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Corrective Measures Evaluation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54, Revision 2

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EST. 1943

Prepared by the Environmental Programs Directorate

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Corrective Measures Evaluation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54, Revision 2

September 2011

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EXECUTIVE SUMMARY

This report documents the corrective measures evaluation (CME) conducted for Material Disposal Area (MDA) L, Solid Waste Management Unit (SWMU) 54-006, at Los Alamos National Laboratory's Technical Area 54 in accordance with the Compliance Order on Consent (the Consent Order). MDA L is a decommissioned (i.e., removed from service) subsurface site established for the disposal of nonradioactive liquid chemical waste. The disposal units at MDA L are covered with asphalt to house ongoing Resource Conservation and Recovery Act–permitted chemical waste storage and mixed-waste storage activities.

The subsurface disposal units of MDA L, along with the Area L landfill units, are interspersed across the northern-half of Area L. MDA L consists of 1 inactive subsurface disposal pit (Pit A) and 12 inactive disposal shafts. The Area L landfill consists of 3 inactive surface impoundments (B, C, and D) and 22 inactive disposal shafts.

A subsurface volatile organic compound (VOC) vapor plume is present in the vadose zone at MDA L. The primary sources of subsurface VOC vapors are the two shaft fields at MDA L, and they appear to be a continuing source of VOC vapors.

The objectives of this CME are to identify and evaluate technically appropriate corrective measures alternatives that will

- achieve cleanup objectives in a timely manner,
- protect human and ecological receptors,
- control or eliminate the sources of contamination,
- control migration of released contaminants, and
- manage remediation waste in accordance with state and federal regulations.

Conceptual site models (CSMs) were developed to evaluate primary and secondary release mechanisms from the source areas (pit, impoundments, and shafts). The remedial action objectives (RAOs) for these source areas were determined to be as follows:

- prevent human and ecological exposure to the waste through excavation, biointrusion, and erosion
- prevent human and ecological exposure to the contaminated surface soils and/or subsurface soils through excavation and biointrusion
- prevent groundwater from being impacted above a regulatory standard by the transport of volatile organic compounds through soil vapor
- prevent the creation of contaminated leachate by restricting the infiltration of water into the waste

To complete the corrective measures evaluation, treatment technologies were identified and screened for applicability to the sources of contamination present at MDA L. Applicable treatment technologies were then combined into corrective measure alternatives to address the RAOs for MDA L. The corrective measures alternatives were screened against the threshold criteria per Section VII.D.4.a of the Consent Order. Alternatives that satisfy the threshold criteria were then evaluated and ranked against the balancing criteria identified in Section VII.D.4.b of the Consent Order. The highest-ranking alternative was selected as the recommended corrective measures alternative.

As a result of this evaluation, the recommended corrective measures alternative includes constructing an evapotranspiration (ET) cover over the pit, impoundments, and shafts to provide a barrier against human and ecological exposure to waste and contaminated soils. The ET cover also restricts the infiltration of water into the waste by providing a soil medium to hold infiltrated water until it is removed by evaporation at the surface and transpiration through vegetation. The alternative also includes constructing and operating a soil-vapor extraction system to remove vapor-phase VOCs from the subsurface to prevent the downward migration of these VOCs to the groundwater. Performance monitoring and institutional controls will be included to ensure the RAOs have been satisfied. The impact of the recommended alternative on the CSM demonstrates the resulting reduction in exposure potential and future risk. Long-term monitoring at MDA L that couples vapor monitoring in the vadose zone near the disposal units with monitoring in the regional aquifer will provide a defense-in-depth approach to demonstrate the effectiveness of the final remedy.

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1.0 INTRODUCTION

This report documents the corrective measures evaluation (CME) conducted for Material Disposal Area (MDA) L, Solid Waste Management Unit (SWMU) 54-006, at Los Alamos National Laboratory (LANL or the Laboratory). MDA L subsurface disposal units are located within the boundaries of Area L at Technical Area 54 (TA-54) (Figures 1.0-1 and 1.0-2). This CME is developed and submitted pursuant to the March 2005 Compliance Order on Consent (Consent Order).

The Laboratory is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Los Alamos National Security, LLC. The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers 40 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas that are separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft above mean sea level (amsl). The eastern portion of the Pajarito Plateau stands 300 ft to 1000 ft above the Rio Grande.

The Laboratory is participating in a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of the Laboratory's effort is to ensure past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory is currently investigating sites potentially contaminated by past Laboratory operations. These sites are designated as either SWMUs or areas of concern (AOCs).

The objectives of this CME are to identify and evaluate technically appropriate corrective measures alternatives that will

- achieve cleanup objectives in a timely manner,
- protect human and ecological receptors,
- control or eliminate the sources of contamination,
- control migration of released contaminants, and
- manage remediation waste in accordance with state and federal regulations.

MDA L is defined as the subsurface disposal units contained within SWMU 54-006, interspersed across Area L, that are subject to corrective actions under the Consent Order. This CME also addresses the Area L Resource Conservation and Recovery Act (RCRA) subsurface disposal units, referred to as the Area L landfill. This CME does not address Shafts 36 and 37, which are the former lead-stringer storage shafts undergoing RCRA closure. Table 1.0-1 lists the individual units at Area L, their regulatory category, and the basis for their closure. This CME is part of a comprehensive, integrated approach to remediation and closure of all subsurface disposal units at Area L.

Three areas in MDA L are addressed as part of this CME: the pit and impoundments, the shafts, and the vadose zone. Remediation and closure of MDA L requires integration of solutions that address waste and regulatory issues specific to each of these three areas. To achieve corrective actions requires use of recent and historical characterization data as the basis for defining the nature and extent of contamination at MDA L during the CME. The CME report identifies and evaluates appropriate technologies for addressing waste and contaminant concerns specific to each area and to manage potential unacceptable future risk from MDA L. Finally, this CME report screens and evaluates alternatives based on their ability to meet regulatory threshold and balancing criteria and recommends an alternative as the proposed remedy.

MDA L contains hazardous constituents subject to provisions of the RCRA and the New Mexico Hazardous Waste Act, as described in the Consent Order. MDA L subsurface units also contain radioactive constituents regulated by DOE pursuant to the Atomic Energy Act of 1954 (AEA), implementing regulations and DOE orders. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to New Mexico Environment Department (NMED) in accordance with DOE policy and Section III.A of the Consent Order. Decisions with respect to the investigation and remediation of radionuclides are solely within the authority of the DOE under the AEA.

The subsurface disposal units at MDA L are covered with asphalt to house ongoing waste-management activities conducted at Area L. In accordance with the Permit Modification Request (LANL 2007, 110694), approved by NMED on July 24, 2007, corrective action activities for MDA L subsurface units include the cessation of operations in the northern-half of Area L (including aboveground waste storage units), decontamination and decommissioning (D&D) of all structures, removal of asphalt, and regulatory closure of the operating RCRA-permitted aboveground container storage unit (CSU) in accordance with the Laboratory's Hazardous Waste Facility Permit. The costs associated with performing these activities are not included in the evaluation of corrective measures alternatives in this report.

This CME report is organized according to the Consent Order requirements. Table 1.0-2 summarizes the Consent Order requirements and identifies where the applicable requirements are addressed in this report. Section 1 provides an overview of the CME. Section 2 provides a brief site history, describes the relationship among Area L and MDA L surface and subsurface units, discusses the waste inventory, and summarizes the results of previous investigations. Section 3 describes surface and subsurface site conditions. Section 4 summarizes the conceptual site model (CSM) and includes a description of contaminant sources, pathways, and receptors. Section 5 details the regulatory criteria for the CME, including applicable cleanup standards, risk-based screening levels, and risk-based cleanup goals for each pertinent medium at MDA L subsurface units. The Consent Order evaluation criteria process used for screening and evaluating the available treatment technologies as well as the recommended corrective measures alternatives are also discussed in section 5. The identification and screening of technologies are presented in section 6. The corrective measures alternatives are developed from the retained technologies and described in section 7. These alternatives are also screened in section 7 against the four threshold criteria identified in Section VII.D.4.a of the Consent Order. Alternatives that pass the threshold criteria are evaluated further in section 8 against the five balancing criteria of Section VII.D.4.b of the Consent Order. The recommended corrective measures alternative is selected in section 9. The design criteria to meet cleanup objectives are presented in section 10, the proposed schedule is provided in section 11, and references and map data sources are presented in section 12.

This CME report includes appendixes that provide supporting information for sections 1 though 12. Appendix A provides the acronyms and abbreviations that are used throughout the report as well as a metric conversion table and data qualifier definitions. Appendix B provides the volatile organic compound (VOC) screening method for subsurface soil vapors and describes their distributions. Appendix C provides an analysis of the subsurface soil-vapor transport mechanisms and potential plume growth. Appendix D provides information on the groundwater chemistry in the regional aquifer. Appendix E provides a discussion of the local geology and hydrology. Appendix F provides the cost estimates for the corrective measures alternatives identified and carried through section 7. Preliminary design information for potential corrective measures is included in Appendixes G though I: a multilayer cover, an evapotranspiration (ET) cover, and soil-vapor extraction (SVE), respectively.

2.0 BACKGROUND INFORMATION

TA-54 is situated in the east-central portion of the Laboratory on Mesita del Buey (Figure 1.0-1). TA-54 includes four MDAs designated as G, H, J and L; a waste characterization, container storage and transfer facility (TA-54 West); active radioactive waste storage and disposal operations at Area G; active hazardous and mixed-waste storage operations at Area L; and administrative and support areas (Figure 1.0-2). The transfer facility is located at the western end of TA-54, and MDAs H and J are located approximately 500 ft and 100 ft (150 m and 305 m) southeast of the transfer facility, respectively. MDA L is located approximately 1 mi (1.6 km) southeast of the transfer facility. MDA G subsurface units are located within Area G approximately 0.5 mi (0.8 km) southeast of Area L.

Area L is located on the Mesita del Buey, which is a 100- to 140-ft-high finger-shaped mesa that trends southeast. The elevation of Mesita del Buey ranges from 6775 to 6800 ft at Area L. The mesa is approximately 500 ft wide and is bounded by the basin of Cañada del Buey (450 ft to the north) and the basin of Pajarito Canyon (360 ft to the south) (Figure 1.0-2). The topography at Area L slopes gently from west to northeast, gradually steepening in the northeast quadrant of MDA L toward Cañada del Buey. The surface of Area L is covered with a layer of asphalt.

Area L is a 2.5-acre fenced site currently used for RCRA-permitted hazardous waste storage and for permitted and interim status storage of mixed wastes. The subsurface disposal units of MDA L, also referred to as SWMU 54-006, along with the Area L landfill units, are interspersed across the northern-half of Area L. MDA L consists of 1 inactive subsurface disposal pit (Pit A) and 12 inactive disposal shafts (Shafts 2–12 and 18). The Area L landfill consists of 2 inactive surface impoundments (B and D) and 22 inactive disposal shafts (Shafts 1, 13–17, and 19–34). Because the Area L landfill units received hazardous wastes after July 26, 1982, they are defined as regulated units. The Area L landfill “regulated units” are included in this CME because Area L meets the following conditions precedent for the use of “alternative requirements” in 40 Code of Federal Regulations (CFR) 264.110(c):

- the Area L landfill units are situated among SWMUs;
- a release has occurred (e.g., vapor plume has been documents);
- both the Area L landfill units and the one or more SWMUs are likely to have contributed to the release; and
- the corrective action requirements in the Consent Order will satisfy the closure performance standard in 40 CFR 264.111(a) and (b).

The following sections summarize site information. Further information about the current site conditions at MDA L are described in detail in the approved investigation work plan (LANL 2004, 087624, pp. 15–23; LANL 2006, 094673, pp. 1–4; NMED 2007, 098409); the MDA L investigation report and addendum (LANL 2006, 091888; LANL 2007, 096409, pp. 7–9); and quarterly periodic monitoring reports for pore gas. These documents describe the site and include information on the disposal units, waste inventories, characterization activities, analytical sampling results, and assessments of potential present-day risks to human health and the environment.

2.1 Site History

Area L operated from the early 1960s to 1986 as the designated disposal area for nonradiological liquid chemical wastes, including containerized and uncontainerized liquid wastes; bulk quantities of treated aqueous waste; batch-treated salt solutions and electroplating wastes, including precipitated heavy metals; and small-batch quantities of treated lithium hydride. Laboratory drawings AB113 (LANL 1993,

076052) and ENG-C-45259 (LANL 1987, 025606) identify the location and the dimensions of the pit, impoundments, and shafts at Area L.

At Area L, 1 pit, 3 impoundments, and 34 shafts were excavated from the soil surface into the consolidated unit 2 of the Tshirege Member of the Bandelier Tuff. The pit, impoundments, and shafts were unlined.

Pit A was excavated with three near-vertical walls on the west, north, and south sides. A ramp entrance leading down to the flat bottom was excavated on the east side. The total capacity of Pit A was 28,800 ft^3. Pit A received liquid chemical wastes, including containerized and uncontainerized liquid wastes, and functioned as an evaporation pit where bulk quantities of treated aqueous waste from throughout the Laboratory were discharged, pooled, and allowed to evaporate. Disposal records indicate that 5123 ft^3 of waste was disposed of in Pit A. After the aqueous phase evaporated, a salt layer remained on the floor of the disposal pit. Pit A was filled with waste to within 3 ft of the surface, then decommissioned, and covered with crushed consolidated tuff.

Impoundments B, C, and D were excavated into native tuff with near-vertical walls on the east and west sides. Ramps leading down to the flat bottom were excavated on the north and south sides, and the waste was covered with crushed consolidated tuff after the impoundments were decommissioned. The total capacities of Impoundments B, C, and D were 15,120 ft^3, 5040 ft^3, and 12,825 ft^3, respectively. Impoundments B and C were used for evaporating batch-treated salt solutions and electroplating wastes. Disposal records (LANL 1992, 007669) indicate that 2622 ft^3 of aqueous waste was discharged into Impoundment B, pooled, and allowed to evaporate. Upon decommissioning, Impoundments B and C were covered with a minimum of 3 ft of crushed tuff. Impoundment D was used exclusively for treating small-batch quantities of lithium hydride by reaction with water and allowing the neutralized solutions to evaporate. No logbook entries for the volume of waste treated in Impoundments C and D are available.

The waste streams discharged into Pit A and Impoundments B and C were treated solutions from the following four aqueous waste treatment processes (LANL 1992, 007669, pp. 5-115–5-116).

- Ammonium bifluoride waste was neutralized with calcium chloride and calcium hydroxide. The end product was an aqueous solution consisting of ammonium chloride, calcium fluoride, and water.
- Acids and caustics in quantities greater than 55-gal. were diluted to 15% or less concentration, neutralized, and evaporated. Acid solutions were neutralized with sodium hydroxide; base solutions were neutralized with mineral acids. Solids remaining after evaporation were disposed of in the shafts.
- Heavy metals were precipitated and removed before disposal. Heavy metals precipitated from acid solutions were packaged in 15-gal. drums and disposed of in the same shaft(s) as the solids from the neutralized acid solutions; heavy metals precipitated from caustic solutions were also packaged in 15-gal. drums and disposed of in the same shaft(s) at MDA L as the solids from the neutralized caustic solutions (LANL 2003, 076036).
- Cyanide solutions were treated with calcium hypochlorite or calcium chloride and calcium hydroxide at TA-50. The end products of both processes are cyanate, carbon dioxide, and nitrogen. The resulting aqueous solution was tested to ensure complete cyanide treatment. After treatment, the aqueous solution was discharged to Pit A or Impoundments B or C. Solids from the process were placed in metal drums, mixed with cement, and disposed of in shafts at MDA L.
- Chromium waste was treated with sodium hydroxide and one of two reducing agents: sulfur dioxide or sodium bisulfate. The end products of this process were sodium sulfate and chromium

hydroxide. The treated chromium waste was disposed of in the same shaft(s) at MDA L as the solids from the neutralized acid solutions.

The 34 disposal shafts were dry-drilled directly into the Tshirege Member of the Bandelier Tuff. The shafts range from 3 ft to 8 ft in diameter and from 15 ft to 65 ft in depth. To fill cracks and joints, 3 ft of crushed tuff was placed at the bottom of each shaft. After a shaft was filled to within approximately 3 ft of the surface, the area below the surface was sealed with a 3-ft concrete plug (LANL 1992, 007669, p. 5-108).

Disposal Shafts 1 through 34 were used to dispose of containerized and uncontainerized liquid chemical wastes and precipitated solids from the treatment of aqueous waste. Before 1982, containerized liquids were disposed of without adding absorbents. Small containers were typically dropped into a shaft. Larger drums were lowered by crane and arranged in layers of one drum in a 3- or 4-ft-diameter shaft, four to five drums in a 6-ft-diameter shaft, or 6 drums in an 8-ft-diameter shaft. The space around the drums was filled with crushed tuff, and a 6-in. layer of crushed tuff was placed between each layer of drums. Uncontainerized liquid wastes were also disposed of in the shafts. Between 1982 and 1985, only containerized wastes (including organic and inorganic liquids, precipitated heavy metals, and stabilized heavy metals) were disposed of in the shafts.

When the subsurface disposal units at Area L were decommissioned in 1986, the surface was paved with asphalt to accommodate waste management activities (permitted storage of hazardous and mixed waste). The locations of the pit, impoundments, and shafts were inferred from geographical landmarks (i.e., fences, structures) before the asphalt paving was emplaced. No geodetic data exist for the disposal units at Area L (LANL 2004, 087624, p. B-1).

2.2 Site Description

2.2.1 Surface Soils

The soils of Mesita del Buey are derived from the weathering of the Tshirege Member tuffs (phenocrysts and phenocryst fragments, devitrified glass, and minor lithic fragments) and from wind-blown sources. Soils on the flanks of the mesa are developed on Tshirege Member tuffs and colluvium with additions from wind-blown and water-transported sources. Native surface soils have been disturbed by waste management operations over much of Mesita del Buey, but when present, native soils are generally thickest near the center of the mesa and thinnest on the edges.

In general, soils on the mesa surface are thin and poorly developed; they tend to be sandy near the surface and more clay-like beneath the surface. More highly developed soil profiles exist on the north-facing slopes, and they tend to be richer in organic matter. Soil profiles on the south-facing slopes tend to be poorly developed. Soil-forming processes have been identified along fractures in the upper part of the mesa, and the translocation of clay minerals from surface soils into fractures has been described at Mesita del Buey (Newman 1996, 054399).

The original soils near Area L were poorly developed, as is typical of soils derived from Bandelier Tuff and formed under semiarid climate conditions (Nyhan et al. 1978, 005702, p. 24). In general, undisturbed soils on the mesa tops are comprised of the Carjo loam, the Hackroy loam, and the Seaby loam. At Area L, natural or undisturbed surficial soil cover is limited as a result of disposal unit and cover construction. The present-day surface of Area L is crushed tuff covered with an asphalt pad.

Canyon bottoms (Cañada del Buey and Pajarito Canyon) near Area L are covered with colluvium and alluvium that has eroded from the tuff and soils on the mesa top and canyon walls. The canyon rims and slopes are composed of soils from the Hackroy-Rock outcrop complex; the canyon bottoms are

composed of the Tocal, a very fine, sandy loam. Since disposal activities began at Area L, Cañada del Buey has experienced a period of accretion, and eroded soils from Area L as well as other areas at TA-54 have been deposited on the canyon bottom and stream banks. Potentially, these soils may be redistributed downstream during storm runoff events.

2.2.2 Subsurface Geology

A brief description of the site-specific geology at MDA L is summarized in this section. A generalized stratigraphic column for MDA L is shown in Figure 2.2-1. Appendix E, section E-2, presents a more extensive discussion of the site-wide geology for TA-54. Cross-sections in the vicinity of MDA L are shown in Figures E-2.1-2, E-2.1-5, and E-2.1-6.

The facilities and disposal pits of MDA L are located on Mesita del Buey, an erosional highstand of Bandelier Tuff on the eastern part of the Pajarito Plateau. Mesita del Buey is capped by partly to moderately welded tuff of unit 2 (Qbt 2) of the Tshirege Member of the Bandelier Tuff. Qbt 2 is underlain by nonwelded devitrified Tshirege tuff (Qbt 1v), nonwelded vitric Tshirege tuff (Qbt 1g), thin basal Tshirege Tsankawi fall deposits (Qbtt), Cerro Toledo sediments (Qct) of variable thickness, Otowi Member of the Bandelier Tuff nonwelded vitric ash flows (Qbo), and Guaje Pumice Bed (Qbog) fall deposits. The Bandelier Tuff deposits are about 400 ft thick at MDA L. These tuffs overlie a 550-ft thick, varied sequence of volcanic rocks of the Cerros del Rio volcanic series (Tb4), ranging in composition from basalt to trachyandesite. Although this volcanic series is dominated by lava flows, volcanic lithologies have considerable variety, including lavas, flow breccias, cinder deposits, scoria, phreatomagmatic deposits, and interflow sediments. The Cerros del Rio volcanic series overlies sediments of the Puye Formation (Tpf) that includes fanglomerates from local volcanic sources (Tpf) and axial river gravels of the Totavi Lentil (Tpt). The fanglomerates and axial river gravels interfinger in the vicinity of MDA L. Sitewide borehole data indicate the Puye Formation is underlain by pumice-rich alluvial fan deposits of Miocene age and riverine deposits of the Miocene Chamita Formation. The Miocene pumiceous deposits (Tjfp) thin eastward and pinch out in the vicinity of MDA L. The Chamita Formation (Tcar) of the Santa Fe Group consists of variably calcite-cemented sands, silty sands, and gravels.

The regional water table occurs at a depth of about 935 ft beneath MDA L. Because of paleotopographic relief at the base of the Cerros del Rio volcanic series near MDA L, the water table is well within sediments of the Puye Formation west of MDA L at well R-54, and it straddles the contact between the Cerros del Rio volcanic series and Puye Formation north and east of MDA L at wells R-53 and R-56, respectively (Figure E-2.1-5). Thus, the regional aquifer beneath MDA L is largely made up of porous Pliocene and Miocene sedimentary deposits. Farther east, at MDA G, the base of Tb4 is structurally lower and the regional water table is within lavas of the Cerros del Rio volcanic series (Figure E-2.2-1).

2.2.3 Surface Water

No perennial streams flow on Mesita del Buey; water flows only as stormwater and snowmelt runoff on the mesa and in small drainages off the mesa to the north and the south. Stormwater flows at a number of points along the perimeter of TA-54, as identified and characterized in the “TA-54 Stormwater Pollution Prevention Plan” (LANL 2009, 109438), prepared for the Laboratory’s National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit. As a result of runoff, surface erosion occurs primarily as shallow sheet erosion on the relatively flat parts of the mesa and as channel erosion in major drainages from the mesa top. Surface water runoff from Area L is controlled and diverted to an outfall into Cañada del Buey at the northeast corner of the site (Figure 2.2-2).

