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Addendum to the Summary Report for the Corrective Measures Implementation at Consolidated Unit 16-021(c)-99

Los Alamos
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EXECUTIVE SUMMARY

This addendum completes the summary report for the corrective measures implementation (CMI) at Consolidated Unit 16-021(c)-99 (the 260 Outfall) within Technical Area 16 (TA-16) at Los Alamos National Laboratory. The CMI was conducted to remediate soil and tuff contaminated with high explosives and other contaminants in the former TA-16 260 Outfall channel. Two activities were not completed before the CMI summary report was submitted to the New Mexico Environment Department because of inclement weather conditions and safety concerns. These activities included excavating soil and tuff and collecting a confirmation sample at the base of the cliff within the 260 Outfall drainage channel and resampling sediment for ecotoxicity at the Sanitary Wastewater Systems Consolidation (SWSC) Cut.

The removal activities and final confirmation sampling at the lower 260 Outfall drainage channel were conducted in April 2010. These data, along with the rest of the 2009 confirmation sampling data and historical post-interim measure data, were used to conduct a revised human health risk-screening assessment for the 260 Outfall drainage channel. The risk-screening assessment results indicated no potential unacceptable risks exist for the industrial, construction worker, and residential scenarios for the 260 Outfall drainage channel.

The SWSC Cut sediment toxicity testing of chironomids was completed in March 2010, after the 2009 CMI silver data were obtained from the off-site laboratory. The toxicity test results indicated no significant reductions in *Chironomus tentans* survival or growth occurred in the SWSC Cut sediment.

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Acronyms and Abbreviations

BV	background value
CMI	corrective measures implementation
CMS	corrective measures study
COPC	chemical of potential concern
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
HQ	hazard quotient
HI	hazard index
HE	high explosives
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
IM	interim measure
LANL	Los Alamos National Laboratory
NMED	New Mexico Environmental Department
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RFA	RCRA facility assessment
RfD	reference dose
RFI	RCRA facility investigation
RPF	Records Processing Facility
SAL	screening action level
SF	slope factor
SL	slope factor
SMO	Sample Management Office
SSL	soil screening level

SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWSC	Sanitary Wastewater Systems Consolidation
TA	technical area
TATB	triaminotrinitrobenzene
TAL	target analyte list
TNT	2,4,6-trinitrotoluene
UCL	upper confidence limit
UTL	upper tolerance limit
VOC	volatile organic compound

1.0 INTRODUCTION

This addendum completes the summary report for the corrective measures implementation (CMI) at Consolidated Unit 16-021(c)-99 (the 260 Outfall) within Technical Area 16 (TA-16) at Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.0-1). The CMI was conducted to remediate soil and tuff contaminated with high explosives (HE) and other contaminants within the former TA-16 260 Outfall channel, and in alluvial sediment and water within Cañon de Valle. Two activities were not completed before the CMI summary report was submitted (LANL 2010, 108868) because of heavy snow and limited access: excavating and collecting a confirmation sample at the base of the cliff within the lower 260 Outfall drainage channel and resampling sediment for ecotoxicity (after off-site laboratory results for silver were received) at the Sanitary Wastewater Systems Consolidation (SWSC) Cut. This addendum presents the results from these two activities at the 260 Outfall drainage channel and the SWSC Cut in Cañon de Valle. Completion of these two activities fulfills the requirements of the CMI work plan for Consolidated Unit 16-021(c)-99 (LANL 2007, 098192).

The removal activities and final confirmation sampling at the lower 260 Outfall drainage channel were conducted in April 2010. The confirmation sampling data, along with the other 2009 CMI confirmation sampling data and historical post-interim measure (IM) data, were used to conduct the revised human health risk-screening assessment for the 260 Outfall drainage channel.

The SWSC Cut sediment toxicity testing was completed in March 2010 after the 2009 CMI silver data were received. The sediment at the location with the highest silver concentration was resampled and tested for toxicity to *Chironomus tentans* (*C. tentans*).

2.0 BACKGROUND

2.1 Site Description and Operational History

Consolidated Unit 16-021(c)-99 consists of Solid Waste Management Units (SWMUs) 16-003(k) and 16-021(c).

SWMU 16-003(k) consists of 13 sumps and approximately 1200 ft of associated former drainlines and troughs (since removed) that lead from HE-machining building 16-260 to the 260 Outfall drainage channel (Figures 2.1-1 and 2.1-2). HE-contaminated water flowed from the sumps into the concrete trough and ultimately to the 260 Outfall, located approximately 200 ft east of building 16-260, and into Cañon de Valle.

Building 16-260 had been used since 1951 to process and machine HE. Water was used to machine HE (which is slightly water-soluble); wastewater from machining operations contained dissolved HE and potential entrained HE cuttings. Wastewater treatment consisted of routing the water to 13 settling sumps to recover any entrained cuttings. From 1951 to 1996, the water from these sumps was discharged to the 260 Outfall. In 1994, outfall discharge volumes were measured at several million gallons per year. The discharge volumes were probably higher during the 1950s when HE-production output from building 16-260 was substantially greater than it was in the 1990s (LANL 1994, 076858). In the past, barium had been a constituent of certain HE formulations, and thus barium was also present in the outfall wastewater from building 16-260.

From the late 1970s to 1996, the 260 Outfall was permitted by the U.S. Environmental Protection Agency (EPA) to operate as Outfall No. 05A056 under the Laboratory’s National Pollutant Discharge Elimination System (NPDES) permit (EPA 1990, 012454). The last NPDES permitting effort for the 260 Outfall occurred in 1994. The NPDES-permitted 260 Outfall was deactivated in November 1996 and removed from the permit in January 1998 (LANL 2007, 098192).

SWMU 16-021(c) consists of three sections: an upper drainage channel fed directly by the 260 Outfall, a former settling pond, and a lower drainage channel leading to Cañon de Valle (Figure 2.1-2). The former settling pond was approximately 50 ft long and 20 ft wide and was located in the upper drainage channel, approximately 45 ft below the 260 Outfall. The drainage channel runs approximately 600 ft northeast from the 260 Outfall to the bottom of Cañon de Valle. A 15-ft near-vertical cliff is located approximately 400 ft from the 260 Outfall and marks the break between the upper and lower drainage channels.

During the 2000–2001 IM, more than 1300 yd^3 of contaminated soil was removed from the former settling pond and channel (LANL 2002, 073706). Approximately 90% of the HE in the Consolidated Unit 16-021(c)-99 source area was removed (LANL 2002, 073706). A low-permeability cap was installed on top of the former settling pond during the IM. The cap consisted of crushed tuff/bentonite mixture and was approximately 20 in. thick.

HE-contaminated water from the 260 Outfall entered the former settling pond and drained into the 260 Outfall drainage channel, which was a substantial pathway for contamination identified in downgradient components of the Consolidated Unit 16-021(c)-99 hydrogeologic system, including SWSC Cut. SWSC Cut is next to SWSC Spring and SWSC pipeline and derived its name because it is a roadcut for the SWSC pipeline (Figure 2.1-2).

2.2 Historical Investigations

Multiple investigations of Consolidated Unit 16-021(c)-99 have been conducted and are summarized below.

A Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) (LANL 1990, 007512) summarized soil and water sampling results from the 1970s for the outfall area. The RFA data showed substantially elevated HE contamination in the sediment, outfall, and sump water. Levels up to 27 weight percent (270,000 mg/kg) of 1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) were reported in the area of the former settling pond. The data showed HE contamination extending from the discharge point to Cañon de Valle (Baytos 1971, 005913; Baytos 1976, 005920).

The Phase I RCRA facility investigation (RFI) (LANL 1996, 055077) concentrated on characterizing contamination at the drainage channel and its intersection with Cañon de Valle, including alluvial sediment, surface water, and groundwater. The New Mexico Environment Department (NMED) approved the report in 1998 (NMED 1998, 093664).

The Phase II RFI (LANL 1998, 059891) further delineated contamination in the tuff surge beds beneath the drainage channel and in Cañon de Valle sediment, surface water, and groundwater. The Phase II RFI included the sampling of surface and near-surface soil and tuff within the drainage and the sampling of 13 boreholes drilled to depths between 17 and 115 ft in and near the drainage. The Phase II RFI also included extensive field screening for RDX and 2,4,6-trinitrotoluene (TNT) using immunoassay methods as well as sampling for other contaminants. A risk assessment was also performed. NMED approved the report in September 1999 (NMED 1999, 093666).

An IM remedial excavation was conducted in the outfall drainage channel and settling basin in 2000 and 2001. More than 1300 yd^3 of contaminated material containing approximately 8500 kg of HE was removed from these areas. The investigation results are presented in the IM report (LANL 2002, 073706), which was approved by NMED on January 13, 2003 (NMED 2003, 076174).

The Phase III RFI (LANL 2003, 077965) included analyses of water and sediment data collected since the Phase II RFI (post-1998), a study of spring dynamics, a geomorphic alluvial sediment study, geophysical studies, and baseline risk assessments for the 260 Outfall source area and for selected reaches in Cañon de Valle and Martin Spring Canyon. In addition, a baseline ecological risk assessment was performed for Cañon de Valle. The NMED approved the Phase III RFI report in June 2004 (NMED 2004, 093248).

An alluvial corrective measures study (CMS) conducted in November 2003 addressed the contaminants remaining in the unsaturated subsurface and the alluvial system in Cañon de Valle. The intermediate and regional groundwater CMS report (LANL 2003, 085531) focused on the contaminants in the deep-perched zone and the regional aquifer.

2.3 2009 CMI at 260 Outfall Drainage Channel and SWSC Cut

The 2009 CMI was conducted to remediate soil and tuff contaminated with HE and other contaminants in the 260 Outfall channel (including a concrete trough, former settling pond, and outfall drainage channel) and in the alluvial systems of Cañon de Valle and Martin Spring Canyon. The CMI was completed (in 2009) in accordance with the approved CMI work plan (LANL 2007, 098192; NMED 2009, 107307), with the exception of two activities that could not be completed during the 2009 CMI because of heavy snow and limited access. These activities included (1) excavating and collecting a confirmation sample at the base of the cliff (location 16-06405) within the lower 260 Outfall drainage channel and (2) resampling sediment (location 16-608204) at the SWSC Cut for toxicity testing. These activities were completed in April and March 2010, respectively, and are discussed below.

2.3.1 260 Outfall Drainage Channel

The 260 Outfall drainage channel excavation (location 16-06405) is located 5 ft below a cliff in the lower outfall drainage channel (Figure 2.1-2). During the 2009 CMI activities, soil and tuff were excavated from an area 5 ft by 5 ft by 1.5 ft deep. Field-screening samples collected from the base of the excavation indicated RDX concentrations above the cleanup level. Additional excavation and confirmation sampling were completed at this location in April 2010 and are summarized below.

Excavation of a 5 ft by 5 ft by 3 ft deep area was completed on April 30, 2010, using hand tools. After field screening confirmed the concentrations of HE were below cleanup levels, a confirmation sample was collected from the base of the excavated area.

The confirmation sample was screened on-site for radiological activity using an Eberline E-600 radiation meter with an SHP-380AB alpha/beta scintillation detector before being transported to the Laboratory's Sample Management Office (SMO). The sample was submitted to an off-site contract laboratory for analysis of HE, target analyte list (TAL) metals, volatile organic compounds, and semivolatile organic compounds. A field duplicate sample was submitted for the same analyses as the confirmatory samples for quality assurance/quality control purposes. Tables 2.3-1 and 2.3-2 present the inorganic chemicals above background values (BVs) and organic chemicals detected at location 16-06405 during the April 2010 sampling, respectively. Tables 2.3-3 and 2.3-4 present the inorganic chemicals above BVs and organic chemicals detected, respectively, at the 260 Outfall drainage channel following the 2000–2001 IM and the 2009–2010 CMI remedial actions.

2.3.2 SWSC Cut

Previous investigations indicated channel soil in the vicinity of the SWSC sewer pipeline (referred to as the SWSC Cut) contained elevated concentrations of silver, which resulted in sediment toxicity to *C. tentans* (LANL 2003, 077965). CMI sampling was conducted at five locations at the SWSC Cut (Figure 2.1-2). The samples were analyzed for TAL metals, and silver concentrations ranged from 11.9 mg/kg to 38.5 mg/kg, as presented in Table 4.2-2 of the 2009 CMI summary report (LANL 2010, 108868). The location with the highest silver concentration (location 16-608204) was resampled and the sediment submitted for toxicity testing of *C. tentans*.

Resampling of the sediment at location 16-608204 was conducted on March 10, 2010. The sample was screened on-site for radiological activity using an Eberline E-600 radiation meter with an SHP-380AB alpha/beta scintillation detector before the samples were transported to the SMO. The sample was submitted to an off-site contract laboratory for toxicity testing using the EPA 10-d survival and growth sediment toxicity test with the larval insect *C. tentans* (EPA 2000, 073776). The objective of this test is to determine whether the sediment affects the survival and growth of *C. tentans*. Table 2.3-5 presents the results of the survival and growth test. The toxicity test report is provided in Appendix D.

3.0 SUMMARY OF RISK-SCREENING ASSESSMENT AT 260 OUTFALL

3.1 Historical Human Health Risk Assessment Results

A human health baseline risk assessment was conducted for the 260 Outfall drainage channel at Consolidated Unit 16-021(c)-99 as part of the Phase III RFI (LANL 2003, 077965). The risk assessment evaluated the potential exposures from chemicals of potential concern (COPCs) in soil and tuff (aluminum, arsenic, barium, iron, manganese, thallium uranium, HMX, RDX, and TNT) to an on-site environmental worker, a trail user, and a construction worker. The total excess cancer risks were below the NMED target risk level of 1×10^{-5} target risk for the trail user and construction worker, but slightly above the target risk level for the environmental worker (3×10^{-5}). Noncancer hazards were below a hazard index (HI) of 1.0 for the environmental worker and trail user but was approximately 2.0 for the construction worker.

3.2 Revised Human Health Risk-Screening Assessment

Results of the human health baseline risk assessments indicated the need for further remedial actions within the 260 Outfall drainage channel. The 2009–2010 CMI included removing soil and tuff from areas that previously exceeded risk-based screening levels following the 2000–2001 IM. The areas included the 260 Outfall concrete trough, the former settling pond, and isolated pockets of soil and tuff (Figure 2.1-2). Plates 1 and 2 present the inorganic chemicals detected above BVs and organic chemicals detected, respectively, in the 260 Outfall drainage channel following the 2000–2001 IM and the 2009–2010 CMI remedial actions. Tables 2.3-3 and 2.3-4 present the inorganic chemicals above BVs and organic chemicals detected, respectively, at the 260 Outfall drainage channel following the 2000–2001 IM and the 2009–2010 CMI remedial actions.

The revised human health risk-screening assessment for the 260 Outfall drainage channel (using post-IM and 2009–2010 CMI data) was conducted for the industrial worker, construction worker, and residential scenario. The residential scenario was evaluated per the Compliance Order on Consent. Because the baseline risk assessment indicated no potential adverse health effects to the trail user, the trail user scenario was not reevaluated. Details of the risk assessment are provided in Appendix A. Background comparisons, including statistical analyses, and box plots are presented in Appendix B. Data are presented in Appendix C (on CD included with this document).

The total excess cancer risks for the industrial and residential scenarios are 3×10^{-6} and 4×10^{-6}, respectively, which are less than the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HIs for the industrial and residential scenarios are 0.09 and 0.7, respectively, which are less than the NMED target HI of 1.0 (NMED 2009, 108070).

Cancer risk was not evaluated for the construction worker because there were no carcinogenic COPCs for the construction worker scenario [RDX has a noncancer soil screening level (SSL) for this scenario]. The HI for the construction worker scenario is approximately 2, which is slightly above the target HI. The elevated HI is primarily from manganese. However, the manganese exposure point concentration is similar to the range of background concentrations for soil and tuff, and the construction worker SSL for manganese is within the range of background concentrations. Therefore, the SSL for manganese substantially overestimates the potential risk, and without manganese the HI for the construction worker is approximately 1, which is equivalent to the target HI.

4.0 SUMMARY OF SWSC CUT ECOTOXICITY TESTING

4.1 Historical Evaluation for *C. tentans*

A 2001 aquatic assessment indicated benthic macroinvertebrates in Cañon de Valle showed general decreases from 1997 in numbers of species, sensitive species, and community metrics (LANL 2003, 077965). These changes were primarily from a combination of the elimination of flow augmentation by effluent discharges and the continuing drought that had reduced natural sources of water to the canyon.

Toxicity tests on the sediment and site water next to the Cañon de Valle benthic macroinvertebrate sampling site using *C. tentans* was conducted as part of the Phase III RFI (LANL 2003, 077965). The Phase III RFI toxicity test indicated no adverse effects on the survival and growth of *C. tentans*, except at one location (LANL 2003, 077965). The only effects occurred at the SWSC Cut site, with 22.5% survival and an increase in growth. The mortality was reported to be associated with silver in the sediment and water. The apparent increase in growth over the control organisms was thought to be associated with the presence of RDX in the sediment (LANL 2003, 077965).

4.2 Revised Toxicity Evaluation for *C. tentans*

Results of previous investigations indicated the need for further testing of toxicity at the SWSC Cut. The 2009–2010 CMI investigation and remediation activities included collecting sediment samples from the SWSC Cut area and submitting them for TAL metal analysis. The sediment sample collected from location 16-608204 had the highest silver concentration (38.5 mg/kg) at the SWSC Cut and was submitted to Pacific EcoRisk for sediment toxicity testing.

The toxicity test consisted of exposing *C. tentans* to the SWSC Cut sediment from location 16-608204 for 10 d, after which the effects on survival and growth were evaluated. The results of the test are summarized in Table 2.3-5, and the report is provided in Appendix D. No significant reductions of *C. tentans* survival or growth occurred in the SWSC Cut sediment.

5.0 CONCLUSIONS

This addendum to the CMI summary report describes the completion of field activities conducted in 2010 at Consolidated Unit 16-021(c)-99, which included removing soil from a 260 Outfall drainage channel location and collecting a confirmation sample, and collecting sediment from the SWSC Cut in Cañon de Valle for toxicity testing.

The confirmation sampling data collected in 2009–2010 as well as the post-IM data from 2000 were used to revise human health risk assessments for the 260 Outfall drainage channel. The risk-screening assessments indicated no potential unacceptable risks from COPCs for the industrial worker, construction worker, and residential scenarios at the 260 Outfall drainage channel. No potential unacceptable risks for the construction worker exist after manganese (which has an exposure point concentration and SSL within the range of background concentrations) was removed from the evaluation.

A sediment sample from SWSC Cut was tested for toxicity using *C. tentans*. The toxicity test results indicated no significant reductions of *C. tentans* survival or growth in the SWSC Cut sediment.

The field activities, human health risk-screening assessments, and the toxicity test complete the CMI objectives and activities at Consolidated Unit 16-021(c)-99 in the 260 Outfall drainage channel and SWSC Cut in Cañon de Valle.

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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.

