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2014 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project

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2014 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project

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1.0 INTRODUCTION

This monitoring plan is submitted pursuant to the Los Alamos National Laboratory's (LANL's or the Laboratory's) letter dated November 7, 2013, to reestablish completion dates for Compliance Order on Consent deliverables resulting from flooding in September 2013 and the lapse in federal appropriations in October 2013, both of which constituted force majeure events (LANL 2013, 250970). The objective of this monitoring plan is to evaluate the effect of mitigation measures undertaken in the Los Alamos and Pueblo Canyons (LA/Pueblo) watershed under the New Mexico Environment Department– (NMED-) approved "Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons" (LANL 2008, 101714) and the "Supplemental Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons" (LANL 2008, 105716). In accordance with these work plans, the Laboratory has undertaken several activities to reduce flood energy and associated sediment transport. Because contaminants migrate with sediment entrained in runoff, reduced sediment transport will thus reduce contaminant transport, which is the primary objective of these activities.

Two types of monitoring that began in 2010 and will continue in the foreseeable future are designed to meet the following objectives: (1) monitor geomorphic changes in the canyon bottom facilitating continued evaluation of past mitigation measures and (2) assess performance of controls by collecting and analyzing storm water runoff samples at gage and monitoring stations located throughout the watershed. Monitoring conducted in the LA/Pueblo watershed in 2010 was performed in accordance with the "Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project" (LANL 2009, 107457) and the "Approval with Modifications, Los Alamos and Pueblo Canyons Sediment Transport Monitoring Plan" (NMED 2010, 108444). Monitoring in the LA/Pueblo watershed in 2011 was performed in accordance with the "2011 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project" (LANL 2011, 201578) and the "Approval with Modifications [for the] 2011 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project" (NMED 2011, 203705). Monitoring conducted in the LA/Pueblo watershed in 2012 was performed in accordance with the "2012 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 2" (LANL 2012, 222833) and the "Approval [for the] 2012 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 2" (NMED 2013, 521854). Monitoring conducted in 2013 in the LA/Pueblo watershed was performed in accordance with the "2013 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 1" (LANL 2013, 243432) and the "Approval [for the] 2013 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 1" (NMED 2013, 523106). Monitoring planned for 2014 builds upon these previous documents.

Extensive and intense rain across the Pajarito Plateau during the week of September 10, 2013, resulted in a severe flood in Pueblo Canyon on September 13, 2013. A portion of the Pueblo Canyon wetland experienced a 900-ft advance of a head-cut. Several key aspects of the mitigations in Pueblo Canyon are damaged or destroyed. Gage station E059 was destroyed. Willows planted for flood mitigations were scoured out or damaged, and the wing ditch in Pueblo Canyon was destroyed. Channel widening and loss of a distinct south channel bank also occurred between the Pueblo Canyon grade-control structure (GCS) and the gage at E060.1. The Pueblo and DP Canyons GCSs, the upper Los Alamos Canyon sediment detention basins, and the basins above the Los Alamos Canyon low-head weir were not damaged and are all operational. A replacement gage station, E059.5, will be installed before the 2014 monsoon season begins. Maintenance and bank protection will be implemented between the Pueblo Canyon GCS and the gage station at E060.1. New mitigations are being conducted in Pueblo Canyon to reduce the potential for further head-cutting, to stabilize eroded stream banks, and to establish new floodplains that will facilitate deposition in accordance with the U.S. Army Corps of Engineers' authorization to conduct stabilization activities in the Pueblo Canyon water course (LANL 2014, 524744). Storm water and geomorphic monitoring conducted under this plan will evaluate the potential impacts of the changes that occurred in the watershed and the efficacy of the mitigations over time.

Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with U.S. Department of Energy policy. Water-quality results from storm water events are systematically uploaded to the publically accessible environmental monitoring database, Intellus New Mexico.

2.0 MONITORING GEOMORPHIC CHANGES

Monitoring of geomorphic changes (e.g., sediment deposition or erosion) associated with the mitigation measures has been conducted using three methods: (1) repeat cross-section surveys, (2) channel thalweg surveys, and (3) general area surveys. These surveys have been conducted at the locations described below. The surveys have been conducted annually to document geomorphic changes that may have occurred during the previous summer monsoon season. The optimal time for conducting surveys is selected based on the weather, the presence or absence of ponded water in sediment-retention basins, and the ability to work in wetlands after dense vegetation has senesced. Figure 2.0-1 shows the mitigation areas where surveys have been conducted and where repeat surveys are planned. Potential channel elevation changes (aggradation or incision) will continue to be monitored by directly comparing the previous thalweg elevation at each surveyed cross-section with current survey results.

2.1 Pueblo Canyon

P-2W survey area/former P-2W cross-vane structures (CVSs)—In Pueblo Canyon Reach P-2W between the confluence of Graduation and Kwage Canyons, two cross-sections were originally surveyed in April and May 2010 near each of the three CVSs (Figure 2.0-1): one 50 ft upcanyon and one 50 ft downcanyon of the apex rock of each structure. A longitudinal thalweg profile was also surveyed over these 100-ft intervals. Although the CVSs were damaged during floods in 2010 (LANL 2010, 111125) and have been abandoned, annual resurveys in this area allow monitoring of potential geomorphic changes in Pueblo Canyon upstream from the Los Alamos County Wastewater Treatment Facility (WWTF) outfall. Since the CVSs no longer exist, the Laboratory proposes to change the survey area name to “P-2W survey area” in future plans and reports.

P-3W willow-planting area—Between the County WWTF outfall and access road in Reach P-3E, a total of 18 cross-sections were originally surveyed in October 2009 in the area where willows were planted in spring 2008 and 2009 (Figure 2.0-1). These cross-sections were divided between the upper, middle, and lower thirds of this area. A total of six cross-sections were surveyed in each of these three areas at 100-ft intervals. A longitudinal channel thalweg profile was also surveyed in each of these areas. The willows were damaged in September 2013 flooding, and their survival rate is being assessed. Annual resurveys at the willow-planting area are intended to document anticipated aggradation of floodplain surfaces where willows will slow flood water and trap sediment as well as monitor any changes to thalweg elevation in this area.

P-3E survey area/former P-3E wing ditch—In Pueblo Canyon near the access road in Reach P-3E, five cross-sections were originally surveyed in November 2009 downcanyon from the wing ditch (Figure 2.0-1) at 100-ft intervals, and a longitudinal channel thalweg profile was also surveyed over this distance. The wing ditch was abandoned when culverts were installed during road reconstruction completed by Los Alamos County in 2011. This area is surveyed annually to allow the monitoring of potential geomorphic changes in this part of the wetland. Since the wing ditch no longer exists, the Laboratory proposes to change the survey area name to “P-3E survey area” in future plans and reports.

P-3FE and P-4W transition area—In Pueblo Canyon Reaches P-3FE and P-4W, a total of 23 cross-sections were originally surveyed in September and October 2009 at 100-ft intervals for a total of 1100 ft above and below a transition area separating a broad upcanyon wetland (reach P-3FE) from a narrower downcanyon wetland within incised geomorphic surfaces (Reach P-4W) (LANL 2011, 203661). A head-cut advanced through the survey area during the September 13, 2013, flood. Additional bank cross-section surveys conducted above the head-cut will be repeated to monitor the effects of stabilization efforts. Annual resurveys in these reaches are intended to monitor geomorphic changes in this portion of Pueblo Canyon, particularly those related to potential changes in the transition area.

Pueblo Canyon GCS—A total of 15 cross-sections were originally surveyed in April 2010 at 100-ft intervals for a distance of 1500 ft above the Pueblo Canyon GCS (Figure 2.0-1). Three cross-sections were also surveyed below the GCS at 100-ft intervals to document any changes to the channel downcanyon of the structure. A longitudinal channel thalweg profile was also surveyed in this area. Annual resurveys in this area are intended to document expected sediment accumulation above the GCS and to monitor changes in the upcanyon wetland.

2.2 Los Alamos Canyon

DP Canyon GCS—In Reach DP-2, a total of 11 cross-sections were originally surveyed in April and May 2010 above the DP Canyon GCS (Figure 2.0-1) at 100-ft intervals upcanyon of the structure. Two cross-sections were also surveyed below the GCS at 100-ft intervals to document any changes to the channel downcanyon of the structure. A longitudinal channel thalweg profile was also surveyed over this area. Annual resurveys in this area are intended to document expected sediment accumulation above the GCS. Flooding in September 2013 did not damage the DP Canyon GCS.

Los Alamos Canyon low-head weir—In 2009, after modifications were made to the sediment detention basin above the Los Alamos Canyon low-head weir, including establishing three separate basins, an initial topographic survey of this area was conducted in July 2009. The basins were reexcavated in May 2013 and again in April and May 2014. Flooding on September 13, 2013, caused a large accumulation of sediments in the three upstream basins. Irregular topography associated with basalt mounds and constructed modifications above the weir warrant a more detailed survey than can be conducted with repeat cross-sections. Annual resurveys of this area are intended to document expected sediment accumulation within the basins from monsoon-derived flow in the canyon and the readiness of the basins to accept new sediments.

Detention basins below the 01-001(f) drainage—A general topographic survey was originally conducted in March 2010 of sediment detention basins constructed below Solid Waste Management Unit (SWMU) 01-001(f). The basins were reexcavated in June 2011 to prepare for expected floods following the Las Conchas fire, and a new baseline survey was conducted in July 2011. Annual resurveys of this area are intended to document sediment accumulation within the basins and available water storage capacity within the basins. Flooding on September 13, 2013, caused minor damage to the detention basins. Specifically, the lower spillway of the lower basin eroded and will be repaired before the 2014 monsoon season.