2.2.4 Vadose Zone Hydrology

The vadose zone is the zone between the land surface and the regional water table within which the hydraulic pressure is less than atmospheric barometric pressure. Beneath MDA L, the pores within the vadose zone are unsaturated (i.e., they contain both air and water). Mesita del Buey is one of the drier mesas at the Laboratory and on the Pajarito Plateau. Infiltration occurs into the shallow subsurface mostly during snowmelt or following intense summer thunderstorms. Moisture from the shallow subsurface of the mesa is removed by ET. Figure 2.2-3 presents data showing that average potential ET rates exceed precipitation rates throughout the year at TA-54. That is, little to no water is available for infiltration at the site. Percolation into the deeper subsurface of the mesa appears to be very low. Newman et al. (2005, 099163) estimated percolation rates and vadose zone travel times in undisturbed, disturbed, and paved areas across TA-54 using moisture, chloride, and stable isotope data from shallow (1 to 2 m deep) cores. The study looked at vegetated and unvegetated areas. Under undisturbed and vegetated conditions, percolation rates on Mesita del Buey are estimated to be approximately 0.2 mm/yr; under disturbed conditions and beneath pavement, less ET occurs and percolation rates can range up to 10 mm/yr (Newman et al. 2005, 099163). Similar average percolation rates are confirmed by several independent studies (Birdsell et al. 2005, 092048; Kwicklis et al. 2005, 090069). These studies evaluated average travel times for conservative waterborne contaminants (dissolved constituents that do not adsorb or precipitate and are not present in the vapor phase) from the surface to the regional aquifer. Travel times of several hundred years to several thousand years are predicted under disturbed and undisturbed conditions, respectively. Adsorbing waterborne constituents will migrate more slowly. Vapor-phase contaminants may migrate more quickly as discussed in Appendixes B and C. The CSM for contaminant migration through the unsaturated zone at TA-54 is presented in detail in the revised MDA G CME Plan (LANL 2007, 098608) and summarized in section 4 of this report.

Krier et al. (1997, 056834) present moisture data from core samples collected within the boundary of MDA L, including beneath the pit and impoundments and in an adjacent area east of MDA L. The data indicate higher moisture contents within MDA L than in the adjacent area. For example, for Qbt 2 samples, gravimetric moisture ranged from 4% to 10% g/g within MDA L and from 0.03% to 5% g/g east of the site (Krier et al. 1997, 056834). The elevated moisture contents within MDA L are consistent with a disturbed and paved former liquid-disposal site. Field moisture content was measured at 5-ft intervals in borehole 54-24241 in the upper 250 ft of tuff at Area L and was less than 11.3% g/g (LANL 2006, 091888). At these moisture contents, most of the fractures beneath MDA L are dry, and pore water occurs in the tuff matrix. Enhanced ET and declining subsurface moisture will likely occur following asphalt removal and revegetation, as was observed at TA-49 following installation of an ET cover (Levitt et al. 2005, 107562).

No significant perched-intermediate groundwater occurs beneath MDA L. Borehole 54-24399, the deepest borehole to date at MDA L, was drilled to a depth of 650 ft and did not encounter perched groundwater (LANL 2006, 093910, p. 14). Regional wells drilled in areas next to MDA L (R-20, R-21, R-32, R-38, R-53, R-54, and R-56) also did not encounter perched-intermediate groundwater (Ball et al. 2002, 071471; Kleinfelder 2003, 090047; LANL 2003, 079600; LANL 2003, 079602; LANL 2009, 105298; LANL 2010, 108787; LANL 2010, 110482). Perched-intermediate groundwater occurs in wells R-55 and R-23/R-23i, located 7200 and 8200 ft (2.2 and 2.5 km) southeast of MDA L, respectively (LANL 2003, 079601; Kleinfelder 2006, 092495). Perched-intermediate groundwater also occurs in wells R-40/40i and R-37, located 3280 and 3600 ft (1 and 1.1 km), respectively, northwest of MDA L (LANL 2009, 106432). This water is thought to be localized beneath the canyon floor and to result from infiltration along the canyon, which has a large drainage area.

2.2.5 Regional Aquifer Hydrology

The regional aquifer beneath the Pajarito Plateau is the aquifer that provides water supply for the Laboratory and municipal purposes. Depths to the regional aquifer range between 1200 ft (366 m) along the western edge of the plateau and about 600 ft (183 m) along the eastern edge. The decrease in depth eastward is largely from the slope of the land surface, which dips to the east. Beneath MDA L, the regional water-table elevation is approximately 5860 ft above sea level (asl) at R-53; 5863 ft asl at R-54; and 5858 ft asl at R-56 (Figure E-3.3-2) or approximately 935 ft below ground surface (bgs) and within the Cerros del Rio basalts and the Puye Formation (Figure E-2.1-12).

As with the conditions observed elsewhere beneath the Pajarito Plateau, the regional aquifer beneath MDA L is a complex heterogeneous system that includes deep, predominantly confined zones and shallow, predominantly unconfined zones. There are no lithologic observations that demonstrate the existence of clearly defined aquitards or confining layers that provide hydraulic separation between the deep and shallow zones of the regional aquifer. However, the vertical hydraulic stratification of the regional aquifer has been observed at numerous aquifer locations where there are deep and shallow monitoring well screens. The vertical hydraulic stratification is indicated by (1) pronounced vertical differences in hydraulic heads, and (2) a lack of vertical propagation of pumping drawdown caused by pumping tests and water supply-well pumping. The vertical stratification of the regional aquifer is also demonstrated by the PM-2 spinner test (LANL 2009, 106939, Appendix J). The vertical hydraulic separation is most likely caused by pronounced vertical aquifer anisotropy; that is, the lateral permeability is substantially higher than the vertical permeability. The anisotropy is probably caused by the depositional layering of the hydrostratigraphic units. Based on the existing observations, the degree of hydraulic communication between these zones is (1) relatively poor and (2) spatially variable depending on local hydrogeologic conditions and hydrostratigraphy. The poor hydraulic communication between the two zones does not preclude the possibility that some contaminant migration may occur between the shallow and deep zones. Between the two zones, the hydraulic gradient has a downward vertical component because of water supply pumping in the deep zone, creating the possibility that downward contaminant flow may occur along “hydraulic windows,” although these flows have not been directly observed.

Beneath MDA L, the shallow portion of the regional aquifer (near the water table) is predominantly under phreatic (unconfined) conditions and has limited thickness (approximately 98 to 164 ft [30 to 50 m]). Groundwater flow and contaminant transport directions in this zone generally follow the hydraulic gradients along the regional water table. The deep portion of the regional aquifer is predominantly under confined conditions, and it is stressed by Pajarito Plateau water-supply pumping. Water-supply pumping causes small water-level fluctuations (generally less than 0.1 ft) in the shallow phreatic (unconfined) zone. Currently, the largest seasonal fluctuations in the shallowest monitoring screens in the regional aquifer near MDA L have been observed at R-20 screen 1, which varies 0.6 ft (0.2 m) (Appendix E); however, this screen is located approximately 80 ft below the regional water table (Table E-3.1-1).

The water table map of the regional aquifer beneath the Pajarito Plateau is presented in Figure E-3.3-1. The map is based on the water levels observed in the shallowest screens in all the regional monitoring wells. The map includes the data collected at the recently installed regional wells near MDA L (R-53, R-54, and R-56); the map is based on monthly-averaged, regional-aquifer water-level data from February 2011.

The structure of the regional aquifer flow near MDA L is represented in greater detail by two water-table (piezometric) maps in Figures E-3.3-2 through E-3.3-4 (based on monthly-averaged, regional-aquifer water-level data from February 2011). The contour lines in Figures E-3.3-1 and E-3.3-2 are equivalent and based on the water levels from the uppermost screens in the regional aquifer; the maps represent the

general structure of the groundwater flow along the regional water table (water-level data are presented in Figure E-3.3-2). The water-level contour map in Figure E-3.3-3 incorporates information from the deeper screens in the regional aquifer at the monitoring wells with more than one screen (water-level data are presented in Figure E-3.3-3). Figure E-3.3-3 attempts to represent the structure of the groundwater flow about 100 ft (the average distance between the shallow and deep screens in the regional wells; Table E-3.1-1) below the regional water table based on the available information.

Because the water-level contour maps in Figures E-3.3-2 and E-3.3-3 are somewhat similar, the contours are compared in Figure E-3.3-4. The general directions and hydraulic gradients of the groundwater flow in the shallow and deep sections of the regional aquifer appear to be similar as well. The magnitude of the groundwater flow gradients beneath MDA L is in the range of 0.003–0.01 m/m. The major differences are in the area near R-54 and R-53. The deep screens of the monitoring wells near MDA L respond to water-supply pumping (R-20, R-54, R-53, R-56, R-21, R-32; Table E-3.1-2; the R-21 screen is located substantially below the regional water table; Table E-3.1-1). The shallow screens of R-54, R-53, and R-56 do not respond to water-supply pumping; the impact of the water-supply pumping on the water table near R-20 is unknown because the shallowest R-20 screen is 80 ft below the regional water table (Table E-3.1-1). Therefore, the differences in the water-level contours between the shallow and deeper sections of the aquifer (Figure E-3.3-4) are expected to be predominantly caused by the water-supply pumping; it is feasible that the differences are also influenced by aquifer heterogeneity and more local-scale regional aquifer recharge.

It is important to emphasize that well PM-2 has not actively been used to supply water since the summer of 2007, and the observed pumping effects on the water levels since then are from the pumping of PM-4 only. It is expected that use of PM-2 will start again in the fall of 2011. Based on existing hydrogeological data, PM-2 has a larger influence than PM-4 on the deep water levels in the regional aquifer beneath TA-54. Future PM-2 pumping may, therefore, further influence the deep regional aquifer flow system beneath MDA L. It is not expected that the water-supply pumping will change the magnitude and directions of the regional flow in the shallow phreatic zone. PM-2 is screened approximately 1004 to 2280 ft bgs (or 160 to 1440 ft below the regional water table). Because of (1) the poor vertical hydraulic communication between the deep and shallow zones of the regional aquifer and (2) a lack of pumping effects on the directions and magnitude of groundwater flow along the regional water table (any potential contaminants from MDA L are expected to arrive at the top of the regional aquifer), it is expected that any potential contaminants migrating from MDA L will follow the ambient water table gradients in the shallow zone of the regional aquifer rather than diverting toward the deep sections of the aquifer pumped by the water supply wells.

Groundwater flow in the regional aquifer beneath MDA L also appears to be influenced by the Cerros del Rio basalts, which are located in the upper section of the aquifer (Figures E-3.3-1 through E-3.3-3). The location of the Cerros del Rio basalts at the water table and their estimated thickness beneath the regional water table are shown in Figure E-2.1-12. The regional structure of the groundwater flow in the aquifer beneath MDA L may also be influenced by (1) local-scale infiltration recharge along Pajarito Canyon and (2) lateral propagation of large-scale mountain-front aquifer recharge occurring to the west of MDA L.

Additional information on the groundwater flow directions is discussed in Appendix E.

2.2.6 Historical Preservation and Archaeology

Known archaeological sites exist in the immediate vicinity of Area L, which has been thoroughly characterized for archaeological sites and structures that may be subject to historical preservation (LANL

1992, 007669). The exact locations of existing archaeological sites are not identified in this report to protect their cultural resources.

2.3 Area L Waste Inventory

Waste disposal records for Area L are found in unnumbered disposal logbooks (LANL 2003, 076036) used to record information on the type, date, location, and volume of waste placed in MDA L and Area L landfill units. Records generated before 1974 are incomplete, and many logbook entries contain only brief descriptions of wastes disposed of at Area L (i.e., waste types, volumes, and disposal locations were not always provided). An estimate of the types and quantities of waste disposed of at Area L was compiled in the approved RCRA Phase I facility investigation (RFI) work plan for Operable Unit 1148 (LANL 1992, 007669, pp. 5 110–5-116). Two waste inventory databases were developed based on the original logbook entries (LANL 2004, 087624). The Source Term Database contains information on untreated waste, and the Batch Waste Source Term Database describes waste that underwent batch treatment before disposal. The two databases do not indicate that tritium was a contaminant disposed of at MDA L; however, environmental data indicate it is present.

2.4 Waste Unit Categorization by Regulatory Driver

The waste management units at Area L are placed into four categories based on their regulatory status. Fourteen of the inactive corrective action disposal units stopped accepting hazardous wastes before July 26, 1982, and 24 inactive subsurface disposal units continued to accept hazardous wastes after July 26, 1982. Although these units are defined as “regulated units” in 40 CFR 264.90, they are not subject to closure under the Laboratory’s Hazardous Waste Facility Permit. These units meet the criteria in 40 CFR 264.110(c) for the use of “alternative requirements” rather than closure under 40 CFR 264 Subpart N. Therefore, they will be remediated through corrective action under the Consent Order.

Active waste management operations are also ongoing at Area L in CSUs that are subject to RCRA-permit and/or interim-status requirements. The active CSU activities include hazardous and mixed low-level waste (MLLW) storage and processing (for off-site shipment and disposal) and are primarily conducted on paved areas overlying the inactive units. Figure 2.0-1 shows and Table 1.0-1 lists the inactive subsurface disposal units and surface CSUs.

2.4.1 Regulated Units

The regulated units in Area L include Shafts 1, 13–17, and 19–34 and Impoundments B and D. As discussed above, the alternative requirements for these regulated units will be established using this CME process for MDA L per Section VII.D of the Consent Order. Upon NMED’s selection of the remedy for MDA L, the Laboratory will prepare and submit a corrective measures implementation (CMI) work plan, which will fulfill the requirements for closure and postclosure plans for the landfill units specified in 40 CFR Sections 264.112 and 264.118.

2.4.2 Corrective Action Disposal Units

The corrective action disposal units in Area L include Shafts 2–12 and 18, Pit A, and Impoundment C. These units are subject to corrective action requirements under the Consent Order.

2.4.3 Aboveground CSU

The outdoor hazardous waste CSU in Area L is used to store hazardous, mixed, and/or other chemical wastes (e.g., polychlorinated biphenyl [PCB]) and is included in the Laboratory's Hazardous Waste Facility Permit. Because only the northern-half of the CSU will be impacted by the implementation of the corrective measure, the Laboratory's Hazardous Waste Facility Permit must be modified to perform D&D of aboveground structures and to perform closure for the northern-half of the CSU. The southern part of the Area L CSU will continue as an active storage unit.

2.4.4 Belowground CSU

The belowground CSU in Area L includes Shafts 36 and 37, which were used between 1988 and 2004 to store mixed waste. Lead stringers were stored in these belowground shafts for the shielding provided while short-lived radioactive materials decayed to adequate levels for further processing. The stored lead stringers were removed in September 2004, and closure decontamination activities were completed in July 2005. A closure certification report was submitted to NMED for approval in October 2006 (LANL 2006, 098199).

2.5 Summary of Previous Investigations

MDA L has been the subject of numerous investigation activities. Phase I RFI activities were conducted between 1993 and 1995; follow-on and Consent Order site investigation activities were conducted between 2004 and 2007; two soil-vapor extraction (SVE) pilot studies were conducted in 1995 and 2006; and ongoing pore-gas monitoring activities continue at the site. Investigation activities are summarized in the following sections.

2.5.1 Summary of Phase I RFI

Phase I RFI activities were conducted at MDA L between 1993 and 1995. Investigation activities included sediment sampling in the drainage between the outfall and Cañada del Buey, air sampling, borehole sampling across the site. The results of Phase I RFI activities were documented in the RFI report for channel sediment pathways from MDAs G, H, J, and L (LANL 1996, 054462) and in both the investigation work plan (IWP) and the historical investigation report (Appendix B of the IWP [LANL 2004, 087624]) for MDA L.

Eight locations in the drainage between the outfall and Cañada del Buey were selected for sediment sampling to determine if contaminants had migrated from MDA L (Figure 2.5-1). Samples were collected and field screened for gross-alpha, -beta, and -gamma radiation. The sample with the highest gross alpha and gross beta, the sample with the highest gross gamma, and two other randomly selected samples (for a total of four) were submitted to an off-site contract laboratory for analysis of target analyte list (TAL) metals, PCBs, pesticides, radionuclides (by alpha and gamma spectroscopy), tritium, and strontium-90 (LANL 1996, 054462, pp. 57, A2-1–A2-2). No inorganic chemicals were detected at concentrations above the sediment background values (BVs) in any of the channel sediment samples. The pesticide 4,4'-methoxychlor was detected in three samples at a maximum concentration of 0.063 mg/kg. No other organic compounds were detected in the sediment samples (Figure 2.5-2).

Detected concentrations of radionuclides were compared with the sediment BVs or the sediment fallout values (FVs), depending on whether the radionuclide is naturally occurring or a fallout radionuclide (LANL 1998, 059730, pp. 25–30) (Table 2.5-1). Plutonium-238 was the only radionuclide detected in sediment

samples above its respective BV or FV. The highest detected concentration for plutonium-238 (0.011 pCi/g) exceeded the associated sediment FV of 0.006 pCi/g.

Seven vertical boreholes and 11 angled boreholes were installed at MDA L as part of RFI activities (Figure 2.5-3). Boreholes ranged in depth from 41 to 523 ft bgs. One of the vertical boreholes was located next to the western shaft field, and one was located adjacent to Pit A. The other five vertical boreholes were located outside of Area L to the east. Five of the angled boreholes were installed to investigate the area beneath the pit and impoundments. Two of the angled boreholes were installed beneath the shaft fields. The remaining four angled boreholes were installed outside Area L to the southeast. A total of 184 core samples were collected from these boreholes. All samples were analyzed for VOCs, and the majority of samples were analyzed for TAL metals, pesticides, PCBs, semivolatile organic compounds (SVOCs), cyanide, pesticides, and radionuclides (americium-241, cesium-137, plutonium and uranium isotopes, and tritium).

Core sample results indicated that concentrations of aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, uranium, vanadium, and zinc were above BVs (Table 2.5-2). Nineteen VOCs were detected in core samples, although at trace concentrations (Table 2.5-3).

Core samples from seven boreholes were analyzed for tritium; five of these samples were analyzed for americium-241, cesium-137, and plutonium and uranium isotopes. Americium-241, cesium-137, and isotopic plutonium were not compared with FVs but were evaluated only on the basis of detection. Tritium was the only radionuclide identified in the core samples (Figure 2.5-4 and Table 2.5-4).

Ambient-air samples were collected for VOC analysis at two locations over 8 d on the northern perimeter of MDA L and at a background location next to Bandelier National Monument (Figure 2.5-5). Measured concentrations of selected aromatic and halogenated hydrocarbons at ambient-air sampling locations 4 and 5 (Figure 2.5-5) are presented in Tables 2.5-5a and 2.5-5b. Only organic compounds consistently detected in four or more samples are presented. The data set collected at the Bandelier National Monument (location 3 of Figure 2.5-5) for the analytes listed in these tables is presented in Table 2.5-5c.

Two surveys conducted in August 1993 and August 1994 measured VOC surface flux across MDA L (Figure 2.5-6). The results of the surface flux VOC measurement investigations are summarized in a report prepared by Trujillo et al. (1998, 058242). Seventy locations were sampled during the 1993 survey; an additional 32 locations were sampled in the 1994 survey. The majority of the 1993 sampling locations were on the mesa top at MDA L, while most of the 1994 sampling locations were in the slopes and drainages on the sides of the mesa. The EMFLUX surface flux measurement locations are shown in Figure 2.5-7.

Twenty VOCs were detected in the 102 EMFLUX samples collected in 1993 and 1994 (Trujillo et al. 1998, 058242). The detected VOCs in the 1993 samples include acetone, benzene, bromobenzene, 2-butanone, carbon tetrachloride, chlorobenzene, chloroform, chloromethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, ethylbenzene, n-propylbenzene, perchloroethene (PCE), toluene, 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), Freon-113, and xylene. Fewer VOCs were detected in the 1994 samples from the hillsides and were limited to acetone, chlorobenzene, chloroform, 1,1-dichloroethane (DCA), 1,1-dichloroethene, methylene chloride, PCE, toluene, TCA, TCE, Freon-113, and xylene.

The highest surface flux measurements for TCA, PCE, and TCE were detected in samples collected in 1993 from the mesa top. Freon-113 and acetone were also detected in many samples at relatively low levels compared with the three main VOCs: TCA, TCE, and PCE. The 1994 EMFLUX data from the

hillsides indicate much lower surface flux than those measured on top of the mesa in 1993; the most prevalent VOCs in the 1994 data were also TCA, PCE, and TCE. The compound 1,1-dichloroethene was also detected at a relatively high frequency in the 1994 samples on the north slope of the mesa. Freon-113 was detected frequently in the 1994 data set at low levels in samples collected on the southern slope of the mesa. A plot showing the TCA surface flux results at MDA L is provided in Figure 2.5-8.

Tritium flux was measured at five locations near MDA L during the summer of 1993 and three locations during the summer of 1994. Tritium flux chamber locations are shown in Figure 2.5-6, and the results are presented in Table 2.5-6.

2.5.2 Summary of Consent Order Investigation Activities

As part of the NMED-approved IWP for MDA L (LANL 2004, 087624; NMED 2004, 089306), seven shallow vertical boreholes (ranging from approximately 150 ft to 300 ft bgs) and one deep vertical borehole (approximately 660 ft bgs) were installed at MDA L in 2004–2005 to further define the nature and extent of contamination at the site (Figure 2.5-9). Seventy-nine core samples were collected from the boreholes and analyzed for inorganic chemicals, including TAL metals, VOCs, SVOCs, and radionuclides. In each borehole, pore-gas samples were collected from the base depth of the nearest adjacent disposal unit and from the total depth (TD) of the borehole and analyzed for VOCs and tritium. One sediment sample from the drainage channel to Cañada del Buey was also collected and analyzed for inorganic chemicals, including TAL metals, pesticides/PCBs, and radionuclides. Investigation results and conclusions are detailed in the revised MDA L investigation report (LANL 2006, 091888).

No radionuclide or inorganic chemicals were detected at levels that exceeded BVs or FVs in channel sediments. The only organic compound detected in channel sediments was Aroclor-1260 at a concentration of 0.0013 mg/kg (Figure 2.5-10).

Core samples confirmed the presence of a number of organic compounds at trace levels beneath the former disposal units (Figure 2.5-11) and were consistent with the results obtained during the Phase I RFI. The primary organic compounds detected included trace levels of chlorinated VOCs and several dioxin and furan congeners.