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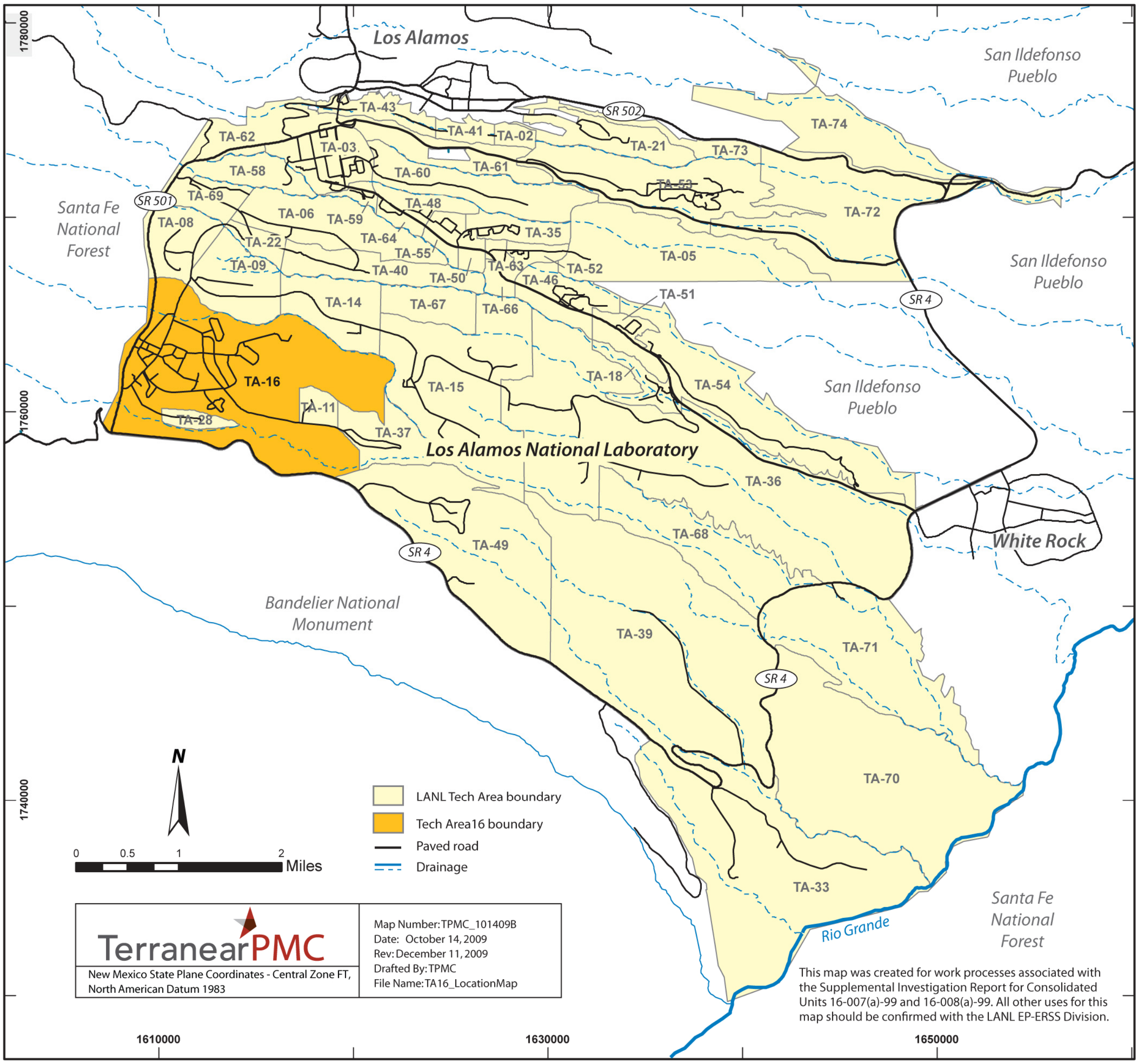

Figure 1.0-1 Location of TA-16 with respect to Laboratory TAs and surrounding areas

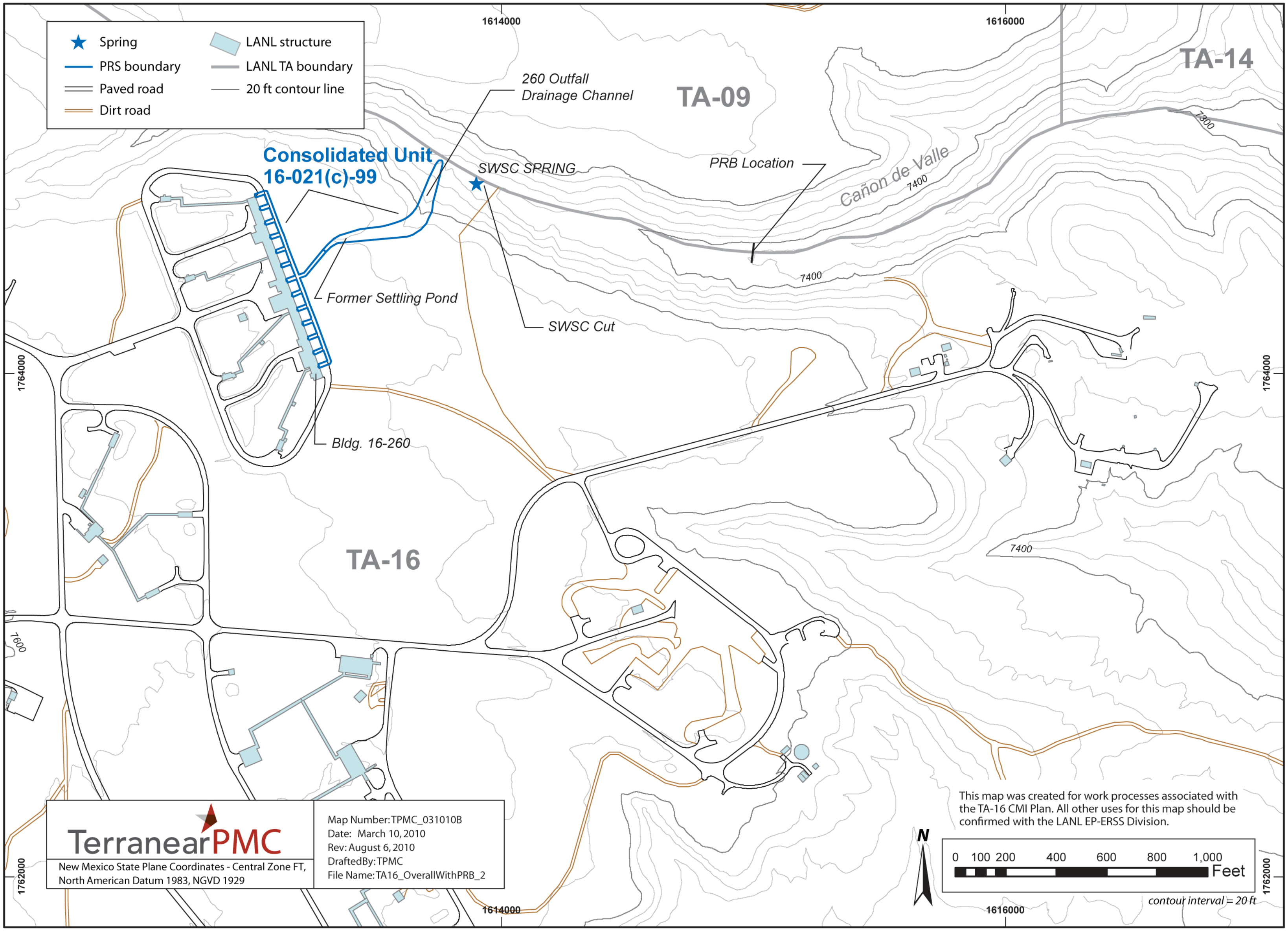

Figure 2.1-1 Location of Consolidated Unit 16-021(c)-99 and associated features

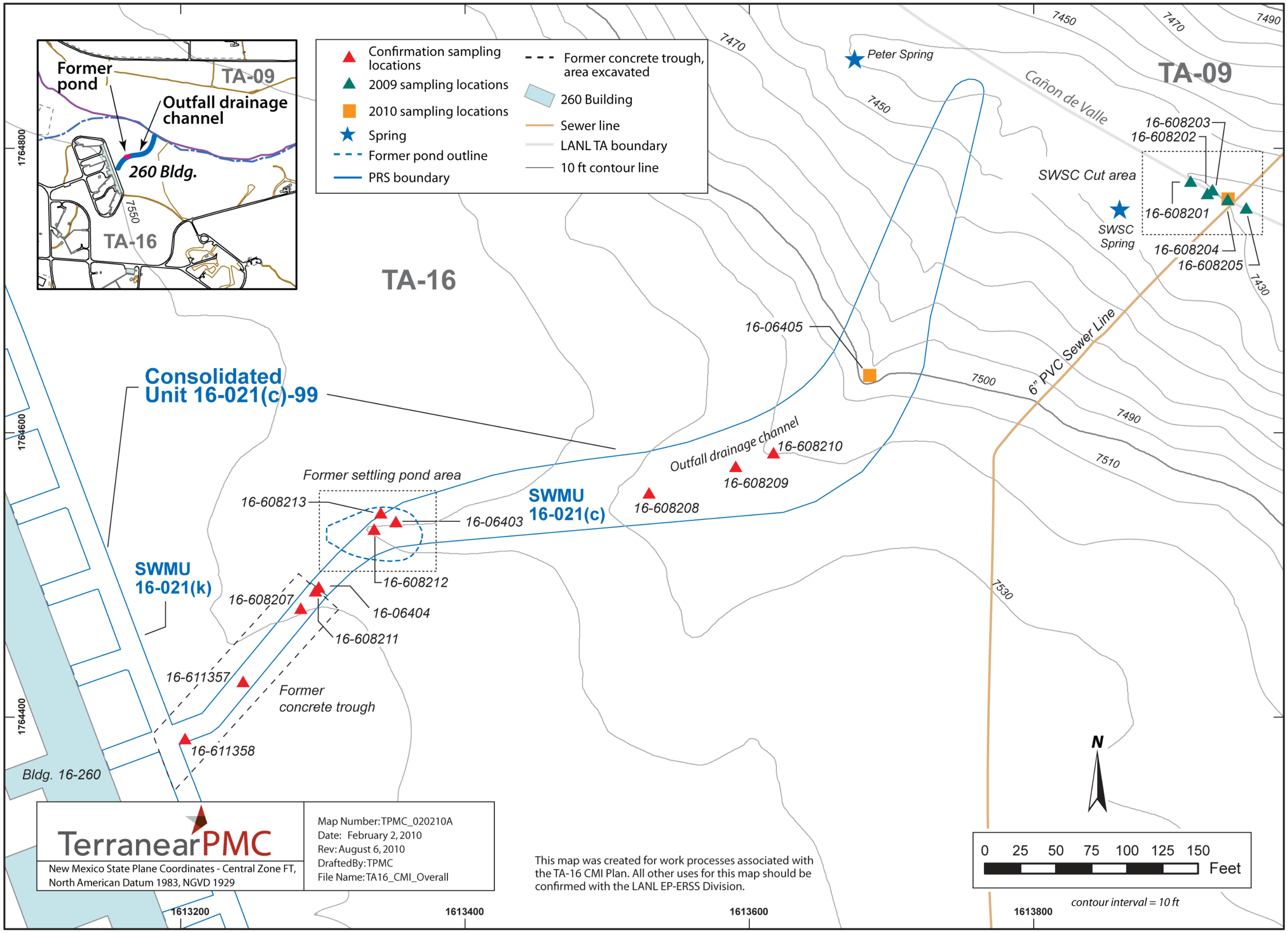

Figure 2.1-2 260 Outfall drainage channel and SWSC Cut CMI sampling locations

Table 2.3-1
Summary of Inorganic Chemicals above BVs in the
2010 CMI Sample from the 260 Outfall Drainage Channel

Sample ID	Location ID	Depth (ft)	Media	Antimony	Barium	Selenium
Qbt 2, 3, 4 BV[a]				**0.5**	**46**	**0.3**
Industrial SSL[b]				**454**	**224000**	**5680**
Construction Worker SSL[b]				**124**	**4350**	**1550**
Residential SSL[b]				**31.3**	**15600**	**391**
RE16-10-16933	16-06405	3.0–3.5	QBT4	0.63 (U[c])	2470 (J-[d])	1.2

Note: Units are in mg/kg.
[a] BVs from LANL (1998, 059730).
[b] SSLs from NMED (2009, 108070).
[c] U = The analyte was analyzed for but not detected.
[d] J- = The analyte was positively identified, and the result is likely to be biased low.

Table 2.3-2
Summary of Organic Chemicals Detected in the 2010 CMI Sample from the 260 Outfall Drainage Channel

Sample ID	Location ID	Depth (ft)	Media	3,5-Dinitroaniline	Acetone	Amino-2,6-dinitrotoluene[4-]	Amino-4,6-dinitrotoluene[2-]	Dinitrotoluene[2,4-]	Dinitrotoluene[2,6-]	HMX	RDX	Trinitrobenzene[1,3,5-]	Trinitrotoluene[2,4,6-]
Industrial SSL[a]				**na[b]**	**851000**	**1900[c]**	**2000[c]**	**103**	**687**	**34200**	**174**	**27000[c]**	**469**
Construction Worker SSL[a]				**na**	**263000**	**601[d]**	**601[d]**	**476**	**239**	**11900**	**715**	**8760[d]**	**141**
Residential SSL[a]				**na**	**67500**	**150[c]**	**150[c]**	**15.7**	**61.2**	**3060**	**44.2**	**2200[c]**	**35.9**
RE16-10-16933	16-06405	3–3.5	QBT4	0.0081 (J-[e])	0.021 (J[f])	0.084 (J-)	0.081 (J-)	0.019 (J-)	0.0099 (J-)	2.5 (J-)	0.55 (J-)	0.015 (J-)	0.14 (J-)

Note: Units are in mg/kg.
[a] SSLs from NMED (2009, 108070) unless otherwise noted.
[b] na = Not available.
[c] SSLs from EPA regional screening table (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).
[d] Construction worker SSL calculated using the toxicity value from the EPA regional tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and the exposure parameters and equation from NMED (2009, 108070).
[e] J- = The analyte was positively identified, and the result is likely to be biased low.
[f] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

Table 2.3-3
Summary of Inorganic Chemicals above BVs in the 2000–2001 IM and 2009–2010 CMI Samples from the 260 Outfall Drainage Channel

Sample ID	Location ID	Depth (ft)	Media	Antimony	Arsenic	Barium	Beryllium	Bromide	Cadmium	Calcium	Cobalt	Iron	Lead	Manganese	Selenium	Silver	Thallium	Uranium	Zinc
Qbt2, 3, 4 BV[a]				**0.5**	**2.79**	**46**	**1.21**	**na[b]**	**1.63**	**2200**	**3.14**	**14500**	**11.2**	**482**	**0.3**	**1**	**1.1**	**2.4**	**63.5**
Sediment BV[a]				**0.83**	**3.98**	**127**	**1.31**	**na**	**0.4**	**4420**	**4.73**	**13800**	**19.7**	**543**	**0.3**	**1**	**0.73**	**2.22**	**60.2**
Soil BV[a]				**0.83**	**8.17**	**295**	**1.83**	**na**	**0.4**	**6120**	**8.64**	**21500**	**22.3**	**671**	**1.52**	**1**	**0.73**	**1.82**	**48.8**
Construction Worker SSL[c]				**1.24E+02**	**6.54E+01**	**4.35E+03**	**1.44E+02**	**na**	**3.09E+02**	**na**	**3.46E+01[d]**	**2.17E+05**	**8.00E+02**	**4.63E+02**	**1.55E+03**	**1.55E+03**	**2.04E+01**	**9.29E+02**	**9.29E+04**
Industrial SSL[c]				**4.54E+02**	**1.77E+01**	**2.24E+05**	**2.26E+03**	**na**	**1.12E+03**	**na**	**3.00E+02[e]**	**7.95E+05**	**8.00E+02**	**1.45E+05**	**5.68E+03**	**5.68E+03**	**7.49E+01**	**3.41E+03**	**3.41E+05**
Recreational SSL[f]				**3.17E+02**	**2.77E+01**	**1.58E+05**	**1.58E+03**	**na**	**7.84E+02**	**na**	**2.38E+02**	**5.54E+05**	**5.60E+02**	**1.10E+05**	**3.96E+03**	**3.96E+03**	**5.23E+01**	**2.38E+03**	**2.38E+05**
Residential SSL[c]				**3.13E+01**	**3.90E+00**	**1.56E+04**	**1.56E+02**	**na**	**7.79E+01**	**na**	**2.30E+01[e]**	**5.48E+04**	**4.00E+02**	**1.07E+04**	**3.91E+02**	**3.91E+02**	**5.16E+00**	**2.35E+02**	**2.35E+04**
RE16-00-0026	16-06370	19–20	QBT3	NA[g]	NA	NA	NA	0.932 (J-[h])	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RE16-00-0034	16-06383	0–0.5	SOIL	—[i]	—	1200	—	NA	—	—	—	—	—	—	—	—	—	—	—
RE16-00-0035	16-06388	0–0.5	SOIL	—	—	930	—	NA	—	—	—	—	—	—	—	2.1	—	2.35 (J-)	—
RE16-00-0038	16-06394	0–0.5	SOIL	—	—	8200	—	NA	—	—	—	—	—	—	—	—	—	—	—
RE16-00-0048	16-06398	4–5.5	QBT3	—	—	890	—	NA	—	—	—	—	—	—	0.387	—	—	—	—
RE16-09-13541	16-06403	2–2.5	SOIL	1.2 (U[j])	—	1320	—	NA	0.602 (U)	—	—	—	—	—	—	—	—	NA	—
RE16-10-16933	16-06405	3–3.5	QBT4	0.63 (U)	—	2470 (J-)	—	NA	—	—	—	—	—	—	1.2	—	—	NA	—
RE16-00-0045	16-06409	0.5–1	SOIL	—	—	6000	—	NA	—	—	—	—	—	—	—	—	—	—	—
RE16-00-0044	16-06411	3–3.5	SOIL	—	9.3	6900	—	NA	—	—	—	—	—	710	—	—	—	1.84 (J-)	—
RE16-00-0041	16-06416	0–0.5	SOIL	—	—	930	—	NA	—	10000	—	—	—	1200	—	—	0.87 (UJ[k])	3.12 (J-)	53
RE16-00-0042	16-06419	0.25–0.75	SOIL	—	—	3400	—	NA	—	—	—	—	—	760	—	—	—	—	—
RE16-00-0043	16-06420	1.5–2	SOIL	—	—	8200	—	NA	—	—	—	—	—	—	—	—	—	—	—
RE16-09-13517	16-608207	6–6.5	SOIL	—	—	561	—	NA	—	—	—	—	—	—	—	—	—	—	—
RE16-09-13529	16-608208	2–2.5	QBT4	1.17 (U)	—	114	—	NA	—	—	—	—	—	—	1.16 (U)	—	—	NA	—
RE16-09-13530	16-608209	1.5–2	QBT4	1.14 (U)	—	378	—	NA	—	—	—	—	—	—	1.1 (U)	—	—	NA	—
RE16-09-13531	16-608210	2–2.5	QBT4	1.07 (U)	—	644	—	NA	—	—	—	—	—	—	1.12 (U)	—	—	NA	—
RE16-09-13532	16-608211	3–3.5	SED	1.24 (U)	—	2230	1.32	NA	0.618 (U)	—	—	13900	—	—	1.26 (UJ)	—	—	NA	—
RE16-09-13533	16-608212	0–3	QBT4	1.16 (U)	—	—	—	NA	—	—	—	—	—	—	1.13 (U)	—	—	NA	—
RE16-09-13534	16-608213	0–2.5	FILL	1.25 (U)	—	—	—	NA	0.627 (U)	—	—	—	—	—	—	—	—	NA	—
RE16-09-13516	16-611357	6–6.5	SOIL	1.1 (U)	—	—	—	NA	0.552 (U)	—	10.3	—	27.5	883	—	—	—	—	—
RE16-09-13515	16-611358	8–8.5	SOIL	1.25 (U)	—	571	—	NA	0.627 (U)	—	—	—	—	—	—	—	—	—	—

Note: All concentrations are in mg/kg.