3.0 MONITORING STORM WATER RUNOFF

In 2014, storm water quality monitoring will be conducted at 12 gage stations (shown in Figure 2.0-1) within the Los Alamos and Pueblo watersheds. Each gage station automatically collects storm water runoff using ISCO samplers. Storm water analytical suites for each gage location are presented in Table 3.0-1. Gage locations are sited to effectively monitor sediment transport and water quality throughout each watershed. Results from storm water runoff monitoring will also be available to document baseline conditions upcanyon of these sites and to evaluate contaminant sources. The goal of the sampling is to collect data (1) that represent spatial and temporal variations in potential contaminant concentrations and suspended sediment concentrations (SSC) in storm water and (2) that allow evaluation of short-term and long-term trends in SSC, suspended sediment yield, and contaminant concentrations associated with the mitigation sites. The monitoring strategy described below was developed to achieve these goals.

3.1 2014 Monitoring Plan Changes

Data collected since implementation of this monitoring strategy in 2010 were reviewed to make recommendations regarding potential changes to analytical suites and/or sampling approaches. Large sections of the upper watersheds of Los Alamos Canyon and a major tributary, Guaje Canyon, were affected by the Las Conchas fire in 2011. As documented after the Cerro Grande fire (Gallaher and Koch 2004, 088747), storm water chemistry can be strongly affected by ash from burn areas. To help evaluate the influence of the Las Conchas fire on storm water quality in 2011, americium-241 and cyanide were added to the analytical suites at gages E026 and E030, and cyanide was added to the analytical suites at the other Los Alamos Canyon gages (E042.1, E050.1, and E109.9). Additionally, SSC measurements across the hydrograph were repeated at the upper boundary station at E026 to better characterize sediment flux from the burn area upstream from Laboratory sites.

The Laboratory proposes removing the fire-related constituents described below from the 2014 monitoring plan based on return to low pre-fire concentrations through 2013. A more detailed discussion of the recovery of certain fire-related constituents within the watershed to low pre-fire conditions is presented in Appendix A. In summary:

- Americium-241 activities increased in ash-laden storm water flowing onto Laboratory property at gages E026 and E030 in 2011 and 2012. Americium-241 activity in storm water returned to pre-fire levels in 2013, and normalized activities in storm water collected at gages E026 and E030 were below canyon sediment background values (BVs) in 2013, as discussed in Appendix A.
- Cyanide concentrations increased at all monitoring locations impacted by ash in 2011 and 2012. Cyanide concentrations in storm water returned to pre-fire levels in 2013, and normalized concentrations in storm water were less than canyon sediment BVs, as discussed in Appendix A.
- Sediment loads increased at all monitoring locations impacted by ash in 2011 and 2012. SSC at the upper boundary station E026 measured in 2013 are below peak values observed in 2012 and 2011, as discussed in Appendix A.

Gage stations E099 and E109.9 were both significantly damaged during the September 13, 2013, flood. In additional, the Laboratory subsequently lost administrative access to these gage stations. Therefore, monitoring at these stations will not be performed in 2014. The gage station at E059 was destroyed by the September 13, 2013, flood. A replacement gage, E059.5, will be installed before the 2014 monsoon season and will assume the monitoring planned at E059 when it is completed. The location is shown in Figure 2.0-1.

3.2 2014 Storm Water Monitoring

Samples will be collected using automated pump samplers at the detention basins below SWMU 01-001(f) at locations CO111041 and CO101038, shown in Figure 3.2-1 and listed in Table 3.0-1. These samples will allow the Laboratory to evaluate how the sediment detention basins and associated vegetative buffer below the basins are performing.

Gaging equipment at E050.1 and E060.1 will be inspected weekly and after each flow event throughout the year; automated samplers and equipment at other gages will be inspected weekly from June 1 to October 31 and monthly from November 1 to May 31. Equipment found to be damaged or malfunctioning will be repaired within 5 business days after the problem is identified. Samples will be retrieved from the field within 1 business day of sample collection using the following priority order, if necessary:

- Lower watershed at E042.1, E050.1, E059.5, and E060.1;
- Upper watershed at E026, E055, E055.5, E056, CO101038, and CO111041; and
- DP Canyon at E038 and E039.1.

Deviations from the planned inspection, maintenance, and sample retrieval objectives will be described in the annual monitoring report, to be submitted to NMED in March 2015.

3.3 Discharge Gaging

Each of the stream gages listed in Table 3.0-1 will be monitored continuously throughout the year. Flooding on September 13, 2013, caused minor to major damage to gage stations throughout the LA/Pueblo watershed (with the exception of E055, E055.5, and E056). All the gage stations will be operational by the beginning of the monitoring period, June 1, 2014. Surveying is currently being performed to establish a new rating curve for the five gage stations (E026, E030, E040, E042.1, and E059.5) that experienced channel-changing flooding. The rating curve will be used to convert stage to discharge.

3.4 Sampling and Analysis

Storm water runoff sampling for SSC analyses at E050.1 and E060.1 will be triggered by discharges of approximately 5 cubic feet per second (cfs). Sampling at E038 will be triggered by discharges of approximately 40 cfs. All other gage stations will be triggered by discharges of approximately 10 cfs. Sampling at the detention basins below SWMU 01-001(f) will be triggered by a liquid-level actuator that detects the presence of water above the sampler intake. Storm water runoff sampling for chemical and radiochemical analyses will be triggered 10 min after the maximum discharge exceeding the triggering discharge. The analytical requirements for storm water samples are listed in Table 3.4-1. Samples at gages will be collected using automated storm water samplers that contain a carousel of twenty-four 1-L bottles and/or twelve 1-L bottles as specified in Tables 3.4-2, 3.4-3, 3.4-4, 3.4-5, and 3.4-6. Sample collection inlets will be placed a minimum of 0.33 ft above the bottom of natural stream channels and at 0.17 ft above the bottom of supercritical flumes. The sampling approach summarized above is intended to allow characterization of suspended sediment flux from the four portions of a typical hydrograph consisting of a rapidly rising limb, a short-duration peak, a rapidly receding limb following the peak, a longer-duration recessional limb, and contaminant concentrations from the portions of each hydrograph following the peak.

The assignment of samples for chemical and radiochemical analyses to segments of the hydrograph after the peak is consistent with NMED's assertion that "Samples collected before the peak flows are highly variable and have limited value in regard to sediment and contaminant transport evaluations" (NMED 2011, 203705). However, evaluation of monitoring data from 2011 suggests this approach is not optimum for estimating chemical and radionuclide transport because the early parts of the hydrograph, where discharge and SSC are highest are not sampled directly for contaminant concentrations, resulting in large uncertainties in contaminant and radionuclide mass/activity transport estimates through a hydrograph. Therefore, because one of the goals of the monitoring is to estimate chemical and radionuclide mass/activity transport at specific stations, the Laboratory recommends that the sampling approach continue to include sampling for targeted radionuclides earlier in each hydrograph. The results from 2012 and 2013 confirm that this approach is valid.

The Laboratory proposes to continue sampling and analyses of radionuclides before the peak of discharge to help improve estimates of radionuclide activity transport. One sample collected on the rising limb of the hydrograph near the peak of discharge will be selected for analyses of gamma spectroscopy radionuclides and isotopic plutonium instead of SSC. The sample for additional radiochemical analyses will be selected based on a visual inspection of the hydrograph before shipment to the analytical laboratory.

To characterize water quality entering and leaving the sediment detention basins and adjoining vegetative buffer below the SWMU 01-001(f) drainage, automated pump samplers will collect storm water from one location immediately upstream of sediment basin 1 and one location at the terminus of the vegetative buffer up to four times annually when storm water discharge is occurring (Figure 3.2-1). This configuration will continue during the 2014 monitoring effort.

Analytical suites vary according to monitoring groups and are based on key indicator contaminants for a given portion of the watershed. Table 3.0-1 shows the monitoring groups and the analytical suite for each location. Evaluation of analytical results will determine the quality of correlations existing between contaminant concentrations and SSCs. Results of SSC analyses will be used to calculate the total mass/activity transported during storm water runoff events at the gages. Particle-size analyses conducted in conjunction with selected SSC analyses will support characterization of chemicals and radionuclides.

The list of analytical suites for each monitoring group presented in Table 3.0-1 is prioritized to guide what analyses will be conducted if the collected water volume for a sample composite is not sufficient for all the planned suites. The analytical method, expected method detection limit (MDL), and minimal detectable activity (MDA) (for radionuclides) are presented in Table 3.4-1. The sampling sequence for CO101038 and CO111041 is presented in Table 3.4-2. The sampling sequence for E026, E030, E040, E055, E055.5, and E056 is presented in Table 3.4-3. Table 3.4-4 provides the sampling sequence at E038 and E039.1. Table 3.4-5 provides the sampling sequence at E042.1 and E059.5. Table 3.4-6 provides the sampling sequence at E050.1 and E060.1. Samples will be submitted for chemical and radiochemical analyses at gage stations E038, E059.5, and E042.1 if samples were collected during the event at their paired downstream gages (E039.1, E060.1, and E050.1, respectively).

Total suspended sediment transport during a runoff event is determined most accurately when discharge is sampled periodically for SSC analysis throughout the hydrograph. Samples for SSC measurements will be collected at 2-min intervals for the first 30 min, then at 20-min intervals throughout runoff events. Repeat measurements will be taken above and below the DP Canyon GCS at E038 and E039.1, above and below the Los Alamos Canyon low-head weir at E042.1 and E050.1, and above and below the Pueblo Canyon GCS at E059.5 and E060.1 to better characterize the performance of the structures. At these stations, a second sampler is dedicated to collecting storm water for SSC analyses with the objective of representing most or all of the duration of runoff. Collecting SSC samples at 2-min intervals during the first 30 min allows better characterization of the early part of the hydrograph and provides bottles for the radiochemical analyses before the storm peak.