Concentrations of inorganic chemicals detected beneath MDA L were indicative of natural variability within the various stratigraphic layers (Figure 2.5-12). In unit Qbt 2, the unit next to the base of the disposal pit and impoundments, the only inorganic chemical detected above BV was barium. In Qbt 1v, the unit below Qbt 2 and underlying the disposal shafts, arsenic, barium, beryllium, copper, nickel, and selenium were detected above BVs. Lithium, fluoride, nitrate, and perchlorate were detected but have no BVs. Appendix M of the revised MDA L investigation report (LANL 2006, 091888) presents a comparison of the inorganic chemical data collected during the Phase I RFI with data from the 2004–2005 investigation. Most of the inorganic chemical data do not indicate a release. Chromium, copper, and nickel results indicate a release beneath disposal units into units Qbt 2 and Qbt 1v. However, these results are bounded by concentrations in deeper samples that are within the background range.

Analytical results from pore-gas samples collected from the eight boreholes confirmed the presence of a vapor-phase plume consisting primarily of VOCs (Figure 2.5-13).

Tritium was detected in pore-gas samples collected from all eight boreholes (Figure 2.5-14). The highest concentration, 153,000 pCi/L, was detected beneath the eastern portion of MDA L (Table 2.5-6).

Ambient air was sampled in and beneath structures at MDA L during the second quarter of fiscal year (FY) 2004 to determine the impact of vapor intrusion into buildings (LANL 2005, 092591, Appendix K).

Samples were collected in seven selected structures located within the fence line of MDA L on an asphalt pad. In addition, samples were collected in building 54-37 (Figure 2.0-1) and in the crawl space beneath this building. Building 54-37 is located immediately outside the access gate on a dirt lot. The mixture of air concentrations detected at the sampling locations did not exceed either American Conference of Governmental Industrial Hygienists threshold limit values or Occupational Safety and Health Administration permissible exposure limits (LANL 2005, 092591).

Subsurface samples were collected from borehole locations 54-24241 and 54-24399 to evaluate moisture properties and to determine if perched water zones were present beneath MDA L. Detailed lithological logging did not identify visibly saturated zones to a depth of 400 ft. Fifty-one samples, collected at approximately 5-ft intervals, were analyzed for moisture content and matric potential analyses. The results of gravimetric moisture analyses showed moisture levels ranging from 1.3% to 27.9% moisture by weight, with all samples, except one, showing moisture levels less than or equal to 11.3% (Table 2.5-7). Laboratory matric potential readings confirmed all samples collected beneath MDA L contained moisture levels below saturation.

Perched groundwater was not encountered during drilling beneath MDA L. Samples collected in borehole 54-24241 from 0 to 250 ft bgs and in borehole 54-24399 from 385 to 400 ft bgs did not identify intervals of saturation.

In response to NMED's August 25, 2006, notice of disapproval (NMED 2006, 093542) of the revised MDA L investigation report (LANL 2006, 091888), supplemental investigation activities were conducted to further define the vertical and lateral extent of subsurface contamination at MDA L. In accordance with NMED's November 13, 2006, approval with modifications letter (NMED 2006, 095114), the Laboratory drilled three additional boreholes in 2007: locations 54-27641, 54-27642, and 54-27643, shown in Figure 2.5-15, were drilled to define the vertical extent of subsurface VOCs and inorganic chemical concentrations. The NMED letter also requested characterization of the waste in Impoundments B, C and D. Results and conclusions of these activities are detailed in the addendum to the MDA L investigation report (LANL 2007, 096409).

The results of inorganic chemical analysis from core samples demonstrate the natural variability within the various stratigraphic layers (Figure 2.5-16). Comparisons of results to BVs are limited by the background data set, which contains a relatively small number of samples for units Qbt 1g, Qct, and Qbo. The sample containing the highest inorganic chemical concentrations was collected from a Qct sample with a high proportion of silt. Higher naturally occurring concentrations of inorganic chemicals have historically correlated with samples containing higher proportions of silt. Concentrations of inorganic chemicals in this sample were below all soil and sediment BVs. Although no BVs exist for Qbog, concentrations of inorganic chemicals in Qbog are less than Qbo BVs; thus, they likely represent naturally occurring levels of inorganic chemicals. Background values for inorganic chemicals in the other lower Qbo units are exceeded by factors of approximately 2 or less. Lithium was detected in all samples but has no BV. Lithium concentrations are similar to but below the concentrations detected during 2004–2005 investigation activities and likely reflect naturally occurring levels.

Acetone, methylene chloride, toluene, and TCE were the only VOCs detected in the core samples (Figure 2.5-17). Acetone concentrations in samples and trip blanks were similar, indicating possible contamination during handling, shipping, storage, and/or analyses. Concentrations of the four VOCs detected in MDA L core samples were near detection limits and are not indicative of ongoing releases from the former waste disposal unit.

An evaluation of the pore-gas data from the three new boreholes and additional samples from the old boreholes confirm the presence of vapor-phase VOCs associated with sources in the eastern and

western disposal shaft fields. Six VOCs, including DCA, dichloroethylene (DCE), TCA, TCE, PCE, and Freon-113, were detected in each pore-gas sample collected. Concentrations of these VOCs reach their maximum concentrations in the shallower Qbt 2, Qbt 1v, and Qbt 1g units of the Bandelier Tuff. Concentrations of each VOC decrease in the unit Qct and unit Qbo of the Bandelier Tuff. Concentrations of VOCs are lowest in the Tertiary Cerros del Rio basalts (Tcb) sampled from periodic monitoring boreholes (Tables 2.5-8 and 2.5-9). These analytical results confirm the conclusions of the 2004–2005 investigation, which reported that the plumes are in a near-steady state, and that vapor-phase concentrations do not indicate the presence of a free liquid source in the subsurface beneath MDA L.

Based on the distribution of VOC concentrations with depth, the vertical extent of contamination is affected by physical processes governing plume distribution (e.g., release depth and diffusive transport). The increase in concentration with depth in the near-surface unit (Qbt) results from the proximity of sampling depths to contaminant sources and the potential for VOC losses near the surface from diffusion to the atmosphere. An evaluation of the vertical extent of vapor-phase contamination across multiple stratigraphic units, including Qbt, Qct, Qbo, and Tcb, indicates a decrease in VOC concentrations to a maximum sampled depth of 660 ft bgs.

Activities of tritium detected during the 2007 supplemental investigation were below the U.S. Environmental Protection Agency (EPA) drinking water guideline of 20,000 pCi/L (Figure 2.5-18).

Appendix H of the addendum to the MDA L investigation report (LANL 2007, 096409) details the sampling of Impoundments B, C, and D at MDA L from February to April 2007. A total of 21 boreholes were advanced into the three impoundments using the direct-push method. Seven boreholes were advanced into Impoundment B, five were advanced into Impoundment C, and nine were advanced into Impoundment D. The majority of the VOCs, including PCE, TCA, and TCE, were detected in samples collected from Impoundment B. Eleven VOCs were detected in Impoundment C samples, with PCE detected in seven of the eight samples collected.

PCE, the only VOC detected in Impoundment D samples, was detected in three of the nine samples collected. However, diesel range organics–total petroleum hydrocarbons were detected in eight of the nine samples collected, and bis(2-ethylhexyl)phthalate was detected in one sample.

NMED approved the addendum to the investigation report in 2007 (NMED 2007, 098409).

2.5.3 Summary of SVE Pilot Studies

Two active in situ SVE pilot studies have been conducted at MDA L to evaluate the viability of SVE as a method to remove VOCs from the subsurface and to minimize the growth of the subsurface VOC plumes in the event that the source term changes substantially (e.g., one or more of the containers holding liquid waste within the disposal shafts fail). The first study was conducted in 1995; the second was conducted in 2006.

The 1995 SVE pilot study was conducted over a 34-d period at the eastern edge of the VOC vapor plume, outside the boundary of MDA L (Figure 2.5-19). The results and conclusions of the pilot study are detailed in the pilot vapor extraction test at MDA L (ERM/Golder 1997, 070334). The 1995 SVE pilot study utilized a single 9-in. extraction borehole (borehole 54-01017) installed to a TD of 150 ft bgs and cased to a depth of approximately 75 ft bgs. A 5-horsepower (hp), 208-volt regenerative blower rated to 200 ft^3/min with a maximum vacuum of 88 in. of water (in.-H_2O) was used to extract the pore gas. Total extraction air flow and vacuum from the borehole, extraction air temperature, atmospheric pressure, differential pressure, and VOC concentrations were measured during the test.

During the pilot study, the SVE system was operated at an extraction air flow rate of approximately 25 ft^3/min. Evaluation of the differential pressure monitored in nearby vapor-monitoring wells indicated that the radius of influence (ROI) of the extraction system extended approximately 140 ft horizontally from the extraction interval.

Little change was seen in VOC concentrations or in differential pressures measured below the extraction interval. Fresh air from the surface was drawn down to the high-permeability region of the Qbt stratigraphic layer (starting approximately 120 ft bgs), particularly the Qbt 1vc layer, and then moved laterally through this layer to the extraction borehole. These layers, which coincided with the highest contaminant concentration levels, provided a large percentage of the total extracted flow.

The 1995 SVE pilot study demonstrated that VOC vapors in the tuff beneath MDA L move readily toward an extraction borehole with little or no sorption, making SVE well-suited for plume control and/or remediation (ERM/Golder 1997, 070334). A comparison of the measured data with pretest modeling results also indicated standard numerical and analytical modeling techniques could be used to predict air flow within the subsurface.

In addition to further validating the viability of SVE to remove VOCs from MDA L, the 2006 pilot study was intended to provide design, operational, and cost information necessary for evaluating SVE as a remedial alternative during the CME. The operation and results of the SVE pilot test is detailed in the 2006 summary report of the in situ SVE pilot study at MDA L (LANL 2006, 094152). Following the completion of the second pilot test, a three-dimensional (3-D) site-scale numerical analysis was conducted using SVE pilot test data to determine the effective ROI and to evaluate long-term performance of a full-scale SVE system. The analysis was also conducted to evaluate the impact to the site in the event of a sudden release of VOCs (e.g., the sudden failure of five drums containing TCA) to the vadose zone. The complete results and conclusions of these analyses are provided in “Soil Vapor Extraction Pilot Test at Technical Area 54, Material Disposal Area L: Numerical Modeling in Support of Decision Analysis” (Stauffer et al. 2007, 097871).

The second SVE pilot test was conducted in two extraction boreholes, each installed near the two disposal shaft fields (see Figure 2.5-20). The western-most extraction borehole, SVE-West, was located near Shafts 26–34. The eastern-most extraction borehole, SVE-East, was located near Shafts 1–25. Each borehole was constructed with an open-extraction interval that extended from approximately 65 ft bgs to 215 ft bgs. The extraction intervals correspond to units Qbt 1vu, Qbt 1vc, and Qbt 1g.

A 100 ft^3/min skid-mounted SVE pilot system was used to conduct the extraction tests. Active vapor extraction was conducted at SVE-West for 25 d. The extraction air flow rate varied between 95 and 105 standard cubic feet per minute (scfm), with corresponding vacuums of 53 in.-H_2O and 60 in.- H_2O, respectively. Active vapor extraction was conducted at SVE-East for 22 d. The extraction air flow rate was set to 105 scfm, with a corresponding vacuum of 67 in.-H_2O.

VOC concentrations were monitored in each extraction borehole to evaluate the removal of VOCs from each source area and to provide an estimate of the total VOC mass removed. VOC concentrations and differential pressure were also monitored in pore-gas monitoring boreholes located at varying distances from each extraction borehole to evaluate the SVE system ROI and to assess the overall impact of active extraction on VOC concentrations in the plumes. Contaminated vapor effluent was treated with two epoxy-lined steel canisters plumbed in series, each containing 400 lb of granular active carbon (GAC).

Results of the 2006 SVE pilot study determined that active SVE is a viable technology for removing the VOC vapor plumes at MDA L. TCA concentrations monitored in SVE-West during the extraction test declined from approximately 900 ppmv to less than approximately 150 ppmv. An estimated 330 lb of

TCA and approximately 500 lb of total VOCs were extracted from SVE-West. TCA concentrations monitored in SVE-East during the extraction test declined from approximately 294 ppmv to approximately 157 ppmv. An estimated 175 lb of TCA and approximately 300 lb of total VOCs were extracted from SVE-East.

Results of the 3-D numerical analysis estimated that the effective ROI was approximately 120 ft. The analysis also concluded that an SVE system the same size as that used during the pilot test was capable of removing a significant portion of TCA released to the vadose zone in the event of a sudden failure of five buried drums. Predicted concentrations in the upper 130 ft of the mesa would be reduced by active SVE to prerelease concentrations within 2 to 3 mo of extraction; however, concentrations at depths greater than 130 ft bgs would not be as effectively removed from the mesa because of variability in permeability values. The analyses further concluded that if no action were taken to remediate VOC plumes using SVE, under both a sudden release scenario and long-term slow leaking scenario (e.g., without drum failure), VOC plumes were not likely to reach the regional aquifer at concentrations greater than a few ppmv within the next 100 yr (Stauffer et al. 2007, 097871).

2.5.4 Summary of Pore-Gas Monitoring

Pore-gas monitoring activities have been conducted at MDA L since 1985 to characterize the VOC plume at MDA L. Quarterly pore-gas monitoring began in 1990 after EPA issued Module VIII of the Laboratory's Hazardous Waste Facility Permit, which included requirements for quarterly pore-gas sampling at MDA L as an input to the RFI. The Consent Order further required pore-gas monitoring during the site investigations and submittal of a long-term pore-gas monitoring plan. Currently, pore-gas sampling activities are implemented in accordance with the revised interim subsurface vapor-monitoring plan or vapor-monitoring plan (LANL 2007, 099372), approved with modifications by NMED (2007, 098999); with the revised table of monitoring boreholes submitted to NMED in May 2008 (McInroy 2008, 104475); and with the approved new monitoring borehole 54-610786 (NMED 2009, 107653).

The vapor-monitoring plan for MDA L requires field screening of 187 completed sample ports in 27 vapor-monitoring boreholes and 1 open borehole (NMED 2007, 098999). The vapor-monitoring plan also requires collecting VOC and tritium samples from 85 of the 187 sampling ports within 24 of the 27 completed boreholes and 1 open borehole. Vapor-monitoring boreholes, port depths, and corresponding sampling intervals that were field screened and sampled during the most recently reported monitoring event (second quarter fiscal year 2010, from January 25 to March 3, 2010) are presented in Table 2.5-10. Pore-gas monitoring borehole locations are shown in Figure 2.5-21.

VOC and tritium samples are collected from each stratigraphic unit. Where two or more pore-gas sampling ports are constructed in the same stratigraphic unit, the port closest to the base of the nearest disposal unit is sampled.

Because sampling methods and resulting data quality have changed substantially over the years, pore-gas data before 1997 were not subject to the current quality assurance (QA)/quality control (QC) procedures. Data collected from 1997 to the present have been subjected to rigorous QA/QC procedures.

Results of long-term pore-gas monitoring activities at MDA L have concluded that three VOCs are the primary constituents in the subsurface at MDA L. These constituents include TCA—the predominant VOC detected in pore gas—and TCE and PCE. Ongoing analyses of pore-gas monitoring data indicate two source areas of the subsurface vapor-phase VOC plume: the eastern source area (Shafts 1–28) and the western source area (Shafts 29–34). The nature and extent of the VOC vapor plume is discussed in subsequent sections and in Appendix B.

2.5.5 Summary of Cañada del Buey Investigation

MDA L drains toward Cañada del Buey, and runoff and sediment transported from the site may potentially impact the canyon. MDA L does not drain to the Pajarito Canyon watershed located south of TA-54. The Cañada del Buey investigation, conducted by the Laboratory from 1999 to 2008, addressed sediment, surface water, and shallow perched groundwater potentially impacted by SWMUs and AOCs located within the Cañada del Buey watershed. The revised Cañada del Buey investigation report (LANL 2009, 107497) describes these investigations.

The possible impact of releases from MDA L on sediment was evaluated using data collected from two sediment investigation reaches in the south fork of Cañada del Buey (LANL 2009, 107497). Reach CDBS-1W is located in the south fork upcanyon from MDA L, and reach CDBS-1E is located in the south fork downcanyon from MDA L. The spatial distribution of COPCs suggest minor releases of inorganic chemicals and radionuclides from the vicinity of MDA L. Out of 20 samples, one result for cyanide in reach CDBS-1E was above the sediment BV, and cyanide was not detected above the BV in CDBS-1W. The radionuclides americium-241, plutonium-238, and plutonium-239/240 were also detected above the sediment BVs in reach CDBS-1E but not in CDBS-1W. Sediment data collected from reaches farther downcanyon, including reach CDB-4 immediately above NM 4 and White Rock, indicate no detected off-site transport of contaminants in Cañada del Buey. No persistent surface water flow or shallow alluvial groundwater occurs in Cañada del Buey near or downcanyon from MDA L. In fact, stormwater flow generally occurs less than once a year in this portion of the canyon. Any impacts of COPCs released from MDA L have been restricted to Laboratory land.

2.6 Status of Groundwater Monitoring

The coupled monitoring network for MDA L uses vapor monitoring in the vadose zone near the disposal units along with regional aquifer monitoring to provide a defense-in-depth monitoring approach.

Groundwater monitoring at the Laboratory is currently conducted in accordance with the 2010 Interim Facility-Wide Groundwater Monitoring Plan (IFGMP) (LANL 2010, 109830). The monitoring at TA-54 provides the basis for accurately describing the groundwater conditions beneath TA-54, including MDA L. The monitoring well network at MDA L includes new wells drilled in 2010 that are part of the overall effort to further characterize the groundwater conditions. The groundwater monitoring network for TA-54 includes both perched-intermediate and regional wells (Figure 2.6-1).

At TA-54, groundwater monitoring is being conducted to support both the corrective measures process for SWMUs under the Consent Order and in support of the RCRA permit for operating units within TA-54. The Consent Order (Section IV.A.1) states, “Implementation of the groundwater monitoring requirements of this Consent Order will fulfill the groundwater monitoring requirements of the Hazardous Waste Regulations, 20.4.1.500 4103 NMAC (incorporating 40 C.F.R. Part 264, Subpart F).”

Groundwater characterization for TA-54 is conducted with perched-intermediate well screens at R-40i, R-40 screen 1, R-23i, R-37 screen 1, and R-55i, and 18 regional wells: R-20, R-21, R-22, R-23, R-32, R-37, R-38, R-39, R-40, R-41, R-49, R-51, R-52, R-53, R-54, R-55, R-56, and R-57 (Figure 2.6-1). R-22 is not currently sampled. The actively sampled wells have one or two screens, all of which are equipped with purgeable sampling systems. Table 2.6-1 provides information on the roles of each well in the TA-54 monitoring network specific to MDAs G, H, and L. Wells specific to MDA L include R-20, R-21, R-32, R-38, R-40, R-40i, R-53, R-54, and R-56. Table 2.6-2 shows the monitoring frequency and analyte suites specified for the active screens in these nine wells in the 2010 IFGMP (LANL 2010, 109830). Each screen is also equipped with a dedicated pressure transducer for continuous monitoring of groundwater levels.

Data from the groundwater monitoring network around TA-54 show sporadic detections of a variety of contaminants including, most notably, several VOCs. The temporal and spatial nature of the occurrences do not, however, clearly indicate the presence of a discernable plume or a source related to MDA L or other sources at TA-54 (LANL 2009, 106939). Further evaluation of existing groundwater data for MDA L is included later in this report.

The regional monitoring-well network around MDA L is designed to provide reliable detection of potential contaminants reaching the regional aquifer. The wells are located both upgradient and downgradient of MDA L. The monitoring network includes single-screen (R-38, R-21, and R-32) and two-screen (R-20, R-54, R-53, and R-56) wells. In the two-screen wells, the upper screen is generally set near the water table to monitor the first arrival of contaminants in the aquifer, and the lower screen is placed deeper within permeable aquifer sediments to monitor potential preferential transport pathways at depth and to provide information on potential vertical gradients.

Hydrogeologic data also suggest the screened regional-aquifer zones at the regional monitoring wells near MDA L are either unconfined or partially confined (Table E-3.1-1): for example, R-20 screen 1, R-54 screen 1, R-53 screen 1, R-56 screen 1, and R-32 screen 1. This suggests that the upper well screens and the regional water table are likely hydraulically connected. The barometric pressure responses of the monitoring screens (barometric efficiency less than 100%) demonstrate a connection between the screens and the vadose zone (i.e., the screens are not confined; Table E-3.1-4): for example, R-20 screen 2, R-54 screen 2, R-53 screen 1, and R-32 screen 2. The cross-well hydraulic responses between R-56, R-54, R-53, and R-21 during pumping tests (section E-3.1) demonstrate that the well screens have good hydraulic communication with the aquifer.

Early detection of contaminant migration in the deep vadose zone is provided through vapor monitoring. The vapor-monitoring network at MDA L includes sampling ports located next to the disposal units and in deeper stratigraphic units (i.e., the Otowi Member, the Guaje Pumice Bed, and the Cerros del Rio basalts) that are well-suited to provide early detection of contaminants at concentrations of concern for groundwater contamination. Contaminants above conservative Tier I screening levels (Appendix B) have not been detected in the basalt, and continued monitoring of these ports is recommended.

3.0 SITE CONDITIONS

The following sections summarize the current nature and extent of contamination in surface and subsurface media at MDA L.

3.1 Surface Conditions

The current surface of MDA L is covered with a 4- to 6-in.-thick asphalt pad and structures that are regulated by the Laboratory's Hazardous Waste Permit. The surface structures above the MDA L pit, impoundments, and shafts are shown in Figure 2.0-1 and include the following:

- Dome 215
- Canopy 62
- Pads 35, 36, and 58

3.2 Subsurface Conditions

3.2.1 Subsurface Utilities

The location of subsurface utilities is shown in Figure 3.2-1, and utilities include electricity and communication lines and potable water, fire water, and sewer.

3.2.2 Pit A and Impoundments B, C, and D

Impoundments B, C, and D were sampled in 2007 (LANL 2007, 096409). Results of the previous sampling indicate that the waste in the impoundments would be classified as MLLW if removed. Pit A has not been sampled because it is overlaid by a permitted RCRA hazardous waste storage facility.

3.2.3 Nature and Extent of Vadose Zone Contaminants

A subsurface VOC vapor plume is present in the vadose zone at MDA L. The primary sources of subsurface VOC vapors are the two shaft fields at MDA L, and they appear to be a continuing source of VOC vapors. In addition, vapors are transported predominantly by vapor-phase diffusion throughout the Bandelier Tuff units. In the dry environment present at MDA L, this process is faster than migration in the liquid phase. There is some uncertainty related to the mechanisms that control vapor transport through the fractured and less porous Cerros del Rio. It is uncertain whether vapor transport through the basalt will be uniform or will follow preferential pathways. Both vapor diffusion and advective vapor transport may occur in the basalt (Appendix C).

Appendix B describes the methodology used to screen vapor-phase VOCs detected in the vadose zone. A two-tiered method screening evaluation was developed to identify vapor-phase VOCs that could potentially affect groundwater at concentrations exceeding applicable cleanup standards. The screening method is summarized below.

