ERID-213289

LA-UR-12-1080
March 2012
EP2012-0044

2012 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

Los Alamos National Laboratory, operated by Los Alamos National Security, LLC, for the U.S. Department of Energy under Contract No. DE-AC52-06NA25396, has prepared this document pursuant to the Compliance Order on Consent, signed March 1, 2005. The Compliance Order on Consent contains requirements for the investigation and cleanup, including corrective action, of contamination at Los Alamos National Laboratory. The U.S. government has rights to use, reproduce, and distribute this document. The public may copy and use this document without charge, provided that this notice and any statement of authorship are reproduced on all copies.

EP2012-0044

2012 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project

March 2012

Responsible project manager:

Printed Name	Signature	Title	Organization	Date
Steve Veenis		Project Manager	Environmental Programs	3/7/12

Responsible LANS representative:

Printed Name	Signature	Title	Organization	Date
Michael J. Graham		Associate Director	Environmental Programs	3/7/12

Responsible DOE representative:

Printed Name	Signature	Title	Organization	Date
George J. Rael		Manager	DOE-LASO	3-9-2012

CONTENTS

1.0 INTRODUCTION

This monitoring plan is submitted pursuant to the New Mexico Environment Department's (NMED's) approval with modification letter, dated June 3, 2011 (NMED 2011, 203705), of the "2011 Monitoring Plan for Los Alamos and Pueblo Canyons Sediment Transport Mitigation Project" (LANL 2011, 201578). The objective of this monitoring plan is to evaluate the effect of mitigation measures that were undertaken in the Los Alamos and Pueblo Canyons (LA/Pueblo) watershed under the 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, several activities have been undertaken to reduce flood energy and associated sediment transport. These activities include willow planting, construction of cross-vane structures (CVSs), a wing ditch, grade-control structures (GCSs), sediment detention basins, and modification of basins above a low-head weir. Because contaminants migrate with sediment entrained in runoff, reduced sediment transport will thereby reduce contaminant transport, which is the primary objective of these activities.

Two types of monitoring that began in 2010 continued in 2011 and will continue in the foreseeable future to meet the objectives of (1) monitoring geomorphic changes in the canyon bottom that are measures of performance of various mitigations and (2) collecting and analyzing stormwater runoff samples at gage and monitoring stations located throughout the watershed. Monitoring conducted during 2010 in the LA/Pueblo watershed was performed per 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 conducted during 2011 in the LA/Pueblo watershed was performed per 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). This monitoring plan builds upon these previous documents.

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 (DOE) policy. Water quality results from stormwater events are systematically uploaded to the publically accessible environmental monitoring database, RACER.

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. Surveys have been conducted annually in late fall, winter, or early spring to document geomorphic changes that may have occurred during the previous summer monsoon season. The optimal time is selected based on the weather, the presence or absence of ponded water in constructed basins, and the ability to work in wetlands after dense vegetation has senesced. Figure 2.0-1 shows the areas where surveys have been conducted, and where repeat surveys are planned after the 2012 monsoon season, as described below.

Evaluation of survey data from previous years (e.g., LANL 2011, 203661) indicates the channel thalweg surveys are not the best method for evaluating changes in channel elevation in the survey areas. Specifically, because of changes in thalweg sinuosity and year-to-year variability in survey point spacing that affect the total cumulative length of the survey, thalweg profiles from 1 yr cannot be reliably overlain on profiles from a previous year to evaluate changes in channel elevation. Instead, potential channel elevation changes (aggradation or incision) can be more effectively monitored by directly comparing thalweg elevation at each surveyed cross-section in successive years. Therefore, the Laboratory proposes to discontinue annual thalweg surveys and instead will evaluate channel elevation changes directly at the cross-sections.

2.1 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) (Figure 2.0-1). A longitudinal survey of the thalweg elevation through this area was also conducted that encompasses an area where willows were planted in spring 2009. 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.

Upper willow-planting area—A total of 18 cross-sections were originally surveyed in October 2009 in the area where willows were planted in spring 2008 and 2009 between the new County of Los Alamos wastewater treatment plant (WWTP) outfall and the wing ditch (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. Annual resurveys at the upper 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.

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 monitor potential changes in the upcanyon wetland.

CVSs—Two cross-sections were originally surveyed in April and May 2010 in the vicinity of 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 serve to monitor potential geomorphic changes in Pueblo Canyon upstream from the WWTP outfall.