Except at E050.1 and E060.1, where all events are monitored for all parameters, if four runoff events have been sampled at a gaging station, subsequent events with discharge less than the largest discharge will be analyzed for SSC only. At upper watershed gages where a single sampler containing a carousel of twelve 1-L bottles is installed, the first and last sample collected from these subsequent storms will be analyzed for SSC. At locations where a sampler containing a carousel of twenty-four 1-L bottles is installed and dedicated to collection of samples throughout the entire hydrograph (i.e., upstream and downstream of watershed mitigations), samples collected from this 24-bottle carousel from these subsequent storms will be analyzed for SSC. In this way, SSC analyses are obtained at many different times during the hydrograph, and suspended sediment transport for the entire runoff event can be characterized.

4.0 REPORTING

All data discussed and collected as part of this 2014 monitoring plan will be presented in the "Storm Water Performance Monitoring in the Los Alamos/Pueblo Watershed during 2014," to be submitted to NMED on or by March 31, 2015. An update to the sediment transport mitigation project monitoring plan will also be submitted to NMED on or by March 31, 2015.

5.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Gallaher, B.M., and R.J. Koch, September 2004. "Cerro Grande Fire Impacts to Water Quality and Stream Flow near Los Alamos National Laboratory: Results of Four Years of Monitoring," Los Alamos National Laboratory report LA-14177, Los Alamos, New Mexico. (Gallaher and Koch 2004, 088747)

LANL (Los Alamos National Laboratory), February 2008. "Interim Measure Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons," Los Alamos National Laboratory document LA-UR-08-1071, Los Alamos, New Mexico. (LANL 2008, 101714)

LANL (Los Alamos National Laboratory), October 2008. "Supplemental Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons," Los Alamos National Laboratory document LA-UR-08-6588, Los Alamos, New Mexico. (LANL 2008, 105716)

LANL (Los Alamos National Laboratory), October 2009. "Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-09-6563, Los Alamos, New Mexico. (LANL 2009, 107457)

LANL (Los Alamos National Laboratory), October 2010. "Interim Assessment to Report Storm Damage to Sediment Control Structures and Monitoring Stations in Los Alamos and Pueblo Canyons," Los Alamos National Laboratory document LA-UR-10-7281, Los Alamos, New Mexico. (LANL 2010, 111125)

LANL (Los Alamos National Laboratory), March 2011. "2011 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project," Los Alamos National Laboratory document LA-UR-11-0943, Los Alamos, New Mexico. (LANL 2011, 201578)

LANL (Los Alamos National Laboratory), May 2011. "2010 Geomorphic Changes at Sediment Transport Mitigation Sites in the Los Alamos and Pueblo Canyon Watersheds," Los Alamos National Laboratory document LA-UR-11-2970, Los Alamos, New Mexico. (LANL 2011, 203661)

LANL (Los Alamos National Laboratory), September 2012. "2012 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 2," Los Alamos National Laboratory document LA-UR-12-24779, Los Alamos, New Mexico. (LANL 2012, 222833)

LANL (Los Alamos National Laboratory), June 2013. "2013 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 1," Los Alamos National Laboratory document LA-UR-13-24419, Los Alamos, New Mexico. (LANL 2013, 243432)

LANL (Los Alamos National Laboratory), November 7, 2013. "Evaluation of Compliance Order on Consent Deliverables Due to Flooding and Lapse in Appropriations Force Majeure Events," Los Alamos National Laboratory letter (EP2013-0256) to J. Kieling (NMED-HWB) from J. Mousseau (LANL) and P. Maggiore (DOE-NA-00-LA), Los Alamos, New Mexico. (LANL 2013, 250970)

LANL (Los Alamos National Laboratory), April 14, 2014. "Request for Authorization to Conduct Stabilization and Habitat Restoration Work in Pueblo Canyon," Los Alamos National Laboratory letter (ENV-DO-14-0083) to J. Lillard (USACE) and N. Schaeffer (NMED-SWQB) from A.R. Grieggs (LANL), Los Alamos, New Mexico. (LANL 2014, 524744)

NMED (New Mexico Environment Department), January 11, 2010. "Approval with Modifications, Los Alamos and Pueblo Canyons Sediment Transport Monitoring Plan," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 108444)

NMED (New Mexico Environment Department), June 3, 2011. "Approval with Modifications, 2011 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 203705)

NMED (New Mexico Environment Department), January 23, 2013. "Approval, 2012 Monitoring Plan for Los Alamos and Pueblo Canyons, Sediment Transport Mitigation Project, Revision 2," New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and J.D. Mousseau (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2013, 521854)

NMED (New Mexico Environment Department), July 19, 2013. "Approval, 2013 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project, Revision 1," New Mexico Environment Department letter to P. Maggiore (DOE-LASO) and J.D. Mousseau (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2013, 523106)

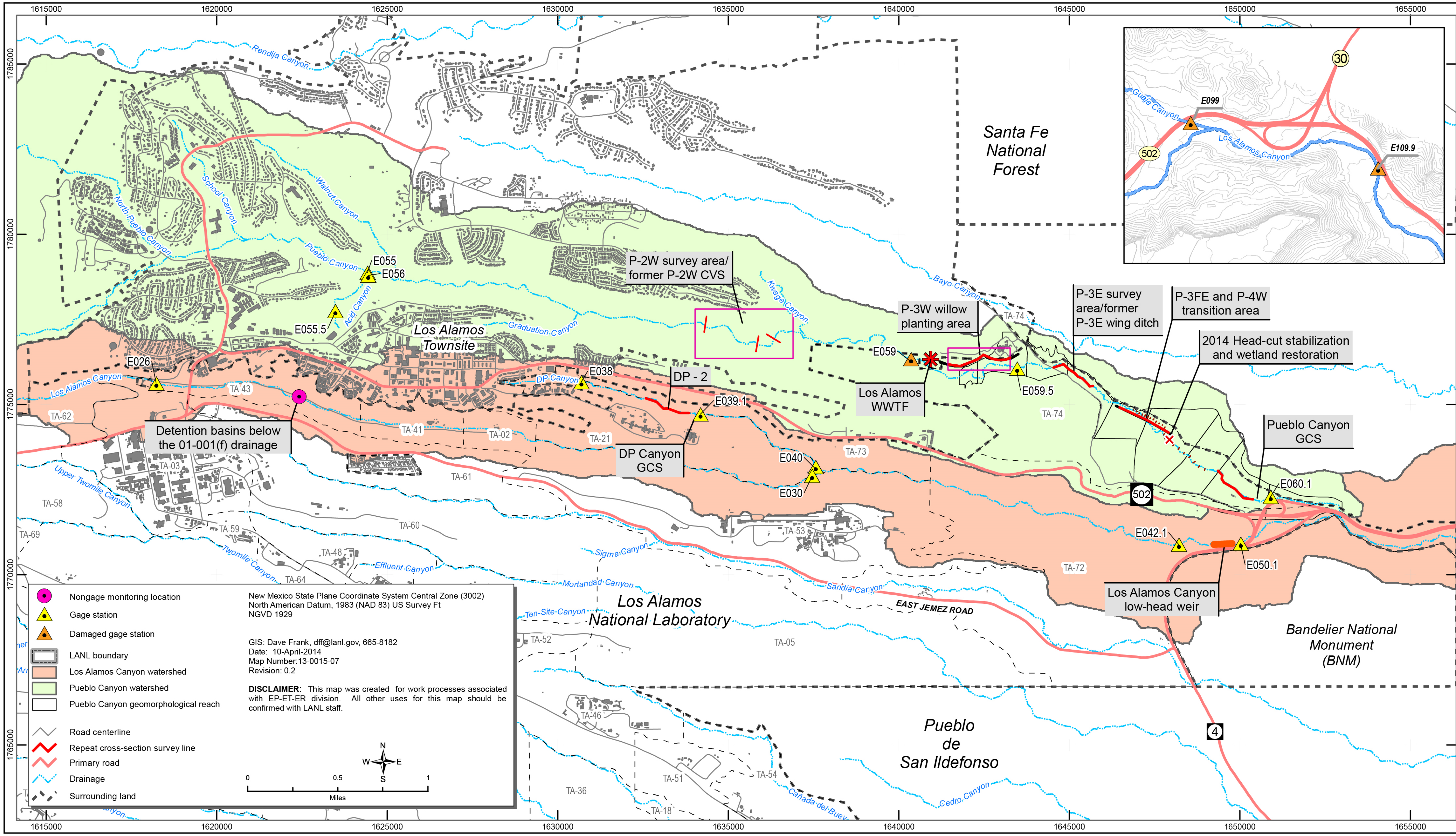

Figure 2.0-1 Los Alamos and Pueblo Canyons showing monitoring locations and sediment transport mitigation sites