- For the Tier I method, Henry's law is used to identify the vapor-phase VOC concentration threshold that would have to be exceeded for a given VOC to potentially impact the groundwater at concentrations above applicable groundwater standards. The Tier I screening method is consistent with screening performed in the pore-gas periodic monitoring reports.
- For the Tier II method, the analysis used takes into account the migration of the VOCs and subsequent mixing with groundwater immediately below the site. This migration of VOCs through the vadose zone includes both the soil pore water and vapor phases. The resulting groundwater concentration following mixing is calculated and compared with applicable groundwater standards. If that calculated groundwater concentration exceeds a standard, further evaluation of the soil-vapor data is required to assess the potential impact that the particular VOC may have on groundwater.

The main constituent of the vapor plume is TCA. The nature and extent of this constituent is used to define the plume characteristics, as detailed in Appendix B. Figure 3.2-2 shows the subsurface distribution of TCA for concentrations exceeding 423,000 $\mu g/m^3$ using contour intervals in map and cross-sectional views. These concentrations represent averages of four recent quarters of vapor sampling data from 2009 to 2010 (LANL 2010, 109955). Vapor-phase TCA concentrations indicate the plume extends approximately 750 ft along the mesa and 400 ft across the mesa. The plume has two distinct lobes, with the highest concentrations centered around the two shaft fields, and the concentrations near the eastern shaft field higher than those near the western shaft field. In addition, the plume is located closer to Cañada del Buey than to Pajarito Canyon. Figure 3.2-2 shows that concentrations decrease with depth

and that most of the TCA mass is present in the upper 250 ft of the mesa within the Tshirege Member of the Bandelier Tuff (units Qbt 2, Qbt 1v, and Qbt 1g).

Appendix B provides mass estimates for TCA and TCE of 428 kg and 245 kg, respectively, accounting for both vapor and liquid phases. Of these masses, approximately 100% and 90% of the TCA and TCE, respectively, are located in the Tshirege Member within the 423,000 $\mu g/m^3$ and 20,000 $\mu g/m^3$ contours, respectively. These concentrations represent 10 times the screening values for these constituents, as defined in the pore-gas periodic monitoring reports (e.g., LANL 2010, 109955) and the Tier I screening levels defined in Appendix B. Decreasing concentrations and masses are present in deeper units. For example, in the deepest vapor-monitoring interval at MDA L (approximately 550 to 608 ft bgs in monitoring borehole 54-24399) within the basalt, TCA and TCE concentrations were 2100 $\mu g/m^3$and 850 $\mu g/m^3$, or 0.05 and 0.43 times the Tier I screening values, respectively (LANL 2010, 109955).

Contour plots illustrating the vapor concentrations for the chlorinated solvents 1,2-dichloroethane, 1,2-dichloropropane, methylene chloride, PCE, and TCE are presented in Appendix B (Figures B-3.1-7 and B-3.1-8). Vapor concentrations of these VOCs exceed the Tier II screening levels. With the exception of PCE, the distributions of these constituents closely match that of TCA, with the highest concentrations surrounding the east and west shaft fields and located within the Tshirege Member of the Bandelier Tuff. Also, concentrations near the eastern shaft field are higher than near the western shaft field. The maximum PCE concentrations are located in a small area just south of the impoundments and extend toward the west. This confirms the impoundments are a PCE source, as observed during impoundment sampling (LANL 2007, 096409).

Time trends of concentrations measured at several locations from 1997 to the present for TCA, TCE, PCE, 1,2-dichloroethane, 1,2-dichloropropane, and methylene chloride are shown in Figures B-3.2-1 to B-3.2-6 (Appendix B). Periodic data analyses between 2000 and 2006 indicated the TCA plume at MDA L maintained a near steady-state configuration (section 2.5.2). However, it appears that VOC concentrations in the vapor plume near the two shaft fields declined during the 2006 vapor-extraction test and have not completely rebounded to their pretest levels. This trend is observed for all the constituents at well 54-02002, located just south of the eastern shaft field, which has the most complete sampling record since 1997 (Figure B-3.2-6). Trends are less clear at other locations because the data are sparse and variable, and in some areas, the concentrations appear steady or even slightly increasing. However, a 3-D numerical model of the TCA plume that integrates a current data set indicates that the long-term overall mass of the plume following the 2006 SVE test is less than before the test (Appendix C). The VOC surface flux investigations showed that vapors exit the top and sides of the mesa through unpaved areas. Given that the vapor concentrations are not declining (although they are still depressed because of the SVE pilot test project) and that vapors continually exit the top and sides of the mesa, the wastes located within both the eastern and western shafts are likely generating additional vapors.

A temporal analysis of the data show measured vapor-phase concentrations vary between sampling intervals. As noted in Appendix B (Table B-3.2-1 and Figures B-3.2-2 and B-3.2-6), recent TCA and TCE concentrations following the SVE test at monitoring wells 54-02022 and 54-02002 were noted to be at near-steady levels. The results at these two monitoring wells appear to be randomly distributed around a new median value over time, with variability of approximately 15%–50% about the median value over 10 recent quarters of data (Appendix B). Such variability is common for soil-vapor concentrations. The American Society for Testing and Materials (ASTM) International in its “Standard Guide for Soil Gas Monitoring in the Vadose Zone” notes “soil gas monitoring does not provide repeatable quantitative information over time due primarily to the dynamic nature of phase equilibria in the vadose zone and secondarily to unavoidable inconsistencies in sampling practice” (ASTM 2006, 110404). Therefore, it is

best practice to consider several rounds of pore-gas data rather than individual sampling events when determining plume characteristics or trends.

3.2.4 Nature and Extent of Groundwater Contaminants

Groundwater monitoring at TA-54 provides the basis for accurately describing groundwater conditions beneath TA-54. To evaluate the potential impact of MDA L on the water quality in the regional aquifer, a screening protocol was implemented to evaluate the presence of contaminants in groundwater from wells that comprise the monitoring network for MDA L (Appendix D). The MDA L network wells include the following nine upgradient and downgradient regional wells: R-20, R-21, R-32, R-38, R-40, R-40i, R-53, R-54, and R-56 (Figure 2.6-1). Table D-1.0-1 summarizes well installation and rehabilitation dates and the number of groundwater sampling events at each well as of May 2011. At least four quarters of groundwater data are available for each of these wells, with the single exception of dual-screen well R-56, which was completed in July 2010 and for which three quarters of groundwater data were available as of May 2011.

In Appendix D, validated water-quality data available for the wells as of August 2011 are screened against one-half of the groundwater cleanup level as well as against the Laboratory's groundwater background values (for naturally occurring constituents). A summary of all chemicals detected at these wells relative to these screening levels is presented in Appendix D. Evaluation of these screening results in Appendix D considers factors such as frequency of detection, data for corresponding quality assurance and quality control samples such as field duplicates and blanks, persistence, trends, and relationship to field activities at a well such as redevelopment or installation of a sampling system.

The following constituents exceeded the lowest applicable groundwater standards at least once in water-quality samples collected from one of the monitoring wells near MDA L:

- Inorganic constituents in samples collected from active monitoring wells: nitrate-nitrite (at R-20 screen 1); aluminum (at R-32); antimony (at R-40 screen 1); iron (at R-32, R-40i, and R-54 screen 1); and manganese (at R-40 screen 1, R-40i, and R-54 screen 1)
- Inorganic constituents in samples collected from well screens that subsequently have been plugged and abandoned because of residual effects of drilling products or that have been rehabilitated and converted to purgeable sampling configurations: arsenic (at R-20 screen 3); iron (at R-20 screen 3 and R-32 screen 3); and manganese (at R-20 screens 2 and 3, and R-32 screen 3)
- Organic constituents: benzene (at R-38); 1,4-dioxane (at R-20 screen 2); and bis(2-ethylhexyl)phthalate (at R-32, R-38, and R-54); arsenic (at R-20); iron (at R-20, R-32, and R-54 screen 1)

The conditions under which these exceedances occurred are explained in Appendix D. These exceedances are generally associated with initial characterization sampling at a well (which often yields anomalous chemical results); effects of drilling such as residual products, the presence of reducing conditions in the screened interval; an unreliable analytical method (e.g., for 1,4-dioxane at R-20 screen 2); or a suspect analytical result.

TCE was detected twice above one-half its standard at R-20 screen 2 following well rehabilitation and conversion activities in 2008–2009, but its concentrations declined steadily since then to a value near the method detection limit (MDL) (see Figure D-3.0-1). TCE may be a contaminant at this location; however, analyses presented in Appendixes B and D indicate the probability is low that TCE from MDA L could be present in groundwater in the absence of several other cocontaminants, particularly TCA. In addition,

other Pajarito Canyon sources (such as TA-18) may be potential sources of TCE if the detections at R-20 screen 20 are related to site contamination rather than to drilling or construction products or to rehabilitation and conversion activities or drilling (see section D-4.4). To date, TCA has not been detected in regional wells around MDA L, and TCE has been detected only in R-20 (lower screen 2) and in the first characterization sample collected from R-53 screen 2.

Other VOCS have been detected in the regional wells around MDA L that are also present in the vapor plume beneath MDA L vapor plume. These are acetone, 2-butanone, ethylbenzene, toluene, and xylene isomers. The analysis presented in Appendix D indicates these contaminants are not persistent after the first few rounds of sampling at a well following installation or rehabilitation or, in the case of 1,3-xylene+1,4-xylene, are detected near the MDL (Figures D-3.1-1, D-3.6-1, and D-3.8-1). However, as for TCE, these constituents are not detected with other VOCs that would be expected to be collocated based on the chemical nature and transport properties of VOCs present in the vapor phase beneath MDA L.

Based on the available data, no compelling evidence indicates that the chemical constituents detected in monitoring wells around MDA L are related to those known to be present in the vadose zone beneath MDA L. There is, however, uncertainty related to the transport of vapor-phase constituents toward groundwater through the unsaturated Cerros del Rio basalts, as described in section 3.2.3. In the near term, TA-54 monitoring-network wells, including those specific to MDA L, will continue to be sampled on a quarterly basis, consistent with the 2010 IFGMP (LANL 2010, 109830). It is noted that water-quality sampling of the uppermost screen in R-40 is proposed to be discontinued in the 2011 IFGMP (LANL 2011, 205231) because this perched-intermediate screen is in a low-permeability formation and cannot provide sufficient water to ensure a reliable water-quality sample (Appendix D). Additional monitoring of water levels will enhance the understanding of the relationship between vapor-phase contaminants and observations in groundwater. Any corrective actions taken to limit the potential transport of VOCs toward groundwater will also help to minimize the uncertainty related to this transport pathway.

4.0 CONCEPTUAL SITE MODEL FOR MDA L

A CSM is a representation of site conditions that conveys what is known or suspected about the sources, releases and release mechanisms, contaminant fate and transport, exposure pathways, potential receptors, and risks. CSMs are developed based on analyses and interpretations of existing site knowledge, observations, and data. They describe contaminant sources, release mechanisms (i.e., transport pathways), exposure media, and potential receptors (EPA 1989, 008021, pp. 4-10). The sources, pathways, and receptors applicable to MDA L are shown pictorially in Figure 4.0-1. The MDA L CSMs were used to support risk-based decision-making and as an aid in identifying potential remedial alternatives.

Schematic diagrams of the CSMs that display the release mechanisms from the sources (i.e., the pit, impoundments, and shafts) to potential receptors as well as potential resulting risks are shown in Figures 4.0-2 and 4.0-3, respectively. The CSM diagrams describe whether the exposure pathways are complete under current and future site conditions. For the future scenario, an assumption is made that institutional controls are not maintained, the asphalt is removed, and no remedy is implemented. Current and future risks are also qualitatively evaluated for the purpose of this CME.

4.1 Primary Sources of Contamination

Two primary sources of buried waste are recognized for MDA L: (1) the pit and impoundments and (2) the shafts. These are distinguished because of their different geometry and waste disposal practices, and the effects that these factors have on release mechanisms and potential corrective measures. MDA L was

used for nonradiological liquid chemical waste disposal. All the primary sources have a mixture of inorganic compounds (i.e., metals and metallic salts), organic compounds, and PCBs. A compilation of available disposal records suggests that the overall inventory has more organic than inorganic chemicals by volume (IT Corporation 1992, 023247, pp. 5-110–5-113). For the purposes of this CME report, the CSMs focus on the transport and risks associated with hazardous constituents.

4.2 Primary Release Mechanisms

Five primary release mechanisms are identified for each primary waste source (Figures 4.0-2 and 4.0-3) and include (1) overflows and surface spills to surface soils during waste emplacement, (2) source leaks into subsurface soils, (3) volatilization of VOCs to become soil vapor, (4) excavation, biointrusion, and surface erosion of the waste, and (5) cliff retreat and seismic events that expose waste. Surface soils are defined here as those that extend from the ground surface to 1 ft bgs. Subsurface soils are defined here as unconsolidated subsurface materials and consolidated rock located at depths greater than 1 ft bgs.

Source leaks and volatilization, and future excavation, biointrusion, and erosion of the waste differ somewhat for the two sources, as discussed below. Currently, excavation, biointrusion, and erosion into the waste do not occur because site access is controlled, and the asphalt makes the waste inaccessible. Exposure of the waste from cliff retreat or seismic events is not currently a complete pathway. However, cliff retreat and seismic events are potential release mechanisms that may result in complete pathways in the future.

4.2.1 Pit A and Impoundments B, C, and D

Leaks of uncontainerized liquids into the subsurface soils beneath Pit A and the impoundments likely occurred during and soon after disposal. Core samples collected beneath Impoundments B and C show concentrations above background for chromium, copper, and nickel in unit Qbt 2 to 35 or 40 ft, indicating a release to the tuff (LANL 2006, 091888, Appendix M). Core samples collected below Pit A and Impoundment D do not indicate a clear trend. Because containerized liquids may have been disposed of in Pit A, leaks from containers may still occur.

Volatilization of uncontainerized liquid VOCs into the air at the surface likely occurred during and soon after disposal at Pit A and the impoundments because of the large surface area of these disposal units. This volatilization into the air decreased the inventory for subsequent volatilization into the soil. Volatilization from containers, however, may still occur in Pit A.

After the asphalt is removed, the crushed tuff covering Pit A and the impoundments is subject to future excavation, biointrusion and erosion, which may expose wastes. Exposure by excavation is a function of the volume and depth of waste excavated and will depend largely upon site access. Biointrusion into the waste has the potential to spread contaminants into subsurface or surface soils through (1) adsorption of soluble chemicals by plant roots or (2) movement of wastes by burrowing animals. For plants common to Mesita del Buey, roots are most abundant in the upper 6.6 ft (2 m) but may extend deeper for some bushes and trees (French et al. 2008, 106890). Burrow depths for ants and small mammals are generally less than 3.3 ft (1 m), although a small fraction of burrows extend to depths of 6.6 ft (2 m) (French et al. 2008, 106890). These rooting and burrow depths cited are similar to the estimated crushed tuff thickness that covers the impoundment waste, and biointrusion could potentially bring waste to the surface. Under the future conditions assumed in the CSM, which includes further loss of cover maintenance, deeper-rooted plant communities and larger animal populations may be established.

Erosion is another primary release mechanism that can expose waste. Generally, surface erosion will result in a gradual thinning of the crushed tuff covering the pit, impoundments, and shafts as well as the mesa itself over extended periods of time, and eroded sediments will be transported into the adjacent canyons. However, the quantities and intensities of precipitation falling on the disposal units will determine the generation of surface runoff and, hence, rates and patterns of erosion (Wilson et al. 2005, 092034).

4.2.2 Disposal Shafts

Leaks of uncontainerized liquids into the subsurface soils beneath and next to the disposal shafts most likely occurred during and soon after disposal. Leaks from containers in the shafts may still occur. Data from core samples collected east of the eastern shaft field show concentrations above background for chromium, copper and nickel from approximately 100 to 150 ft in units Qbt 1v and Qbt 1g, indicating a potential release to the tuff from the shafts (LANL 2006, 091888, Appendix M).

Volatilization of uncontainerized liquid VOCs likely occurred predominantly into soil vapor during and soon after disposal in the shafts. Volatilization from containers is believed to still occur in the shafts because soil-vapor concentrations remain elevated. The mechanism for this ongoing source of VOCs is unknown, but may be from poor sealing or slow degradation of the drums.

After the asphalt is removed, the shafts are subject to future excavation, biointrusion, and erosion. However, the 3-ft concrete plugs that cover the shafts provide more protection from these processes than does the crushed tuff that covers the pit and impoundments.

4.3 Secondary Sources of Contamination

Three secondary sources are generated directly from primary release mechanisms (Figures 4.0-2 and 4.0-3). These are surface soils, subsurface soils, and soil vapor. Migration of contaminants between surface soils and subsurface soils can occur through biointrusion and volatilization (via upward and downward movement through the soil column) and infiltration and percolation of water (via downward movement only). Excavation and erosion can also promote migration of contaminants between subsurface soils and surface soils.

4.4 Secondary Release Mechanisms

Several secondary release mechanisms can further spread contaminants from secondary sources toward potential receptors (Figures 4.0-2 and 4.0-3). For surface soils, these mechanisms are (1) stormwater runoff and erosion, (2) volatilization and vapor diffusion of VOCs, (3) inadvertent excavation, (4) biointrusion, and (5) wind. For subsurface soils, the secondary release mechanisms are (1) leaching by percolating water, (2) volatilization/vapor diffusion of VOCs, (3) inadvertent excavation, and (4) biointrusion. For soil vapor, the secondary release mechanism is vapor transport, consisting predominantly of vapor diffusion through the tuff units and a combination of vapor diffusion and advection in the basalt.

Stormwater runoff, erosion, excavation, and biointrusion promote migration for contaminants mixed with surface and subsurface soils, much like that for the waste materials described in section 4.2.1.

Leaching of contaminants from the disposal units and downward migration by percolating water will continue at a slow rate based on the build-up of moisture beneath the asphalt pad. This rate is expected to be up to 10 mm/yr, as described in section 2.2.4. Travel times from the leaching of dissolved-phase,

nonsorbing species (such as general inorganic anions and nonvolatile organic compounds) from the source areas to the regional aquifer in excess of several hundred years are predicted under this scenario (Birdsell et al. 2005, 092048). When the asphalt is removed and especially if plants become established at the site, leaching and percolation rates will decrease further and travel times for dissolved constituents to the aquifer will be longer. Both vadose zone and regional groundwater data indicate this release mechanism to groundwater is currently incomplete for both inorganic and organic chemicals.

Volatilization and vapor diffusion of VOCs can occur in both surface soils and in subsurface soils with subsequent migration in soil vapor. VOCs in liquid waste or in pore water volatilize to form soil vapor as determined by Henry's law partitioning. Vapor-phase diffusion is a relatively rapid process, which under existing conditions (low infiltration rates) is faster than unsaturated water flow and accounts for the observed migration to depth of VOCs in soil vapor within the Bandelier Tuff (Stauffer et al. 2005, 090537).

Topography is an important control on vapor transport at MDA L. With low contaminant concentrations in the air phase along the top and sides of the mesas, the steepest concentration gradients are toward the surface, which leads to preferential VOC transport toward the external mesa boundaries and yields releases of VOCs to the atmosphere, as observed from the surface flux survey conducted at the site (section 2.5.1). Shallow vapor-phase contaminants will tend to diffuse out at the surface, while deeper vapor-phase contaminants may diffuse deeper. In paved areas, asphalt decreases this mechanism somewhat because it blocks the diffusive transport of VOC vapors from exiting at the surface (Stauffer et al. 2005, 090537). Diffusive gradients may also spread vapor-phase contaminants downward toward the regional aquifer. Although uniform diffusive contaminant migration is observed in the high porosity tuff, it is uncertain whether or not diffusion through the low-porosity, fractured Cerros del Rio basalt is uniform or not (Appendix C). In addition, air flow within the basalt may contribute to migration of vapor-phase VOCs.

4.4.1 Pit A and Impoundments B, C and D

Vapor-phase VOCs originating from the pit and impoundments are likely located relatively shallow and will tend to diffuse preferentially to air rather than toward groundwater. The pore-gas data presented in Appendix B show lower concentrations near the impoundments than near the shaft fields for most contaminants. A shallow detection of PCE may be associated with the impoundments based on vapor data collected south of Impoundment D (Appendix B) and characterization of the impoundment waste (section 2.5.2; LANL 2007, 096409). After the asphalt is removed, the diffusion rate to air at the surface is expected to increase.

4.4.2 Disposal Shafts

Vapor-phase VOCs originating from the shafts are spread in the vadose zone from the surface to depths of approximately 300 ft (Appendix B). The surface flux measurements clearly showed releases from the shafts to the surface (Figure 2.5-8; Trujillo et al. 1998, 058242). In addition, pore-gas data indicate VOC plumes to 300 ft bgs centered around the shafts (Appendix B). Vapor-phase diffusion from the shafts currently impacts air at the surface and will impact air into the future. Vapor-phase transport may potentially impact groundwater in the future, but the future impact to regional groundwater is not known because of uncertainty related to vapor transport through the basalt.

4.5 Exposure Media

Contact with contaminated environmental media creates exposure pathways for both human and ecological receptors. Seven potential exposure media are identified for the site (1) sediment, (2) surface water, (3) air, (4) soil, (5) dust, (6) groundwater, and (7) waste (Figures 4.0-2 and 4.0-3).

4.6 Receptors and Risks

Three potential receptors are identified: (1) humans, (2) ecological receptors, and (3) groundwater. Groundwater is an exposure medium because it is used by both human and ecological receptors. Groundwater is also included in the CSM as a receptor because it is a resource. Human and ecological receptors may be exposed to potentially contaminated media if pathways become complete through exposure routes such as inhalation, ingestion, or dermal contact. The air pathway from surface soils includes releases both to outside air and for vapor intrusion into buildings. Risks to human health and the environment may occur if elevated concentrations of contaminants are present in the exposure media.

Both current and future risks are qualitatively evaluated below (Figures 4.0-2 and 4.0-3). The future risk scenario includes removing the existing asphalt pavement that covers the disposal units and the loss of institutional controls.

4.6.1 Pit A and Impoundments B, C, and D

Under current conditions, three transport pathways are considered to be either potentially complete or complete (Figure 4.0-2).