[a] BVs are from LANL (1998, 059730).

[b] na = Not available.

[c] SSLs from NMED (2009,108070) unless otherwise noted.

[d] Construction worker SSL calculated using the toxicity value from the EPA regional tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and the exposure parameters and equation from NMED (2009, 108070).

[e] SSLs from EPA regional screening table (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[f] SSLs from LANL (2010, 108613).

[g] NA = Not analyzed.

[h] J- = The analyte was positively identified, and the result is likely to be biased low.

[i] — = Not detected or not above BV.

[j] U = The analyte was analyzed for but not detected.

[k] UJ = The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.

Table 2.3-4
Summary of Organic Chemicals Detected in the 2000–2001 IM and 2009–2010 CMI Samples from the 260 Outfall Drainage Channel

Sample ID	Location ID	Depth (ft)	Media	3,5-Dinitroaniline	Acetone	Amino-2,6-dinitrotoluene[4-]	Amino-4,6-dinitrotoluene[2-]	Amino-DNTs	Benzoic Acid	Di-n-butylphthalate	Dinitrotoluene[2,4-]	Dinitrotoluene[2,6-]	HMX	Isopropyltoluene[4-]	Naphthalene	RDX	TATB	Toluene	Trichlorofluoromethane	Trinitrobenzene[1,3,5-]	Trinitrotoluene[2,4,6-]
Construction Worker SSL[a]				**na[b]**	**2.63E+05**	**6.01E+02[c]**	**6.01E+02[c]**	**na**	**9.52E+05[c]**	**2.38E+04**	**4.76E+02**	**2.39E+02**	**1.19E+04**	**1.03E+04[d]**	**7.02E+02**	**7.15E+02**	**na**	**2.11E+04**	**5.82E+03**	**8.76E+03[c]**	**1.41E+02**
Industrial SSL[a]				**na**	**8.51E+05**	**1.90E+03[e]**	**2.00E+03[e]**	**na**	**2.50E+06[e]**	**6.84E+04**	**1.03E+02**	**6.87E+02**	**3.42E+04**	**1.49E+04[d]**	**2.52E+02**	**1.74E+02**	**na**	**5.79E+04**	**6.76E+03**	**2.70E+04[e]**	**4.69E+02**
Recreational SSL[f]				**na**	**7.02E+05**	**1.44E+03**	**1.44E+03**	**na**	**1.59E+06**	**3.99E+04**	**8.25E+01**	**4.01E+02**	**1.99E+04**	**5.27E+04[d]**	**1.95E+03**	**2.33E+02**	**na**	**6.08E+04**	**4.98E+04**	**1.99E+04**	**3.01E+02**
Residential SSL[a]				**na**	**6.75E+04**	**1.50E+02[e]**	**1.50E+02[e]**	**na**	**2.40E+05[e]**	**6.11E+03**	**1.57E+01**	**6.12E+01**	**3.06E+03**	**3.21E+03[d]**	**4.50E+01**	**4.42E+01**	**na**	**5.57E+03**	**2.01E+03**	**2.20E+03[e]**	**3.59E+01**
RE16-00-0027	16-06370	4–5	QBT3	NA[g]	NA	0.11 (J-[h])	0.14 (J-)	NA	NA	NA	0.054 (J-)	—	0.17 (J-)	NA	NA	1.8	NA	NA	NA	0.72	—
RE16-00-0024	16-06370	9–10	QBT3	NA	NA	0.21 (J[i])	0.25 (J)	NA	NA	NA	—	—	0.38	NA	NA	1.7	NA	NA	NA	0.55	—
RE16-00-0031	16-06370	16.6–18.4	QBT3	NA	NA	0.24 (J)	0.43	NA	NA	NA	0.083 (J)	—	0.71	NA	NA	4.6	NA	NA	NA	2.5	0.27 (J)
RE16-00-0026	16-06370	19–20	QBT3	NA	NA	—[j]	0.26 (J)	NA	NA	NA	—	—	0.12 (J)	NA	NA	1.3	NA	NA	NA	0.33	0.79
RE16-00-0025	16-06370	32–33	QBT3	NA	NA	0.18 (J)	0.22 (J)	NA	NA	NA	—	—	0.44	NA	NA	1.5	NA	NA	NA	0.47	0.2 (J)
RE16-00-0028	16-06370	36.5–37	QBT3	NA	NA	—	—	NA	NA	NA	0.18 (J)	—	0.12 (J)	NA	NA	1.8	NA	NA	NA	1.3	—
RE16-00-0030	16-06370	41–41.8	QBT3	NA	NA	—	0.11 (J)	NA	NA	NA	0.33	—	0.45	NA	NA	4.4	NA	NA	NA	4.3	—
RE16-00-0029	16-06370	69–70	QBT3	NA	NA	—	—	NA	NA	NA	—	—	—	NA	NA	0.77	NA	NA	NA	1.7	—
RE16-00-0035	16-06388	0–0.5	SOIL	NA	—	—	—	NA	—	—	—	—	27	0.001 (J)	—	—	NA	0.00092 (J)	0.018	—	—
RE16-00-0038	16-06394	0–0.5	SOIL	NA	—	—	—	NA	—	—	—	—	310	—	—	—	NA	—	—	—	—
RE16-00-0048	16-06398	4–5.5	QBT3	NA	—	NA	NA	1 (J+[k])	—	—	—	—	63 (J+)	—	—	16 (J+)	NA	—	—	—	1 (J+)
RE16-09-13541	16-06403	2–2.5	SOIL	—	—	0.552	0.972	NA	—	—	—	—	95.9 (J)	—	—	24.3	12.1	—	—	—	0.467 (J)
RE16-10-16933	16-06405	3–3.5	QBT4	0.0081 (J-)	0.021 (J)	0.084 (J-)	0.081 (J-)	NA	—	—	0.019 (J-)	0.0099 (J-)	2.5 (J-)	—	—	0.55 (J-)	—	—	—	0.015 (J-)	0.14 (J-)
RE16-00-0045	16-06409	0.5–1	SOIL	NA	—	—	—	NA	—	0.086 (J)	0.13 (J)	—	2000	—	—	—	NA	—	—	—	—
RE16-00-0044	16-06411	3–3.5	SOIL	NA	—	—	—	NA	—	—	0.097 (J)	—	1700	—	—	—	NA	—	—	—	—
RE16-00-0041	16-06416	0–0.5	SOIL	NA	—	—	—	NA	—	—	—	—	4.6	—	0.052 (J)	—	NA	—	—	—	—
RE16-00-0042	16-06419	0.25–0.75	SOIL	NA	—	—	—	NA	0.022 (J)	—	0.13 (J)	—	43	0.0012 (J)	—	—	NA	—	—	—	—
RE16-00-0043	16-06420	1.5–2	SOIL	NA	—	—	—	NA	—	—	0.14 (J)	—	1400	—	—	—	NA	—	—	—	—
RE16-09-13517	16-608207	6–6.5	SOIL	—	0.0462 (J)	0.374 (J)	0.23 (J)	NA	—	—	—	—	2.63	—	—	8.09 (J+)	—	—	—	0.648	2.77
RE16-09-13529	16-608208	2–2.5	QBT4	—	0.00867 (J)	—	—	NA	—	—	—	—	8.19 (J)	—	—	0.665	0.461 (J)	—	—	—	—
RE16-09-13530	16-608209	1.5–2	QBT4	—	—	—	—	NA	—	—	—	—	43.6 (J)	—	—	0.576	1.97	—	—	—	—
RE16-09-13531	16-608210	2–2.5	QBT4	—	0.022 (J)	—	—	NA	—	—	—	—	14 (J)	—	—	0.279 (J)	0.412 (J)	—	—	—	—
RE16-09-13532	16-608211	3–3.5	SED	—	—	0.891	0.535	NA	—	—	—	—	—	—	—	16.8 (J)	16.6 (J+)	—	—	—	4.59 (J+)
RE16-09-13533	16-608212	0–3	QBT4	—	—	2.56	0.645	NA	—	—	—	—	6.9 (J)	—	—	34.7 (J)	—	—	—	0.761 (J+)	24.3 (J)
RE16-09-13534	16-608213	0–2.5	FILL	—	—	1.89	2.17	NA	—	—	—	—	17.6 (J+)	—	—	44.1 (J)	0.303 (J)	—	—	1.01 (J+)	9.91 (J)

Table 2.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Media	3,5-Dinitroaniline	Acetone	Amino-2,6-dinitrotoluene[4-]	Amino-4,6-dinitrotoluene[2-]	Amino-DNTs	Benzoic Acid	Di-n-butylphthalate	Dinitrotoluene[2,4-]	Dinitrotoluene[2,6-]	HMX	Isopropyltoluene[4-]	Naphthalene	RDX	TATB	Toluene	Trichlorofluoromethane	Trinitrobenzene[1,3,5-]	Trinitrotoluene[2,4,6-]
Construction Worker SSL[a]				**na[b]**	**2.63E+05**	**6.01E+02[c]**	**6.01E+02[c]**	**na**	**9.52E+05[c]**	**2.38E+04**	**4.76E+02**	**2.39E+02**	**1.19E+04**	**1.03E+04[d]**	**7.02E+02**	**7.15E+02**	**na**	**2.11E+04**	**5.82E+03**	**8.76E+03[c]**	**1.41E+02**
Industrial SSL[a]				**na**	**8.51E+05**	**1.90E+03[e]**	**2.00E+03[e]**	**na**	**2.50E+06[e]**	**6.84E+04**	**1.03E+02**	**6.87E+02**	**3.42E+04**	**1.49E+04[d]**	**2.52E+02**	**1.74E+02**	**na**	**5.79E+04**	**6.76E+03**	**2.70E+04[e]**	**4.69E+02**
Recreational SSL[f]				**na**	**7.02E+05**	**1.44E+03**	**1.44E+03**	**na**	**1.59E+06**	**3.99E+04**	**8.25E+01**	**4.01E+02**	**1.99E+04**	**5.27E+04[d]**	**1.95E+03**	**2.33E+02**	**na**	**6.08E+04**	**4.98E+04**	**1.99E+04**	**3.01E+02**
Residential SSL[a]				**na**	**6.75E+04**	**1.50E+02[e]**	**1.50E+02[e]**	**na**	**2.40E+05[e]**	**6.11E+03**	**1.57E+01**	**6.12E+01**	**3.06E+03**	**3.21E+03[d]**	**4.50E+01**	**4.42E+01**	**na**	**5.57E+03**	**2.01E+03**	**2.20E+03[e]**	**3.59E+01**
RE16-09-13516	16-611357	6–6.5	SOIL	—	—	—	—	NA	—	—	—	—	4.46	—	—	3.55 (J+)	—	—	—	—	—
RE16-09-13515	16-611358	8–8.5	SOIL	—	—	—	—	NA	—	—	—	—	84.4	—	—	34.5 (J+)	3.2 (J)	—	—	0.18 (J)	—

Note: All concentrations are in mg/kg.

[a] SSLs from NMED (2009,108070) unless otherwise noted.

[b] na = Not available.

[c] Construction worker SSL calculated using the toxicity value from the EPA regional tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) and the exposure parameters and equation from NMED (2009, 108070).

[d] Isopropylbenzene used as a surrogate based on structural similarity.

[e] SSLs from EPA regional screening table (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[f] SSLs from LANL (2010, 108613).

[g] NA = Not analyzed.

[h] J- = The analyte was positively identified, and the result is likely to be biased low.

[i] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

[j] — = Not detected or not above BV.

[k] J+ = The analyte was positively identified, and the result is likely to be biased high.

Table 2.3-5
Summary of the Results of the *C. tentans* Survival and Growth Test

Sample ID	Mean Survival (%)	Mean Growth (mg ash-free dry weight)
Laboratory control	78.8	0.52
SWSC Cut sediment	77.5	0.72

Appendix A

Risk Assessments

A-1.0 INTRODUCTION

This appendix presents the results of the human health risk-screening assessments conducted in support of environmental characterization following the 2009–2010 corrective measures implementation (CMI) at the source area for Consolidated Unit 16-021(c)-99, located in Technical Area 16 (TA-16) at Los Alamos National Laboratory (LANL or the Laboratory). The objective of the CMI was to remediate soil and tuff contaminated with high explosives (HE) and other contaminants. The CMI was conducted in accordance with the approved CMI work plan (LANL 2007, 098192; NMED 2009, 107307).

A-2.0 BACKGROUND

The risk-screening assessments of post-CMI activities focus on the chemicals of potential concern (COPCs) identified and evaluated for potential risk during the Phase III Resource Conservation, and Recovery Act (RCRA) facility investigation (RFI) (LANL 2003, 077965). The Phase III RFI considered exposures to an on-site environmental worker, a trail user, and a construction worker.

For the trail user, the total excess cancer risk from potential exposures to COPCs in soil and tuff was less than the New Mexico Environment Department (NMED) target risk level of 1×10^{-5} and the noncancer hazard was below the target hazard index (HI) of 1.0 (LANL 2003, 077965). Therefore, no unacceptable potential risk to the trail user exists at Consolidated Unit 16-021(c).

The HI for the environmental worker was below 1.0. However, the total excess cancer risk was slightly above the NMED target risk level of 1×10^{-5} (LANL 2003, 077965). Consequently, the risk to the environmental worker required further evaluation. It should be noted that the environmental worker scenario is replaced by the industrial scenario in this assessment.

The total excess cancer risk for the construction worker was below the NMED target risk level of 1×10^{-5}. However, the HI for the construction worker was above 1.0 (LANL 2003, 077965). Consequently, the risk to the construction worker required further evaluation.

In addition to the industrial and construction worker scenarios evaluated in this appendix, the residential scenario was also assessed in accordance with the requirements of the Compliance Order on Consent.

Consolidated Unit 16-021(c)-99 was also evaluated for ecological risk in the Phase III RFI (LANL 2003, 077965). The ecological risk assessment followed U.S. Environmental Protection Agency (EPA) and NMED guidance (EPA 1997, 059370; NMED 2000, 070107). The ecological risk assessment found elevated metal concentrations in small mammals but not at levels that are likely to cause adverse effects for the Mexican spotted owl. The numbers of species, population densities, and reproductive classes indicated that the small mammal populations are not being adversely affected by contaminants.

The ecological assessment of the aquatic system in the canyon found some differences between the site’s benthic macroinvertebrates and reference canyons. A 2001 aquatic assessment indicated benthic macroinvertebrates in Cañon de Valle showed general decreases from 1997 in numbers of species, sensitive species, and community metrics (LANL 2003, 077965). These changes were primarily from a combination of the elimination of flow augmentation by effluent discharges and the continuing drought that had reduced natural sources of water to the canyon. Toxicity tests using *Chironomus tentans* (*C. tentans*) on the sediment and site water next to the Cañon de Valle benthic macroinvertebrate sampling site was conducted as part of the Phase III RFI (LANL 2003, 077965).

The test results indicated that there were no adverse effects on survival and growth, except at one location (LANL 2003, 077965). The only effects occurred at the Sanitary Wastewater Systems Consolidation (SWSC) Cut site, with 22.5% survival and an increase in growth. The mortality was associated with silver in the sediment and water. The apparent increase in growth over the control organisms was thought to be associated with the presence of hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in the sediment (LANL 2003, 077965).

A-2.1 Site Descriptions and Operational History

TA-16 was established for the purposes of developing explosive formulations, casting and machining explosive charges, and assembling and testing explosive components for the nuclear weapons program. Almost all the work has been conducted in support of the development, testing, and production of explosive charges for the implosion method. Present-day use of this site is essentially unchanged, although facilities have been upgraded and expanded as explosive and manufacturing technologies have advanced.

Consolidated Unit 16-021(c)-99 at TA-16 is comprised of a settling pond and an upper and lower drainage channel that extends from the 260 Outfall downgradient to the confluence of the drainage and Cañon de Valle. The source area was excavated during an interim measure (IM) conducted from winter 2000 to the summer of 2001 (LANL 2002, 073706). The IM removed more than 1300 yd^3 of contaminated soil, sediment, and tuff containing approximately 90% of the HE compounds from the source area. However, HE and barium still remain in the Consolidated Unit 16-021(c)-99 source area in isolated locations throughout the drainage channel. Spot removal of contaminated soil was performed in 2009–2010 (LANL 2010, 108868). The risk-screening assessments presented in this appendix are based on the data following the latest remediation effort.

A-2.2 Investigation Sampling

The analytical results from the IM activities (data collected in 2000) and the CMI confirmation sampling (LANL 2010, 108868) conducted in 2009–2010 are used to evaluate potential risks to human health. Only those data determined to be of decision-level quality are included in the final data sets evaluated in this appendix.

A-2.3 Determination of COPCs

The Phase III RFI identified chemicals above screening action levels (SALs) at Consolidated Unit 16-021(c)-99 (LANL 2003, 077965). Chemicals above SALs included aluminum, arsenic, barium, iron, manganese, thallium, uranium, 1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), RDX, and 2,4,6-trinitrotoluene (TNT).

Inorganic COPCs were reevaluated following the CMI sampling by performing comparisons to background concentrations. The results are presented in Appendix B (Tables B-1 and B-2). As a result of the comparisons to background concentrations, some inorganic COPCs from the Phase III RFI were eliminated and were not evaluated in the risk-screening assessments. All previously identified organic COPCs (HMX, RDX, and TNT) were retained for further evaluation. Concentrations of previously identified organic COPCs in the CMI samples did not result in additional organic COPCs in the risk assessments. However, three HE [3,5-dinitroaniline, 2,6-dinitrotoluene,and triaminotrinitrobenzene (TATB)] were detected in the CMI samples but were not previously detected. These three HE are discussed in the uncertainty section.

The industrial scenario utilized sample data collected from 0–1 ft below ground surface (bgs). The construction worker and the residential scenarios utilized sample data collected from 0–10 ft bgs. However, sampling depths often overlapped because of multiple investigations; therefore, samples with a starting depth less than the lower bound of the interval for each scenario were included in the risk-screening assessments for a given scenario.