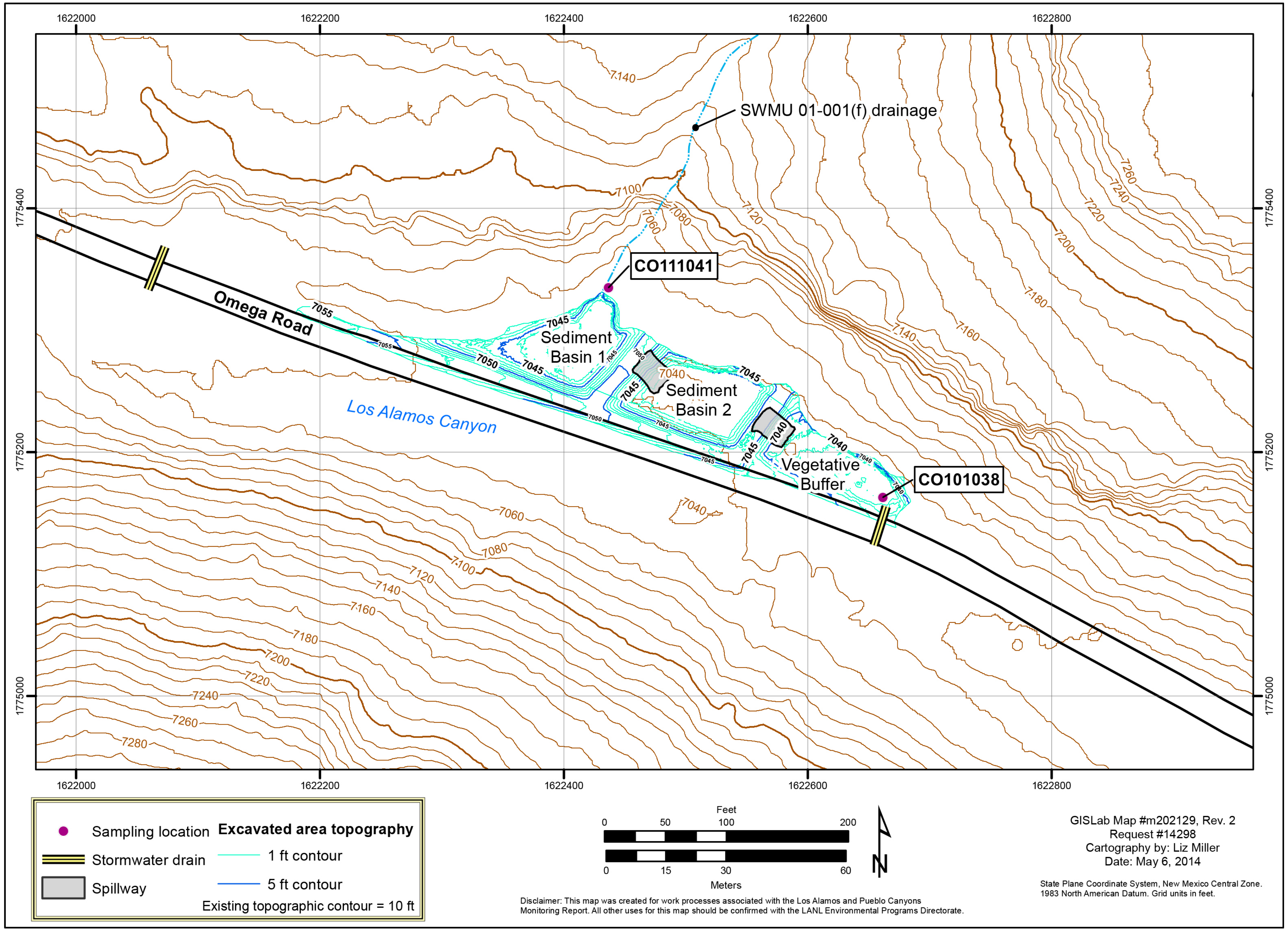

Figure 3.2-1 Detention basins and sampling locations below the SWMU 01-001(f) drainage

Table 3.0-1
Locations and Analytical Suites for Storm Water Samples

Monitoring Group	Locations	Analytical Suites[a]
Upper Los Alamos Canyon gages	E026, E030	PCBs[b] (by Method 1668A), gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, dioxin/furans, strontium-90, TAL[c] metals, hardness, SSC, particle size
DP Canyon gages	E038, E039.1, E040	PCBs (by Method 1668A), gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, strontium-90, TAL metals, hardness, SSC, particle size
Upper Pueblo Canyon and Acid Canyon gages	E055, E055.5, E056	PCBs (by Method 1668A), isotopic plutonium, TAL metals, hardness, SSC, particle size
Lower Los Alamos Canyon gages	E042.1, E050.1	PCBs (by Method 1668A), gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, americium-241 (by alpha spectroscopy), dioxins/furans, strontium-90, TAL metals, hardness, SSC, particle size
Lower Pueblo Canyon gages	E059.5, E060.1	PCBs (by Method 1668A), gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, americium-241 (by alpha spectroscopy), strontium-90, TAL metals, hardness, SSC, particle size
Detention basins and vegetative buffer below the SWMU 01-001(f) drainage	CO101038, CO111041	PCBs (by Method 1668A), TAL metals, hardness, isotopic uranium, total organic carbon, SSC, particle size
BDD[d]-Required Monitoring	E050.1, E060.1	PCBs (by Method 1668A), dioxins/furans, gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, americium-241 (by alpha spectroscopy), strontium-90, gross alpha, gross beta, radium-226/radium-228, TAL metals, hardness, SSC, particle size

[a] Suites are listed in order of priority to guide analysis of limited water volume. SSC is independent of prioritization because it is derived from separate sample bottles.

[b] PCBs = Polychlorinated biphenyls.

[c] TAL = Target analyte list; hardness is calculated from calcium and magnesium, components of the TAL list.

[d] BDD = Buckman Direct Diversion.

Table 3.4-1
Analytical Requirements for Storm Water Samples

Analytical Suite	Method	Detection Limit[a]	Upper Los Alamos Canyon	DP Canyon	Upper Pueblo Canyon and Acid Canyon	Lower Los Alamos Canyon	Lower Pueblo Canyon	BDD[b]-Required Monitoring	Detention Basins below the SWMU 01-001(f) Drainage
PCBs[c]	EPA:1668A	25 pg/L	√[d]	√	√	√	√	√	√
Isotopic plutonium	HASL-300	0.5 pCi/L	√	√	√	√	√	√	—[e]
Gamma spectroscopy	EPA:901.1	10 pCi/L (cesium-137)	√	√	—	√	√	√	—
Isotopic uranium	HASL-300	0.5 pCi/L	√	√	—	√	√	√	√
Americium-241	HASL-300	0.5 pCi/L	—	—	—	√	√	√	—
Strontium-90	EPA:905.0	0.5 pCi/L	√	√	—	√	√	√	—
TAL[f] metals	EPA:200.7/200.8/245.2	Variable	√	√	√	√	√	√	√
Dioxins and furans	EPA:1613B	50 pg/L	√	—	—	√	—	√	—
Gross alpha	EPA:900	10 pCi/L	—	—	—	—	—	√	—
Gross beta	EPA:900	10 pCi/L	—	—	—	—	—	√	—
Radium-226/radium-228	EPA:903.1/EPA:904	0.5/0.5 pCi/L	—	—	—	—	—	√	—
SSC	EPA:160.2	10 mg/L	√	√	√	√	√	√	√
Total organic carbon	SW-846:9060	0.5 mg/L	—	—	—	—	—	—	√
Particle size	ASTM:C1070	0.01%	√	√	√	√	√	√	√

[a] MDL or MDA for radionuclides.
[b] BDD = Buckman Direct Diversion.
[c] PCBs = Polychlorinated biphenyls.
[d] √ = Monitoring planned.
[e] — = Monitoring not planned.
[f] TAL = Target analyte list; hardness is calculated from calcium and magnesium, components of the TAL list.

Table 3.4-2
Sampling Sequence for Collection of Storm Water Samples at the Detention Basins and Vegetative Buffer below the SWMU 01-001(f) Drainage

Sample Bottle (1 L)	CO101038, CO111041	
	Start Time (min) 12-Bottle ISCO	Analytical Suite
1	Trigger	SSC; particle size
2	Trigger +1	PCBs[a] (UF[b])
3	Trigger +2	PCBs (UF)
4	Trigger +3	TAL[c] metals (F[d]/UF)
5	Trigger +4	Isotopic uranium (UF)
6	Trigger +5	TOC[e] (UF)
7	Trigger +6	Extra bottle
8	Trigger +7	Extra bottle
9	Trigger +8	Extra bottle
10	Trigger +9	Extra bottle
11	Trigger +10	Extra bottle
12	Trigger +11	Extra bottle

[a] PCBs = Polychlorinated biphenyls.
[b] UF = Unfiltered.
[c] TAL = Target analyte list.
[d] F = Filtered.
[e] TOC = Total organic carbon.

Table 3.4-3
Sampling Sequence for Collection of
Storm Water Samples at E026, E030, E055, E055.5, and E056

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E026 and E030	E055, E055.5, and E056
		Analytical Suites	Analytical Suites
1	Max+10	SSC, particle size	SSC (UF[a]); particle size
2	Max+11	PCBs[b] (UF)	PCB (UF)
3	Max+12	PCBs (UF)	PCB (UF)
4	Max+13	Gamma spectroscopy(UF)	Isotopic plutonium (UF)
5	Max+14	Isotopic plutonium; isotopic uranium (UF)	TAL[c] metals (F[d]/UF)
6	Max+15	Isotopic plutonium; isotopic uranium (UF)	SSC
7	Max+16	Strontium-90 (UF)	Extra bottle
8	Max+17	Dioxins and furans (UF)	Extra bottle
9	Max+18	Dioxins and furans (UF)	Extra bottle
10	Max+19	TAL metals (F/UF)	Extra bottle
11	Max+20	SSC	Extra bottle
12	Max+21	Extra bottle	Extra bottle

[a] UF = Unfiltered.

[b] PCBs = Polychlorinated biphenyls.

[c] TAL = Target analyte list.

[d] F = Filtered.