Wing ditch—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 designed to divert water from the main channel through the upper part of the lower Pueblo Canyon wetland into an abandoned channel to the south. However, the wing ditch is no longer needed for this purpose because new culverts installed during road reconstruction completed by the County of Los Alamos in 2011 immediately upstream from the wing ditch effectively divert water into this formerly abandoned channel. Although no longer needed to perform monitoring, annual resurveys in this area serve to monitor potential geomorphic changes in this part of the wetland.

2.2 Los Alamos Canyon

DP Canyon GCS—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.

Los Alamos Canyon low-head weir—After modifications were made in 2009 to the sediment detention basin above the Los Alamos Canyon low-head weir, including development of three separate basins, an initial topographic survey of this area was conducted in July 2009 (Figure 2.0-1). The basins were reexcavated in June 2011 in preparation for expected floods following the Las Conchas fire, and a new baseline survey was conducted in July 2011. Irregular topography associated with basalt mounds and constructed modifications above the weir warrants a more detailed survey than can be conducted with repeat cross-sections, and instead the topography of the area is surveyed in detail. Annual resurveys of this area enable annual measurements of sediment accumulation within the basins.

Upper Los Alamos Canyon detention basins—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 in preparation for expected floods following the Las Conchas fire, and a new baseline survey was conducted in July 2011. Annual resurveys of this area enable annual measurements of sediment accumulation within the basins.

3.0 MONITORING STORMWATER RUNOFF

Stormwater monitoring will be conducted at locations shown in Figure 2.0-1 and listed in Table 3.0-1. These locations are collectively situated to compartmentalize monitoring data for performance evaluation of the sediment transport mitigation sites within the watershed. Data will also be available to document baseline conditions upcanyon of these sites and evaluate contaminant sources. The goals of the sampling are (1) to collect data that represent variations in contaminant concentrations and suspended sediment concentrations (SSC) within runoff events at each location and (2) to evaluate short-term and long-term trends in SSC, suspended sediment yield, and contaminant concentrations associated with the mitigation sites. The monitoring strategy described below is developed to achieve these goals. After implementation of this plan, data collected during 2010, 2011, and 2012 will be reviewed and recommendations will be made, if appropriate, regarding potential changes to analytical suites and/or sampling.

Large parts 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), stormwater chemistry can be strongly affected by incorporation of ash from burn areas. To help evaluate the influence of the Las Conchas fire on stormwater quality in 2011, americium-241 and cyanide were added to the analytical suites at 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, repeat SSC measurements across the hydrograph were made at the upper boundary station at E026 to better characterize sediment flux from the burn area upstream from Laboratory sites. These modifications to the monitoring plan will continue in 2012.

Additionally, samples will be collected using automated pump samplers at the detention basins below SWMU 01-001(f) at the locations shown in Figure 3.0-1 and listed in Table 3.0-1. These samples will allow the performance of the sediment detention basins to be evaluated. Planned monitoring at the detention basins will be unchanged from 2011.

As directed in the approval with modifications for the 2011 monitoring plan (NMED 2011, 203705), sampling was conducted in Graduation Canyon during 2011. The results of these analyses were reported in the March 2012 “Stormwater Performance Monitoring in the Los Alamos/Pueblo Watershed during 2011” (LANL 2012, 211396). Continued monitoring at this location is not proposed.

3.1 Discharge Gaging

Each of the stream gages listed in Table 3.1-1 will be monitored continuously for stage. Each gage, except for E099 in lower Guaje Canyon (Figure 2.0-1), has an established rating curve that will be reviewed annually or after large channel-altering floods to enable conversion of stage to discharge. Additionally, a rating curve will be developed for E099 during 2012, if possible.

3.2 Sampling and Analysis

Stormwater runoff sampling for SSC analyses at each of the monitoring locations, except E050.1, E060.1, E109.9 and at the detention basins below SWMU 01-001(f), will be triggered by discharges of approximately 10 cubic feet per second (cfs). Sampling for SSC analyses at E050.1, E060.1, and E109.9 will be triggered by 5-cfs discharges to ensure sampling at small discharges that may extend to the Rio Grande. Sampling at the detention basins below SWMU 01-001(f) will be triggered by an actuator detecting the presence of water above the sampler intake. Stormwater runoff sampling for chemical and radiochemical analyses will be triggered 10-min following the maximum discharge exceeding the triggering discharge. Analytical requirements for stormwater samples are listed in Table 3.2-1. Samples at gages will be collected using automated stormwater samplers that contain a carousel of 24 1-L bottles and/or 12 1-L bottles as specified in Tables 3.2-2, 3.2-3, 3.2-4, 3.2-5, and 3.2-6. Sample collection inlets will be placed a minimum of 4 in. above the bottom of natural stream channels and a minimum of 0.2 ft above the bottom of supercritical flumes. The sampling approach 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, and a longer-duration recessional limb, and contaminant concentrations from the portions of each hydrograph following the peak.