Tables A-2.2-1 and A-2.2-2 summarize the COPCs evaluated for potential risk at Consolidated Unit 16-021(c)-99. Some of the COPCs may not be evaluated for potential risk under one or more scenarios because they were not found within the depth intervals associated with a given scenario.

A-2.4 Inorganic Chemical Background Comparisons

For inorganic chemicals, data are evaluated by sample media to facilitate the comparison with media-specific background data. To identify inorganic COPCs, the first step is to compare the sample result with the BV. This process begins with a simple comparison of site data with the BV. The BVs are used to represent the upper end of concentration distribution. If sampling results are above the BV and sufficient data are available (10 or more sampling results), statistical tests are used to compare the site sample data with the background dataset for the appropriate media. If statistical tests cannot be performed because of insufficient data or a high percentage of nondetects, the sampling results are compared only to the greater of the BV or the maximum background concentration in the appropriate media. If any sampling result is above the BV and/or the maximum background concentration, the chemical is identified as a COPC. The same evaluation is performed using sample DLs when an inorganic chemical is not detected but has DLs above the BV.

Comparisons between site-specific data and Laboratory background data are performed using a variety of statistical methods. The BV comparisons are followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions (e.g., a test of the hypothesis that site concentrations are elevated above background levels). Nonparametric tests most commonly performed include the Gehan test (modification of the Wilcoxon Rank Sum test) and the quantile test (Gehan 1965, 055611; Gilbert and Simpson 1990, 055612).

The Gehan test is recommended when between 10% and 50% of the data sets are nondetections. It handles data sets with nondetections reported at multiple detection limits in a statistically robust manner (Gehan 1965, 055611; Millard and Deverel 1988, 054953). The Gehan test is not recommended if either of the two data sets has more than 50% nondetections. If there are no nondetected concentrations in the data, the Gehan test is equivalent to the Wilcoxon Rank Sum test. The Gehan test is the preferred test because of its applicability to a majority of environmental data sets and its recognition and recommendation in EPA-sponsored workshops and publications.

The quantile test is better suited to assessing shifts in a subset of the data. The quantile test determines whether more of the observations in the top chosen quantile of the combined data set come from the site data set than would be expected by chance, given the relative sizes of the site and background data sets. If the relative proportion of the two populations being tested is different in the top chosen quantile of the data than in the remainder of the data, the distributions may be partially shifted because of a subset of site data. This test is capable of detecting a statistical difference when only a small number of concentrations are elevated (Gilbert and Simpson 1992, 054952). The quantile test is the most useful distribution shift test where samples from a release represent a small fraction of the overall data collected. The quantile test is applied at a prespecified quantile or threshold, usually the 80th percentile. The test cannot be performed if more than 80% (or, in general, more than the chosen percentile) of the combined data are nondetected values. It can be used when the frequency of nondetections is approximately the same as the quantile being tested. For example, in a case with 75% nondetections in the combined background and site data set, application of a quantile test comparing 80th percentiles is appropriate. However, the test cannot be performed if nondetections occur in the top chosen quantile. The threshold percentage can be adjusted to accommodate the detection rate of an analyte, or to look for differences further into the distribution tails. The quantile test is more powerful than the Gehan test for detecting differences when only a small percentage of the site concentrations are elevated.

Occasionally, if the differences between two distributions appear to occur far into the tails, the slippage test might be performed. This test evaluates the potential for some of the site data to be greater than the maximum concentration in the background data set if, in fact, the site data and background data came from the same distribution. This test is based on the maximum concentration in the background data set and the number (“n”) of site concentrations that exceed the maximum concentration in the background set (Gilbert and Simpson 1990, 055612, pp. 5–8). The result (p-value) of the slippage test is the probability that “n” site samples (or more) exceed the maximum background concentration by chance alone. The test accounts for the number of samples in each data set (number of samples from the site and number of samples from background) and determines the probability of “n“ (or more) exceedances if the two data sets came from identical distributions. This test is similar to the BV comparison in that it evaluates the largest site measurements but is more useful than the BV comparison because it is based on a statistical hypothesis test, not simply on a statistic calculated from the background distribution.

For all statistical tests, a p-value less than 0.05 was the criterion for accepting the null hypothesis that site sampling results are not different than background.

A-3.0 CONCEPTUAL SITE MODEL

The conceptual site model for the 260 Outfall has been described in detail in the Phase III RFI report (LANL 2003, 077965). Additional information has been presented in the CMS report (LANL 2003, 085531).

The scenarios evaluated in the revised human health risk assessments included the industrial, construction worker, and residential scenarios. The industrial scenario is the current and reasonably foreseeable future land use of this area. Human receptors may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, and dermal contact pathways. Direct contact exposure pathways from subsurface contamination to human receptors are complete for the resident and the construction worker. The conceptual site model is presented in Figure A-3.1-1.

A-3.3 Exposure Point Concentration Calculations

The exposure point concentrations (EPCs) represent upper bound concentrations of COPCs. For comparison to risk-screening levels, the upper confidence limit (UCL) of the arithmetic mean was calculated and used as the EPC. The UCLs were calculated using all available decision-level data within the depth range of interest. If an appropriate UCL of the mean could not be calculated or if the UCL exceeded the maximum concentration, the maximum detected concentration of the COPC was used as the EPC. The summary statistics, including the EPC for each COPC for the human health risk-screening assessments and the distribution used for the calculation, are presented in Tables A-2.2-1 and A-2.2-2.

Calculation of UCLs of the mean concentrations was done using the EPA ProUCL 4.00.05 software (EPA 2007, 096530), which is based on EPA guidance (EPA 2002, 085640). The ProUCL program calculates 95%, 97.5%, and 99% UCLs and recommends a distribution and UCL. The UCL for the recommended calculation method was used as the EPC. The ProUCL software performs distributional tests on the data set for each COPC and calculates the most appropriate UCL based on the distribution of the data set. Environmental data may have a normal, lognormal, or gamma distribution but are often nonparametric (no definable shape to the distribution). The ProUCL documentation strongly recommends against using the maximum detected concentration for the EPC. The maximum detected concentration was used to represent the EPC for COPCs only when there were too few detects to calculate a UCL. Input and output data files for the ProUCL calculations are provided as Attachment A-1 (on CD).

A-4.0 HUMAN HEALTH RISK-SCREENING ASSESSMENT RESULTS

The human health risk-screening assessments were conducted for Consolidated Unit 16-021(c)-99. The site was assessed under the industrial scenario using data from 0-1 ft below ground surface (bgs) and under the construction worker and residential scenarios using data from 0-10 ft bgs. The human health risk-screening assessments compare the UCL of the mean concentration or the maximum detected concentration of each COPC with soil screening levels (SSLs).

A-4.1 Soil Screening Levels

The human health risk-screening assessments were conducted using SSLs for the industrial, construction worker, and residential scenarios from NMED guidance (NMED 2009, 108070). The SSLs are based on a target noncarcinogenic hazard quotient (HQ) of 1.0 and a target cancer risk of 1×10^{-5} (NMED 2009, 108070). Exposure parameters used to calculate the industrial, construction worker, and residential SSLs are presented in Table A-4.1-1.

A-4.2 Results of Human Health Screening Evaluation

The EPC of each COPC in soil was compared with the SSLs for the industrial, construction worker, and residential scenarios. For carcinogenic COPCs, the EPCs were divided by the SSL and multiplied by 1×10^{-5}. The sum of the carcinogenic risks was compared with the NMED target cancer risk level of 1×10^{-5}. For noncarcinogenic COPCs, an HQ was generated for each COPC by dividing the EPC by the SSL. The HQs were summed to generate a hazard index (HI), which was compared with the NMED target HI of 1.0.

The results of the risk screening assessment for the industrial scenario are presented in Tables A-4.2-1 and A-4.2-2. The total excess cancer risk is 3×10^{-6}, which is less than the NMED target risk of 1×10^{-5} (NMED 2009, 108070). The industrial HI is 0.09, which is below the NMED target of 1.0 (NMED 2009, 108070).

The results of the risk-screening assessment for the construction worker scenario are presented in Table A-4.2-3. No carcinogenic COPCs exist for the construction worker (RDX has a noncancer SSL for this scenario). The construction worker HI is approximately 2, which is slightly above the NMED target of 1.0 (NMED 2009, 108070). The elevated HI is primarily from manganese

The results of the risk-screening assessment for the residential scenario are presented in Tables A-4.2-4 and A-4.2-5. The total excess cancer risk for the residential scenario is approximately 4×10^{-6}, which is below the NMED target risk of 1×10^{-5} (NMED 2009, 108070). The residential HI is 0.7, which is below the NMED target of 1.0 (NMED 2009, 108070).

A-4.3 Uncertainty Analysis

The human health risk-screening evaluations are subject to varying degrees and types of uncertainty. Aspects of data evaluation and COPC identification, exposure evaluation, toxicity evaluation, and the additive approach all contribute to uncertainties in the risk-evaluation process.

A-4.3.1 Data Evaluation and COPC Identification Process

A primary uncertainty associated with the COPC identification process is the possibility that a chemical may be inappropriately identified as a COPC when it is actually not a COPC or that a chemical may not be identified as a COPC when it actually should be identified as a COPC. All organic chemicals previously identified in the Phase III RFI (LANL 2003, 077965) were retained. Inorganic chemicals were appropriately identified as COPCs because they were compared with background concentrations or had detection limits above background. However, background concentrations may not be representative of certain subunits of the Bandelier Tuff (e.g., fractured, clay-rich material) since such samples are not included in the background data set.

Along with the previously identified HE (HMX, RDX, and TNT), 3,5-dinitroaniline, 2,6-dinitrotoluene, and TATB were detected in the 2009–2010 samples. Dinitroaniline[3,5-] was detected in only one sample at 0.0081 mg/kg. No toxicity data are available from NMED or EPA to calculate SSLs. However, industrial and residential SSLs are available for 4-nitroaniline in the EPA regional tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm). Nitroaniline[4-] is a carcinogen with residential and industrial SSLs of 240 mg/kg and 860 mg/kg, respectively. Based on these SSLs for a structurally similar chemical, the frequency of detection, and the low concentration detected, 3,5-dinitroaniline does not contribute to the potential risk. Dinitrotoluene[2,6-] was analyzed for in 2000 but was not detected in 11 samples. It was analyzed for again in 2009 and 2010 and detected once at a concentration of 0.0099 mg/kg. The industrial, construction worker, and residential SSLs are 687 mg/kg, 239 mg/kg, and 61.2 mg/kg, respectively (NMED 2009, 108070). Based on these SSLs, the frequency of detection, and the low concentration detected, 2,6-dinitrotoluene does not contribute to the potential risk. TATB was not analyzed for in the 2000 samples but was analyzed in 11 samples collected during the 2009–2010 investigation. TATB was detected in seven samples collected during the 2009–2010 samples with a maximum concentration of 16.6 mg/kg. Trinitrobenzene[1,3,5-] is a noncarcinogen with residential and industrial SSLs of 2200 mg/kg and 27,000 mg/kg, respectively. Based on these SSLs for a somewhat similar chemical, TATB does not contribute to the potential risk.

Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. However, because the concentrations used in the risk-screening evaluations include those detected below estimated quantitation limits and are above background, data evaluation uncertainties are expected to have little effect on the risk-screening results.

A-4.3.2 Exposure Assessment

To the degree that actual activity patterns are not represented by those activities assumed by the scenarios, uncertainties are introduced in the assessment, and the evaluations presented here over- or underestimate potential risk. An individual may be subject to exposures in a different manner than the exposure assumptions used to derive the SSLs. For the sites evaluated, individuals might not be on-site now or in the future for that frequency and duration. The assumptions for the industrial SSLs are that the potentially exposed individual is outside on-site for 8 h/d, 225 d/yr, and 25 yr (NMED 2009, 108070), while the construction worker SSLs are based on exposure of 8 h/d, 250 d/yr, and 1 yr (NMED 2009, 108070). The residential SSLs are based on exposure of 24 h/d, 350 d/yr, and 30 yr (NMED 2009, 108070). As a result, the industrial, construction worker, and residential scenarios evaluated at these sites likely overestimate the exposure and risk/dose.

A number of assumptions are made relative to exposure pathways, including input parameters, whether a given pathway is complete, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with default values (NMED 2009, 108070). When several upper-bound values are combined to estimate exposure for any one pathway, the resulting risk estimate can exceed the 99^{th} percentile, and therefore, can exceed the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and result in exposure in the same manner as if they were in soil overestimates the potential exposure and risk to receptors.

Uncertainty is introduced in the concentration aggregation of data for estimating the EPCs at a site. Risk from a single location or area with relatively high COPC concentrations may be underestimated by using a representative, sitewide value. The use of a UCL is intended to provide a protective, upper-bound (i.e., conservative) COPC concentration and is assumed to be representative of the average exposure to a COPC across the entire site. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site.

The HI of approximately 2 for the construction worker scenario indicates a potential risk may exist primarily from manganese. However, the potential risk is overestimated because of uncertainties associated with the EPC and SSL for manganese. The manganese EPC is 571 mg/kg, which is similar to the BVs for Qbt 2, 3, 4 and soil (482 mg/kg and 671 mg/kg, respectively) and the ranges of background concentrations (Qbt 2, 3, 4 background concentrations range from 22 mg/kg to 752 mg/kg and the soil background concentrations range from 76 mg/kg to 1100 mg/kg). In addition, the construction worker SSL (463 mg/kg) is similar to the BVs and ranges of background concentrations. Therefore, the exposure to manganese is overestimated, and the HI is not representative of the potential risk. If manganese is not included, the HI for the construction worker is approximately 1, which is equivalent to the NMED target HI. Therefore, no potential unacceptable risk for the construction worker scenario exists at Consolidated Unit 16-021(c)-99.

A-4.3.3 Toxicity Evaluation

The primary uncertainty associated with the SSLs is related to the derivation of toxicity values used in their calculation. Toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SSLs used in this risk screening evaluation (NMED 2009, 108070). Uncertainties were identified in five areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) inter-individual variability in the human population, (3) the derivation of RfDs and SFs, (4) the chemical form of the COPC, and (5) the use of surrogate chemicals.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. Differences in body weight, surface area, and pharmacokinetic relationships between animals and humans are taken into account to address these uncertainties in the dose-response relationship. However, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.

Individual Variability in the Human Population. For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the no observed adverse effect level (NOAEL). The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk evaluation; this factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

Derivation of RfDs and SFs. The RfDs and SFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision that could lead to an over- or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For carcinogens, the weight of evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

Chemical Form of the COPC. COPCs may be bound to the environment matrix and not available for absorption into the human body. However, it is assumed that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk.

Use of Surrogate Chemicals. The use of surrogates for some chemicals that do not have EPA-approved or provisional toxicity values also contributes to uncertainty in risk assessment. In this assessment, 4-nitroaniline and 1,3,5-trinitrobenzene were used to qualitatively assess 3,5-dinitroaniline and TATB, respectively. The detected concentrations for these two HE relative to the SSLs for 4-nitroaniline and 1,3,5-trinitrobenzene indicate that 3,5-dinitroaniline and TATB do not contribute substantially to the potential risk.

A-4.3.4 Additive Approach

For noncarcinogens, the effects of exposure to multiple chemicals are generally unknown and possible interactions could be synergistic or antagonistic, resulting in either an overestimation or underestimation of the potential risk. Additionally, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for noncarcinogenic effects may be overestimated for individual COPCs that act by different mechanisms and on different target organs but are addressed additively.

A-4.4 Interpretation of Human Health Risk Screening Results

Industrial Scenario

The total excess cancer risk for the industrial scenario is 3×10^{-6}, which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.09, which is below the NMED target HI of 1.0 (NMED 2009, 108070).

Construction Worker Scenario

There are no carcinogenic COPCs for the construction worker scenario. The construction worker HI is approximately 2, which is above the NMED target HI of 1.0 (NMED 2009, 108070). The elevated HI is primarily from manganese. Because the EPC and the construction worker SSL for manganese are similar to the soil and Qbt 2, 3, 4 BVs and the ranges of soil and tuff background concentrations, the potential risk is substantially overestimated. Without manganese, the HI for the construction worker is approximately 1, which is equivalent to the NMED target HI. Therefore, no unacceptable risk exists for the construction worker scenario.

Residential Scenario

The total excess cancer risk for the residential scenario is 4×10^{-6}, which is below the NMED target risk level of 1×10^{-5} (NMED 2009, 108070). The HI is 0.7, which is below the NMED target HI of 1.0 (NMED 2009, 108070).

A-5.0 CONCLUSIONS AND RECOMMENDATIONS

A-5.1 Human Health Risk

The human health risk-screening assessments found the total excess cancer risks and HIs for the industrial, construction worker, and residential scenarios to be below the NMED target levels. The potential risk associated with manganese for the construction worker scenario is overestimated by the SSL and the EPC; both are similar to background concentrations. As a result, there are no potential unacceptable risks to human health at Consolidated Unit 16-021(c)-99.

A-5.2 Ecological Risk

The baseline ecological risk assessment conducted for the Phase III RFI found no evidence of ecological effects at Consolidated Unit 16-021(c)-99, except for sediment toxicity to *C. tentans* at one location. This location was resampled and the sediment tested as part of the CMI activities at Consolidated Unit 16-021(c)-99. The results of the latest sediment toxicity test are presented in Appendix D and discussed in the addendum report. The other aspects of the ecological risk assessment were not reevaluated following CMI remediation efforts.

A-6.0 REFERENCES

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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.