Table 3.4-4
Sampling Sequence for Collection of Storm Water Samples at E038, E039.1, and E040

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E038 and E039.1	E040	E038 and E039.1	
		Analytical Suites	Analytical Suites	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge[a]
1	Max+10	PCBs[b] (UF[c])	SSC; particle size	Trigger	SSC
2	Max+11	PCBs (UF)	PCBs (UF)	Trigger+2	SSC
3	Max+12	Gamma spectroscopy (UF)	PCBs (UF)	Trigger+4	SSC
4	Max+13	Isotopic uranium; isotopic plutonium (UF)	Gamma spectroscopy (UF)	Trigger+6	SSC
5	Max+14	Isotopic uranium; isotopic plutonium (UF)	Isotopic uranium; isotopic plutonium (UF)	Trigger+8	SSC
6	Max+15	Strontium-90 (UF)	Isotopic uranium; isotopic plutonium (UF)	Trigger+10	SSC
7	Max+16	TAL[d] metals (F[e]/UF)	Strontium-90 (UF)	Trigger+12	SSC
8	Max+17	Extra bottle	TAL metals (F/UF)	Trigger+14	SSC
9	Max+18	Extra bottle	SSC	Trigger+16	SSC
10	Max+19	Extra bottle	Extra bottle	Trigger+18	SSC; particle size
11	Max+20	Extra bottle	Extra bottle	Trigger+20	SSC
12	Max+21	Extra bottle	Extra bottle	Trigger+22	SSC
13	n/a[f]	n/a	n/a	Trigger+24	SSC
14	n/a	n/a	n/a	Trigger+26	SSC
15	n/a	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	n/a	Trigger+30	SSC
17	n/a	n/a	n/a	Trigger+50	SSC
18	n/a	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	n/a	Trigger+90	SSC
20	n/a	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	n/a	Trigger+130	SSC
22	n/a	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	n/a	Trigger+190	SSC

[a] Two SSC analysis collected before the peak of discharge will be replaced by gamma spectroscopy and isotopic plutonium analyses.

[b] PCBs = Polychlorinated biphenyls.

[c] UF = Unfiltered.

[d] TAL = Target analyte list.

[e] F = Filtered.

[f] n/a = Not applicable.

Table 3.4-5
Sampling Sequence for Collection of Storm Water Samples at E042.1 and E059.5

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E042.1	E059.5	E042.1 and E059.5	
		Analytical Suites 12-Bottle ISCO	Analytical Suites 12-Bottle ISCO	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge[a]
1	Max+10	PCBs[b] (UF[c])	PCBs (UF)	Trigger	SSC
2	Max+11	PCBs (UF)	PCBs (UF)	Trigger+2	SSC
3	Max+12	Gamma spectroscopy (UF)	Gamma spectroscopy (UF)	Trigger+4	SSC
4	Max+13	Isotopic plutonium, americium-241, and isotopic uranium (UF)	Isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+6	SSC
5	Max+14	Isotopic plutonium, americium-241, and isotopic uranium (UF)	Isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+8	SSC
6	Max+16	Dioxins/furans (UF)	TAL[d] metals (F[e])	Trigger+10	SSC
7	Max+17	TAL metals (F/UF)	TAL metals (UF)	Trigger+12	SSC
8	Max+18	Strontium-90 (UF)	Strontium-90 (UF)	Trigger+14	SSC
9	Max+60	PCBs (UF)	PCBs (UF)	Trigger+16	SSC; particle size
10	Max+61	Isotopic plutonium (UF)	Isotopic plutonium (UF)	Trigger+18	SSC
11	Max+105	PCBs (UF)	PCBs (UF)	Trigger+20	SSC
12	Max+106	Isotopic plutonium (UF)	Isotopic plutonium (UF)	Trigger+22	SSC
13	n/a[f]	n/a	n/a	Trigger+24	SSC
14	n/a	n/a	n/a	Trigger+26	SSC
15	n/a	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	n/a	Trigger+30	SSC
17	n/a	n/a	n/a	Trigger+50	SSC; particle size
18	n/a	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	n/a	Trigger+90	SSC; particle size
20	n/a	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	n/a	Trigger+130	SSC
22	n/a	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	n/a	Trigger+190	SSC

[a] Two SSC analysis collected before the peak of discharge will be replaced by gamma spectroscopy and isotopic plutonium analyses.

[b] PCBs = Polychlorinated biphenyls.

[c] UF = Unfiltered.

[d] TAL = Target analyte list.

[e] F = Filtered.

[f] n/a = Not applicable.

Table 3.4-6
Sampling Sequence for Collection of Storm Water Samples at E050.1 and E060.1

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	E050.1 and E060.1	E050.1 and E060.1	
		Analytical Suites 12-Bottle ISCO	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO 1-L Poly Wedge[a]
1	Max+10	PCBs[b] (UF[c])	Trigger	SSC
2	Max+11	PCBs (UF)	Trigger+2	SSC
3	Max+12	Gamma spectroscopy (UF)	Trigger+4	SSC
4	Max+13	Isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+6	SSC
5	Max+14	Isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+8	Radium-226 (UF)
6	Max+16	Strontium-90 (UF)	Trigger+12	Radium-228 (UF)
7	Max+17	TAL[d] metals (F[e]/UF)	Trigger+14	SSC
8	Max+18	Dioxins/furans (UF)	Trigger+16	Gross alpha/beta (UF)
9	Max+60	PCB (UF)	Trigger+18	SSC; particle size
10	Max+61	Isotopic plutonium (UF)	Trigger+20	SSC
11	Max+105	PCB (UF)	Trigger+22	SSC
12	Max+106	Isotopic plutonium (UF)	Trigger+24	SSC
13	n/a[f]	n/a	Trigger+26	SSC
14	n/a	n/a	Trigger+28	SSC
15	n/a	n/a	Trigger+30	SSC
16	n/a	n/a	Trigger+50	SSC
17	n/a	n/a	Trigger+70	SSC; particle size
18	n/a	n/a	Trigger+90	SSC
29	n/a	n/a	Trigger+110	SSC; particle size
20	n/a	n/a	Trigger+130	SSC
21	n/a	n/a	Trigger+150	SSC
21	n/a	n/a	Trigger+170	SSC
23	n/a	n/a	Trigger+190	SSC
24	n/a	n/a	Trigger+210	SSC

[a] Two SSC analysis collected before the peak of discharge will be replaced by gamma spectroscopy and isotopic plutonium analyses.

[b] PCBs = Polychlorinated biphenyls.

[c] UF = Unfiltered.

[d] TAL = Target analyte list.

[e] F = Filtered.

[f] n/a = Not applicable.

Appendix A

Justification for Changes to 2014 Monitoring

In 2013, the Los Alamos watershed showed recovery from impacts from the 2011 Las Conchas fire. As a result, Los Alamos National Laboratory (the Laboratory) proposes to discontinue monitoring initiated in response to the fire. In 2011, americium-241 and cyanide were added to the analytical suites at gages E026 and E030, and cyanide was added to the analytical suites at the other Los Alamos Canyon gages (E042.1, E050.1, and E109.9). Additionally, suspended sediment concentrations (SSC) measurements across the hydrograph were repeated at the upper boundary station at E026 to better characterize sediment flux from the burn area upstream from Laboratory sites.

An assessment of analytical data generated from storm water samples collected since 2000 in Los Alamos and Pueblo Canyon watersheds shows the extent of recovery. Activities of americium-241 at E026 and E030 and the concentrations of cyanide spiked in ash-laden storm water collected in 2011 and 2012. In storm water collected in 2013, the activities of americium-241 at E026 and E030 and the concentrations of cyanide returned to levels detected before the Las Conchas fire. In sediments entrained in storm water collected in 2013, the activities of americium-241 at E026 and E030 and the concentrations of cyanide returned to levels expected in canyon sediments unaffected by Laboratory activities.

Background concentrations of inorganic chemicals, naturally occurring radionuclides, and fallout radionuclides within Los Alamos Canyon sediments are presented in a Laboratory report and accepted by regulatory authorities (LANL 1998, 059730). Storm water entrains canyon sediments during flooding and is representatively collected during storms using automated ISCO samplers. By normalizing pollutant concentrations in storm water to the sediment content of the storm water, it is possible to determine when pollutant loads within storm water may be attributed to background constituents and when contaminated sediments are entrained in storm water at concentrations greater than background.

Americium-241

Americium-241 is a constituent of atmospheric fallout from nuclear weapons testing during the 1950s and 1960s, accumulates in biomass, and is released when combusted during wildland fires. Atmospheric fallout is the predominant source of americium-241 in Los Alamos Canyon upstream of E030. Before the Las Conchas fire, americium-241 monitoring was discontinued at E026 and E030 because only background sources of americium-241 were detected upstream of E030. During the 2011 monitoring season, americium-241 was added to constituents monitored at E026 and E030 to document expected increases in americium-241 in ash following the Las Conchas fire. Americium-241 activities increased in ash-laden storm water collected in 2011 and 2012. Americium-241 activity in storm water was not detected in 2013 (Figure A-1), and activities in storm water normalized to suspended sediment collected at E026 and E030 in 2013 fell below canyon sediment background activity of 0.04 pCi/g (Figure A-2).

The results of americium-241 analyses from storm water samples collected at E026 and E030 since 2000 were reviewed and are summarized in Table A-1. Americium-241 can be analyzed using alpha or gamma spectroscopy. Detection limits and uncertainties produced by the gamma spectroscopy analytical method are not adequate to detect activities of americium-241 present in storm water affected only by atmospheric fallout. Therefore, only analyses produced by alpha spectroscopy methods were included in this evaluation.