- The erosion of surface soil/sediment and stormwater runoff pathways are complete. Although the asphalt-covered area should not be affected by these processes, areas next to the asphalt may have contaminated surface soils that are subject to sediment and stormwater transport. However, based on field sampling, the current risk from these pathways is very low.
- The air pathway (volatilization/vapor diffusion) is complete for VOCs. However, based on the low vapor fluxes emitted at the surface (Figure 2.5-8; Trujillo et al. 1998, 058242) and the results of indoor air monitoring performed at the site (section 2.5.2; LANL 2005 092591), the risk from exposure, including vapor intrusion into buildings, is very low.
- The vapor transport pathway to the groundwater resource is potentially complete, but the current risk to the groundwater resource is considered to be very low. There is uncertainty related to vapor transport mechanisms through the Cerros del Rio basalt to groundwater. Very low VOC concentrations, well below the Tier I screening levels (Appendix B), are present in vapor samples collected in the basalt. In addition, the groundwater data do not clearly indicate a release of VOCs from MDA L to the groundwater (Appendix D).

All other pathways are currently considered incomplete. The excavation and biointrusion pathways for the surface and subsurface soils and for the waste are currently incomplete because of site controls and asphalt cover. The wind pathway for surface soils is currently incomplete because of the asphalt cover. The vapor transport pathway to a groundwater receptor is currently incomplete because no water-supply wells directly tap into groundwater located directly beneath MDA L. Leaching to groundwater is not considered complete because of the expected long travel times. Currently no waste is exposed through cliff retreat or seismic events (Birdsell et al. 2005, 092048).

Under future conditions, the transport processes have longer to develop and pathways may become complete. For the CSM, RCRA closure activities (including removal of the asphalt cover) are assumed to

be finished, and institutional controls are assumed to cease. These changes impact the following pathways and exposure scenarios (Figure 4.0-2). Most risks are for human health and ecological receptors unless groundwater is specified.

- Stormwater runoff and erosion remain complete. In the future, sediment and surface water concentrations may increase after the asphalt cover is removed, resulting in a low future risk from exposure.
- The air pathway (volatilization/vapor diffusion) remains complete for VOCs. In the future, air concentrations may increase after the asphalt cover is removed, resulting in a low future risk from exposure. However, D&D of all structures during preclosure will eliminate potential future vapor intrusion into buildings.
- Erosion, excavation, and biointrusion may result in potentially complete pathways in the future. Surface soils are expected to be clean following RCRA closure of the aboveground CSU, resulting in very low risk from exposure that may increase to medium risk in time as these processes mix surface and subsurface soils. Direct contact with subsurface soils brought to the surface through erosion, excavation, or biointrusion will yield higher concentrations and may result in a medium risk from exposure. If these processes directly expose wastes, a medium risk from exposure could result.
- Wind is considered to be a potentially complete future pathway for exposure to dust. The future risk of this pathway is considered to be very low because sediment concentrations are low (section 2.5.2) and surface soils are expected to be clean following RCRA closure.
- Leaching of water soluble contaminants from subsurface soils to groundwater is considered to be a potentially complete future pathway. However, completion of the leaching pathway is expected to occur over a long time frame (e.g., several hundred to several thousand years [Birdsell et al. 2005, 092048]) because of low infiltration rates across the mesa top, the distance to groundwater, and the water soluble contaminants (such as metals) that strongly adsorb to subsurface soils and rocks. This pathway results in a very low risk from exposure.
- The vapor transport pathways throughout the vadose zone to groundwater will continue to be potentially complete. There is uncertainty related to long-term vapor transport through the basalt; thus, VOCs could potentially impact groundwater in the future. The potential risks to the groundwater resource are considered to be very low to medium because measured vapor-phase concentrations of PCE exceed the Laboratory-proposed Tier II screening value (Appendix B) very near the ground surface, and the impoundments may be the source.
- The future human health and ecological receptor risks from exposure to contaminated groundwater (from vapor-phase transport of contaminants from the impoundments to groundwater) are considered to be very low. The groundwater exposure location for receptors is not likely to occur within the bounds of MDA L. Therefore, the concentrations of any contaminants reaching groundwater in the future will decrease because of dilution, dispersion, and attenuation before contaminants reach a groundwater well. It is unlikely that groundwater would be extracted from a location having significant VOC concentrations.
- Exposure to waste from cliff retreat and seismic activities may result in a potentially complete pathway. However, cliff retreat along Cañada del Buey will occur over a long time frame (e.g., several hundred to thousands of years [see sections E-2.2 and E-2.3]), resulting in a very low risk from exposure.

4.6.2 Disposal Shafts

Under current conditions, a few transport pathways are considered to be complete or potentially complete (Figure 4.0-3).

- Erosion of surface soil/sediment and stormwater runoff pathways are complete. Although the asphalt-covered area should not be affected by these processes, areas next to the asphalt may have contaminated surface soils that are subject to sediment and stormwater transport. However, based on field sampling, the current risk from these pathways is very low.
- The air pathway (volatilization/vapor diffusion) is complete for VOCs. However, based on the low vapor fluxes emitted at the surface (Figure 2.5-8; Trujillo et al. 1998, 058242) and the results of indoor air monitoring performed at the site (section 2.5.2; LANL 2005, 092591), the risk from exposure is very low.
- The vapor transport pathway to the groundwater resource is potentially complete, but the current risk to the groundwater resource is considered to be very low. There is uncertainty related to vapor transport mechanisms through the Cerros del Rio basalt to groundwater. Very low VOC concentrations, well below the Tier I screening levels (Appendix B), are present in vapor samples collected in the basalt. In addition, the groundwater data do not clearly indicate a release of VOCs from MDA L to the groundwater (Appendix D).

All other pathways are currently considered incomplete as described under the current conditions in section 4.6.1.

Under future conditions, the transport processes have longer to develop and pathways may become complete. For the CSM, RCRA closure activities (including removal of the asphalt cover) are assumed to be complete, and institutional controls are assumed to cease. These changes impact the following pathways and exposure scenarios (Figure 4.0-3). Most risks are for human health and ecological receptors unless groundwater is specified.

- Stormwater runoff and erosion remain complete. In the future, sediment and surface water concentrations may increase after the asphalt cover is removed, resulting in a low future risk from exposure.
- The air pathway remains complete for VOCs. Air concentrations in the future may increase after the asphalt cover at MDA L is removed, resulting in a future low risk from exposure. D&D of all structures during preclosure of MDA L (section 1.0) will limit potential for vapor intrusion into buildings.
- Erosion, excavation, and biointrusion may result in potentially complete future exposure pathways. Direct contact with subsurface soils brought to the surface through excavation or biointrusion will yield higher concentrations and may result in a medium risk from exposure. If these processes directly expose wastes, a medium risk from exposure could result. The assumed future medium exposure risk is based on uncertainty related to the inventory and concentrations of hazardous constituents in the waste.
- Wind is considered to be a potentially complete future pathway for exposure to dust. The future risk of this pathway is very low because sediment concentrations are low (section 2.5.2), and surface soils are expected to be clean following RCRA closure.
- Leaching of water-soluble contaminants from subsurface soils to groundwater is considered to be a potentially complete future pathway. However, completion of the leaching pathway is expected to occur over a long time frame (e.g., several hundred to several thousand years (Birdsell et al.

2005, 092048) because of infiltration rates across the mesa top and the distance to groundwater and because many of the water-soluble contaminants (such as metals) strongly adsorb to subsurface soils and rocks. This pathway results in a very low future risk from exposure.

- The vapor-transport pathways to groundwater will potentially become complete. There is uncertainty related to long-term vapor transport through the basalt; thus, VOCs could potentially impact groundwater in the future. The potential future risks to the groundwater resource are considered to be medium because measured vapor-phase concentrations of several VOCs surrounding the shaft fields and in the vadose zone below the shaft fields exceed the Laboratory-proposed Tier II screening values (Appendix B).
- The future human health and ecological receptor risks from exposure to contaminated groundwater are considered to be very low. The groundwater exposure location for receptors is not likely to occur within the bounds of Area L. Therefore, the concentrations of any contaminants reaching groundwater in the future will decrease because of dilution, dispersion, and attenuation before contaminants reach a groundwater well. It is unlikely that groundwater would be extracted from a location having significant VOC concentrations.
- Exposure of waste from cliff retreat and seismic activities may result in a potentially complete pathway. However, cliff retreat along Cañada del Buey will occur over a long time frame (e.g., several hundred to several thousand years), resulting in a very low future risk from exposure (sections E-2.2 and E-2.3).

4.7 Remedial Action Objectives

The remedial action objectives (RAOs) address exposure pathways with the potential for medium risk from exposure. Based on the CSMs, the RAOs for MDA L are as follows:

- prevent human and ecological exposure to the waste through excavation, biointrusion, and erosion
- prevent human and ecological exposure to the contaminated surface soils and/or subsurface soils through excavation and biointrusion
- prevent groundwater from being impacted above a regulatory standard by the transport of VOCs through soil vapor

A final RAO is defined to address uncertainty related to potential leachate production from the unlined pit, impoundments, and shafts at MDA L. If excess water accumulates in the units, contaminated leachate may be generated and transport downward from the site. Although water accumulation has not been observed, it is an undesired condition that warrants long-term prevention.

- prevent the creation of contaminated leachate by restricting the infiltration of water into the waste

5.0 CORRECTIVE ACTIONS AND CLOSURE REQUIREMENTS

5.1 Media Cleanup Standards

The cleanup and screening levels described in Section VIII of the Consent Order were followed to determine the recommended corrective measures alternative (Table 5.1-1). Cleanup levels are based on the New Mexico Water Quality Control Commission's (NMWQCC's) groundwater and surface water standards and NMED's cleanup levels for protection of human health and are consistent with the EPA's National Oil and Hazardous Substance Pollution Contingency Plan, 40 CFR Section 300.430(e)(2)(i)(A)(*2*).

NMED selected a human health target risk level of 10^{-5} and a hazard index (HI) of 1.0 for establishing site-specific cleanup levels for one or more contaminants for which toxicological data are published. NMED and the EPA have soil screening levels (SSLs) and maximum contaminant levels (MCLs), and the NMWQCC has adopted groundwater and surface water standards described below.

5.1.1 Soil

For residential and industrial land use, NMED specified SSLs that are based on a target total excess cancer risk of 10^{-5} and for noncarcinogenic contaminants a target HI of 1.0. Residential and industrial SSLs are from NMED's "Technical Background Document for Development of Soil Screening Levels, Revision 5.0" (NMED 2009, 108070). If an NMED SSL has not been established for a contaminant for which toxicological information is published (NMED 2009, 108070), the Laboratory uses the most recent version of the EPA Region 6 human health medium-specific screening level for residential and industrial soil.

These SSLs will be used as cleanup levels as specified in the Section VIII.B.1 of the Consent Order if an excavation alternative is selected.

5.1.2 Groundwater

The corrective measures alternative chosen will be required to meet the groundwater-quality standards given in Section VIII.A of the Consent Order. These standards include the NMWQCC groundwater standards, including alternative abatement standards (20.6.2.4103 New Mexico Administrative Code [NMAC]), drinking water MCLs adopted by EPA under the federal Safe Drinking Water Act (42 U.S. Code Sections 300f to 300j-26) or the Environmental Improvement Board (20.7.10 NMAC). If both a NMWQCC standard and an MCL have been established for an individual substance, then the lower of the two levels is considered the cleanup level for that substance.

If no MCL or NMWQCC standard is available, the Laboratory will use EPA regional tap water screening levels (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm), adjusted to 10^{-5} risk for carcinogens and/or an HI of 1.0 for noncarcinogens as the basis for proposing a cleanup level for the contaminant. If the naturally occurring (background) concentration of a contaminant exceeds the standard, then the cleanup goal defaults to the background concentration for that specific contaminant.

5.1.3 Surface Water

No permanent surface water is present at MDA L, and MDA L does not have discharges of pollutants to surface water subject to a permit under Section 402 of the federal Clean Water Act. Therefore, the surface-water cleanup levels contained in Section VIII.C of the Consent Order are not applicable to corrective measures at MDA L.

5.1.4 Pore Gas

The Consent Order does not specifically address cleanup standards, screening levels, or other regulatory criteria for soil vapor. The Laboratory therefore recommends a two-tiered approach to screen vapor-phase VOCs detected in the vadose zone. A screening method that compares vapor-phase concentrations with screening values is presented in the periodic monitoring reports for vapor-sampling activities at the Laboratory (e.g., LANL 2010, 109955) and is discussed below as a Tier I screening evaluation. Because several VOCs exceed the screening value at MDA L, a two-tiered method is applied

to identify vapor-phase VOCs and vadose zone pore-gas concentrations that could potentially affect groundwater at concentrations exceeding applicable cleanup levels (Figure B-1.0-1).

The screening process uses all data from a select period of record and is initially inclusive of constituents with low frequency of detection or other variables that are considered later in the screening process as part of an uncertainty analysis. The screening approach is described in Appendix B using recently reported soil-vapor monitoring data from MDA L. The Tier I methodology is extremely conservative and does not consider dilution or attenuation. If Tier I screening levels are not exceeded, then VOCs would not be able to contaminate groundwater above cleanup levels, and no further evaluation is necessary. If Tier I screening levels are exceeded, then a less conservative but more realistic approach using the Tier II method is performed.

- For the Tier I method, Henry's law is used to identify the vapor-phase VOC concentration threshold that would have to be exceeded for a given VOC to potentially impact the groundwater at concentrations above applicable groundwater standards. The Tier I screening method is consistent with screening performed in the pore-gas periodic monitoring reports.
- For the Tier II method, the analysis used takes into account the migration of the VOCs and subsequent mixing with groundwater immediately below the site. This migration of VOCs through the vadose zone includes both the soil pore water and vapor phases. The resulting groundwater concentration following mixing is calculated and compared with applicable groundwater standards. If that calculated groundwater concentration exceeds a standard, further evaluation of the soil-vapor data is required to assess the potential impact that the particular VOC may have on groundwater.

5.2 Hazardous Waste Regulations

The active CSU at MDA L is subject to closure under the Hazardous Waste Facility Permit. The Closure Plan for this unit is included in Attachment G, specifically, G.15, of the Hazardous Waste Facility Permit.

As discussed previously, surface Impoundments B and D and 22 disposal shafts at MDA L accepted hazardous wastes after July 26, 1982. These "regulated units" have been incorporated into this CME under the "alternative requirements" provision in 40 CFR 264.110(c).

Upon NMED's issuance of a Statement of Basis outlining its selected remedy for MDA L, the Laboratory will prepare and submit a CMI plan. Because the regulated units at MDA L are undergoing corrective action under the Consent Order rather than closure under the Hazardous Waste Facility Permit, it is not necessary to obtain a post-closure permit for these units (63 Federal Regulations 56715). The implementation of any controls in the CMI plan, including long-term monitoring and maintenance, will be managed under the Hazardous Waste Facility Permit (Sections III.W.1 and III.W.3.b of the Consent Order).

5.3 Consent Order CME Requirements

The purpose of the CME is to identify and evaluate potential remedial alternatives for MDA L. This CME focuses on realistic remedies, is tailored to this site, and is consistent with expected future land uses. Consent Order–specified evaluation criteria were used in this report to select the recommended corrective measures alternative for MDA L subsurface units based on evaluation of specific site conditions, including the contaminant inventory, the design of the disposal units, the environmental setting, and the nature and extent of contamination. Sections VII.D.4.a and VII.D.4.b of the Consent Order provide threshold and balancing criteria for screening and evaluation of prospective corrective

measures, respectively. These criteria are listed in sections 5.3.1 and 5.3.2. Figure 5.3-1 presents a flow chart of the selection process used to determine the recommended corrective measures alternative.

5.3.1 Threshold Criteria

All alternatives were screened based on the threshold criteria described in Section VII.D.4.a of the Consent Order. The alternative selected must meet the following criteria:

1. be protective of human health and the environment;
2. attain media cleanup standards;
3. control the source or sources of any release so as to reduce or eliminate, to the extent practicable, further releases of contaminants that may pose a threat to human health and the environment; and
4. comply with applicable standards for management of wastes.

5.3.2 Remedial Alternative Evaluation Criteria (Balancing Criteria)

Section VII.D.4.b of the Consent Order identifies five evaluation criteria (also known as balancing criteria) against which each alternative shall be evaluated in proposing a recommended alternative. The balancing criteria are as follows:

1. long-term reliability and effectiveness;
2. reduction of toxicity, mobility, or volume;
3. short-term effectiveness;
4. implementability; and
5. cost.

The justification for the recommended corrective measures alternative includes the supporting rationale based on the factors listed in sections 7 and 8 as well as a discussion of short- and long-term objectives for the site and the benefits and possible risks of the recommended alternative.

6.0 IDENTIFICATION OF TREATMENT TECHNOLOGIES

Section 6.1 describes the process used to identify treatment technologies, and section 6.2 screens treatment technologies applicable at MDA L. The technologies retained in section 6.2 are summarized in section 6.3 and carried forward to section 7 for inclusion into corrective measures alternatives.

6.1 Classification of Treatment Technologies

General types of corrective measures technologies potentially applicable to MDA L site conditions and waste types were selected from the comprehensive technology list developed by the Federal Remediation Technologies Roundtable (FRTR 2009, 104730, Table B-1), available at http://www.frtr.gov/matrix2/appd_b/append_b.html.

For wastes disposed at MDA L, potentially appropriate technologies fall into the four general categories listed below:

- containment
- in situ treatment
- excavation/retrieval
- ex situ treatment

Within the containment category, the subcategories evaluated are vertical barriers, deep and near surface horizontal barriers, and surface barriers. Within the treatment categories, the subcategories include biological, chemical, physical, and thermal treatment. The excavation/retrieval technology will require either on-site waste disposal, off-site waste disposal, or ex situ treatment.

6.2 Screening of Technologies

Corrective action guidance from EPA (1994, 095975, p. 58) and DOE (1993, 073487, pp. 4-51-4-52) require screening of potential corrective measures technologies to eliminate those that prove impractical to implement, that rely on technologies not likely to perform satisfactorily or reliably, or that do not achieve the corrective action objectives within a reasonable time frame. When technologies provide similar benefits, cost is often also used as a screening tool.

For the MDA L CME, the screening of technologies included the following:

- review of site setting and characterization data and the CSM to identify conditions that may limit or promote the use of certain technologies;
- identification of the waste characteristics that limit the effectiveness or feasibility of technologies; and
- identification of the level of technology development, performance record and inherent construction, and O&M requirement for each technology considered.

6.2.1 Containment Technologies

Containment technologies are intended to limit migration of contaminants or limit infiltration into the vadose zone. Such technologies may include surface and subsurface barriers, and various orientations and compositions of barriers may be used. The general functionality and potential applicability of each containment technology considered at MDA L are discussed below.

6.2.1.1 Vertical Barriers

Vertical barrier technologies, such as grout curtains, synthetic membranes, and reactive barriers, were considered of limited benefit for MDA L applications because the absence of near-surface groundwater at the site already limits lateral migration of most contaminants. Limiting the lateral component of vapor-phase transport of a limited number of volatile contaminants at the site is one potential application for vertical barriers at MDA L. However, this technology has been demonstrated primarily with shallow groundwater contamination, and its applicability for vapor-phase contamination is unproven.

Vertical barrier technologies were not retained.

6.2.1.2 Deep Subsurface Horizontal Barriers

The purpose of a deep subsurface horizontal barrier, such as forced grout injection, is to contain downward aqueous-phase contaminant transport, and the technology is generally suitable for sites with known aqueous-phase releases and/or climates with significant infiltration from the surface. Bottom barriers are horizontal subsurface barriers (i.e., underground barriers that run parallel to the surface) that prevent vertical liquid migration by providing a floor of impermeable materials beneath the waste. Groundwater monitoring data have not demonstrated that aqueous-phase liquids are being released.

Deep subsurface horizontal barrier technologies were not retained.

6.2.1.3 Near-Surface Horizontal Barriers

Near-surface horizontal barriers created by a soil-grout mixture or vitrification could potentially provide protection from exposure by controlling intrusion into the waste by plants, animals, or people. Additionally, these barriers could limit the transport of contaminants by reducing infiltration of water through the waste. However, these technologies do not provide water storage. Rainfall that does not infiltrate may migrate to the edge of the treated area, potentially creating a focused area of recharge and increasing infiltration in those areas.

Near-surface horizontal-barrier technologies were not retained.

6.2.1.4 Surface Barriers

Barriers placed on the surface of disposal sites may provide exposure protection, restrict infiltration of water, provide resistance to water and wind erosion, prevent or minimize intrusion into wastes by plants or animals, act as a deterrent to inadvertent human intrusion, and limit flux of gas-phase contaminants. Surface barriers can allow MDA L to meet the threshold criteria for protecting human health and the environment.

Surface barriers would likely be drawn from the following readily available technologies.

Asphalt Cover

Asphalt provides protection from contaminated soils and waste as well as a substantial barrier to surface erosion processes but has been shown at another Laboratory site, MDA AB Area 2 at TA-49 (LANL 1999, 063918, p. 22), to trap moisture that would otherwise be evaporated or transpired from the subsurface. Such trapped moisture could induce downward transport of dissolved contaminants toward groundwater. Because maintaining low moisture content is a desirable feature for MDA L, an asphalt cover is not suitable for this site.

Asphalt cover technology was not retained.

Concrete Cap

A concrete cap consists of a single layer of concrete that provides protection from contaminated soils and waste. However, as with the asphalt cover, moisture trapped under the cap is of concern. Such trapped moisture could induce downward transport of dissolved contaminants toward groundwater. Additionally, because of the size of the cap required to cover the pit/impoundments and shafts, the potential exists for significant cracking, thus limiting the cap's effectiveness.

Concrete cap technology was not retained.

Soil Barrier

A soil barrier consists of adding soil and planting vegetation over the disposal unit to provide an exposure barrier to contaminated soils and waste. The soil barrier is not equivalent to a store-and-release type of cover and only protects against erosion and inadvertent access. A soil barrier, unlike an ET cover, does not restrict infiltration of water and is therefore not applicable to MDA L.

Soil-barrier technology was not retained.

Biointrusion Barriers

Various materials have been used as biointrusion barriers to control the intrusion of plants and animals into hazardous waste landfills. Installation of horizontal barriers constructed of angular cobbles, 4 to 6 in. in diameter with an overlying filter layer composed of sand and gravel, inhibits deep-rooting plants and discourages burrowing animals. The filter layer is designed to prevent fine soils in the overlying cover soil from migrating into the barrier. Results of an animal intrusion experiment conducted at the Laboratory using pocket gophers demonstrated that cobbles and cobbles with gravel effectively prevented animal intrusion. The weight and size of the cobbles prevented these animals from burrowing below the barrier. Cobbles were also effective in limiting root intrusion because the spaces between the cobbles are relatively free of soil and water (Nyhan 1989, 006876).

Chain-link fencing laid on the surface of a cover has been used successfully at a Laboratory site to discourage burrowing animals while having no observable impact on beneficial vegetation (LANL 1999, 063919).

As a standalone technology, a biointrusion barrier does not restrict infiltration of water and was not retained. However, biointrusion barriers can be incorporated into enhanced cover designs considered for MDA L.