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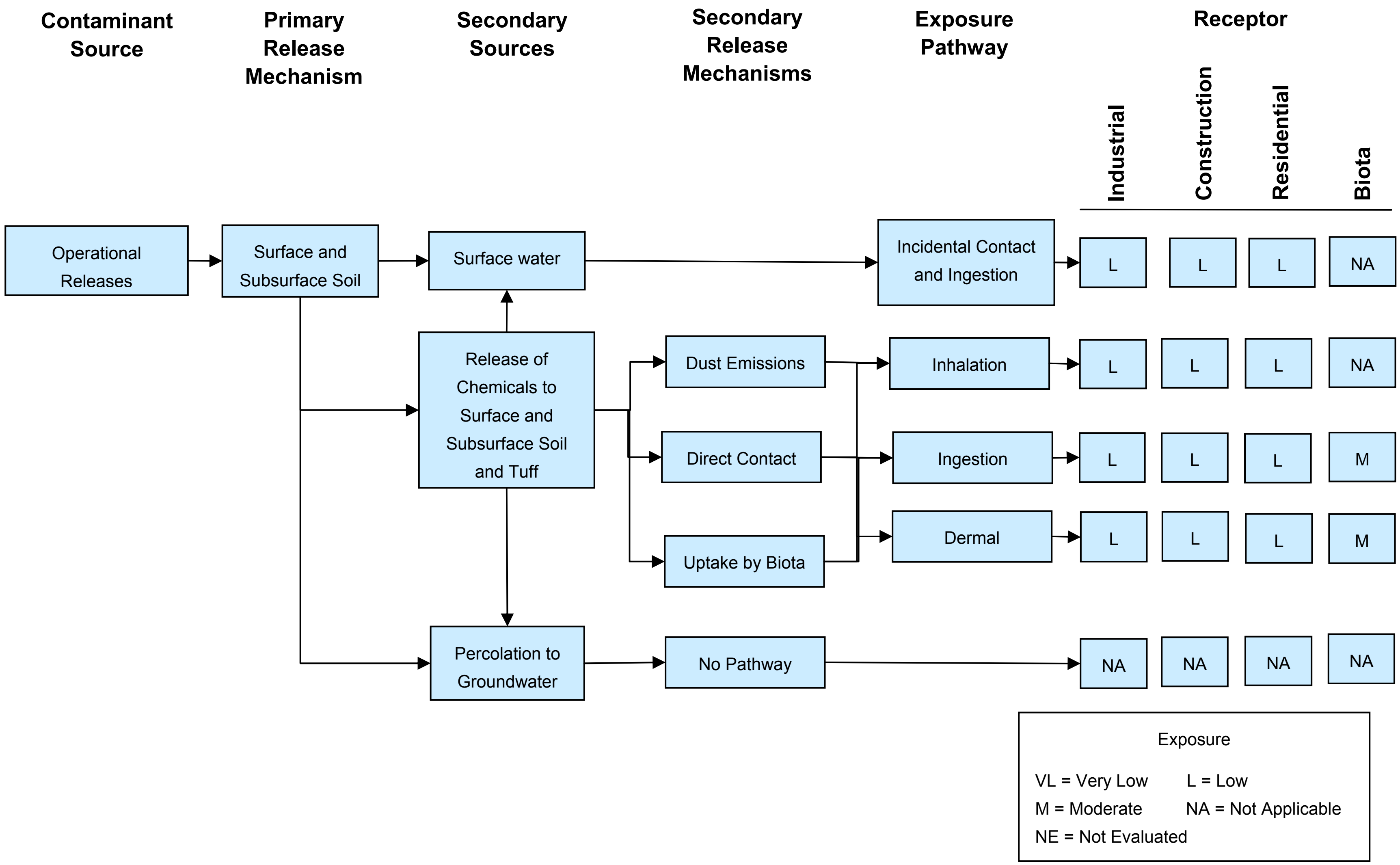

Figure A-3.1-1 Conceptual site model for Consolidated Unit 16-021(c)-99

Table A-2.2-1
EPCs for Consolidated Unit 16-021(c)-99 for the Industrial Scenario (0–1 ft bgs)

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Barium	8	8	32.9 (J[a])	8200	Normal	4623	95% Student's-t UCL
Manganese	8	8	145 (J-[b])	1200	Normal	744.6	95% Student's-t UCL
Organic Chemicals (mg/kg)							
HMX	8	7	2.2 (U[c])	2000	Gamma	1382	95% KM (Chebyshev) UCL
RDX	8	2	1 (U)	100 (U)	Nonparametric	44.1	Maximum detected concentration
Trinitrotoluene[2,4,6-]	8	2	0.25 (U)	25 (U)	Nonparametric	24.3	Maximum detected concentration

[a] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
[b] J- = The analyte was positively identified, and the result is likely to be biased low.
[c] U = The analyte was analyzed for but not detected.

Table A-2.2-2
EPCs for Consolidated Unit 16-021(c)-99 for the Construction and Residential Scenarios (0–10 ft bgs)

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Barium	20	20	32.9 (J[a])	8200	Gamma	3877	95% Approximate Gamma UCL
Iron	20	20	5700	14000	Gamma	10913	95% Approximate Gamma UCL
Manganese	20	20	145 (J-[b])	1200	Gamma	571.4	95% Approximate Gamma UCL
Uranium	12	12	0.447	3.12	Normal	1.84	Student’s t-test
Organic Chemicals (mg/kg)							
HMX	21	20	0.17 (J-)	2000	Lognormal	855.1	95% KM (Chebyshev) UCL
RDX	22	14	0.279 (J)	200 (U[c])	Gamma	15.45	95% KM (BCA) UCL
Trinitrotoluene[2,4,6-]	22	7	0.14 (J-)	50 (U)	Gamma	4.833	95% KM (t) UCL

[a] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
[b] J- = The analyte was positively identified, and the result is likely to be biased low.
[c] U = The analyte was analyzed for but not detected.

Table A-4.1-1
Exposure Parameter Values Used to Calculate
Chemical SSLs for the Industrial, Construction Worker, and Residential Scenarios

Parameters	Residential Values	Industrial Values	Construction Worker Values
Target HQ	1	1	1
Target cancer risk	10^{-5}	10^{-5}	10^{-5}
Averaging time (carcinogen)	70 yr × 365 d	70 yr × 365 d	70 yr × 365 d
Averaging time (noncarcinogen)	Exposure duration × 365 d	Exposure duration × 365 d	Exposure duration × 365 d
Skin absorption factor	Semivolatile organic compound (SVOC) = 0.1	SVOC = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific	Chemical-specific
Adherence factor–child	0.2 mg/cm^2	n/a[a]	n/a
Body weight–child	15 kg (0–6 yr of age)	n/a	n/a
Cancer slope factor–oral (chemical-specific)	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$
Cancer slope factor–inhalation (chemical-specific)	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$
Exposure frequency	350 d/yr	225 d/yr	250 d/yr
Exposure time	24 hr/d	8 hr/d	8 hr/d
Exposure duration–child	6 yr	n/a	n/a
Age-adjusted ingestion factor	114 mg-yr/kg-d	n/a	n/a
Age-adjusted inhalation factor	11 m^3-yr/kg-d	n/a	n/a
Inhalation rate–child	10 m^3/d	n/a	n/a
Soil ingestion rate–child	200 mg/d	n/a	n/a
Particulate emission factor	6.61×10^9 m^3/kg	6.61×10^9 m^3/kg	2.1×10^6 m^3/kg
Reference dose–oral (chemical-specific)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)
Reference dose–inhalation (chemical-specific)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)
Exposed surface area–child	2800 cm^2/d	n/a	n/a
Age-adjusted skin contact factor for carcinogens	361 mg-yr/kg-d	n/a	n/a
Volatilization factor for soil (chemical-specific)	(m^3/kg)	(m^3/kg)	(m^3/kg)
Body weight–adult	70 kg	70 kg	70 kg
Exposure duration[b]	30 yr	25 yr	1 yr
Adherence factor–adult	0.07 mg/cm^2	0.2 mg/cm^2	0.3 mg/cm^2
Soil ingestion rate–adult	100 mg/d	100 mg/d	330 mg/d
Exposed surface area–adult	5700 cm^2/d	3300 cm^2/d	3300 cm^2/d
Inhalation rate–adult	20 m^3/d	20 m^3/d	20 m^3/d

Note: Parameter values from NMED 2009, 108070.
[a] n/a = Not applicable.
[b] Exposure duration for lifetime resident is 30 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (24 yr).

Table A-4.2-1
Industrial Carcinogenic Screening
Evaluation for Consolidated Unit 16-021(c)-99

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	Cancer Risk
RDX	44.1	174	2.5E-06
		Total Excess Cancer Risk	**3E-06**

* SSLs from NMED (2009, 108070).

Table A-4.2-2
Industrial Noncarcinogenic Screening
Evaluation for Consolidated Unit 16-021(c)-99

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	HQ
Barium	4623	224000	2.1E-07
Manganese	744.6	145000	5.1E-08
HMX	1382	34200	4.0E-02
Trinitrotoluene[2,4,6-]	24.3	469	5.2E-02
		HI	**0.09**

* SSLs from NMED (2009, 108070).

Table A-4.2-3
Construction Worker Noncarcinogenic Screening
Evaluation for Consolidated Unit 16-021(c)-99

COPC	EPC (mg/kg)	Construction SSL* (mg/kg)	HQ
Barium	3877	4350	8.9E-01
Iron	10913	217000	5.0E-02
Manganese	571.4	463	1.2E+00
Uranium	1.84	929	2.0E-03
HMX	855.1	11900	7.2E-02
RDX	15.45	715	2.2E-02
Trinitrotoluene[2,4,6-]	4.833	141	3.4E-02
		HI	**2.3**

* SSLs from NMED (2009, 108070).

Table A-4.2-4
Residential Carcinogenic Screening
Evaluation for Consolidated Unit 16-021(c)-99

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	Cancer Risk
RDX	15.45	44.2	3.5E-06
		Total Excess Cancer Risk	**4E-06**

* SSLs from NMED (2009, 108070).

Table A-4.2-5
Residential Noncarcinogenic Screening
Evaluation for Consolidated Unit 16-021(c)-99

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	HQ
Barium	3877	15600	2.5E-01
Iron	10913	54800	2.0E-06
Manganese	571.4	10700	5.3E-07
Uranium	1.84	235	7.8E-03
HMX	855.1	3060	2.8E-01
Trinitrotoluene[2,4,6-]	4.833	35.9	1.4E-01
		HI	**0.7**

* SSLs from NMED (2009, 108070)