Cyanide

Cyanide is a combustion product and has historically been a component of aerially dispersed fire retardant. Cyanide naturally occurring in canyon sediments is the predominant source in the Los Alamos/Pueblo watershed. Before the Las Conchas fire in 2011, monitoring for cyanide was discontinued at all Los Alamos and Pueblo gages in 2010. During the 2011 monitoring season, cyanide was added to constituents monitored at all fire-affected gages—E026, E030, E042.1, E050.1, E099, and E109.9,in Los Alamos and Guaje Canyons—to monitor expected increases following the Las Conchas fire. Cyanide concentrations were elevated at all monitoring locations impacted by ash in 2011 and 2012 (Figure A-3). In 2013, cyanide concentrations in storm water normalized to suspended sediment fell below the expected canyon sediment background concentration of 0.82 mg/kg (Figure A-4).

The results of cyanide analyses from storm water samples collected in Los Alamos and Pueblo Canyons since 2000 were reviewed and are summarized in Table A-2. The results for both total cyanide and cyanide amenable to chlorination provide a reliable measure of cyanide present in storm water and thus were included. Results rejected because of quality or analytical problems were excluded from the review.

Suspended Sediment

Following the Las Conchas fire, two changes were made to better characterize the mass of sediment moving past the gage at E026 onto Laboratory property. Repeat measurements of suspended sediment across the hydrograph were added to the analytical suite at E026, and the American Society for Testing and Materials (ASTM) Method D3977-97 to determine suspended sediment replaced EPA Method 160.2 to measure selected suspended sediment.

Total suspended solids (TSS) in storm water have traditionally been measured at the Laboratory using U.S. Environmental Protection Agency (EPA) Method 160.2. Analyses produced by this method have been reported as either TSS or SSC; in this report these analyses are referenced as TSS, irrespective of the parameter reported. In the EPA method, TSS is measured using an aliquot of sample that has been filtered and dried. This EPA method was originally designed for analyses of wastewater samples. Subsampling required by EPA Method 160.2 produces results that under represent the actual amount of solid material in storm water samples. The EPA method has been shown to be fundamentally unreliable for analyzing natural water samples (Gray et al. 2000, 255422).

Beginning in 2012, SSC analyses in storm water samples were measured using ASTM Method D3977-97. Analyses produced by this method have only been reported as SSC. In the ASTM method, the SSC of storm water is measured by evaporating the entire sample volume to dryness.

TSS measurements made by EPA Method 160.2 recover approximately one-third of suspended sediment measured by ASTM Method D3977-97 (Figure A-5). Measurements of suspended sediment will continue to be made using ASTM Method D3977-97, which will improve estimates of mass/activity transport through the watershed. Repeat measurements of constituents are not needed to measure the performance of controls associated at gage E026; therefore, repeat analyses of suspended sediment through the hydrograph are not needed at this upper boundary location. Concentrations of suspended sediment measured at gage E026 in storm water since 2000 are presented in Figure A-6.

REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Gray, J.R., G.D. Glysson, L.M. Turcios, and G.E. Schwarz, August 2000. "Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data," U.S. Geological Survey Water-Resources Investigations Report 00-4191, Reston, Virginia. (Gray et al. 2000, 255422)

LANL (Los Alamos National Laboratory), September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 059730)

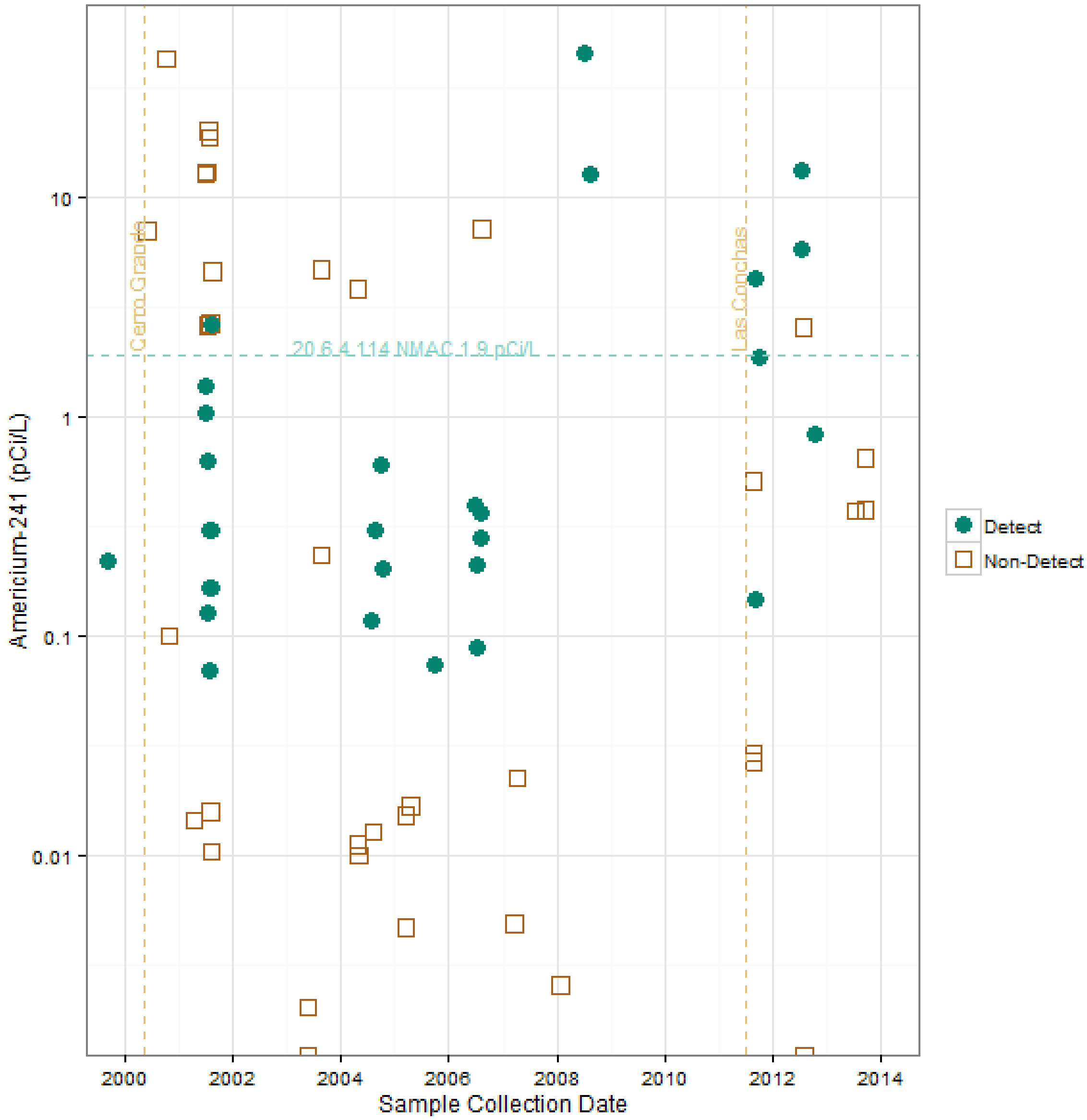

Figure A-1 Americium-241 activity at gages E026 and E030 in the Los Alamos watershed

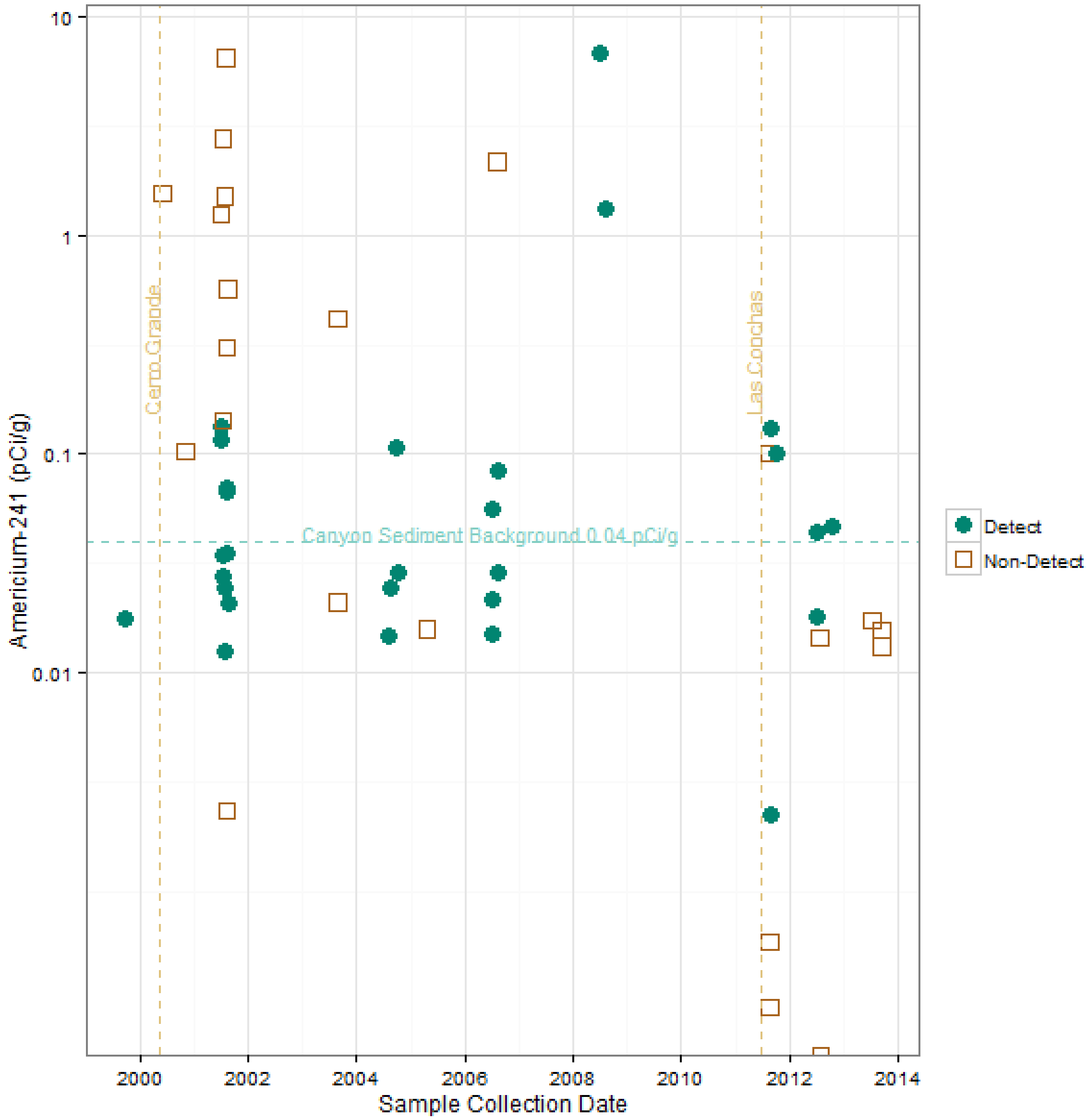

Figure A-2 **Americium-241 normalized activity at gages E026 and E030 with sediment concentration greater than 500 mg/L**