The restriction of samples for chemical and radionuclide analyses to parts of the hydrograph following the peak meets a requirement by NMED to not collect such samples before the peak (NMED 2011, 203705). However, evaluation of monitoring data from 2011 suggests this approach is not optimum for estimating contaminant flux 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 flux estimates through a hydrograph. Therefore, if a goal of the monitoring is to estimate contaminant flux at specific stations, the Laboratory recommends that the sampling approach be modified to include sampling for targeted radionuclides earlier in each hydrograph.

The Laboratory proposes to add analyses of radionuclides before the peak of discharge to help improve estimates of contaminant flux. 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 radionuclide analyses will be selected based on a visual inspection of the hydrograph following sample collection and prior to shipment to the analytical laboratory.

To characterize water quality entering and leaving the detention basins below the SWMU 01-001(f) drainage, automated pump samplers will collect stormwater from locations above and below the basins up to four times annually when stormwater discharge is occurring (Figure 3.0-1).

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.

SSC analyses, which are common to all groups, will allow determination of correlations between contaminant concentrations and SSC. The SSC analyses will also allow calculations of the total mass transported during stormwater runoff events at the gages.

Evaluation of stormwater data from the LA/Pueblo watershed and other parts of the Pajarito Plateau (e.g., LANL 2011, 207316) indicate that gross alpha, gross beta, radium-226, and radium-228 results are dominated by background conditions and are not useful for monitoring potential Laboratory impacts on stormwater quality. Therefore, the Laboratory proposes to discontinue these analyses in 2012 for the evaluation of sediment transport mitigation. Additionally, analyses of filtered radionuclides at E109.9 are not useful for monitoring potential Laboratory impacts on stormwater quality. However, DOE and the Buckman Direct Diversion Board have agreed that analyses of gross alpha, gross beta, radium-226, and radium-228 will be conducted at E050.1, E060.1, and E109.9 and that filtered radionuclides will be analyzed at E109.9 as long as the May 2010 memorandum of understanding between DOE and the board of the Buckman Direct Diversion requires their continued analyses.

Samples collected will be analyzed for the analytical suites described in Table 3.0-1. Samples will be submitted for chemical and radionuclide analyses at gage stations E059 and E042.1 if samples were collected during the event at their paired downstream gages (E060.1 and E050.1, respectively). The list of analyses for each monitoring group is prioritized to guide which analyses will be conducted if the collected water volume for a sample composite is insufficient to fulfill all planned suites. The priority is consistent with the order of the constituents listed in Table 3.0-1. The analytical method, expected method detection limit (MDL), and minimal detectable activity (MDA) (for radionuclides) are presented in Table 3.2-1. The sampling sequence for CO101038 and CO111041 is presented in Table 3.2-2. The sampling sequence for E030, E040, E055, E055.5, and E056 is presented in Table 3.2-3. Table 3.2-4 provides the sampling sequence at E026, E038, and E039.1. Table 3.2-5 provides the sampling sequence at E042.1 and E059. Table 3.2-6 provides the sampling sequence at E050.1 and E060.1. Table 3.2-7 provides the sampling sequence at E109.9.

Total suspended sediment transport during a runoff event at a station is determined most accurately when discharge is sampled periodically for SSC analysis through a hydrograph. During 2010, SSC was measured at 2- or 3-min intervals for the first 30 min then at 20-min intervals throughout each runoff event only at lower watershed gages. During 2011, SSC measurements were added at 3-min intervals for the first 30 min then at 20-min intervals throughout runoff events using a second automated sampler containing a carousel of 24 1-L bottles above and below the DP Canyon GCS at E038 and E039.1 to better characterize performance of the GCS and upcanyon floodplains and in upper Los Alamos Canyon below the ice rink at E026 to help characterize Las Conchas fire effects. The second sampler was dedicated to collecting stormwater for SSC analyses with the goal of representing most or all of the duration of runoff. This focus will be maintained during monitoring in 2012; however, all SSC samples will be collected at 2-min intervals during the first 30 min to better characterize the early part of the hydrograph and to provide bottles for the proposed additional radionuclide analyses.