Appendix B

Box Plots and Statistical Results

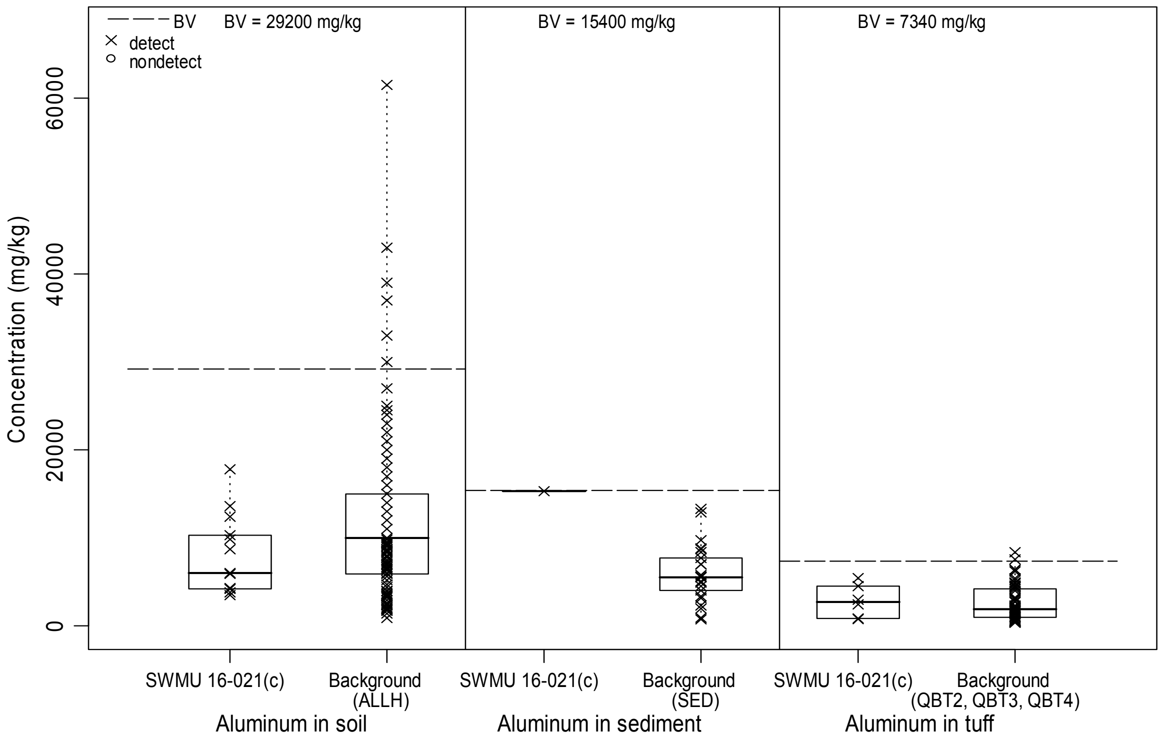

Figure B-1 Box plot for aluminum in soil, sediment, and tuff

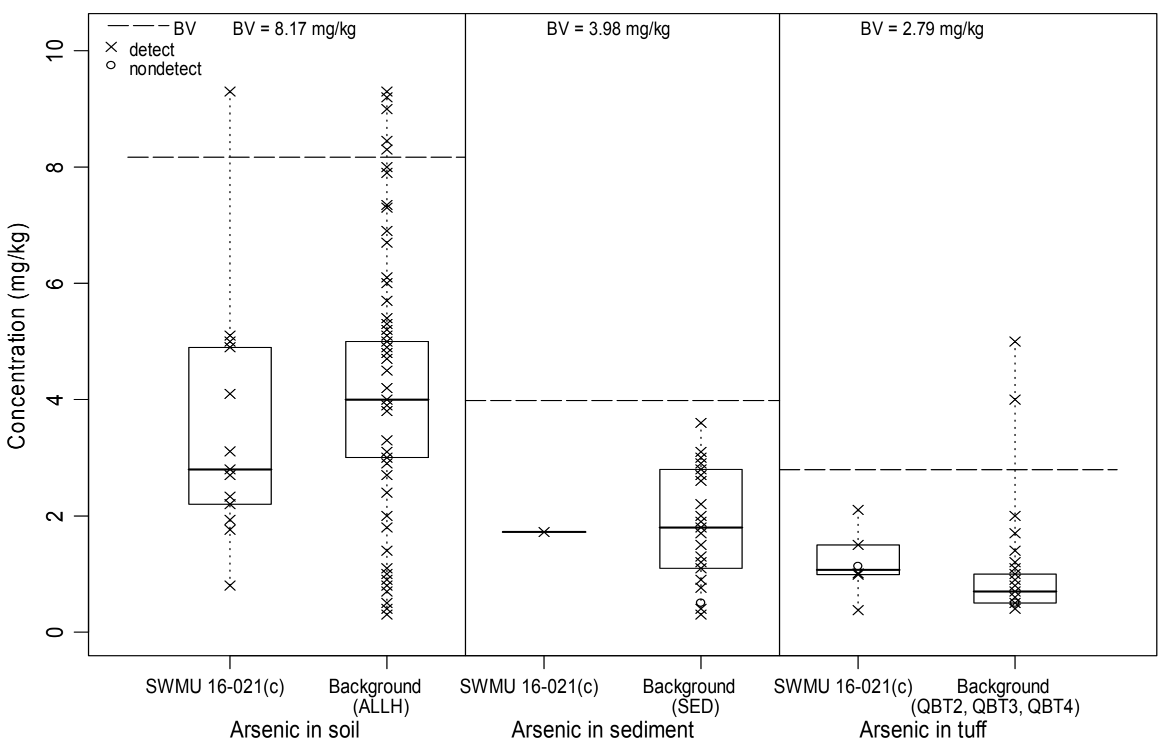

Figure B-2 Box plot for arsenic in soil, sediment, and tuff

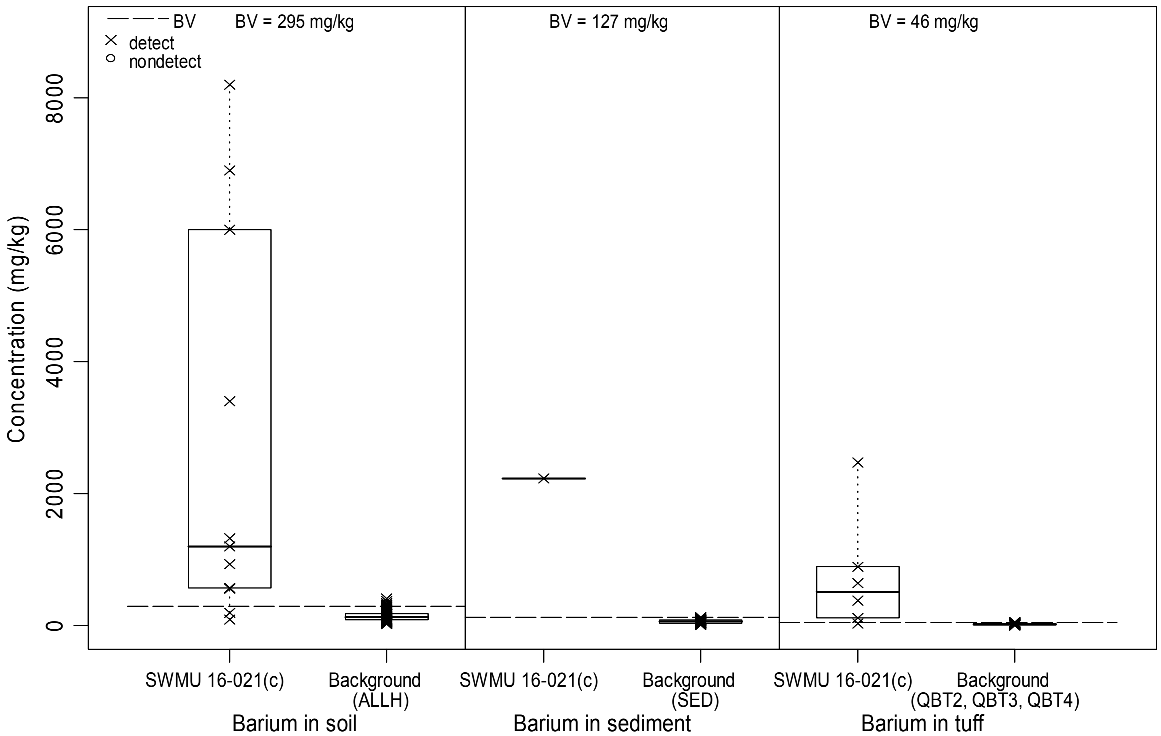

Figure B-4 Box plot for barium in soil, sediment, and tuff

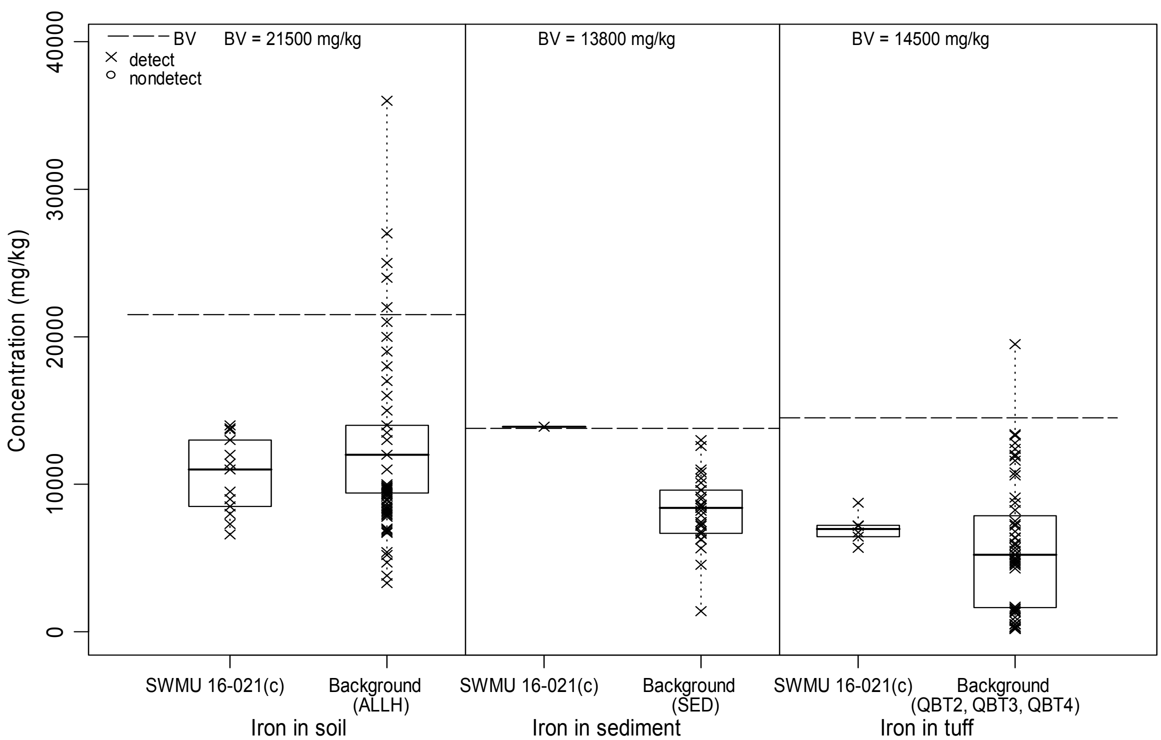

Figure B-5 Box plot for iron in soil, sediment, and tuff

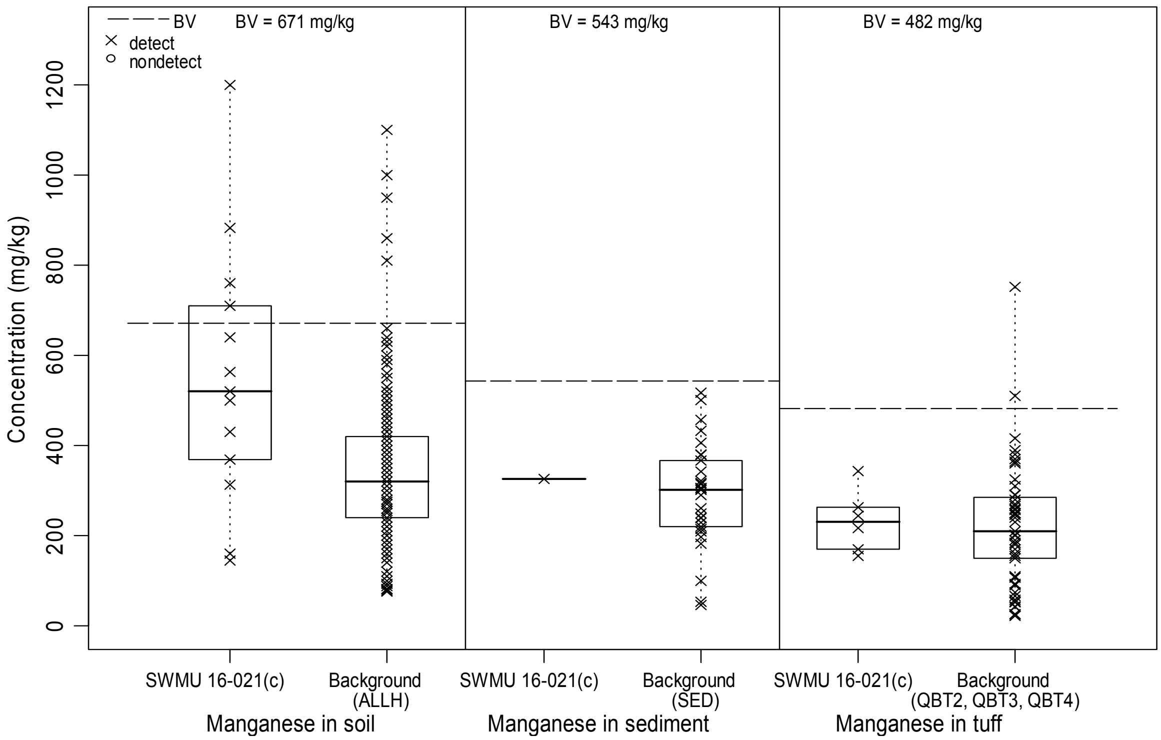

Figure B-6 Box plot for manganese in soil, sediment, and tuff

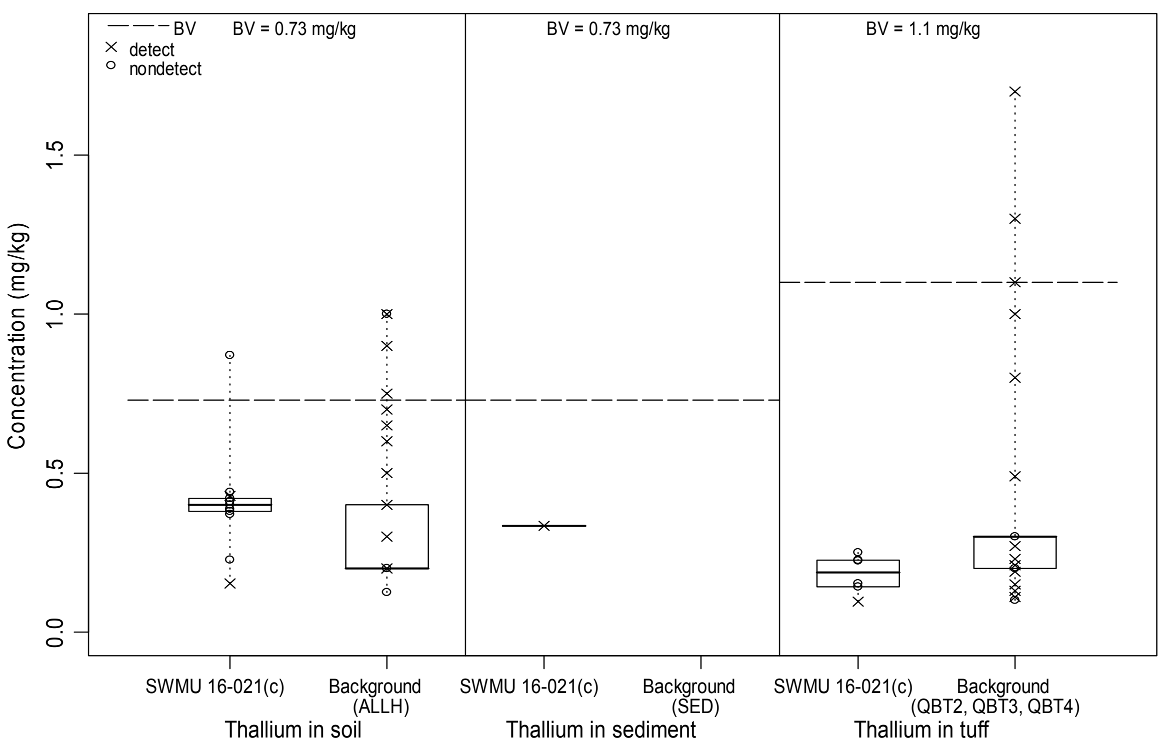

Figure B-7 Box plot for thallium in soil, sediment, and tuff

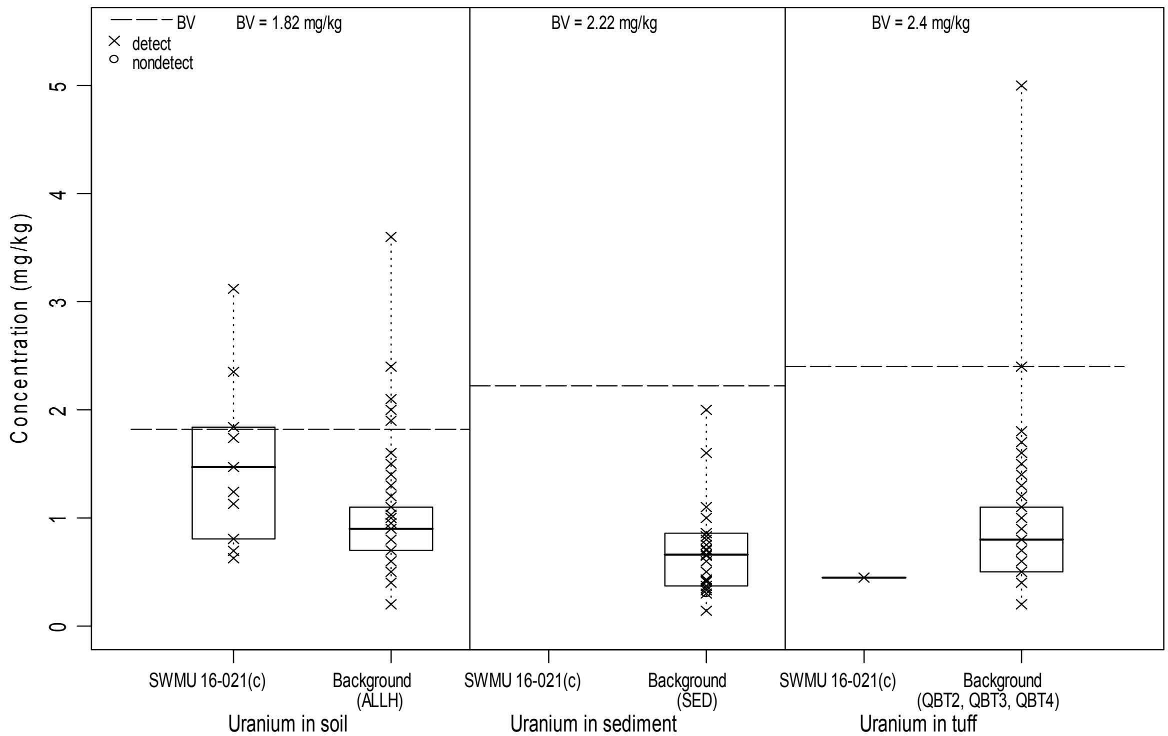

Figure B-8 Box plot for uranium in soil and tuff

Table B-1
Consolidated Unit 16-021(c)-99 Statistical Comparisons to Background for the Industrial Scenario (0–1 ft below ground surface)

Analyte	Media	Number of Analyses	Number of Detects	Maximum Detected Concentration (mg/kg)	BV (mg/kg)	Maximum Background Concentration (mg/kg)	COPC?	Reason for Elimination or Retention
Aluminum	Soil	7	7	10300	29200	61500	No	Site maximum < BV
Aluminum	Tuff	1	1	767	7340	8370	No	Site maximum < BV
Arsenic	Soil	7	7	5.1	8.17	9.3	No	Site maximum < BV
Arsenic	Tuff	1	0	Not detected	2.79	5	No	Not detected above BV
Barium	Soil	7	7	8200	295	410	Yes	Site maximum > BV and maximum background concentration
Barium	Tuff	1	1	32.9	46	51.6	No	Site maximum < BV
Iron	Soil	7	7	12000	21500	36000	No	Site maximum < BV
Iron	Tuff	1	1	6440	14500	19500	No	Site maximum < BV
Manganese	Soil	7	7	1200	671	1100	Yes	Site maximum > BV and maximum background concentration
Manganese	Tuff	1	1	155	482	752	No	Site maximum < BV
Thallium	Soil	7	1	0.153	0.73	1	No	Site maximum < BV, DL> BV, but < maximum background concentration
Thallium	Tuff	1	0	Not detected	1.1	1.7	No	Not detected above BV
Uranium	Soil	6	6	3.12	1.82	3.6	No	Site maximum > BV but < maximum background concentration

Table B-2
Consolidated Unit 16-021(c)-99 Statistical Comparisons to Background for the Construction Worker and Residential Scenarios (0–10 ft below ground surface)

Analyte	Media	Number of Analyses	Number of Detects	Maximum Detected Concentration (mg/kg)	BV (mg/kg)	Maximum Background Concentration (mg/kg)	Gehan	Quantile	Slippage	COPC?	Reason for Elimination or Retention
Aluminum	Soil	13	13	17800	29200	61500	n/a[a]	n/a	n/a	No	Site maximum < BV
Aluminum	Tuff	6	6	5420	7340	8370	n/a	n/a	n/a	No	Site maximum < BV
Aluminum	Sediment	1	1	15300	15400	13300	n/a	n/a	n/a	No	Site maximum < BV
Arsenic	Soil	13	13	9.3	8.17	9.3	0.8507	0.7683	n/a	No	Site maximum > BV; Pass Gehan and Quantile tests
Arsenic	Tuff	6	5	2.1	2.79	5	n/a	n/a	n/a	No	Site maximum < BV
Arsenic	Sediment	1	1	1.72	3.98	3.6	n/a	n/a	n/a	No	Site maximum < BV
Barium	Soil	13	13	8200	295	410	1.44E-07	4.05E-07	n/a	Yes	Site maximum > BV; Fail Gehan test
Barium	Tuff	6	6	2470	46	51.6	n/a	n/a	n/a	Yes	Site maximum > BV and maximum background concentration
Barium	Sediment	1	1	2230	127	127	n/a	n/a	n/a	Yes	Site maximum > BV and maximum background concentration
Iron	Soil	13	13	14000	21500	36000	n/a	n/a	n/a	No	Site maximum < BV
Iron	Tuff	6	6	8750	14500	19500	n/a	n/a	n/a	No	Site maximum < BV
Iron	Sediment	1	1	13900	13800	13000	n/a	n/a	n/a	Yes	Site maximum > BV and maximum background concentration
Manganese	Soil	13	13	1200	671	1100	0.001564	0.0007416	n/a	Yes	Site maximum > BV; Fail Gehan test

Table B-2 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Maximum Detected Concentration (mg/kg)	BV (mg/kg)	Maximum Background Concentration (mg/kg)	Gehan	Quantile	Slippage	COPC?	Reason for Elimination or Retention
Manganese	Tuff	6	6	343	482	752	n/a	n/a	n/a	No	Site maximum < BV
Manganese	Sediment	1	1	326	543	517	n/a	n/a	n/a	No	Site maximum < BV
Thallium	Soil	13	2	0.428	0.73	1	n/a	0.9823	1	No	DL > BV; Pass Quantile and Slippage tests
Thallium	Tuff	6	1	0.0957	1.1	1.7	n/a	n/a	n/a	No	Site maximum < BV
Thallium	Sediment	1	1	0.334	0.73	na[b]	n/a	n/a	n/a	No	Site maximum < BV
Uranium	Soil	11	11	1.82	3.12	3.6	0.006041	0.001177	n/a	Yes	Site maximum > BV; Fail Gehan test
Uranium	Tuff	1	1	0.45	2.4	5	n/a	n/a	n/a	No	Site maximum < BV

[a] n/a = Not applicable.

[b] na = Not available.

Appendix C

Analytical Suites and Results and Analytical Reports
(on CD included with this document)

Appendix D

Report for Toxicity Evaluation for Chironomus tentans

PACIFIC ECORISK | ENVIRONMENTAL CONSULTING & TESTING

May 19, 2010

Keith Greene
Los Alamos National Laboratory
Bldg 1237, Drop Point O3U
Los Alamos, NM 87545

Dear Mr. Greene:

I have enclosed two (2) copies of our report "An Evaluation of the Toxicity of Los Alamos National Laboratory Sediment to the Larval Insect *Chironomus tentans*" describing the toxicity testing of the sediment sample (designated "RE16-10-14020") that was collected on March 10, 2010. The results of our testing are summarized below:

Effects of the Sediment "RE16-10-14020" on *Chironomus tentans*
There were ***no*** significant reductions in *Chironomus tentans* survival or growth in this sediment.

If you have any questions regarding this testing, please give me a call at (707) 207-7762.

Sincerely,

R. Scott Ogle, Ph.D.
CEO & Special Projects Director

This testing was performed under Lab Order 15838. The test results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report, and only relate to the sample(s) tested. This report shall not be reproduced, except in full, without the written consent of Pacific EcoRisk.

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2250 Cordelia Road
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2792 W. Loker Avenue, Ste. 100
Carlsbad, CA 92010
phone : 760.602.7919
fax : 760.602.9119

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An Evaluation of the Toxicity of Los Alamos National Laboratory Sediment to the Larval Insect *Chironomus tentans*

Sample collected March 10, 2010

Prepared For

Los Alamos National Laboratory
Bldg 1237, Drop Point O3U
Los Alamos, NM 87545

Prepared by

Pacific EcoRisk
2250 Cordelia Rd.
Fairfield, CA 94534

May 2010

An Evaluation of the Toxicity of Los Alamos National Laboratory Sediment to the Larval Insect *Chironomus tentans*

Sample collected March 10, 2010

Table of Contents

Appendices

1. INTRODUCTION

The Los Alamos National Laboratory (LANL) contracted Pacific EcoRisk (PER) to perform a toxicity evaluation of an ambient sediment sample collected from a watershed that may have received surface water runoff or groundwater from historical and/or current LANL operations. This toxicity evaluation consisted of performing the US EPA 10-day survival & growth sediment toxicity test with the larval insect *Chironomus tentans*. This test was conducted for the sediment sample (designated "RE16-10-14020") that was collected on March 10, 2010. In order to assess the sensitivity of the test organisms to toxic stress, a reference toxicant test was also performed. This report describes the performance and results of this testing.

2. TEST PROCEDURES

The methods used in conducting these tests followed the US EPA guidelines "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates, Second Edition" (EPA/600/R-99/064).

2.1 Receipt and Handling of the Sediment Samples

On March 10, 2010, LANL staff collected a sample of sediment into an appropriately-cleaned sample container (Table 1). The sediment sample was transported via overnight delivery, on ice and under chain-of-custody, to the PER laboratory facility in Fairfield, CA. The sediment sample was logged in and stored in the dark at 0-6°C, except when being used to prepare the test replicates for this testing. The chain-of-custody record for the collection and delivery of this sample is provided in Appendix A.

Table 1. Collection of Los Alamos National Laboratory sediment sample.

Sample ID	Date of Sample Collection
RE16-10-14020	3/10/10

2.2 Sediment Toxicity Testing with *Chironomus tentans*

The freshwater sediment toxicity test with *Chironomus tentans* consists of exposing the 3rd instar larvae to the sediment for 10 days, after which effects on survival and growth are evaluated. The specific procedures used in this testing are described below.

Second-to-third instar *Chironomus tentans* larvae were obtained from a commercial supplier (EC&T, Superior, WI). These larvae were maintained in EPA synthetic moderately hard water at

23°C, and were fed slurried ground Tetramin® flake fish food, as per EPA guidelines. Immediately prior to the start of the tests, healthy third-instar larvae were collected from these cultures for use in inoculating the test.

The sediment was tested at the 100% concentration only. The Lab Control treatment sediment consisted of a composited and homogenized mixture of sediments collected from several reference sites as part of previous PER sampling and testing projects; this sediment has been continuously incubated in tanks of freshwater at 23°C for several months.

There were 8 replicates for each test treatment. Each replicate container consisted of a 300 mL tall-form glass beaker with a 3 cm ribbon of 540 μm mesh NITEX attached to the top of the beaker with silicone sealant. Approximately 24 hrs prior to test initiation, each of the sediment samples was homogenized, after which ~100 mL of the homogenized sediment was loaded into each test replicate. Each of the test replicates was then carefully filled with overlying water, consisting of EPA synthetic moderately-hard water, modified for use in sediment toxicity tests as per the EPA test guidelines. The replicates with sediments and clean overlying water were maintained in a temperature-controlled room at 23°C under cool-white fluorescent lighting on a 16:8 L:D photoperiod.

