sediment deposits ≥5 cm thick; if analytical budget insufficient to sample all locations, prioritize and defer some until 2010.

** Radionuclide suite in Sandia Canyon may be decreased following completion of the Sandia Canyon Investigation Report, eliminating analytes with no confirmed LANL sources in sediment in the watershed.

*** Analytical suite in Cañada del Buey and Mortandad Canyon above the Rio Grande may be modified following completion of the Cañada del Buey Investigation Report, eliminating analytes with no confirmed LANL sources in sediment in the watershed.

**** Three locations; defer to 2010.

***** New location.