If four runoff events have been sampled at a 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 12 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 24 1-L bottles is installed and dedicated to collection of samples throughout the entire hydrograph (i.e., upstream and downstream of watershed mitigations), all 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

The repeat cross-section and general area surveys will be conducted in late fall to early spring, as described above. The survey data, plotted cross-sections, and discussion will be provided in an annual report submitted on May 30 of each year.

Previous plans proposed reporting analytical and discharge data for each water year (October to September) and accompanying discussion, annually on February 28. Beginning in 2011, the Laboratory also included runoff events in October in the annual report because fall storms can be important in the total sediment transport in some years, and providing a complete set of calendar-year events seemed more appropriate than waiting to report on October events until the following year's report. Because the monitoring period has been extended by 1 mo, the Laboratory proposes to extend the reporting date by 1 mo as well, to March 31 of each year, to allow a more complete evaluation of data. This report delivery schedule will allow time to combine analytical data from off-site laboratories with finalized discharge data from the gage stations, the latter of which typically requires 3 mo for data processing (e.g., January 31 for discharge data obtained in October of the previous calendar year) and sufficient time for data evaluation.

Because of the proposed changes to the annual report date to March 31, the Laboratory proposes also to change the date for the annual update of the monitoring plan to April 10. This later date to submit the plan will allow insights gained from evaluation of the previous year's data to be better incorporated into the plan.

The objective of both reports is to review the data in the context of the mitigation measures implemented under the work plans as described in section 1.0 and evaluate overall watershed performance. Additionally, evaluations of geomorphic change will include considerations of the need for adaptive management at any of the mitigation sites in the watershed.

5.0 REFERENCES

The following list includes all documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers 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 NMED 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 2011. “Los Alamos National Laboratory Environmental Report 2010,” Los Alamos National Laboratory report LA-14445-ENV, Los Alamos, New Mexico. (LANL 2011, 207316)

LANL (Los Alamos National Laboratory), February 2012. “Stormwater Performance Monitoring in the Los Alamos/Pueblo Watershed during 2011,” Los Alamos National Laboratory document LA-UR-12-0029, Los Alamos, New Mexico. (LANL 2012, 211396)

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)