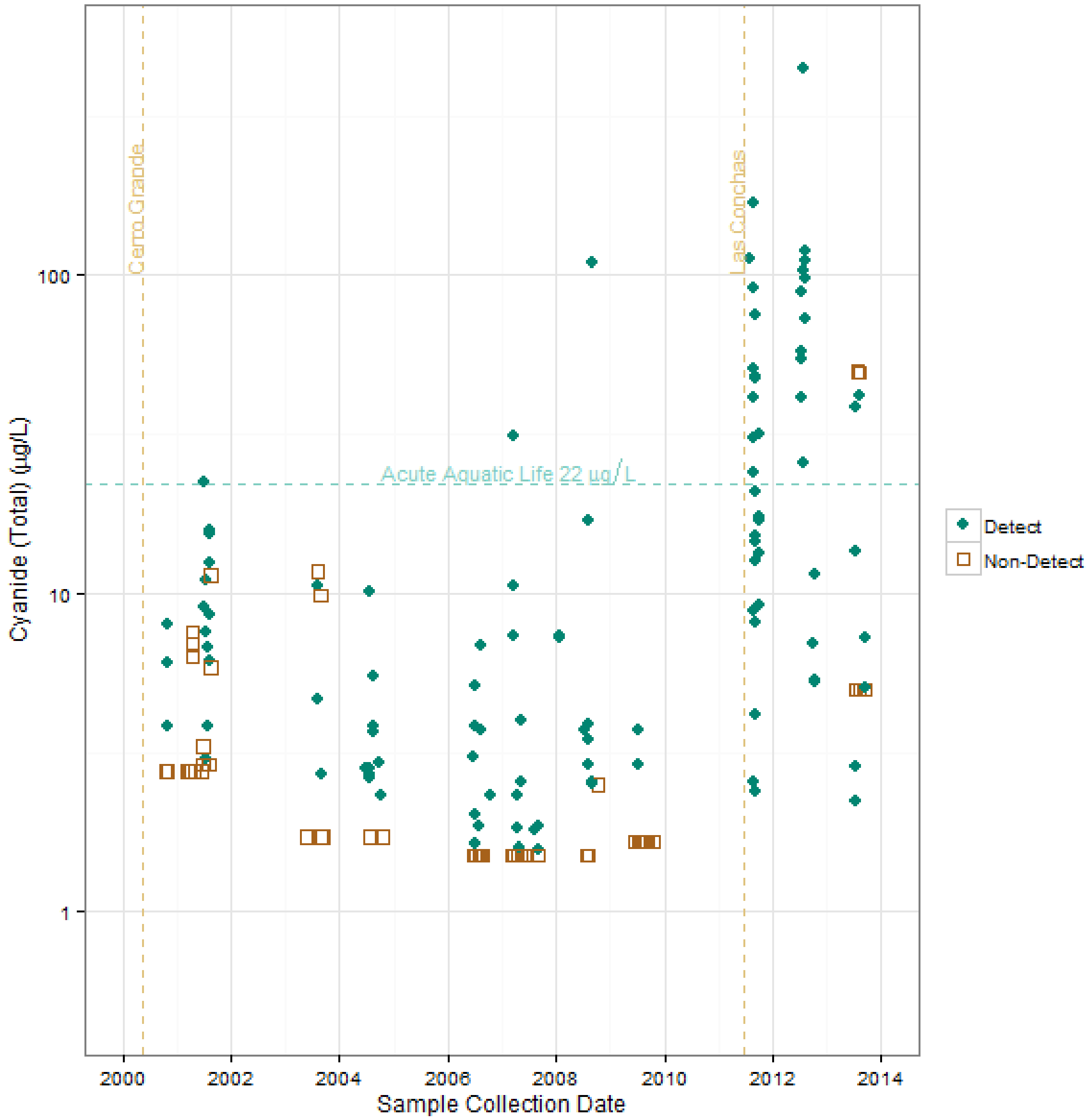

Figure A-3 Cyanide concentration in the Los Alamos watershed

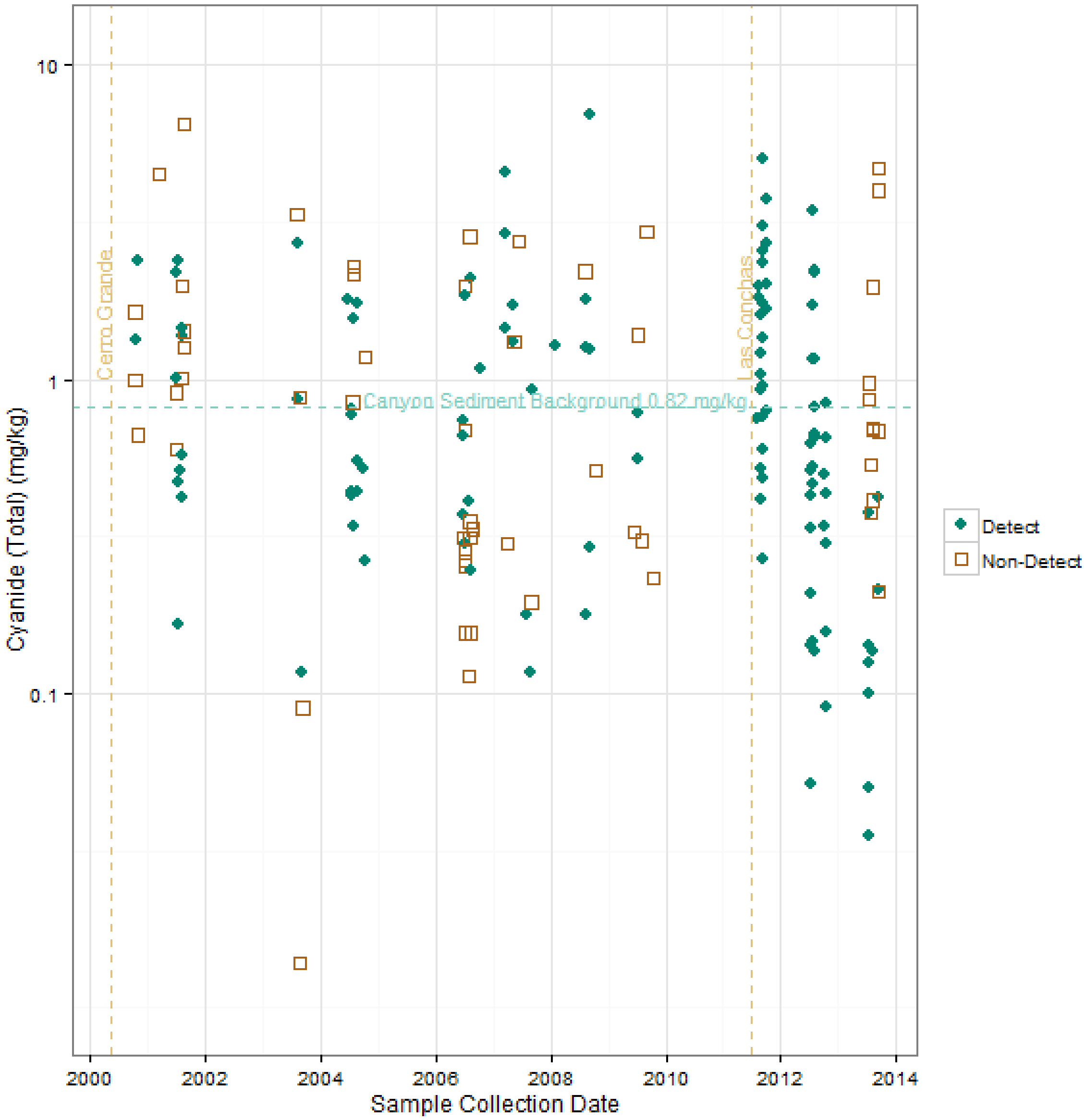

Figure A-4 Cyanide normalized concentration in the Los Alamos watershed with suspended sediment concentrations greater than 500 mg/L