After this initial ~24 hr period, the overlying water in each replicate was flushed with 2 volumes of the overlying water. A small aliquot of the renewed overlying water in each of the 8 replicates per treatment was then collected and composited for measurement of "initial" water quality characteristics (pH, D.O., conductivity, alkalinity, hardness, and total ammonia). The tests were then initiated with the random allocation of 10 3rd-instar *Chironomus* into each replicate, followed by the addition of 1.5 mL of the slurried ground Tetramin® flake fish food.

Each day, for the following 9 days, each test replicate was examined for the presence of any dead *Chironomus* or the presence of pupal exuvia. A small aliquot of the overlying water in each of the 8 replicates (per treatment) was then collected and composited as before for measurement of "old" D.O., after which each replicate was flushed with 2 volumes of fresh overlying water. Another small aliquot of the overlying water in each of the 8 replicates was then collected and composited as before for measurement of "new" D.O., after which each replicate was fed 1.5 mL of the slurried ground Tetramin® flake fish food.

After 10 days exposure, each replicate was examined for the presence of pupal exuvia. An aliquot of overlying water was collected from each replicate and composited for analysis of the test treatment "final" water quality characteristics. The sediment in each replicate were then carefully sieved using a #40 (425 μm mesh) stainless steel sieve, and the number of surviving *Chironomus* determined; animals were identified as either larvae, pupae, or adult (each pupal exuvia was counted as a surviving adult). The surviving larval *Chironomus* from each replicate were then rinsed with de-ionized water, and transferred to a pre-dried (i.e., pre-ashed) and pre-tared weighing pan. These were then dried at 100°C for 24 hrs and re-weighed to determine the mean "dry" weight per individual *Chironomus*. Each replicate pan was then placed into a muffle furnace and ashed at 550°C for 2 hrs, after which the pans were placed within a desiccator. After the pans had cooled, they were each re-weighed to determine the mean ash-free dry wt (= mean final "dry" weight minus the mean "ashed" weight, divided by the number of organisms in the pan). The data for each sediment treatment were analyzed and compared to the Lab Control treatment to determine whether or not any statistically significant reductions in survival and/or growth were observed. All statistical analyses were performed using the CETIS® statistical software (TidePool Scientific, McKinleyville, CA).

2.2.1 Reference Toxicant Testing of the *Chironomus tentans*

In order to assess the sensitivity of the test organisms to toxic stress, reference toxicant testing was performed. The reference toxicant test consists of an acute 48-hr static toxicity test with KCl at concentrations of 0, 1.25, 2.5, 5, 10, and 20 g/L. There were 3 replicates at each treatment, each replicate consisting of 400 mL of test media in a 600 mL HDPE beaker. The test was initiated by randomly allocating 10 chironomids into each of the replicate beakers. The beakers were placed in a temperature-controlled room at 23°C under a 16:8 L:D photoperiod. The resulting test survival data were analyzed to determine key dose-response point estimates (e.g., EC_{50}); all statistical analyses were made using the CETIS® software. These response endpoints were then compared to the "typical response" range established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by this lab.

3. RESULTS

3.1 Effects of the LANL Sediment Sample on *Chironomus tentans*

There results of this sediment toxicity test are summarized in Table 2. There were ***no*** significant reductions in *Chironomus tentans* survival or growth in the RE16-10-14020 LANL sediment.

The test data & summary of statistical analyses for this test are presented in Appendix B.

Table 2. Effects of Los Alamos sediment samples on *Chironomus tentans* survival and growth

Sample ID	Mean % Survival	Mean Growth (mg, ash-free dry wt)
Lab Control	78.8	0.52
CASA-08-8862	77.5	0.72

3.1.1 Reference Toxicant Toxicity to *Chironomus tentans*

The results of this test are presented in Table 3. There was 100% survival at the Lab Control treatment. The EC_{50} was 5.3 g/L KCl. These results are consistent with the "typical response" range established by reference toxicant tests previously performed in this laboratory, indicating that the *Chironomus* used in these tests were responding to toxic stress in a typical fashion.

The test data sheets and summary of statistical analyses for this test are presented in Appendix C.

Table 3. Reference toxicant testing: Effects of KCl on *Chironomus tentans*.

KCl Treatment (g/L)	Overall Mean % Survival
Lab Control	100
1.25	100
2.5	**83.3***
5	**80***
10	**0***
20	**0***
Summary of Statistics	
EC_{50} =	5.3 g/L KCl

* - The response at this test treatment was significantly less than the Lab Control treatment response at $p < 0.05$.

4. SUMMARY AND CONCLUSIONS

Effects of the Sediment "RE16-10-14020" on *Chironomus tentans*
There were ***no*** significant reductions in *Chironomus tentans* survival or growth in this sediment.

4.1 QA/QC Summary

Test Conditions - Test conditions (pH, D.O., temperature, etc.) for the reported testing were within acceptable limits for these test organisms. All such analyses were performed according the laboratory Standard Operating Procedures.

Negative Control - The biological responses for the test organisms at the Lab Control treatment were within acceptable limits.

Positive Control - The results for the concurrent reference toxicant test were consistent with the "typical response" range established by the reference toxicant test database, indicating that these test organisms were responding to toxic stress in a typical fashion.

Appendix A

Chain-of-Custody Record for the Los Alamos National Laboratory Sediment Sample

Wednesday, March 10, 2010

LAB CHAIN OF CUSTODY DOCUMENT NUMBER: 10-2407C

REQUEST NUMBER: 10-2407

LOS ALAMOS
NATIONAL LABORATORY

ATTN: Scott Olge
Pacific Ecorisk Laboratories
2250 Cordelia Rd.
Fairfield, CA 94534
LAB REQUEST COMMENTS: Chronimus

TURNAROUND/REPORT DUE: 4/9/2010
TURNAROUND REQ'D: 30

SAMPLE ID	CTNR	CTNR DESC	ORDER	PRESERV	MATRIX
RE16-10-14020	1	POLY	Bioassay	None	SED

Relinquished By:	Date	Time	Received By:	Date	Time
[signature]	3/10/10	3:00	[signature]	3-11-10	11:48
Printed Name / Signature			Printed Name / Signature		
Printed Name / Signature			Printed Name / Signature		
Printed Name / Signature			Printed Name / Signature		

Received for DISPOSAL By: **Date** **Time** **Remarks:**

Printed Name Signature

Hard Copy Required

Wednesday, March 10, 2010

REQUEST NUMBER: 10-2407

LOS ALAMOS
NATIONAL LABORATORY

ATTN: Scott Olge
Pacific Ecorisk Laboratories
2250 Cordelia Rd.
Fairfield, CA 94534

These Samples are on:
LANL Request Number:10-2407
Per Agreement Number:(707)207-7760
Project Cost Code: MR3A0531TXH0

Please analyse the enclosed samples
according to the schedule indicated:

SHIP DATE: 3/10/2010
TURNAROUND/REPORT DUE: 4/9/2010
TURNAROUND REQ'D: 30 Days

RAD SCREENING: Yes, Below Background
LAB REQUEST COMMENTS: Chronimus

LANL ER SMO CONTACT:

Signature:

PRIORITY	METHOD CODE	CNTNR	SAMPLE ID	SAMPLE MATRIX	DATE SAMPLED	SPECIAL INSTRUCTIONS
	EPA:100.2	1	RE16-10-14020	SED	3/10/2010	

Final Page of REQUEST NUMBER 10-2407

Appendix B

Test Data and Summary of Statistics for the Evaluation of Los Alamos National Laboratory Sediment Toxicity to *Chironomus tentans*

CETIS Summary Report

Report Date: 03 May-10 15:11 (p 1 of 1)
Test Code: 00-0775-3264/38230

Chironomus 10-d Survival and Growth Sediment Test — Pacific EcoRisk

Batch ID:	13-1849-6753	**Test Type:**	Survival-AF Growth	**Analyst:**	Drew Gantner
Start Date:	20 Mar-10 12:00	**Protocol:**	USEPA Freshwater Sediment (2000)	**Diluent:**	Not Applicable
Ending Date:	30 Mar-10 12:00	**Species:**	Chironomus tentans	**Brine:**	Not Applicable
Duration:	10d 0h	**Source:**	Environmental Consult & Test	**Age:**	12

Sample ID:	05-8375-3663	**Code:**	Freshwater Sedi	**Client:**	Los Alamos National Laboratory
Sample Date:	10 Mar-10 12:30	**Material:**	Freshwater Sediment	**Project:**	15838
Receive Date:	11 Mar-10 11:45	**Source:**	Los Alamos National Laboratory		
Sample Age:	9d 23h (0 °C)	**Station:**	RE16-10-14020		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
18-5224-6902	Mean AF Weight-mg	100	>100	N/A	18.8%	1	Equal Variance t Two-Sample Test
14-1138-3729	Survival Rate	100	>100	N/A	13.9%	1	Equal Variance t Two-Sample Test

Mean AF Weight-mg Summary

Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0	Control Sed	8	0.522	0.486	0.559	0.428	0.708	0.0179	0.0979	18.7%	0.0%
100		8	0.722	0.676	0.768	0.574	0.915	0.0226	0.124	17.2%	-38.2%

Survival Rate Summary

Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0	Control Sed	8	0.788	0.737	0.838	0.5	0.9	0.0248	0.136	17.2%	0.0%
100		8	0.775	0.731	0.819	0.6	1	0.0213	0.116	15.0%	1.59%

Mean AF Weight-mg Detail

Conc-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	Control Sed	0.528	0.708	0.473	0.466	0.452	0.491	0.428	0.633
100		0.736	0.592	0.574	0.887	0.915	0.68	0.717	0.674

Survival Rate Detail

Conc-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	Control Sed	0.8	0.5	0.7	0.8	0.9	0.9	0.9	0.8
100		0.8	0.8	0.8	1	0.6	0.7	0.8	0.7

CETIS Analytical Report

Report Date: 03 May-10 15:11 (p 1 of 2)
Test Code: 00-0775-3264/38230

Chironomus 10-d Survival and Growth Sediment Test — **Pacific EcoRisk**

Analysis ID:	18-5224-6902	**Endpoint:**	Mean AF Weight-mg	**CETIS Version:**	CETISv1.7.0
Analyzed:	03 May-10 15:10	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run	100	>100	N/A	1	18.8%

Equal Variance t Two-Sample Test

Control	vs	Conc-%	Test Stat	Critical	MSD	P-Value	Decision(5%)
Control Sed		100	-3.58	1.76	0.0983	0.9985	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	0.1596135	0.1596135	1	12.8	0.0030	Significant Effect
Error	0.1745465	0.01246761	14			
Total	0.33416	0.1720811	15			

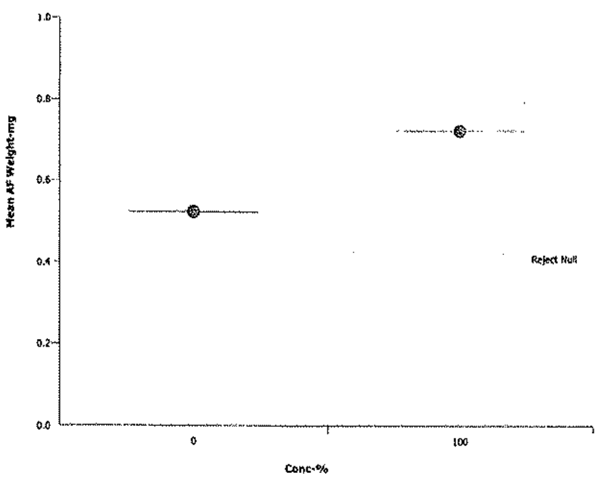
ANOVA Assumptions

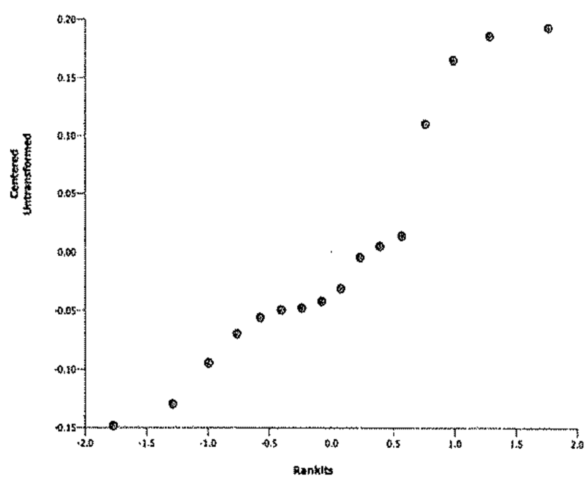
Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Variance Ratio F	1.6	8.89	0.5488	Equal Variances
Distribution	Shapiro-Wilk Normality	0.894		0.0647	Normal Distribution

Mean AF Weight-mg Summary

Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0	Control Sed	8	0.522	0.485	0.56	0.428	0.708	0.0182	0.0979	18.7%	0.0%
100		8	0.722	0.675	0.769	0.574	0.915	0.023	0.124	17.2%	-38.2%

Graphics





Chironomus 10-d Survival and Growth Sediment Test			Pacific EcoRisk
Analysis ID: 14-1138-3729	**Endpoint:** Survival Rate	**CETIS Version:** CETISv1.7.0	
Analyzed: 03 May-10 15:10	**Analysis:** Parametric-Two Sample	**Official Results:** Yes	

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run	100	>100	N/A	1	13.9%

Equal Variance t Two-Sample Test

Control	vs	Conc-%	Test Stat	Critical	MSD	P-Value	Decision(5%)
Control Sed		100	0.217	1.76	0.138	0.4155	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	0.001158329	0.001158329	1	0.0472	0.8311	Non-Significant Effect
Error	0.3433439	0.02452457	14			
Total	0.3445022	0.02568289	15			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Variance Ratio F	1.07	8.89	0.9325	Equal Variances
Distribution	Shapiro-Wilk Normality	0.949		0.4725	Normal Distribution

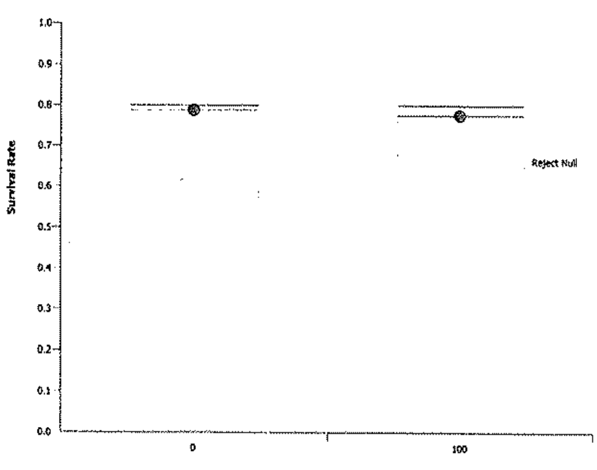
Survival Rate Summary

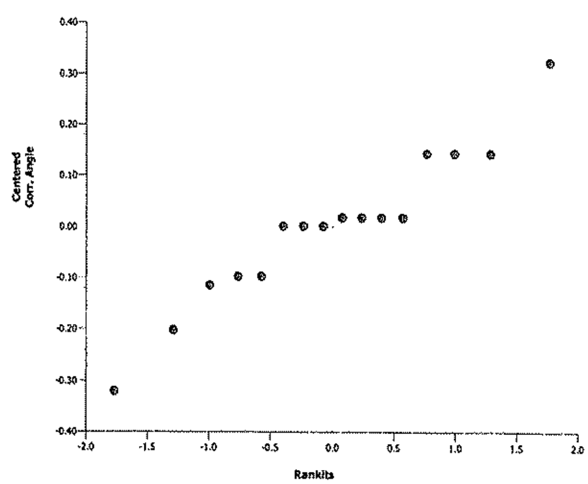
Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0	Control Sed	8	0.787	0.736	0.839	0.5	0.9	0.0252	0.136	17.2%	0.0%
100		8	0.775	0.731	0.819	0.6	1	0.0216	0.116	15.0%	1.59%

Angular (Corrected) Transformed Summary

Conc-%	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0	Control Sed	8	1.11	1.05	1.17	0.785	1.25	0.0296	0.159	14.4%	0.0%
100		8	1.09	1.03	1.15	0.886	1.41	0.0286	0.154	14.1%	1.54%

Graphics





10-Day *Chironomus tentans* Freshwater Sediment Toxicity Test Data

Client: **Pacific EcoRisk** Project #: 15838 Organism Log Number: 5113

Species: *Chironomus tentans* Test ID#: 38230 Organism Age/Size: 12 days

Day	Date	Temp. (°C)	Control D.O. (Old)	Control D.O. (New)	RE16-10-14020 D.O. (Old)	RE16-10-14020 D.O. (New)	Sign-off:
0	3/20/10	22.5		8.8		7.2	AM Change: BH
			A 10 B 10	C 10 D 10	A 10 B 10	C 10 D 10	WQ: BH
			E 10 F 10	G 10 H 10	E 10 F 10	G 10 H 10	Initiation Counts: [illegible]
	Meter ID	94	RDO2	RDO2			Confirmation Counts: [illegible]
1	3/21/10	22.6	7.0	8.9	6.1	7.8	AM Change: CG
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: CG
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: CG
	Meter ID	9A	RDO1	RDO1			Mortality Counts: CG
2	3/22/10	22.5	7.3	7.7	6.2	6.5	AM Change: EW
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: EW
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: MO
	Meter ID	9A	RDO1	RDO1			Mortality Counts: EW
3	3/23/10	22.3	5.8	6.5	4.3	5.8	AM Change: EW
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: EW
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: BT
	Meter ID	9A	RDO1	RDO1			Mortality Counts: EW
4	3/24/10	22.6	6.6	7.1	5.4	6.5	AM Change: EW
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: EW
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: EW
	Meter ID	9A	RDO1	RDO1			Mortality Counts: EW
5	3/25/10	22.7	6.1	7.3	4.8	6.4	AM Change: YM
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: YM
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: SG
	Meter ID	9A	RDO3	RDO3			Mortality Counts: YM
6	3/26/10	22.6	5.5	7.5	4.7	7.1	AM Change: BH
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: BH
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: CG
	Meter ID	22A	RDO3	RDO3			Mortality Counts: BH
7	3/27/10	22.9	4.9	6.8	7.4	7.8	AM Change: BH
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: BH
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: BH
	Meter ID	22A	RDO1	RDO1			Mortality Counts: BH
8	3/28/10	22.9	4.8	7.3	7.2	8.0	AM Change: SG
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: SG
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: SG
	Meter ID	22A	RDO1	RDO1			Mortality Counts: SG
9	3/29/10	22.0	6.5	7.7	8.6	8.8	AM Change: CG
			A 0 B 0	C 0 D 0	A 0 B 0	C 0 D 0	WQ: CG
			E 0 F 0	G 0 H 0	E 0 F 0	G 0 H 0	PM Change: EW
	Meter ID	22A	RDO2	RDO2			Mortality Counts: CG
10	3/30/10	22.6	# Alive/Replicate		# Alive/Replicate		Termination Counts: BA
			A 8 B 5	C 7 D 8	A 8 B 8	C 8 D 10	
			E 9 F 9	G 9 H 8	E 6 F 7	G 8 H 7	
	Meter ID	22A					