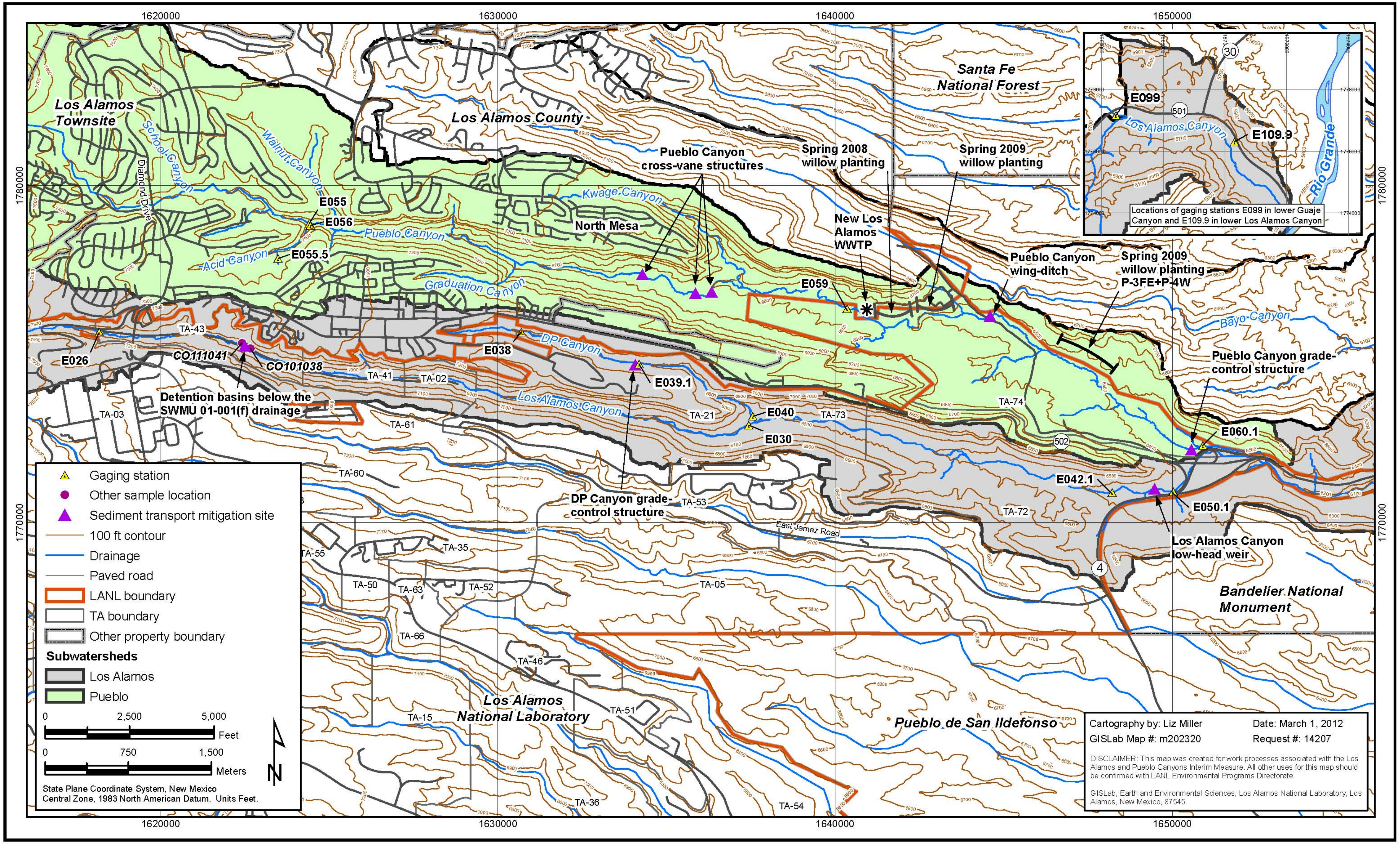

Figure 2.0-1 Los Alamos and Pueblo canyons showing monitoring locations and sediment transport mitigation sites