Compacted Clay Cover

Compacted clay covers have successfully controlled excess infiltration at RCRA-regulated landfills. However, clay liners are far less effective in arid and semiarid climates than more humid environments because the clay tends to dry out and crack, allowing moisture to flow directly into disposal units (Mulder and Haven 1995, 071297, p. 7). As a standalone technology, compacted clay covers are not suitable for MDA L. However, compacted clay layers can be incorporated into multilayer cover designs considered for MDA L.

Compacted clay cover technology was not retained.

Multilayer Cover (RCRA Cover)

This technology was evaluated even though the regulated units at MDA L are being addressed under the Consent Order using alternative requirements.

Multilayer covers consist of different geologic and synthetic materials layered in a specific order to control various potentially detrimental processes and conditions (e.g., infiltration, erosion, and biointrusion). RCRA Subtitle C covers belong within this category. A standard RCRA Subtitle C cover includes the following: a surface vegetation layer, a sand drainage layer, a flexible

geomembrane, and a base layer of compacted soil (typically clay) to meet hydraulic conductivity limits. The geomembrane is a thin impermeable barrier of synthetic material that offers very little structural capacity. Multilayer covers can be compromised if any of their components are not suited for the site.

Los Alamos's arid climate is considered potentially incompatible with the typical clay layer of the RCRA Subtitle C multilayer cover. Clay components are far less effective in arid to semiarid climates because the clay tends to dry out and crack, allowing moisture to flow directly into the disposal unit (Mulder and Haven 1995, 071297, p. 7). While there are long-term concerns associated with desiccation of the clay layer, the geomembrane may provide protection against infiltration of water should the clay layer crack.

The multilayer cover technology was retained.

ET Cover

The ET cover concept relies on the soil to act as a "sponge" until infiltrated water can be removed via ET (Dwyer et al. 2000, 069673). Generally, ET is defined as the combination of water removed by evaporation from the surface and transpiration through vegetation. ET covers are designed to provide infiltration protection for arid and semiarid environments, where materials such as clays and synthetic/geosynthetic membranes are less reliable. ET covers may consist of multiple layers of geologic materials suited to achieve the ET criteria. Suitable vegetation is a significant component for most ET covers to aid in the dewatering of the cover material(s). The vegetated ET cover was developed specifically for landfills located in arid and semiarid environments such as Los Alamos (Barnes et al. 1990, 070209, pp. 1201–1202). The earliest research on ET covers was conducted by the Laboratory at a test site within 1 mi of MDA L (Nyhan et al. 1984, 008797; Nyhan 1989, 006876; Nyhan et al. 1989, 006874).

The Los Alamos climate's demand for water or potential ET far exceeds annual precipitation (Figure 2.2-3). The ET cover also provides a medium for native vegetation.

Therefore, ET cover technology was retained.

6.2.2 In Situ Treatment Technologies

In situ waste treatment technologies are used to reduce the mobility and/or toxicity of wastes or to increase their stability without removing the wastes from their disposal location. In situ treatment generally requires longer time periods than other types of waste treatment, and there is less certainty about the uniformity of treatment because of the variability in soil and aquifer characteristics and because the effectiveness of the process is more difficult to verify. Different in situ methods (biological, chemical, physical, and thermal) are appropriate for different contaminants and disposal environments.

6.2.2.1 Natural Attenuation

Natural attenuation uses natural subsurface processes to reduce contaminant concentrations to acceptable levels. The natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil, soil vapor, or groundwater. These in situ processes include adsorption, biodegradation, dispersion, dilution, sorption, volatilization, radioactive decay, chemical reactions, and chemical or biological stabilization.

Consideration of the natural attenuation technology requires evaluation of contaminant degradation rates and products, as well as concentrations at potential downgradient receptor points. The primary objective is demonstrating that natural processes of contaminant degradation will reduce contaminant concentrations below regulatory standards or risk-based levels before potential exposure pathways are completed. In addition, long-term monitoring is conducted to measure degradation rates to evaluate compliance with cleanup objectives. Commonly targeted contaminants for natural attenuation include halogenated VOCs, SVOCs, and fuel hydrocarbons. This technology may also be applicable to the VOCs in the vadose zone. However, the vapor plume at MDA L exceeds the Tier II screening limit, indicating an active technology is preferred to reduce the uncertainty associated with natural attenuation processes.

Natural attenuation technology was not retained.

6.2.2.2 Biological Treatment Technologies

Biological methods using various microorganisms or vegetation have been effective in metabolizing a variety of organic contaminants and also in changing the solubility of certain inorganic chemical and radioactive species in low concentrations during the wastewater treatment processes. Potential in situ biological treatment technologies, including bioventing, enhanced bioremediation, and phytoremediation, provide limited benefit because of the dry soils present at MDA L. Biological treatment is also less viable for many chlorine-containing organic chemicals and may lead to more toxic byproducts than the original contaminant, such as TCE to vinyl chloride.

Biological treatment technologies were not retained.

6.2.2.3 Chemical Treatment Technologies

Chemical treatment, such as chemical oxidation or soil flushing, uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert), separate, or contain the contamination.

These technologies were not considered potentially applicable to the MDA L site because of difficulties in delivering the reactive chemicals uniformly to the soil. Incorporating large quantities of hazardous oxidizing materials or extraction fluids poses additional concerns for workers and possibly the environment.

Chemical treatment technologies were not retained.

6.2.2.4 Physical Treatment Technologies

In situ physical treatment technologies are a diverse group of technologies that include methods to remove mobile contaminants, to increase the mobility of contaminants, to further stabilize contaminants, and to destroy contaminants in place.

Physical treatments would likely be drawn from the following technologies.

SVE

This technology uses vacuum blowers to accelerate the removal of vapor-phase contaminants, primarily VOCs and methane, from the vadose zone. The blowers create a negative pressure or vacuum in one or more boreholes. The vacuum removes the gases or vapors from boreholes by advective transport. This technology commonly requires a treatment system for the contaminated vapor that is extracted from the

subsurface. SVE can be applied as either an active system or as a passive system that uses ambient meteorological conditions to extract vapor-phase contaminants. Passive SVE is enhanced by the use of a wellhead control device that restricts the inward flow of ambient air into the subsurface under high atmospheric barometric conditions, allowing only outward flow of air.

The results of the SVE pilot study conducted at MDA L in 2006 (LANL 2006, 094152) support retaining this technology for further consideration.

Pneumatic Fracturing

Pneumatic fracturing uses the injection of a fluid under pressure to create open fractures in an area where a contaminant plume exists. Opening subsurface flow paths allows access to the contaminated media for removal or treatment. Pneumatic fracturing has the potential to introduce large amounts of water into a formation that has optimal low moisture content and is not desirable. The shallow tuff is already highly fractured; therefore, pneumatic fracturing has limited benefit.

Pneumatic fracturing technology was not retained.

Dynamic Compaction

Dynamic compaction is used to compact and consolidate wastes in place to reduce the potential for settling or sinking over time. The technology has been successfully demonstrated on landfills where subsidence (e.g., settling) over large areas is possible, leading to potentially significant run-on and infiltration of surface water. The area of Pit A and the impoundments is small, and no sign of subsidence is evident since they were closed in the 1980s. Nor is any sign of subsidence evident around the shafts. Dynamic compaction may adversely affect existing waste forms creating the potential for release.

Dynamic compaction technology was not retained.

Jet Grouting Stabilization

Jet grouting employs high-pressure injection of a cementitious grout slurry into a soil strata to hydraulically mix the in situ material with the grout. The grout slurry is injected into and/or around the waste to fill void spaces and to reduce the porosity within and between buried objects. The objective of this treatment is to stabilize the waste form to reduce the infiltration and movement of surface water into and through the waste and to reduce the future potential for subsidence of waste and overburden.

One method involves injecting grout into holes drilled through the waste while simultaneously pulverizing the waste and mixing it with the grout. This approach is applicable only for homogeneous, soil-like wastes. Given the heterogeneous nature of the waste at MDA L, this technology is not viable.

A second waste stabilization method involves the direct injection of grout into void spaces surrounding the waste. A pipe or auger is drilled into the subsurface and slowly rotated and pressurized. The high pressure (4000–13,000 psi) forces the grout laterally through special ports on the sides of the pipe or auger. The slurry exits the jet port at very high velocity, penetrating the soil several inches to several feet away from the ports. The rotating ports destroy soft soil formations while mixing the native soil with cement. Finally, the rotating pipe/auger is drawn slowly upward at a controlled rate to create a nearly cylindrical column of treated soil.

The waste material in the pit, impoundments, and shafts ranges from 3 ft to 65 ft bgs. Use of high pressure at shallower depths could be hazardous to workers. A breach may occur with the high-pressure

application of grout. Additionally, the integrity of the drums and other waste containers in the shafts could be damaged by high-pressure injection of grout. The use of this treatment technology would also have a negative impact on the shafts.

Jet grouting stabilization technology was not retained.

6.2.2.5 Thermal Treatment Technologies

Thermal treatment technologies have been developed and implemented to decompose heat-sensitive contaminants into less toxic or less mobile forms, or to enhance the extractability of a contaminant by heating it into a vapor phase. Heat is generated or delivered using several types of radiation (e.g., microwave, radio frequency, or thermal), using direct conductance of electricity or injecting already-heated materials (e.g., steam). Because most of the contaminant source at the site is contained in drums, and cans, subsurface heating would not enhance the extractability of the source contaminants. VOCs, which are readily extractable given the highly fractured subsurface where air readily travels through the mesa. Therefore, application of this technology at MDA L would provide minimal benefit.

Thermal treatment technologies were not retained.

6.2.3 Excavation/Retrieval Technologies

Excavation and off-site disposal are a well-proven and readily implementable technology. Excavation is the initial component in all ex situ treatments. The potential for excavating/retrieving materials at MDA L varies greatly among waste units because of several factors: the potential to reduce long-term human health and environmental risk versus increased short-term risk to human health and the environment during excavation, availability of treatments necessary to meet disposal requirements, and costs and risks of shipping large quantities of material off-site. Complete removal of all wastes in the shafts requires substantial excavation of the surrounding area.

Excavation/retrieval of materials will require disposal in an appropriate facility. Various methods for excavation and disposal are evaluated below.

6.2.3.1 Excavation

Removal of the shafts could be performed by excavating a large trench access area alongside the shafts, thereby making removal possible. This technology has already been used at MDA G to excavate trenches to a depth of 65 ft. Overburden removal to the north would require excavating the pit and impoundments to provide a complete excavation alternative. Waste in the pit and impoundments can be removed using large-scale soil moving and excavating equipment and containerization tools.

Therefore, excavation technology was retained.

6.2.3.2 Overcoring Retrieval—Shafts

Overcoring retrieval is a technology for retrieving an entire shaft without digging a trench. This method typically involves using a crane to lift and suspend a large-diameter steel casing over the shaft. The diameter of the casing is larger than that of the shaft. The casing is then driven into the ground by a vibratory driver until the casing encompasses the entire shaft. Once the casing has reached the appropriate depth, the casing's open bottom is sealed shut by injecting grout into the ground within the

casing to the base of the core. When the seal has cured and hardened, the entire casing is lifted to retrieve the intact shaft contained within. The excavated core is then backfilled.

This technology has been demonstrated at the DOE facility in Hanford, Washington, to a depth of 25 ft. The shafts at MDA L extend to a depth of 65 ft, and significant uncertainty exists regarding the performance of this technology at that depth.

Overcoring retrieval technology was not retained.

6.2.3.3 Waste Container Retrieval—Shafts

Although access to the MDA L disposal shafts can be gained by removing the concrete caps, the small diameter of the shafts provides a limited space for manipulating their contents. Total removal can only be accomplished by using a crane and manual rigging equipment. While not impossible, this type of excavation is not desirable because of potential risks to workers. Use of grappling devices or magnetic lifts is possible for certain inventory items; however, because of their size or shape, many items can be removed only by manual rigging. Additionally, the unknown conditions of the waste packaging increases the risk to workers and the environment. It is known that the older shafts were not containerized. Therefore, the safety hazards of working in the narrow shafts eliminate this technology as a viable technology for the shafts at MDA L.

Waste container retrieval technology was not retained.

6.2.4 Ex Situ Treatment Technologies

If excavated, MDA L waste materials and/or contaminated media will require characterization to determine whether the material meets the waste acceptance criteria (WAC) of the appropriate treatment, storage, and disposal (TSD) facility. Some of the waste may require treatment before it is reused as backfill or placed in an approved facility. General treatment technologies include neutralization, extraction, thermal treatment, stabilization, and the various debris treatments specified under RCRA. Any wastes excavated at MDA L are expected to meet WAC without the need for further treatment.

Ex situ treatment technologies were not retained.

6.2.5 Waste Management and Disposal

Waste management and disposal are not treatment technologies that apply directly to the RAOs of the waste unit, but because many technologies require waste removal, waste management options are discussed below.

On-Site RCRA Landfill

This technology requires the construction of a new landfill at the Laboratory designed to meet the RCRA Subtitle C minimum technology requirements (MTRs). A RCRA Subtitle C landfill is defined as a disposal facility or part of a facility where hazardous waste is placed. Consolidation or placement of wastes into a RCRA landfill has strict requirements, such as land disposal restrictions (LDRs). RCRA landfill operating permits typically require renewal every 10 yr and include an active monitoring program.

At this time, the Laboratory is not considering constructing a RCRA landfill. A new RCRA landfill requires a siting study and permit approvals, including public comment. This option would delay final action

through the permitting-approval process and construction of the new landfill and impact the Consent Order corrective action requirements.

On-site RCRA landfill is not a preferred option for waste management and disposal.

On-Site Corrective Action Management Unit

Corrective action management units (CAMUs) are used for the on-site management of remediation wastes under RCRA. A CAMU under RCRA is used for on-site TSD of hazardous wastes managed during cleanup. Consolidation or placement of remediation wastes into a CAMU is not considered land disposal and does not trigger LDRs or create a unit subject to MTRs. CAMUs can be temporary or permanent (i.e., can be closed after waste is removed or become a disposal unit).

A CAMU requires prior approval by the New Mexico Secretary of the Environment, a process that includes public comment or incorporation into the existing RCRA permit. This option would delay final action through the approval process and construction of the CAMU and impact the Consent Order corrective action requirements.

On-site CAMU is not a preferred option for waste management and disposal.

Off-Site Disposal

Off-site disposal allows waste to be shipped off-site to permitted facilities. Transportation of wastes in approved trucking containers will occur on public highways. Facilities considered for this option include the Nevada National Security Site (NNSS), the Waste Isolation Pilot Plant (WIPP), EnergySolutions in Clive, Utah, and other approved facilities. The off-site disposal option is readily available and applicable to MDA L wastes.

Therefore, off-site disposal is the preferred option for waste management and disposal.

6.3 Summary of Technologies Retained for Further Evaluation at MDA L

Technologies considered applicable for MDA L and retained for further consideration in developing corrective measures alternatives in section 7 are summarized below.

6.3.1 Containment Technologies

The following technologies are suitable to contain the waste in the pit, impoundments, and shafts at MDA L:

- Surface Barriers—Multilayer RCRA Cover
- Surface Barriers—ET Cover

6.3.2 In Situ Treatment Technologies

The following technology is suitable for managing and treating the subsurface vapor plume at MDA L:

- Physical Treatment—SVE

6.3.3 Excavation/Retrieval Technologies

The following technology is suitable for removing the waste in the pit, impoundments, and shafts at MDA L:

- Excavation

6.3.4 Waste Management and Disposal

The following option is suitable for managing and disposing waste removed from MDA L:

- Off-Site Disposal

7.0 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURES ALTERNATIVES

The process for alternative identification and screening employed in this CME began with identifying and screening technologies that can be used to address previously identified RAOs. Table 7.0-1 presents a matrix of the potential corrective measures alternatives using the technologies that are carried forward from section 6. The corrective measures alternatives are as follows:

- Alternative 1—No Action
- Alternative 2A—Multilayer Cover, SVE, and Institutional Controls
- Alternative 2B—ET Cover, SVE, and Institutional Controls
- Alternative 3A—Multilayer Cover (Shafts), Excavation (Pit and Impoundments), SVE, and Institutional Controls
- Alternative 3B—ET Cover (Shafts), Excavation (Pit and Impoundments), SVE, and Institutional Controls
- Alternative 4—Excavation, SVE, and Institutional Controls

An alternative with excavation of the shafts only, similar to Alternatives 3A and 3B, was considered and determined not to be viable because the size of the excavation would require removing the pit and impoundments as well. Therefore, the removal/excavation of the shafts was only included in Alternative 4.

Preliminary cover design information for the multilayer cover and the ET cover is provided in Appendixes G and H, respectively. Preliminary SVE design information is provided in Appendix I.

Section 7.1 identifies activities that will be undertaken before corrective measures begin. Section 7.2 presents the threshold screening criteria that are listed in Section VII.D.4.a of the Consent Order. Section 7.3 presents the screening of alternatives against the threshold criteria. The alternatives that satisfy all four of the threshold criteria are carried forward into section 8, where they are evaluated against the remedial alternative evaluation criteria (also referred to as balancing criteria) defined in Section VII.D.4.b of the Consent Order.

7.1 Activities Undertaken before Implementation of Corrective Measures

Modifications to the Laboratory's Hazardous Waste Permit will be required before D&D activities can be performed, which requires a Class 1 Permit modification with prior approval for structure removal. The structures identified for removal are part of the outdoor hazardous waste container storage unit in Area L

(the permitted unit [Figure 7.1-1]). The northern portion of the permitted unit will be closed in coordination with the CMI for MDA L.

Storage Dome 215 is 60 ft by 266 ft (15,960 ft^2) and is currently used to store clean empty drums for the waste disposition program at Area G. This structure is part of the permitted unit and will undergo D&D before the final remedy for MDA L is implemented.

Storage Pads 35, 36, and 58 are also part of the permitted unit and are located beneath Canopy 62. Although currently not in use, each pad is approximately 33 ft by 31.5 ft (1050 ft^2) and has a concrete berm. The canopy provides protection from the weather and will require D&D before the final remedy for MDA L is implemented.

Because only the northern-half of the permitted unit will be impacted by the CME process, an additional Class 2 Permit modification to the Laboratory's Hazardous Waste Permit will also be required and will be submitted to NMED. A revised closure plan for Pads 35, 36, and 58, Dome 215, and the asphalt covering the northern half of Area L will also be submitted,

Groundwater monitoring at the Laboratory is being implemented pursuant to the Consent Order under the IFGMP. As a result, groundwater monitoring is not considered an additional requirement of any corrective measure alternative.

7.2 Corrective Measures Threshold Screening Criteria

Section VII.D.4.a of the Consent Order states that to be selected, the remedy alternative must

1. Be protective of human health and the environment.

   Protection of human health and the environment should be evaluated based on reasonably anticipated land use, both now and in the future. It should take into consideration the potential exposure pathways identified in the CSM.

2. Attain media cleanup standards.

   The applicable cleanup standards developed in accordance with Section VIII of the Consent Order are presented in section 5.1. EPA guidance (61 Federal Register 19432, May 1, 1996) states, "Media cleanup standards should reflect the potential risks of the facility and media in question by considering the toxicity of the constituents of concern, exposure pathways, and fate and transport characteristics." EPA guidance further explains, "Attaining media cleanup standards does not necessarily entail removal or treatment of all contaminated material above specific constituent concentrations. Depending on the site-specific circumstances, remedies may attain media cleanup standards through various combinations of removal, treatment, engineering and institutional controls."

3. Control the source or sources of releases so as to reduce or eliminate, to the extent practicable, further releases of contaminants that may pose a threat to human health and the environment.

   Source control measures evaluated may include a combination of treatment, containment, removal, and institutional controls.

4. Comply with applicable standards for management of wastes.

   A remedy must be able to comply with all applicable regulatory requirements for management of any wastes removed or generated during corrective action, as well as closure requirements for any waste or remaining contamination following implementation of the remedial alternative.

7.3 Description and Screening of Alternatives

This section describes the potential corrective measure alternatives for MDA L and presents a qualitative evaluation of these alternatives against the threshold criteria contained in Section VII.D.4.a of the Consent Order. Table 7.3-1 summarizes the evaluation performed in section 7.3.

7.3.1 Alternative 1: No Action

Alternative 1 represents a true no-action alternative. Under this alternative, no action will be taken. Institutional controls will not be maintained and pore-gas monitoring will not be performed. No maintenance of the surface soil will be performed. In summary, this alternative includes

- no monitoring of soil vapor,
- no maintenance, and
- no institutional controls.

7.3.1.1 Protection of Human Health and the Environment

The surface soil will likely erode, which will increase the potential for exposure to waste and contaminated surface and subsurface soils. The potential will exist for exposure through direct contact and biointrusion. This alternative is not protective of human health and the environment.

7.3.1.2 Attainment of Media Cleanup Standards

Under this alternative, the existing waste inventory, which includes wastes subject to regulation as hazardous wastes under RCRA, will not be removed or treated. This alternative does not comply with the EPA guidance for attaining media cleanup standards when waste is left in place. This alternative does not attain media cleanup standards.

7.3.1.3 Control of Source and Releases

The potential exists for continued release of VOCs to the vadose zone. Erosion of soil has the potential to expose buried waste, resulting in potential releases. This alternative will not control sources and releases.

7.3.1.4 Compliance with Applicable Waste Management Standards

No wastes will be generated under the no-action alternative; therefore, it complies with applicable waste management standards.

7.3.1.5 Summary

Although the no-action alternative does not satisfy all of the threshold criteria, it is carried forward for comparison purposes in evaluating the other alternatives.

7.3.2 Alternative 2A: Multilayer Cover, SVE, and Institutional Controls

Under this alternative, two multilayer covers will be installed over two areas of MDA L (Figure 7.3-1). Appendix G details the conceptual design of this proposed multilayer cover. The first cover, approximately 0.15 acres, will be on the western end of MDA L above Shafts 29–34. The second cover, approximately

0.75 acres, will be on the eastern end of MDA L above Shafts 1–28 and the pit and impoundments. The conceptual multilayer cover design (Figure 7.3-2) and construction consist (from the ground surface to the top) of the following:

- site preparation of the existing soil surface, including 3 ft of operational cover above the waste material;
- 2-ft layer of compacted natural or amended soil with a maximum saturated hydraulic conductivity of 1×10^{-7} cm/s (e.g., clay layer);
- 40-mil flexible geomembrane liner to limit downward moisture movement;
- 1-ft drainage layer of sand having a minimum saturated hydraulic conductivity of 1×10^{-2} cm/s; and
- 2-ft soil and vegetation layer graded at slopes between 3%–5%.