Chironomus tentans Sediment Toxicity Test Weight Data

Client: **Los Alamos National Laboratory**
Test Material: **RE16-10-14020**
Test ID #: **38230** Project #: 15838
Test Date: 3/20/10

Initial Ashed Pan Wt Date: 3/26/10 Sign-off: DJ
Dry Wt Date: 4/1/10 Sign-off: DJ
Final Ashed Wt Date: 4/22/10 Sign-off: [signature]

Pan ID	Treatment	Replicate	Initial Ashed Pan Wt (mg)	Dry Pan + Larvae Wt. (mg)	Ashed Pan + Larvae Wt. (mg)	# of Live Organisms: Larvae	Pupae	Adult	Mean Dry Weight (mg)	Mean Ash Free Dry Wt. (mg)
1	Control	A	61.14	70.28	66.06	8	–	–	1.143	0.528
2		B	64.28	71.79	68.25	5	–	–	1.502	0.708
3		C	65.20	72.71	69.40	7	–	–	1.073	0.473
4		D	57.71	66.33	62.60	8	–	–	1.078	0.466
5		E	74.84	81.59	77.52	9	–	–	0.750	0.452
6		F	53.33	62.51	58.09	9	–	–	1.020	0.491
7		G	70.53	78.18	74.33	9	–	–	0.850	0.428
8		H	61.51	70.87	65.81	8	–	–	1.170	0.633
9	100%	A	62.97	64.06	68.17	8	–	–	1.386	0.736
10		B	60.89	70.09	65.35	8	–	–	1.150	0.592
11		C	64.11	72.81	68.22	8	–	–	1.088	0.574
12		D	64.01	80.73	71.86	10	–	–	1.672	0.887
13		E	62.92	72.61	67.12	6	–	–	1.615	0.915
14		F	66.96	76.15	71.39	7	–	–	1.313	0.680
15		G	68.51	79.74	74.00	8	–	–	1.404	0.717
16		H	65.18	74.06	69.34	7	–	–	1.110	0.674
QA 1	–		66.96	66.96	66.95	–	–	–	–	–
QA 2	–		67.82	67.82	67.81	–	–	–	–	–

Freshwater Sediment Test Water Quality Characteristics

Client: Pacific EcoRisk **Species:** *Chironomus tentans*

Initial Water Quality Characteristics for Overlying Water

Date: 3/20/10

Site	pH	D.O. (mg/L)	Conductivity (µS/cm)	Alkalinity	Hardness	Total Ammonia	Test ID #
Control	8.11	7.2	1010	78	100	<1.0	
Silica Control	8.01	8.2	337	52	87	<1.0	
RE16-10-14020	7.20	4.3	311	56	75	<1.0	38230
Sign-off	BH	BH	BH	BH	BH	BH	

Final Water Quality Characteristics for Overlying Water

Date: 3/30/10

Site	pH	D.O. (mg/L)	Conductivity (µS/cm)	Alkalinity	Hardness	Total Ammonia	
Control	7.91	5.4	408	74	107	0.496	
Silica Control	7.87	5.4	337	53	96	0.644	
RE16-10-14020	7.81	7.3	342	57	84	0.716	
Sign-off	YK	YK	YK	YK	YK	YK	

Appendix C

Test Data and Summary of Statistics for the Reference Toxicant Evaluation of the *Chironomus tentans*

Acute Chironomus Survival Test — Pacific EcoRisk

Batch ID:	03-7035-5072	**Test Type:**	Survival (96h)	**Analyst:**	Drew Gantner
Start Date:	20 Mar-10 16:00	**Protocol:**	USEPA Freshwater Sediment (2000)	**Diluent:**	Mod-Hard Synthetic Water
Ending Date:	24 Mar-10 15:15	**Species:**	Chironomus tentans	**Brine:**	Not Applicable
Duration:	95h	**Source:**	Environmental Consult & Test	**Age:**	12

Sample ID:	14-7223-8798	**Code:**	KCl	**Client:**	Reference Toxicant
Sample Date:	20 Mar-10 16:00	**Material:**	Potassium chloride	**Project:**	15852
Receive Date:	20 Mar-10 16:00	**Source:**	Reference Toxicant		
Sample Age:	N/A (22.4 °C)	**Station:**	In House		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
11-9926-4730	96h Survival Rate	1.25	2.5	1.77	5.07%		Dunnett's Multiple Comparison Test

Point Estimate Summary

Analysis ID	Endpoint	Level	g/L	95% LCL	95% UCL	TU	Method
08-2551-3616	96h Survival Rate	EC1	1.69	1.03	2.26		Linear Regression (MLE)
		EC5	2.36	1.63	2.96		
		EC10	2.82	2.07	3.44		
		EC15	3.18	2.42	3.81		
		EC20	3.5	2.74	4.15		
		EC25	3.8	3.04	4.46		
		EC40	4.66	3.9	5.45		
		EC50	5.28	4.49	6.2		

96h Survival Rate Summary

Conc-g/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0	Control	3	1	1	1	1	1	0	0	0.0%	0.0%
1.25		3	1	1	1	1	1	0	0	0.0%	0.0%
2.5		3	0.833	0.812	0.855	0.8	0.9	0.0105	0.0577	6.93%	16.7%
5		3	0.8	0.8	0.8	0.8	0.8	0	0	0.0%	20.0%
10		3	0	0	0	0	0	0	0		100.0%
20		3	0	0	0	0	0	0	0		100.0%

96h Survival Rate Detail

Conc-g/L	Control Type	Rep 1	Rep 2	Rep 3
0	Control	1	1	1
1.25		1	1	1
2.5		0.9	0.8	0.8
5		0.8	0.8	0.8
10		0	0	0
20		0	0	0

96-Hour Acute *Chironomus tentans* Reference Toxicant Test

Client: **Reference Toxicant** Organism Log #: 5113 Age: 12 days

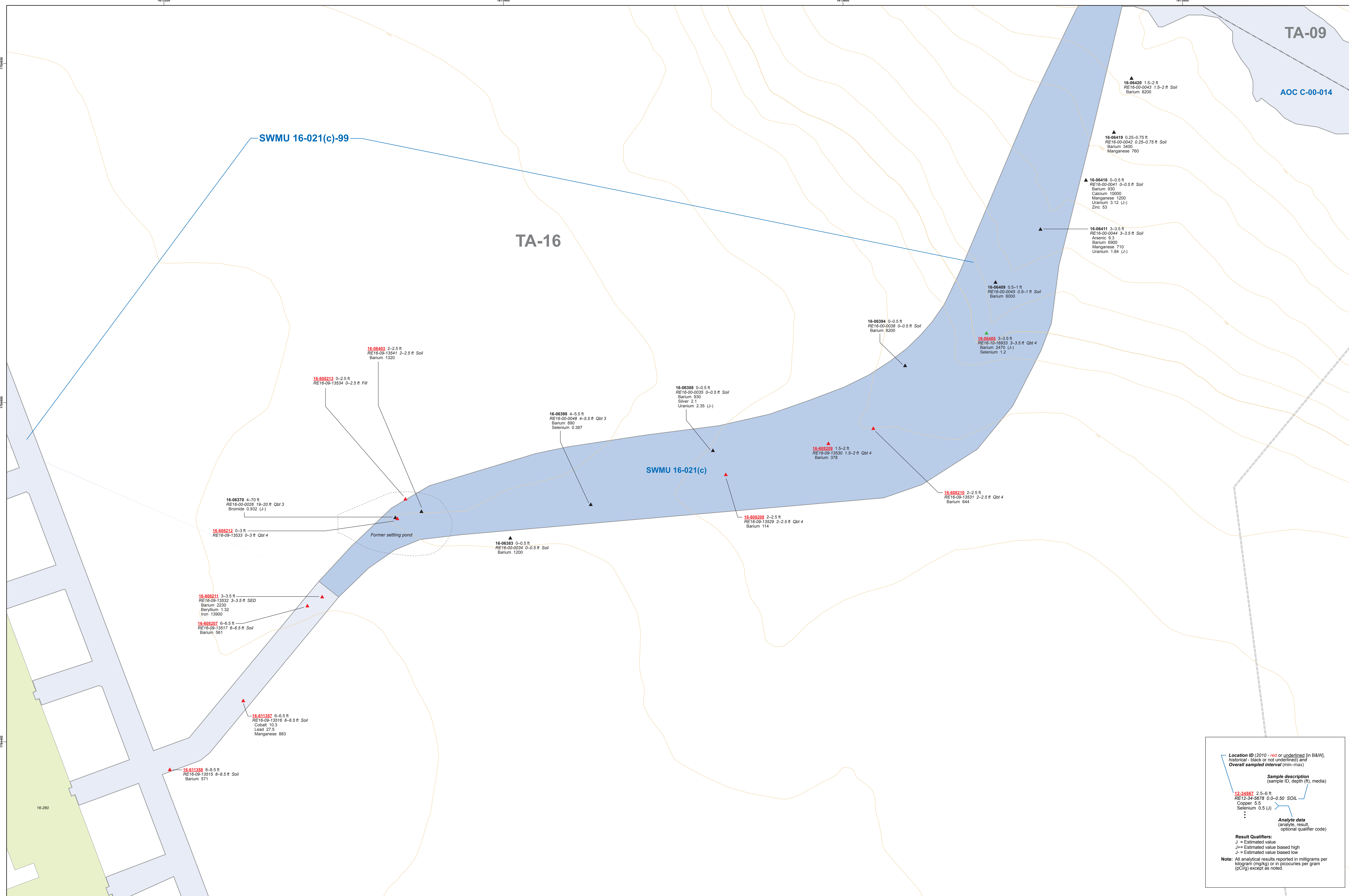
Test Material: Potassium Chloride Organism Supplier: ECT

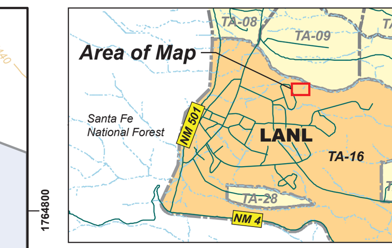
Test ID#: 38231 Project #: 15852 Control/Diluent: EPAMH

Test Date: 3/20/10 Randomization: 3-6-3 Control Water Batch: 1294

Feeding T0 Time: 1545 Initials: MM Feeding T46-hr Time: 1545 Initials: PA

Treatment (g/L)	Temperature (°C)	pH	D.O. (mg/L)	Conductivity (µS/cm)	# of Live Organisms Rep A	Rep B	Rep C	SIGN-OFF
Control	22.4	8.06	7.1	286	10	10	10	Test Solution Prep: SM
1.25	22.4	7.96	6.8	2302	10	10	10	New WQ: DJ
2.5	22.4	7.93	7.1	4680	10	10	10	Initiation Date: 3/20/10
5	22.4	7.91	7.3	8790	10	10	10	Initiation Time: 1600
10	22.4	7.78	6.9	17060	10	10	10	Initiation Signoff: MM
20	22.4	7.58	7.7	~~3290~~ 33700	10	10	10	
Meter ID	20A	PH11	RD01	EC04				
Control	22.5	7.89	7.4	290	10	10	10	Count Date: 3.21.10
1.25	22.5	7.80	7.6	2329	10	10	10	Count Time: 0930
2.5	22.5	7.82	7.5	4710	9	10	9	Count Signoff: PA
5	22.5	7.78	7.6	8850	9	10	10	Old WQ: [illegible]
10	22.5	7.74	7.6	17310	0	0	0	
20	22.5	7.73	7.9	33500	0	0	0	
Meter ID	20A	PH03	RD02	EC05				
Control	22.8	7.83	MO ~~8.9~~ 8.8	290	10	10	10	Count Date: 3.22.10
1.25	22.8	7.85	MO ~~8.2~~ 8.3	2317	10 ~~8~~ PA	10 ~~8~~ PA	~~8~~ 10	Count Time: 1345
2.5	22.8	7.86	MO ~~9.2~~ 8.7	4610	9	9	9	Count Signoff: PA
5	22.8	7.82	8.7	8810	9	10	9	Old WQ: MO
10	—	—	—	—	—	—	—	
20	—	—	—	—	—	—	—	
Meter ID	20A	ph11	RD01	EC03				
Control	22.9	8.03	8.6	294	10	10	10	Count Date: 3.23.10
1.25	22.9	7.93	8.7	2316	10	10	10	Count Time: 915
2.5	22.9	7.88	8.3	4690	9	9	8	Count Signoff: PA
5	22.9	7.87	8.2	8910	9	9	9	Old WQ: HV
10	—	—	—	—	—	—	—	
20	—	—	—	—	—	—	—	
Meter ID	20A	PH 9	RD0 1	EC5				
Control	23.0	8.08	6.4	289	10	10	10	Termination Date: 3.24.10
1.25	23.0	7.83	6.2	2294	10	10	10	Termination Time: 1515
2.5	23.0	7.82	7.2	4680	9	8	8	Termination Signoff: KO/PA
5	23.0	7.84	7.5	8860	8	8	8	Old WQ: EW
10	—	—	—	—	—	—	—	
20	—	—	—	—	—	—	—	
Meter ID	6	PH03	RD02	EC05				





TA-16 260 CMI

This map was created for work processes associated with the TA-16 260 CMI Investigation Report. All other uses for this map should be confirmed with the LANL EP-CAP Division.

0 5 10 20 30 40 50 Feet

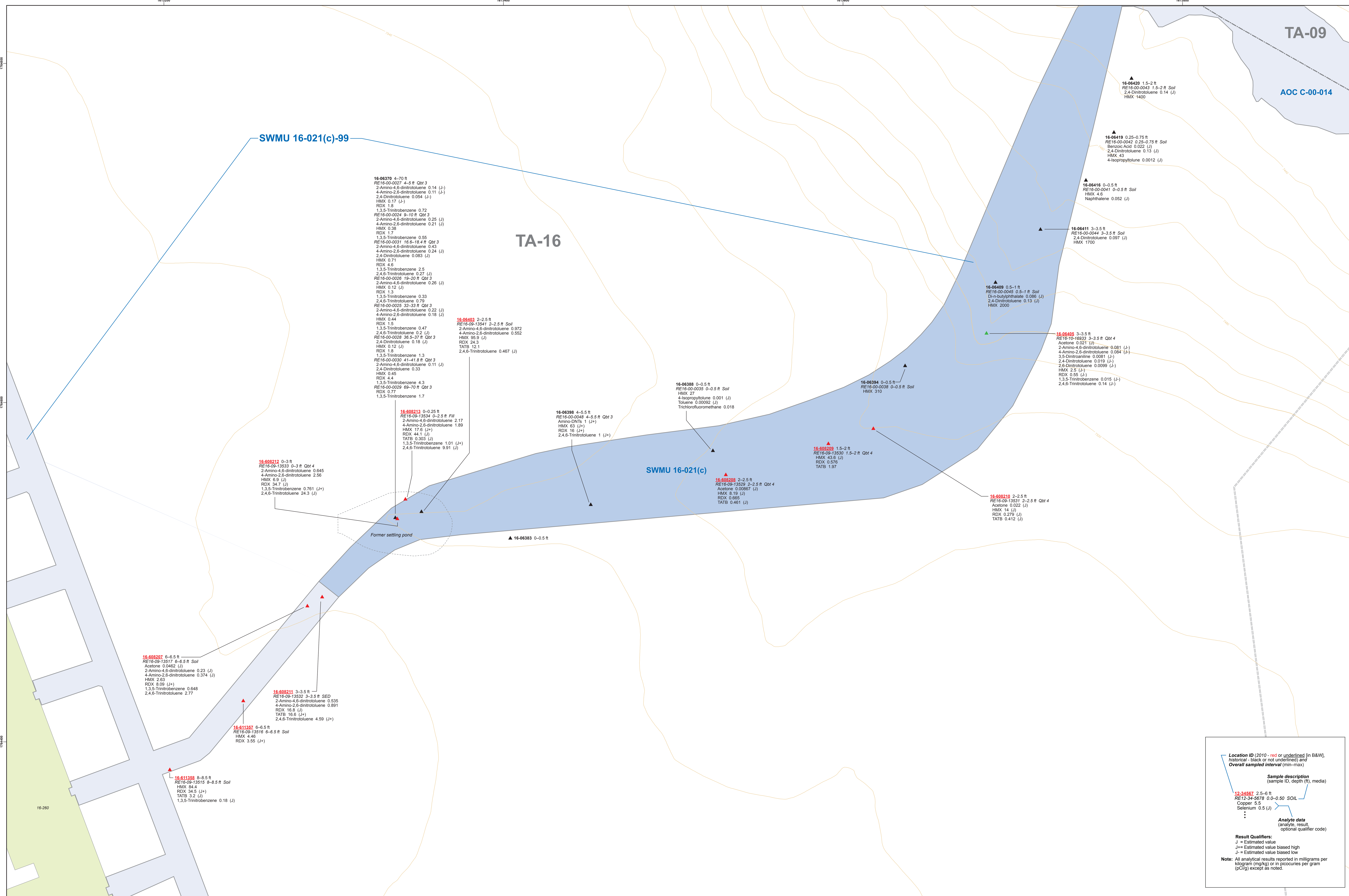
contour interval = 10 ft

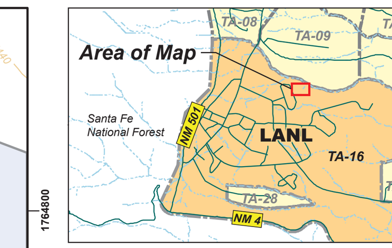
New Mexico State Plane Coordinates - Central Zone FT, North American Datum 1983, NGVD 1929

- 2009 sampling location
- 2010 sampling location
- Historical sampling location
- Subject AOC or SWMU
- LANL structure
- Former settling pond
- Paved road/parking
- Dirt road
- 10 ft contour

Plate 1
Inorganic chemicals detected above BVs in the 2000–2001 IM and 2009–2010 CMI samples from the 260 Outfall drainage channel

Map Number: TPMC_072810A
Date: July 28, 2010 Rev: August 5, 2010
DraftedBy: TPMC File Name: TA16CMI_HITS





TA-16 260 CMI

This map was created for work processes associated with the TA-16 260 CMI Investigation Report. All other uses for this map should be confirmed with the LANL EP-CAP Division.

0 5 10 20 30 40 50 Feet

contour interval = 10 ft

New Mexico State Plane Coordinates - Central Zone FT, North American Datum 1983, NGVD 1929

- 2009 sampling location
- 2010 sampling location
- Historical sampling location
- Subject AOC or SWMU
- LANL structure
- Former settling pond
- Paved road/parking
- Dirt road
- 10 ft contour

Plate 2
Organic chemicals detected in the 2000–2001 IM and 2009–2010 CMI samples from the 260 Outfall drainage channel

Map Number: TPMC_072810A
Date: July 28, 2010 Rev: August 5, 2010
DraftedBy: TPMC File Name: TA16CMI_HITS