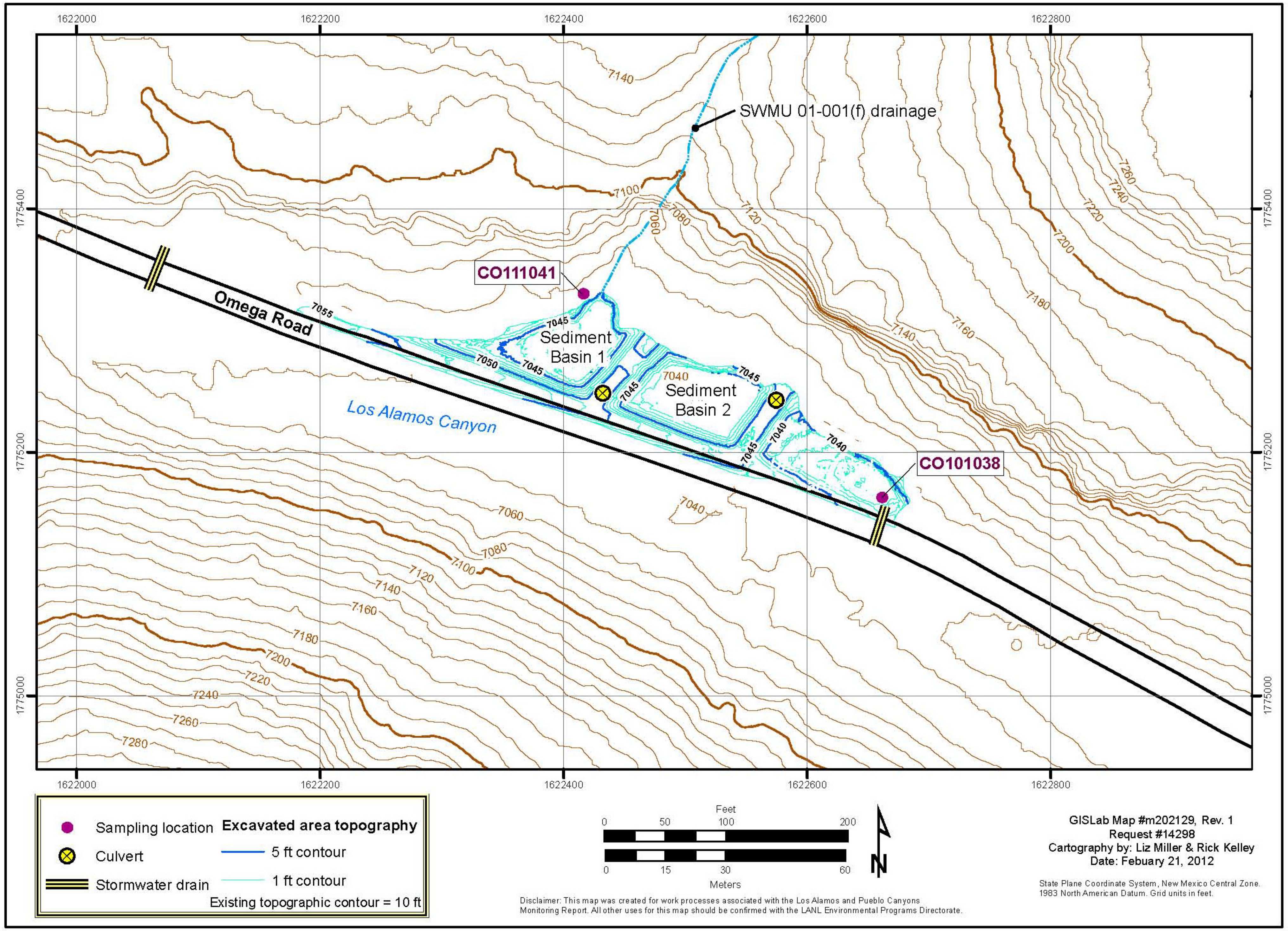

Figure 3.0-1 Detention basins and sampling locations below the SWMU 01-001(f) drainage

Table 3.0-1
Locations and Analytical Suites for Stormwater Samples

Monitoring Group	Locations	Analytical Suites [a,b]
Upper Los Alamos Canyon	E026, E030	PCBs[c] (by Method 1668A), gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, americium-241 (by alpha spectroscopy), strontium-90, dioxins and furans, TAL[d] metals, hardness, cyanide, SSC
DP Canyon gages	E038, E039.1, E040	PCBs (by Method 1668A), gamma spectroscopy radionuclides, isotopic plutonium, isotopic uranium, strontium-90, dioxins and furans, TAL[d] metals, hardness, SSC
Upper Pueblo Canyon and Acid Canyon gages	E055, E055.5, E056	PCBs (by Method 1668A), isotopic plutonium, dioxins and furans, TAL Metals, hardness, SSC
Fire-affected lower watershed gages	E042.1, E050.1, E109.9	PCBs (by Method 1668A), isotopic plutonium, gamma spectroscopy radionuclides, isotopic uranium, americium-241 (by alpha spectroscopy), strontium-90, dioxins and furans, TAL metals, hardness, cyanide, SSC
Lower Pueblo Canyon gages	E059, E060.1	PCBs (by Method 1668A), isotopic plutonium, gamma spectroscopy radionuclides, isotopic uranium, americium-241 (by alpha spectroscopy), strontium-90, dioxins and furans, TAL metals, hardness, SSC
Detention basins and wetland below the SWMU 01-001(f) drainage	CO101038, CO111041	PCBs (by Method 1668A), TAL metals, hardness, isotopic uranium, total organic carbon, SSC
BDD[e]–Required Monitoring	E050.1, E060.1, E109.9	Gross alpha, gross beta, radium-226/radium-228

[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] Radionuclides will be analyzed in filtered and unfiltered samples at E109.9.

[c] PCBs = Polychlorinated biphenyls.

[d] TAL = Target analyte list.

[e] BDD = Buckman Direct Diversion.

Table 3.2-1
Analytical Requirements for Stormwater Samples

Analytical Suite	Method	Detection Limit[a]	Upper Los Alamos Canyon	DP Canyon	Upper Pueblo Canyon and Acid Canyon	Fire Affected Lower Watershed	Lower Pueblo Canyon	BDD[b] Required Monitoring	Detention Basins below the SWMU 01-001(f) Drainage
PCBs[c]	EPA:1668A	25 pg/L	√[d]	√	√	√	√	—[e]	√
Isotopic plutonium	HASL-300	0.5 pCi/L	√	√	√	√	√	—	—
Gamma spectroscopy	EPA:901.1	10 pCi/L (cesium-1137)	√	√	—	√	√	—	√
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	√	√	√	√	√	—	√
Cyanide	EPA:335.4	1.5 µg/L	√	—	—	√	—	—	—
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	—	—	—	—	—	—	√

[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.

Table 3.2-2
Sampling Sequence for Collection of Stormwater Samples at the Detention Basins and Wetland below the SWMU 01-001(f) Drainage

Sample Bottle	CO101038, CO111041	
	Start Time (min) 12-Bottle ISCO	Analytical Suite
1	Trigger	PCB (UF[a])
2	Trigger +1	PCB (UF)
3	Trigger +2	TAL[b] metals (F[c]/UF)
4	Trigger +3	Isotopic uranium (UF)
5	Trigger +4	TOC[d] (UF)
6	Trigger +5	SSC
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] UF = Unfiltered.
[b] TAL = Target analyte list.
[c] F = Filtered.
[d] TOC = Total organic carbons.