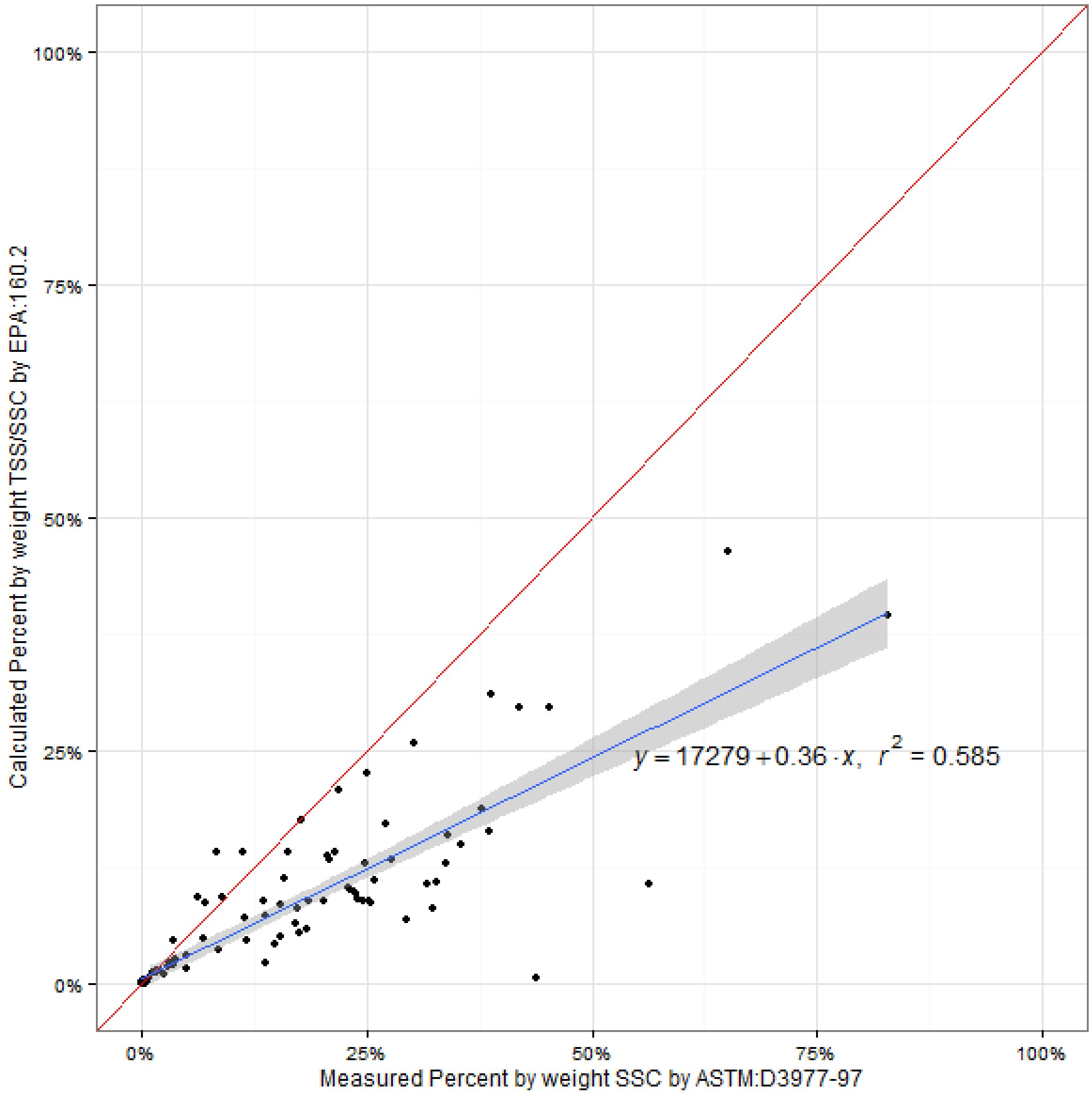

Figure A-5 Calculated TSS versus measured SSC in Los Alamos/Pueblo Canyons during 2012–2013

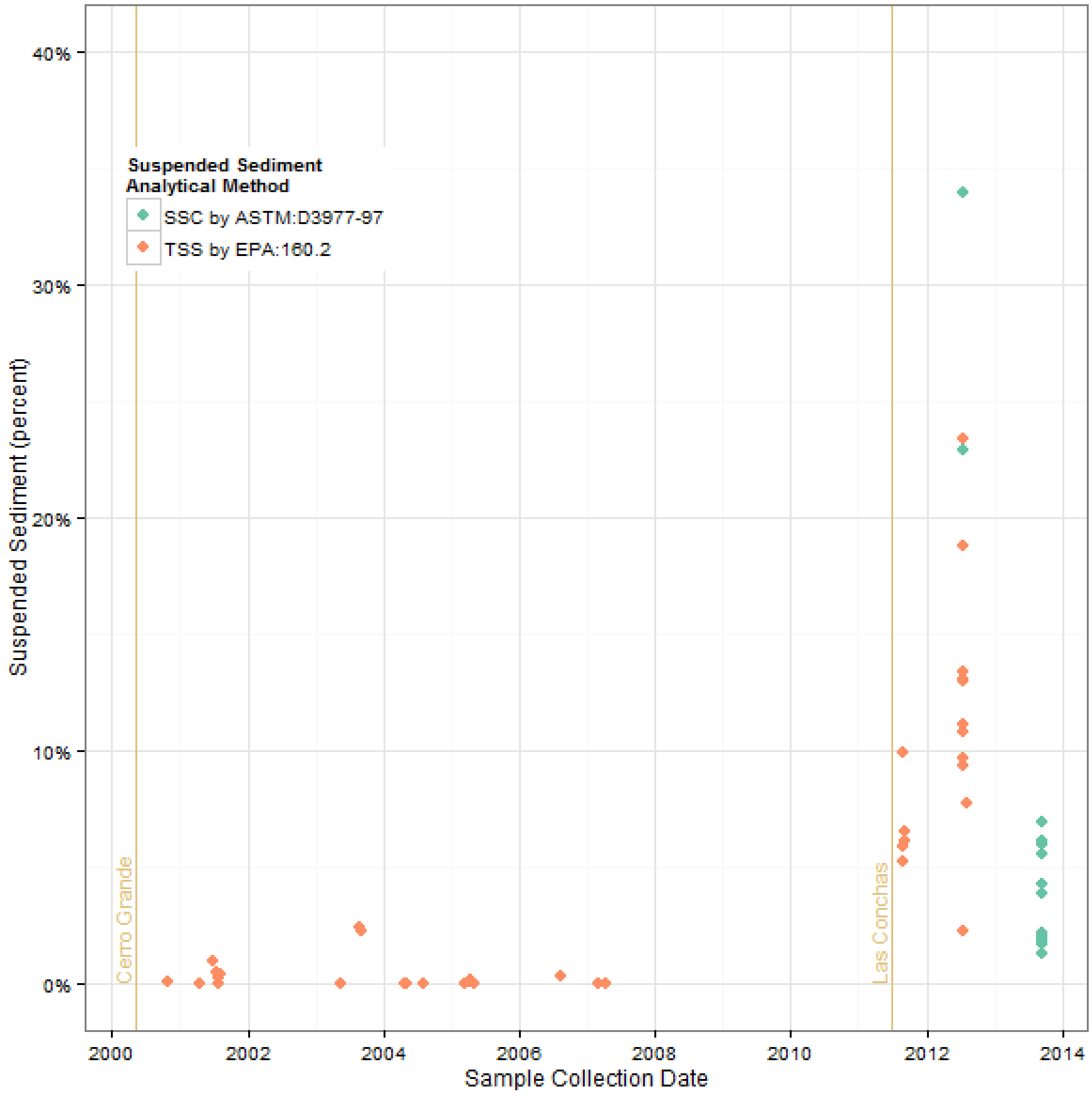

Figure A-6 Measured SSC at gage E026

Table A-1
Summary of Americium-241 Analyses by Alpha Spectroscopy at Gages E026 and E030 since 2000

Station	Analyte	Units	Field Prep	Number of Analyses	Number of Detects	Percent Detect	Minimum Detect	Average Detect	Maximum Detect
E026	Am-241	pCi/L	UF*	18	7	39	0.0697	1.15	5.78
E030	Am-241	pCi/L	UF	35	21	60	0.073	4.07	45.5

*UF = Unfiltered.

Table A-2
Summary of Cyanide Analyses in Storm Water from Los Alamos and Pueblo Watersheds since 2000

Station	Analyte	Units	Field Prep	Number of Analyses	Number of Detects	Percent Detect	Minimum Detect	Average Detect	Maximum Detect
E026	CN(TOTAL)	mg/L	UF*	17	11	65	0.0027	0.0477	0.0211
E030	CN(TOTAL)	mg/L	UF	36	27	75	0.00221	0.109	0.0249
E038	CN(TOTAL)	mg/L	UF	26	11	42	0.00158	0.00466	0.0028
E040	CN(TOTAL)	mg/L	UF	11	4	36	0.00157	0.00721	0.00306
E042	CN(TOTAL)	mg/L	UF	35	15	43	0.00233	0.0313	0.00645
E042.1	CN(TOTAL)	mg/L	UF	13	9	69	0.0152	0.104	0.0594
E050	CN(TOTAL)	mg/L	UF	20	8	40	0.00181	0.0153	0.00509
E050.1	CN(TOTAL)	mg/L	UF	20	18	90	0.00157	0.111	0.0251
E055	CN(TOTAL)	mg/L	UF	23	9	39	0.00169	0.0698	0.0122
E055.5	CN(TOTAL)	mg/L	UF	12	5	42	0.00166	0.0292	0.00779
E056	CN(TOTAL)	mg/L	UF	15	5	33	0.00202	0.0161	0.00561
E059	CN(TOTAL)	mg/L	UF	1	1	100	0.00597	0.00597	0.00597
E099	CN(TOTAL)	mg/L	UF	12	8	67	0.00371	0.0729	0.0259
E109.9	CN(TOTAL)	mg/L	UF	15	13	87	0.00418	0.446	0.119

*UF = Unfiltered.