The conceptual SVE design (Appendix I) includes the following principal assumptions and components:

- Installation of six SVE boreholes (Figure 7.3-3), each to a depth of approximately 200 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 40 to 200 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA L to provide effective extraction of VOC vapors in the vadose zone (see section 3 and Appendixes B and I).
- Installation of three SVE boreholes (Figure 7.3-3) into the Cerro Toledo interval (Qct unit) to approximately 300 ft bgs. These boreholes will be screened within the Qct unit (250 ft to 300 ft bgs) to take advantage of its high permeability. This unit can provide a wider ROI for the SVE system. The purpose of these boreholes is to provide a barrier against farther downward migration of VOC vapors in the vadose zone.
- Two portable, skid-mounted SVE units will be cycled between the six upper zone extraction boreholes during operations. Each SVE unit will utilize a 15 hp blower motor, providing up to 200 scfm at a vacuum of 120 in. of water. The system will be optimized during the initial setup, although a vacuum between 50 and 70 in. of water has been demonstrated to be effective (see section 2.5.3). A third SVE unit, similar to that described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction borehole spacing in the upper units will be based on a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction borehole spacing in the Qct unit is based on a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2 for each borehole.

Institutional and engineering controls will be implemented to limit the potential for future exposure to buried waste and potentially contaminated surface and subsurface soils. These controls are assumed to remain in place for 100 years per DOE guidelines. A restrictive covenant will be placed on the deed and recorded locally and in the EPA institutional controls database. Active monitoring and maintenance will be performed for 30 years. Pore-gas monitoring will be performed to evaluate the performance of the SVE system. Maintenance activities will be performed to address erosion, animal burrowing and to manage vegetation. Fencing will be used to restrict site access.

The multilayer cover minimizes exposure on the surface of the waste facility, prevents vertical infiltration of water into wastes that would potentially create contaminated leachate, and creates a land surface that can support vegetation.

The most efficient means of operating the SVE system is intermittent operation with alternating periods of extraction and rebound. The operational plan for the SVE system is provided in Appendix I. Active SVE will be conducted at an extraction borehole for 30 d. After 30 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring at select pore-gas monitoring wells will be conducted at the end of each 30-d operational period. SVE operations in the Qct unit will follow similar operations. Performance monitoring will provide important information on the effectiveness of the removal and the rebound behavior of the VOC plume, allowing for the opportunity to optimize the operation of the system.

7.3.2.1 Protection of Human Health and the Environment

A multilayer cover will provide protection against erosion, direct contact, biointrusion, and moisture infiltration. The multilayer cover, as described above, places a minimum of 5 ft of varying soil layers between a potential human or ecological receptor and the top of the existing operational cover, thereby breaking the exposure pathway. The multilayer cover is designed to restrict infiltration of water, thereby breaking the contaminant transport pathway (via leaching) to groundwater.

SVE will remove soil-vapor contaminants and will restrict the potential downward migration of VOC-contaminated soil vapors, thereby breaking the contaminant transport pathway (via volatilization) to groundwater.

Institutional controls will be implemented to provide access controls, thereby restricting human exposure. This alternative is protective of human health and the environment.

7.3.2.2 Attainment of Media Cleanup Standards

Under this alternative, the existing waste inventory, which includes wastes subject to regulation as hazardous wastes under RCRA, would not be removed or treated. The installation of a multilayer cover attains media cleanup standards when waste is left in place by breaking the exposure pathway and reducing risk for human and ecological receptors. A multilayer cover will also minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. SVE will achieve media cleanup standards by removing contaminated soil vapors from the subsurface.

This alternative attains media cleanup standards.

7.3.2.3 Control of Source and Releases

A multilayer cover will minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. A multilayer cover will also limit exposure to waste and contaminated surface and subsurface soils and reduce the potential for erosion and dust generation of contaminated surface soils.

The potential exists for continued release of VOCs to the vadose zone that may diffuse to the groundwater. However, these releases would be controlled by SVE, which removes vapor-phase contaminants and prevents their diffusion to groundwater.

This alternative will control sources and releases.

7.3.2.4 Compliance with Applicable Waste Management Standards

No waste is projected to be generated during the construction of the multilayer cover. The off-gas waste stream generated from the operation of the SVE system can be effectively managed to comply with waste management standards.

This alternative complies with applicable waste management standards.

7.3.2.5 Summary

This alternative complies with each of the four threshold criteria. Therefore, this alternative is retained for further consideration.

7.3.3 Alternative 2B: ET Cover, SVE, and Institutional Controls

Under this alternative, two ET covers will be installed over two areas of MDA L (Figure 7.3-1). Appendix H details the conceptual design of these proposed ET covers. The first cover, approximately 0.15 acres, will be on the western end of MDA L above Shafts 29–34. The second cover, approximately 0.75 acres, will be on the eastern end of MDA L above Shafts 1–28 and the pit and impoundments. The conceptual ET cover design (Figure 7.3-5) and construction consist (from the ground surface to the top) of the following:

- site-preparation of the existing soil surface, which includes 3 ft of operational cover above the waste material;
- 1 ft of angular cobbles with a minimum diameter of 4 to 6 in. to act as a biointrusion barrier;
- 0.5 ft of sand and gravel mixture to prevent the mixing of soil layers;
- 3.5 ft of natural or amended soil meeting the water storage capacity of a typical sandy loam; and
- 1.5 ft of natural or amended soil and vegetation, with minimal slopes, to ensure a desired stand of vegetation is maintained.

A conceptual SVE design (Appendix I) will include the following principal assumptions and components:

- Installation of six SVE boreholes (Figure 7.3-3), each to a depth of approximately 200 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 40 to 200 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA L to provide effective extraction of VOC vapors in the vadose zone (see section 3 and Appendixes B and I).
- Installation of three SVE boreholes (Figure 7.3-3) into the Cerro Toledo interval (Qct unit) to approximately 300 ft bgs. These boreholes will be screened within the Qct unit (250 ft to 300 ft bgs) to take advantage of its high permeability. This unit can provide a wider ROI for the SVE system. The purpose of these boreholes is to provide a barrier against farther downward migration of vapor-phase contaminants in the vadose zone.
- Two portable, skid-mounted SVE units will be cycled between the six upper zone extraction boreholes during operations. Each SVE unit will utilize a 15-hp blower motor, providing up to 200 scfm at a vacuum of 120 in. of water. The system will be optimized during the initial setup, although a vacuum between 50 and 70 in. of water has been demonstrated to be effective (see section 2.5.3). A third SVE unit, similar to that described above, will be used to cycle between the extraction boreholes in the Qct unit.

- Extraction borehole spacing in the upper units will be based on a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction borehole spacing in the Qct unit is based on a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2 for each borehole.

Institutional and engineering controls will be implemented to limit the potential for future exposure to buried waste and potentially contaminated surface and subsurface soils. These controls are assumed to remain in place for 100 years per DOE guidelines. A restrictive covenant will be placed on the deed and recorded locally and in the EPA institutional controls database. Active monitoring and maintenance will be performed for 30 years. Pore gas monitoring will be performed to evaluate the performance of the SVE system. Moisture monitoring will be performed to evaluate the performance of the ET cover. Maintenance activities will be performed to address erosion, animal burrowing, and to manage vegetation. Fencing will be used to restrict site access.

The ET cover minimizes exposure on the surface of the waste facility, prevents vertical infiltration of water into wastes that could create contaminated leachate, and creates a land surface that can support vegetation.

The ET cover takes advantage of the semiarid site conditions by evaporating and transpiring water from the cover. The surface of the cover has minimum slope to limit erosion. The ET cover includes little or no clay and no geosynthetic membrane materials, both of which are considered more likely to fail because the clay tends to dry out and crack and the polymer degrades in an arid to semiarid environment.

Engineered ET covers have demonstrated effectiveness in reducing infiltration in semiarid regions (Davenport et al. 1998, 069674, p. 1; Dwyer et al. 2000, 069673, pp. 23–26). ET covers can be adapted to enhance specific desired properties for a given application, such as increased erosion resistance with the addition of gravel surface amendments; enhanced or limited plant growth and types for transpiration by varying depths of enriched soil; modification of the size of the ET reservoir layer above the waste layer by varying the depths of the primary crushed-tuff ET layer; or prevention of biointrusion by using barriers such as cobbles.

The most efficient means of operating the SVE system is intermittent operation with alternating periods of extraction and rebound. The operational plan for the SVE system is provided in Appendix I. Active SVE will be conducted at an extraction borehole for 30 d. After 30 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring at select pore-gas monitoring wells will be conducted at the end of each 30-d operational period. SVE operations in the Qct unit will follow similar operations. Performance monitoring will provide important information on the effectiveness of the removal and the rebound behavior of the VOC plume, allowing for the opportunity to optimize the operation of the system.

7.3.3.1 Protection of Human Health and the Environment

An ET cover will provide protection against erosion, direct contact, biointrusion, and moisture infiltration. The ET cover, as described above, places a minimum of 6.5 ft of varying soil layers between a potential human or ecological receptor and the top of the existing operational cover, thereby breaking the exposure pathway. The ET cover is designed to restrict infiltration of water, thereby breaking the contaminant transport pathway (via leaching) to groundwater.

SVE will remove soil-vapor contaminants and will restrict the downward migration of VOC-contaminated soil vapors, thereby breaking the contaminant transport pathway (via volatilization) to groundwater.

Institutional controls will be implemented to provide access controls, thereby restricting human exposure.

This alternative is protective of human health and the environment.

7.3.3.2 Attainment of Media Cleanup Standards

Under this alternative, the existing waste inventory, which includes wastes subject to regulation as hazardous wastes under RCRA, would not be removed or treated. The installation of an ET cover attains media cleanup standards when waste is left in place by breaking the exposure pathway and reducing risk for human and ecological receptors. An ET cover will also minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. SVE will achieve media cleanup standards by removing contaminated soil vapors from the subsurface.

This alternative attains media cleanup standards.

7.3.3.3 Control of Source and Releases

An ET cover will minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. An ET cover will also limit exposure to waste and contaminated surface and subsurface soils and reduce the potential for erosion and dust generation of contaminated surface soils.

The potential exists for continued release of VOCs to the vadose zone that may diffuse to the groundwater. However, these releases would be controlled by SVE, which removes vapor-phase contaminants and prevents their diffusion to groundwater.

This alternative will control sources and releases.

7.3.3.4 Compliance with Applicable Waste Management Standards

No waste is projected to be generated during the construction of the ET cover. The off-gas waste stream generated from the operation of the SVE system can be effectively managed to comply with waste management standards.

This alternative complies with applicable waste management standards.

7.3.3.5 Summary

This alternative complies with each of the four threshold criteria. Therefore, this alternative is retained for further consideration.

7.3.4 Alternative 3A: Multilayer Cover (Shafts), Excavation (Pit and Impoundments), SVE, and Institutional Controls

Under this alternative, two multilayer covers will be installed over two areas of MDA L and the pit and impoundments will be excavated (Figure 7.3-6). Appendix G describes the conceptual design of this proposed multilayer cover. The first cover, approximately 0.15 acres, will be on the western end of MDA L above Shafts 29–34. The second cover, approximately 0.25 acres, will be on the eastern end of MDA L above Shafts 1–28. The conceptual multilayer cover design (Figure 7.3-2) and construction consist (from the ground surface to the top) of the following:

- site preparation of the existing surface, which includes a 3-ft concrete plug above the waste material in each shaft;
- 2-ft layer of compacted natural or amended soil with a maximum saturated hydraulic conductivity of 1×10^{-7} cm/s (e.g., clay layer);

- 40-mil flexible geomembrane liner to limit downward moisture movement;
- 1-ft drainage layer of sand having a minimum saturated hydraulic conductivity of 1×10^{-2} cm/s; and
- 2-ft soil and vegetation layer graded at slopes between 3%–5%.

The excavation of the pit and impoundments (Figure 7.3-7) would include the following:

- waste removal activities using standard excavation techniques,
- analysis and segregation of the waste for off-site shipment and disposal based on the WAC of the receiving facility,
- replacement in the original excavation of any environmental media meeting the industrial SSLs and backfilled to grade, and
- off-site shipment and disposal of wastes that do not meet the industrial SSLs.

A conceptual SVE design (Appendix I) will include the following principal assumptions and components:

- Installation of six SVE boreholes (Figure 7.3-3), each to a depth of approximately 200 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 40 to 200 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA L to provide effective extraction of VOC vapors in the vadose zone (see section 3 and Appendixes B and I).
- Installation of three SVE boreholes (Figure 7.3-3) into the Cerro Toledo interval (Qct unit) to approximately 300 ft bgs. These boreholes will be screened within the Qct unit (250 ft to 300 ft bgs) to take advantage of its high permeability. This unit can provide a wider ROI for the SVE system. The purpose of these boreholes is to provide a barrier against farther downward migration of VOC vapors in the vadose zone.
- Two portable, skid-mounted SVE units will be cycled between the six upper zone extraction boreholes during operations. Each SVE unit will utilize a 15 hp blower motor, providing up to 200 scfm at a vacuum of 120 in. of water. The system will be optimized during the initial setup, although a vacuum between 50 and 70 in. of water has been demonstrated to be effective (see section 2.5.3). A third SVE unit, similar to that described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction borehole spacing in the upper units will be based on a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction borehole spacing in the Qct unit is based on a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2 for each borehole.

Institutional and engineering controls will be implemented to limit the potential for future exposure to buried waste and potentially contaminated surface and subsurface soils. These controls are assumed to remain in place for 100 years per DOE guidelines. A restrictive covenant will be placed on the deed and recorded locally and in the EPA institutional controls database. Active monitoring and maintenance will be performed for 30 years. Pore gas monitoring will be performed to evaluate the performance of the SVE system. Maintenance activities will be performed to address erosion, animal burrowing, and to manage vegetation. Fencing will be used to restrict site access.

The multilayer cover minimizes exposure on the surface of the waste facility, prevents vertical infiltration of water into wastes that would create contaminated leachate, and creates a land surface that can support vegetation.

Pit A and Impoundments B, C, and D would be excavated using a tiered approach based on hazard level and assessment of specific inventory. Excavation of these areas would be accomplished using standard excavation methods, unless potential or real hazards dictate remote handling. The need for remote handling is not expected. The original units were excavated with nearly vertical walls and an entry ramp on one side. Remediation activities may also proceed with nearly vertical slopes (1 ft horizontal to 6 ft vertical) during excavation (Figure 7.3-7). The estimated volume of excavated materials is presented in Appendix E. Pit A has never been sampled, but based upon review of the inventory, some of the waste will be MLLW. The contents of this pit will be sampled and evaluated during excavation activities. Any cylinders in this pit will have to be examined to determine their content and waste disposition. Following analysis of the waste in Pit A, a waste determination will be made and a path forward identified.

Confirmatory sampling will be conducted to determine how far below the pit and impoundments contaminated material would have to be removed.

All waste requiring off-site disposal would be transported on Pajarito Road. Waste shipped off-site must meet U.S. Department of Transportation shipping requirements and TSD facility-specific WAC and permit conditions before shipping and disposal. The facilities permitted for disposal of MLLW include NNSS and EnergySolutions in Clive, Utah.

The most efficient means of operating the SVE system is intermittent operation with alternating periods of extraction and rebound. The operational plan for the SVE system is provided in Appendix I. Active SVE will be conducted at an extraction borehole for 30 d. After 30 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring at select pore-gas monitoring wells will be conducted at the end of each 30-d operational period. SVE operations in the Qct unit will follow similar operations. Performance monitoring will provide important information on the effectiveness of the removal and the rebound behavior of the VOC plume, allowing for the opportunity to optimize the operation of the system.

7.3.4.1 Protection of Human Health and the Environment

A multilayer cover will provide protection against erosion, direct contact, biointrusion, and moisture infiltration. The multilayer cover, as described above, places a minimum of 5 ft of varying soil layers between a potential human or ecological receptor and the top of the disposal shafts, thereby breaking the exposure pathway. The multilayer cover is designed to restrict infiltration of water, thereby breaking the contaminant transport pathway (via leaching) to groundwater.

Excavation of the pit and impoundments will remove source material.

SVE will remove soil-vapor contaminants and will restrict the downward migration of VOC-contaminated soil vapors, thereby breaking the contaminant transport pathway (via volatilization) to groundwater.

Institutional controls will be implemented to provide access controls, thereby restricting human exposure.

This alternative is protective of human health and the environment.

7.3.4.2 Attainment of Media Cleanup Standards

Wastes will be excavated from the pit and impoundments to a level that meets industrial SSLs. Investigative sampling has indicated soil concentrations beneath the pit and impoundments are currently below the cleanup standards. Environmental media with concentrations below industrial SSLs may be returned to the original disposal unit.

The installation of a multilayer cover attains media cleanup standards when waste is left in place by breaking the exposure pathway and reducing risk for human and ecological receptors. A multilayer cover will also minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants from the shafts. SVE will attain media cleanup standards by removing contaminated soil vapors from the subsurface.

This alternative attains media cleanup standards.

7.3.4.3 Control of Source and Releases

A multilayer cover will minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. A multilayer cover will also limit exposure to waste and contaminated surface and subsurface soils and reduce the potential for erosion and dust generation of contaminated surface soils.

Excavation of the pit and impoundments will remove source material.

The potential exists for continued release of VOCs to the vadose zone that may diffuse to the groundwater. However, these releases would be controlled by SVE, which removes vapor-phase contaminants and prevents their diffusion to groundwater.

This alternative will control sources and releases.

7.3.4.4 Compliance with Applicable Waste Management Standards

Excavated wastes that exceed cleanup standards will be prepared for off-site shipment to meet the WAC of the permitted disposal facility.

No waste is projected to be generated during the construction of the multilayer cover. The off-gas waste stream generated from the operation of the SVE system can be effectively managed to comply with waste-management standards.

This alternative complies with applicable waste-management standards.

7.3.4.5 Summary

This alternative complies with each of the four threshold criteria. Therefore, this alternative is retained for further consideration.

7.3.5 Alternative 3B: ET Cover (Shafts), Excavation (Pit and Impoundments), SVE, and Institutional Controls

Under this alternative, two ET covers will be installed over two areas of MDA L and the pit and impoundments will be excavated (Figure 7.3-6). Appendix H describes the conceptual design of this

proposed ET cover. The first cover, approximately 0.15 acres, will be on the western end of MDA L above Shafts 29–34. The second cover, approximately 0.25 acres, will be on the eastern end of MDA L above Shafts 1–28. The conceptual ET cover design (Figure 7.3-2) and construction consists of (from the ground surface to the top):

- site preparation of the existing surface, which includes a 3-ft concrete plug above the waste material in each shaft;
- 1 ft of angular cobbles with a minimum diameter of 4 to 6 in. to act as a biointrusion barrier;
- 0.5 ft of sand and gravel mixture to prevent the mixing of soil layers;
- 3.5 ft of natural or amended soil meeting the water storage capacity of a typical sandy loam; and
- 1.5 ft of natural or amended soil and vegetation, with minimal slopes, to ensure a desired stand of vegetation is maintained.

The excavation of the pit and impoundments (Figure 7.3-8) would include the following:

- waste removal activities using standard excavation techniques,
- analysis and segregation of the waste for off-site shipment and disposal based on the WAC of the receiving facility,
- replacement in the original excavation of any environmental media meeting the industrial SSLs and backfilled to grade, and
- off-site shipment and disposal of wastes that do not meet the industrial SSLs.

A conceptual SVE design (Appendix I) will include the following principal assumptions and components:

- Installation of six SVE boreholes (Figure 7.3-3), each to a depth of approximately 200 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 40 to 200 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA L to provide effective extraction of VOC vapors in the vadose zone (see section 3 and Appendixes B and I).
- Installation of three SVE boreholes (Figure 7.3-3) into the Cerro Toledo interval (Qct unit) to approximately 300 ft bgs. These boreholes will be screened within the Qct unit (250 ft to 300 ft bgs) to take advantage of its high permeability. This unit can provide a wider ROI for the SVE system. The purpose of these boreholes is to provide a barrier against farther downward migration of VOC vapors in the vadose zone.
- Two portable, skid-mounted SVE units will be cycled between the six upper zone extraction boreholes during operations. Each SVE unit will utilize a 15 hp blower motor, providing up to 200 scfm at a vacuum of 120 in. of water. The system will be optimized during the initial setup, although a vacuum between 50 and 70 in. of water has been demonstrated to be effective (see section 2.5.3). A third SVE unit, similar to that described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction borehole spacing in the upper units will be based on a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction borehole spacing in the Qct unit is based on a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2 for each borehole.

Institutional and engineering controls will be implemented to limit the potential for future exposure to buried waste and potentially contaminated surface and subsurface soils. These controls are assumed to remain in place for 100 years per DOE guidelines. A restrictive covenant will be placed on the deed and recorded locally and in the EPA institutional controls database. Active monitoring and maintenance will be performed for 30 years. Pore gas monitoring will be performed to evaluate the performance of the SVE system. Moisture monitoring will be performed to evaluate the performance of the ET cover. Maintenance activities will be performed to address erosion, animal burrowing, and to manage vegetation. Fencing will be used to restrict site access.

The ET cover minimizes exposure on the surface of the waste facility, prevents vertical infiltration of water into wastes that could create contaminated leachate, and creates a land surface that can support vegetation.

The ET cover takes advantage of the semiarid site conditions by evaporating and transpiring water from the cover. The surface of the cover has minimum slope to limit erosion. The ET cover includes little or no clay and no geosynthetic membrane materials, both of which are considered more likely to fail because the clay tends to dry out and crack and the polymer degrades in an arid to semiarid environment.

Engineered ET covers have demonstrated effectiveness in reducing infiltration in semiarid regions (Davenport et al. 1998, 069674, p. 1; Dwyer et al. 2000, 069673, pp. 23–26). ET covers can be adapted to enhance specific desired properties for a given application, such as increased erosion resistance with the addition of gravel surface amendments; enhanced or limited plant growth and types for transpiration by varying depths of enriched soil; modification of the size of the ET reservoir layer above the waste layer by varying the depths of the primary crushed-tuff ET layer; or prevention of biointrusion by using barriers such as cobbles.

Pit A and Impoundments B, C, and D would be excavated using a tiered approach based on hazard level and assessment of specific inventory. Excavation of these areas would be accomplished using standard excavation methods, unless potential or real hazards dictate remote handling. The need for remote handling is not expected. The original units were excavated with nearly vertical walls and an entry ramp on one side. Remediation activities may also proceed with nearly vertical slopes (1 ft horizontal to 6 ft vertical) during excavation (Figure 7.3-7). The estimated volume of excavated materials is presented in Appendix E. Pit A has never been sampled, but based upon review of the inventory, some of the waste will be MLLW. The contents of this pit will be sampled, characterized, and evaluated during excavation activities. Any cylinders in this pit will have to be examined to determine their content and waste disposition. Following analysis of the waste in Pit A, a waste determination will be made and path forward identified.

Confirmatory sampling will be conducted to determine how far below the pit and impoundments contaminated material would have to be removed.