Table 3.2-3
Sampling Sequence for Collection of Stormwater Samples at E030, E040, E055, E055.5, and E056

Sample Bottle	Start Time (min) 12-Bottle ISCO	E055, E055.5, and E056	E030	E040
		Analytical Suites	Analytical Suites	Analytical Suites
1	Max+10	SSC (UF[a])	SSC	SSC
2	Max+11	PCB[b] (UF)	PCB (UF)	PCB (UF)
3	Max+12	PCB (UF)	PCB (UF)	PCB (UF)
4	Max+13	Isotopic plutonium (UF)	Gamma spectroscopy; isotopic plutonium; americium-241 and isotopic uranium (UF)	Gamma spectroscopy; isotopic plutonium and isotopic uranium (UF)
5	Max+14	Dioxins and furans(UF)	Strontium-90 (UF)	Strontium-90 (UF)
6	Max+15	Dioxins and furans (UF)	Dioxins and furans (UF)	Dioxins and furans (UF)
7	Max+16	TAL[c] metals (F[d]/UF)	Dioxins and furans (UF)	Dioxins and furans (UF)
8	Max+17	SSC	TAL metals (F/UF)	TAL metals (F/UF)
9	Max+18	Extra bottle	Cyanide (UF)	SSC
10	Max+19	Extra bottle	SSC	Extra bottle
11	Max+20	Extra bottle	Extra bottle	Extra bottle
12	Max+21	Extra bottle	Extra bottle	Extra bottle

[a] UF = Unfiltered.
[b] PCB = Polychlorinated biphenyl.
[c] TAL = Target analyte list.
[d] F = Filtered.

Table 3.2-4
Sampling Sequence for Collection of Stormwater Samples at E026, E038, and E039.1

Sample Bottle	Start Time (min) 12-Bottle ISCO	E026	E038 and E039.1	E026, 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	PCB[b] (UF[c])	PCB (UF)	Trigger	SSC
2	Max+11	PCB (UF)	PCB (UF)	Trigger+2	SSC
3	Max+12	Gamma spectroscopy; isotopic plutonium, americium-241 and isotopic uranium (UF)	Gamma spectroscopy; isotopic plutonium and isotopic uranium (UF)	Trigger+4	SSC
4	Max+13	Strontium-90 (UF)	Strontium-90 (UF)	Trigger+6	SSC
5	Max+14	Dioxins and furans (UF)	Dioxins and furans (UF)	Trigger+8	SSC
6	Max+15	Dioxins and furans (UF)	Dioxins and furans (UF)	Trigger+10	SSC
7	Max+16	TAL[d] metals (F[e]/UF)	TAL metals (F/UF)	Trigger+12	SSC
8	Max+17	Cyanide (UF)	Extra bottle	Trigger+14	SSC
9	Max+18	Extra bottle	Extra bottle	Trigger+16	SSC
10	Max+19	Extra bottle	Extra bottle	Trigger+18	SSC
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] One SSC analysis collected before the peak of discharge will be replaced by gamma spectroscopy and isotopic plutonium analyses.
[b] PCB = Polychlorinated biphenyl.
[c] UF = Unfiltered.
[d] TAL = Target analyte list.
[e] F = Filtered.
[f] n/a = Not applicable.

Table 3.2-5
Sampling Sequence for Collection of Stormwater Samples at E042.1 and E059

Sample Bottle	Start Time (min) 12-Bottle ISCO	E042.1	E059	E042.1 and E059	
		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	PCB[b] (UF[c])	PCB (UF)	Trigger	SSC
2	Max+11	Gamma spectroscopy; isotopic plutonium, americium-241, and isotopic uranium (UF)	Gamma spectroscopy; isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+2	SSC
3	Max+12	Strontium-90 (UF)	Strontium-90 (UF)	Trigger+4	SSC
4	Max+13	Dioxins and furans (UF)	Dioxins and furans (UF)	Trigger+6	SSC
5	Max+14	TAL[d] metals (F[e]/UF)	TAL metals (F/UF)	Trigger+8	SSC
6	Max+15	Cyanide (UF)	Extra bottle	Trigger+10	SSC
7	Max+60	PCB (UF)	PCB (UF)	Trigger+12	SSC
8	Max+61	Gamma spectroscopy; isotopic plutonium (UF)	Gamma spectroscopy; isotopic plutonium (UF)	Trigger+14	SSC
9	Max+105	PCB (UF)	PCB (UF)	Trigger+16	SSC
10	Max+106	Gamma spectroscopy; isotopic plutonium (UF)	Gamma spectroscopy; isotopic plutonium (UF)	Trigger+18	SSC
11	Max+150	PCB (UF)	PCB (UF)	Trigger+20	SSC
12	Max+151	Gamma spectroscopy; isotopic plutonium (UF)	Gamma spectroscopy; 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
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] One SSC analysis collected before the peak of discharge will be replaced by gamma spectroscopy and isotopic plutonium analyses.
[b] PCB = Polychlorinated biphenyl.
[c] UF = Unfiltered.
[d] TAL = Target analyte list.
[e] F = Filtered.
[f] n/a = Not applicable.

Table 3.2-6
Sampling Sequence for Collection of Stormwater Samples at E050.1 and E060.1

Sample Bottle	Start Time (min) 12-Bottle ISCO	E050.1	E060.1	E050.1 and E060.1	
		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	PCB[b] (UF[c])	PCB (UF)	Trigger	SSC
2	Max+11	Gamma spectroscopy; isotopic plutonium, americium-241, and isotopic uranium (UF)	Gamma spectroscopy; isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+2	SSC
3	Max+12	Strontium-90 (UF)	Strontium-90 (UF)	Trigger+4	SSC
4	Max+13	Dioxins and furans (UF)	Dioxins and furans (UF)	Trigger+6	SSC
5	Max+14	TAL[d] metals (F[e]/UF)	TAL metals (F/UF)	Trigger+8	Radium-226 (UF)
6	Max+15	Gross alpha/beta (UF) cyanide (UF)	Gross alpha/beta (UF)	Trigger+10	SSC
7	Max+60	PCB (UF)	PCB (UF)	trigger+12	Radium-228 (UF)
8	Max+61	Gamma spectroscopy; isotopic plutonium (UF)	Gamma spectroscopy; isotopic plutonium (UF)	Trigger+14	SSC
9	Max+105	PCB (UF)	PCB (UF)	Trigger+16	SSC
10	Max+106	Gamma spectroscopy; isotopic plutonium (UF)	Gamma spectroscopy; isotopic plutonium (UF)	Trigger+18	SSC
11	Max+150	PCB (UF)	PCB (UF)	Trigger+20	SSC
12	Max+151	Gamma spectroscopy; isotopic plutonium (UF)	Gamma spectroscopy; 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
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] One SSC analysis collected before the peak of discharge will be replaced by gamma spectroscopy and isotopic plutonium analyses.
[b] PCB = Polychlorinated biphenyl.
[c] UF = Unfiltered.
[d] TAL = Target analyte list.
[e] F = Filtered.
[f] n/a = Not applicable.

Table 3.2-7
Sampling Sequence for Collection of Stormwater Samples at E109.9

Sample Bottle	E109.9			
	Start Time (min) 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	PCB[b] (UF[c])	Trigger	SSC
2	Max+11	Gamma spectroscopy; isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+2	SSC
3	Max+12	Strontium-90 (UF)	Trigger+4	SSC
4	Max+13	Dioxins and furans (UF)	Trigger+6	SSC
5	Max+14	TAL[d] metals (F[e]/UF)	Trigger+8	SSC
6	Max+15	Gross alpha/beta (uf) cyanide (UF)	Trigger+10	Gamma spectroscopy; isotopic plutonium, americium-241, and isotopic uranium (F)
7	Max+60	PCB (UF)	Trigger+12	SSC
8	Max+61	Gamma spectroscopy; Isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+14	Strontium-90 (F)
9	Max+105	PCB (UF)	Trigger+16	SSC
10	Max+106	Gamma spectroscopy; Isotopic plutonium, americium-241, and Isotopic uranium (UF)	Trigger+18	Radium-226 (UF)
11	Max+150	PCB (UF)	Trigger+20	SSC
12	Max+151	Gamma spectroscopy; Isotopic plutonium, americium-241, and isotopic uranium (UF)	Trigger+22	Radium-228 (UF)
13	n/a[f]	n/a	Trigger+24	SSC
14	n/a	n/a	Trigger+26	Radium-226 (F)
15	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	Trigger+30	Radium-228 (F)
17	n/a	n/a	Trigger+50	SSC
18	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	Trigger+90	SSC
20	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	Trigger+130	SSC
22	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	Trigger+190	SSC

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

[b] PCB = Polychlorinated biphenyl.

[c] UF = Unfiltered.

[d] TAL = Target analyte list.

[e] F = Filtered.

[f] n/a = Not applicable.