All waste requiring off-site disposal would be transported on Pajarito Road. Waste shipped off-site must meet U.S. Department of Transportation shipping requirements and TSD facility-specific WAC and permit conditions prior to shipping and disposal. The facilities permitted for disposal of MLLW include the NNSS and EnergySolutions in Clive, Utah.

The most efficient means of operating the SVE system is intermittent operation with alternating periods of extraction and rebound. The operational plan for the SVE system is provided in Appendix I. Active SVE will be conducted at an extraction borehole for 30 d. After 30 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring at select pore-gas monitoring wells will be conducted at the end of each 30-d operational period. SVE operations in the Qct unit will follow similar operations. Performance monitoring will provide important information on the effectiveness of the removal

and the rebound behavior of the VOC plume, allowing for the opportunity to optimize the operation of the system.

7.3.5.1 Protection of Human Health and the Environment

An ET cover will provide protection against erosion, direct contact, biointrusion, and moisture infiltration. The ET cover, as described above, places a minimum of 6.5 ft of varying soil layers between a potential human or ecological receptor and the top of the existing operational cover, thereby breaking the exposure pathway. The ET cover is designed to restrict infiltration of water, thereby breaking the contaminant transport pathway (via leaching) to groundwater.

Excavation of the pit and impoundments will remove source material.

SVE will remove soil-vapor contaminants and will restrict the downward migration of VOC-contaminated soil vapors, thereby breaking the contaminant transport pathway (via volatilization) to groundwater.

Institutional controls will be implemented to provide access controls, thereby restricting human exposure.

This alternative is protective of human health and the environment.

7.3.5.2 Attainment of Media Cleanup Standards

Wastes will be excavated from the pit and impoundments to a level that meets the industrial SSLs. Investigative sampling has indicated that soil concentrations beneath the pit and impoundments are currently below the cleanup standards. Environmental media concentrations below industrial SSLs may be returned to the original disposal unit.

The installation of an ET cover attains media cleanup standards when waste is left in place by breaking the exposure pathway and reducing risk for human and ecological receptors. An ET cover will also minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants from the shafts. SVE will achieve media cleanup standards by removing contaminated soil vapors from the subsurface.

This alternative attains media cleanup standards.

7.3.5.3 Control of Source and Releases

An ET cover will minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. An ET cover will also limit exposure to waste and contaminated surface and subsurface soils and reduces the potential for erosion and dust generation of contaminated surface soils.

Excavation of the pit and impoundments will remove source material.

The potential exists for continued release of VOCs to the vadose zone that may diffuse to the groundwater. However, these releases would be controlled by SVE, which would remove vapor-phase contaminants and prevent the diffusion to groundwater.

This alternative will control sources and releases.

7.3.5.4 Compliance with Applicable Waste Management Standards

No waste is projected to be generated during the construction of the ET cover. The off-gas waste stream generated from the operation of the SVE system can be effectively managed to comply with waste management standards.

Excavated wastes that exceed cleanup standards will be prepared for off-site shipment to meet the WAC of the permitted disposal facility.

This alternative complies with applicable waste management standards.

7.3.5.5 Summary

This alternative complies with each of the four threshold criteria. Therefore, this alternative is retained for further consideration.

7.3.6 Alternative 4: Excavation, SVE, and Institutional Controls

Under this alternative, the pit and impoundments and the shafts will be excavated.

The excavation of the pit and impoundments (Figure 7.3-7) and the shafts (Figure 7.3-9) would include the following:

- waste removal activities using standard excavation techniques,
- analysis and segregation of the waste for off-site shipment and disposal based on the WAC of the receiving facility,
- replacement in the original excavation of any environmental media meeting the industrial SSLs and backfilled to grade,
- off-site shipment and disposal of wastes that do not meet the industrial SSLs.

A conceptual SVE design (Appendix I) will include the following principal assumptions and components:

- Installation of six SVE boreholes (Figure 7.3-3), each to a depth of approximately 200 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 40 to 200 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA L to provide effective extraction of VOC vapors in the vadose zone (see section 3 and Appendixes B and I).
- Installation of three SVE boreholes (Figure 7.3-3) into the Cerro Toledo interval (Qct unit) to approximately 300 ft bgs. These boreholes will be screened within the Qct unit (250 ft to 300 ft bgs) to take advantage of the high permeability of this unit. This unit can provide a wider ROI for the SVE system. The purpose of these boreholes is to provide a barrier against farther downward migration of VOC vapors in the vadose zone.
- Two portable, skid-mounted SVE units will be cycled between the six upper-zone extraction boreholes during operations. Each SVE unit will utilize a 15 hp blower motor, providing up to 200 scfm at a vacuum of 120 in. of water. The system will be optimized during the initial setup, although a vacuum between 50 and 70 in. of water has been demonstrated to be effective (see section 2.5.3). A third SVE unit, similar to that described above, will be used to cycle between the extraction boreholes in the Qct unit.

- Extraction borehole spacing in the upper units will be based on a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction borehole spacing in the Qct unit is based on a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2 for each borehole.

Institutional and engineering controls (e.g., fencing) will be implemented to restrict access to the area during site activities. A restrictive covenant, which is assumed to remain in place for 100 yr, will be placed on the deed and recorded locally and in the EPA institutional controls database. Active monitoring and maintenance will be performed for 30 yr. Pore gas monitoring will be performed to evaluate the performance of the SVE system; however, long-term monitoring is not required because the source is removed. Maintenance activities will be performed to address erosion and to manage vegetation.

Pit A and Impoundments B, C, and D would be excavated using a tiered approach based on hazard level and assessment of specific inventory. Excavation of these areas would be accomplished using standard excavation methods, unless potential or real hazards dictate remote handling. The need for remote handling is not expected. The original units were excavated with nearly vertical walls and an entry ramp on one side. Remediation activities may also proceed with nearly vertical slopes (1 ft horizontal to 6 ft vertical) during excavation (Figure 7.3-7). Later, the excavated area may be used to access the shafts or to stage activities. The estimated volume of excavated materials is presented in Appendix E. Pit A has never been sampled, but based upon review of the inventory, some of the waste will be MLLW. The contents of this pit will be sampled, characterized, and evaluated during excavation activities. Any cylinders in this pit will have to be examined to determine their content and waste disposition. Following analysis of the waste in Pit A, a waste determination will be made and a path forward identified.

Shafts 1–34 would be excavated using a parallel trench approach (Figure 7.3-3). In general, trenching would be conducted parallel to the line of the shafts and would take place in 6-ft increments to expose the line of shafts. Waste will be removed from the shafts at each 6-ft interval, and an almost vertical 1:6 side slope would be maintained on the outside edge during excavation operations. The horizontal and vertical extent of contaminated soils was assumed not to extend far beyond the edges of the shafts. The volume of excavated waste is estimated from the actual dimensions of the shaft plus 10% of the access area volume. The total excavation volume varies from this volume because the excavation slopes are not included in the contaminated soils volume to provide a more realistic estimate. A 600-ft-long, 10%-slope haul road into the trench is included in the estimates as uncontaminated excavation as well. The actual dimensions of the access road and the required width of the trench will be determined by the excavator equipment requirements. An outside area will be required for staging of excavated materials. The estimated volume of excavated materials is presented in Appendix E.

The excavated area will be backfilled to grade with soil meeting industrial SSLs. Confirmatory sampling will be conducted to minimize the amount of contaminated material that would require removal.

All waste requiring off-site disposal would be transported on Pajarito Road. Waste shipped off-site must meet U.S. Department of Transportation shipping requirements and TSD facility-specific WAC and permit conditions before the waste can be shipped and disposed of. The facilities permitted for disposal of MLLW include the NNSS and EnergySolutions in Clive, Utah.

Because the source material will have been removed as part of the alternative, the concern over concentration rebound and the need for intermittent operation is diminished. SVE will be conducted at an extraction borehole until extracted contaminant concentrations approach an asymptotic value. Based on previous pilot tests and monitoring, the extraction period is expected to be 90 d. Performance monitoring at select pore-gas monitoring wells will be conducted at the end of each 90-d operational period. After 90 d of extraction, the SVE system will be moved to another extraction borehole. SVE operations in the

Qct unit will follow similar operations. Performance monitoring will provide important information on the effectiveness of the removal of the VOC plume and determine if additional operation is needed. Long-term vapor-monitoring following active SVE is not required for this alternative because the source of VOCs is removed.

7.3.6.1 Protection of Human Health and the Environment

Excavation of the pit, impoundments, and shafts will remove source material.

SVE will remove soil-vapor contaminants and will restrict the downward migration of VOC-contaminated soil vapors, thereby breaking the contaminant transport pathway (via volatilization) to groundwater.

Institutional controls will be implemented to provide access controls, thereby restricting human exposure.

This alternative is protective of human health and the environment.

7.3.6.2 Attainment of Media Cleanup Standards

Wastes will be excavated from the pit, impoundments, and shafts to a level that meets industrial SSLs. Investigative sampling has indicated soil concentrations beneath the pit and impoundments are currently below the cleanup standards. Environmental media with concentrations below industrial SSLs may be returned to the original disposal unit.

SVE will achieve media cleanup standards by removing contaminated soil vapors from the subsurface.

This alternative attains media cleanup standards.

7.3.6.3 Control of Source and Releases

Excavation of the pit, impoundments, and shafts will remove source material.

SVE will remove vapor-phase contaminants and prevent the diffusion to groundwater.

This alternative eliminates sources and releases.

7.3.6.4 Compliance with Applicable Waste Management Standards

Excavated wastes that exceed cleanup standards will be prepared for off-site shipment to meet the WAC of the permitted disposal facility.

The off-gas waste stream generated from the operation of the SVE system can be effectively managed to comply with waste management standards.

This alternative complies with applicable waste management standards.

7.3.6.5 Summary

This alternative complies with each of the four threshold criteria. Therefore, this alternative is retained for further consideration.

8.0 EVALUATION OF ALTERNATIVES AGAINST REMEDIAL ALTERNATIVE EVALUATION CRITERIA

Corrective measures alternatives appropriate for MDA L were screened against the Consent Order threshold criteria listed in section 7. Alternatives found to meet the Consent Order threshold criteria have been brought forward for further evaluation along with the no-action alternative. These alternatives are evaluated against the remedial alternative evaluation criteria (also known as the balancing criteria) from Section VII.D.4.b of the Consent Order.

8.1 Remedial Alternative Evaluation Criteria (Consent Order Section VII.D.4.b)

Section VII.D.4.b of the Consent Order requires the evaluation of each remedial alternative for the factors listed below. These factors shall be balanced in proposing a recommended alternative.

8.1.1 Long-Term Reliability and Effectiveness (Consent Order Section VII.D.4.b.i)

This factor considers the magnitude of risks that will remain after implementation of the remedy, the extent of long-term monitoring or other management that will be required after implementation of the remedy, the uncertainties associated with leaving contaminants in place, and the potential for failure of the remedy. Preference is given to a remedy that reduces risks with little long-term management and that has proven effective under similar conditions.

8.1.2 Reduction of Toxicity, Mobility, or Volume (Consent Order Section VII.D.4.b.ii)

This factor considers the reduction in the toxicity, mobility, and volume of contaminants. Preference is given to a remedy that uses treatment to more completely and permanently reduce the toxicity, mobility, and volume of contaminants.

8.1.3 Short-Term Effectiveness (Consent Order Section VII.D.4.b.iii)

This factor considers the short-term reduction in existing risks that the remedy would achieve; the time needed to achieve that reduction; and the short-term risks that might be posed to the community, workers, and the environment during implementation of the remedy. Preference is given to a remedy that quickly reduces short-term risks without creating significant additional risks.

8.1.4 Implementability (Consent Order Section VII.D.4.b.iv)

This factor considers installation and construction difficulties; O&M difficulties; cleanup technology difficulties; permitting and approvals; and the availability of necessary equipment, services, expertise, and storage and disposal capacity. Preference is given to a remedy that can be implemented quickly and easily, and poses fewer difficulties.

8.1.5 Cost (Consent Order Section VII.D.4.b.v)

This factor considers both capital costs and O&M costs. Capital costs shall include, without limitation, construction and installation costs; equipment costs; land development costs; and indirect costs, including engineering costs, legal fees, permitting fees, startup and shakedown costs, and contingency allowances. O&M costs shall include, without limitation, operating labor and materials costs; maintenance labor and materials costs; replacement costs; utilities; monitoring and reporting costs; administrative costs; indirect costs; and contingency allowances. All costs shall be calculated based on their net present value (PV).

Preference is given to a remedy that is less costly but does not sacrifice protection of human health and the environment.

8.2 Evaluation of Alternatives for MDA L

8.2.1 Alternative 1: No Action

The no-action alternative is described in section 7.3.1.

8.2.1.1 Long-Term Reliability and Effectiveness

An increase in risk is associated with implementation of this alternative because it removes institutional controls. No long-term monitoring or other management will be required because no remedy is implemented. Uncertainty is associated with future exposure to waste resulting from the lack of institutional controls. This alternative does not involve implementation of any action; therefore, no potential exists for remedy failure. This alternative does not provide long-term reliability and effectiveness.

8.2.1.2 Reduction of Toxicity, Mobility, or Volume

Under the no-action alternative, no reduction in toxicity, mobility, or volume occurs.

8.2.1.3 Short-Term Effectiveness

Under the no-action alternative, risk is neither created nor alleviated in the short-term.

8.2.1.4 Implementability

Under the no-action alternative, no remedy is implemented.

8.2.1.5 Cost

Under the no-action alternative, no costs are incurred.

8.2.2 Alternative 2A: Multilayer Cover, SVE, and Institutional Controls

This alternative is described in section 7.3.2.

8.2.2.1 Long-Term Reliability and Effectiveness

Installation of a multilayer cover will reduce erosion, biointrusion, and infiltration and will also reduce the potential for exposure. Los Alamos's arid climate is considered potentially incompatible with the typical clay layer of the cover as clay components may become desiccated and crack when installed in arid to semiarid environments. Long-term maintenance requirements for multilayer covers include visual inspection, removal of unwanted debris and large woody plants, erosion control, and mowing.

Operation of an SVE system will remove vapor-phase VOCs from the source area as well as from the vadose zone and will manage future releases and exposure. Some uncertainty and long-term risks are associated with the continuing release of VOCs from the source area. This uncertainty is managed by performance monitoring to evaluate the effectiveness of the SVE system. Long-term maintenance requirements for the SVE system include regular inspections of the system.

Residual uncertainty and long-term risk will be associated with waste that remains in place. Institutional controls will be used to manage this uncertainty by restricting site access.

8.2.2.2 Reduction of Toxicity, Mobility, or Volume

The multilayer cover will reduce mobility of waste by controlling erosion and infiltration but will have no impact on reduction of toxicity or volume. The multilayer cover will not reduce mobility associated with vapor transport.

SVE will be effective in reducing the mobility and volume of VOC contamination. SVE will have an immediate impact on vapor-phase VOC concentrations.

8.2.2.3 Short-Term Effectiveness

A multilayer cover can be constructed in a short time frame (i.e., approximately 1 yr). This cover poses relatively low risk to the community, workers, and the environment during construction because it does not involve any waste excavation or management. The greatest impacts to human health during cover installation are associated with the physical hazards of construction activities and traffic risks while transporting raw materials to the site. Workers will not be exposed to buried waste during cover construction.

SVE equipment is commercially available and extraction boreholes can be constructed within a 3-mo time frame. The SVE system poses relatively low risk to community, workers, and the environment during construction as demonstrated by the SVE pilot study.

This alternative is effective in the short-term without creating significant additional risk.

8.2.2.4 Implementability

The multilayer cover is installed using standard construction techniques and presents minimal installation and construction difficulties. Following installation, low to moderate maintenance is required.

SVE is a well-developed technology, presenting minimal installation and construction difficulties. Operation of the SVE system may require a modification to the Laboratory's air permit.

8.2.2.5 Cost

The capital cost for installation of site fencing as part of institutional controls is estimated to be $163,000. The capital cost for installation of the multilayer cover is estimated to be $ 1,886,000. Total capital costs for installation of the SVE and monitoring systems are estimated to be $1,169,000. Annual SVE operational and monitoring costs are estimated to be $706,000. The total O&M costs for SVE and the multilayer cover are estimated to be $4,495,000.

The indirect capital costs are estimated to be $7,156,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $4,568,000, which includes professional management and contingency.

The total PV cost is estimated to be $19,979,000 (Table 8.2-1). Assumptions and cost estimates are provided in Appendix F.

8.2.3 Alternative 2B: ET Cover, SVE, and Institutional Controls

This alternative is described in section 7.3.3.

8.2.3.1 Long-Term Reliability and Effectiveness

Installation of an ET cover will reduce erosion, biointrusion, and infiltration and will also reduce the potential for future exposure. The ET cover is reliable over the long-term, and it does not suffer from desiccation issues associated with standard RCRA covers. Long-term maintenance requirements for ET covers include visual inspection, removal of unwanted debris and large woody plants, erosion control, and mowing. ET covers have demonstrated effectiveness in arid and semiarid climates and possibility of failure is relatively low (Dwyer et al. 2007, 098276).

Operation of an SVE system will remove vapor-phase VOCs from the source area as well as from the vadose zone and will manage future releases and exposure. Some uncertainty and long-term risks are associated with the continuing release of VOCs from the source area. This uncertainty is managed by performance monitoring to evaluate the effectiveness of the SVE system. Long-term maintenance requirements for the SVE system include regular inspections of the system.

Residual uncertainty and long-term risk will be associated with waste that remains in place. Institutional controls will be used to manage this uncertainty by restricting site access.

8.2.3.2 Reduction of Toxicity, Mobility, or Volume

The ET cover will reduce mobility of waste by controlling erosion and infiltration but will have no impact on reduction of toxicity or volume. The ET cover will not reduce mobility associated with vapor transport.

SVE will be effective in reducing the mobility and volume of VOC contamination. SVE will have an immediate impact on vapor-phase VOC concentrations.

8.2.3.3 Short-Term Effectiveness

An ET cover can be constructed in a short time frame (i.e., approximately 1 yr). This cover poses relatively low risk to the community, workers, and the environment during construction because it does not involve any waste excavation or management. The greatest impacts to human health during cover installation are associated with the physical hazards of construction activities and traffic risks while transporting raw materials to the site. Workers will not be exposed to buried waste during cover construction.

SVE equipment is commercially available and extraction boreholes can be constructed within a 3-mo time frame. The SVE system poses relatively low risk to community, workers, and the environment during construction as demonstrated by the SVE pilot study.

This alternative is effective in the short-term without creating significant additional risk.

8.2.3.4 Implementability

The ET cover is installed using standard construction techniques and presents minimal installation and construction difficulties. Following installation, low to moderate maintenance is required.

SVE is a well-developed technology, presenting minimal installation and construction difficulties. Operation of the SVE system may require a modification to the Laboratory's air permit.

8.2.3.5 Cost

The capital cost for installation of site fencing as part of institutional controls is estimated to be $163,000. The capital cost for installation of the ET cover is estimated to be $1,830,000. Total capital costs for installation of the SVE and monitoring systems are estimated to be $1,169,000. Annual SVE operational and monitoring costs are estimated to be $706,000. The total O&M costs for SVE and the ET cover (including moisture monitoring) are estimated to be $4,967,000.

The indirect capital costs are estimated to be $6,969,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $4,475,000, which includes professional management and contingency.

The total PV cost is estimated to be $20,052,000 (Table 8.2-2). Assumptions and cost estimates are provided in Appendix F.

8.2.4 Alternative 3A: Multilayer Cover (Shafts), Excavation (Pit and Impoundments), SVE, and Institutional Controls

This alternative is described in section 7.3.4.

8.2.4.1 Long-Term Reliability and Effectiveness

Installation of a multilayer cover will reduce erosion, biointrusion, and infiltration as well as the potential for exposure. Los Alamos's arid climate is considered potentially incompatible with the typical clay layer of the cover as clay components may become desiccated and crack when installed in arid to semiarid environments. Long-term maintenance requirements for multilayer covers include visual inspection, removal of unwanted debris and large woody plants, erosion control, and mowing.

Removal of the waste in the pit and impoundments will eliminate that source and the potential for future exposure from the pit and impoundments. Uncertainties will be managed by collecting confirmatory samples to determine the extent of the excavation. After the waste has been removed, the excavation will be backfilled and the area regraded, revegetated, and maintained to establish the vegetation. This alternative transfers the potential impact of the waste to the permitted off-site disposal facility.

Operation of an SVE system will remove vapor-phase VOCs from the source area as well as from the vadose zone and will manage future releases and exposure. Some uncertainty and long-term risks are associated with the continuing release of VOCs from the source area. This uncertainty is managed by performance monitoring to evaluate the effectiveness of the SVE system. Long-term maintenance requirements for the SVE system include regular inspections of the system.

Residual uncertainty and long-term risk will be associated with waste that remains in the shafts. Institutional controls will be used to manage this uncertainty by restricting site access.

8.2.4.2 Reduction of Toxicity, Mobility, or Volume

The multilayer cover over the shafts will reduce mobility of waste in the shafts by controlling erosion and infiltration but will have no impact on reduction of toxicity or volume. The multilayer cover will not reduce mobility associated with vapor transport.

The removal of waste in the pit and impoundments will reduce toxicity and mobility of contaminants from the current site. However, the sorting and segregation of the excavated materials will increase the volume of waste to be disposed of by increasing the amount of packaging materials necessary for transport and disposal.

SVE will be effective in reducing the mobility and volume of VOC contamination. SVE will have an immediate impact on vapor-phase VOC concentrations.

8.2.4.3 Short-Term Effectiveness

A multilayer cover can be constructed for the shafts in a short time frame (i.e., approximately 1 yr). This cover poses relatively low risk to the community, workers, and the environment during construction because it does not involve any waste excavation or management. The greatest impacts to human health during cover installation are associated with the physical hazards of construction activities and traffic risks while transporting raw materials to the site. Workers will not be exposed to buried waste during cover construction.

Excavation, sorting, segregation, analysis, waste determination, transport, and disposal of the waste from the pit and impoundments would be conducted over a 2-yr period. Removal activities have a higher risk for injuries and accidents. Disturbance and excavation of the units increase the possibility of accidental release of hazardous materials. The possibility of release upon disturbance of the units containing unknown chemical waste increases the short-term risk of contaminant dispersal.

Potential accidents resulting from excavation and associated waste handling include industrial hazards/accidents, fires with release of hazardous materials, spills of hazardous materials, and transportation accidents.

SVE equipment is commercially available and extraction boreholes can be constructed within a 3-mo time frame. The SVE system poses relatively low risk to the community, workers, and the environment during construction as demonstrated by the SVE pilot study.

This alternative is effective in the short-term because waste is removed; however, additional risk is created as a result of excavating and transporting the waste.

8.2.4.4 Implementability

The multilayer cover is installed using standard construction techniques and presents minimal installation and construction difficulties. Following installation, low to moderate maintenance is required.

The pit and impoundments will be excavated using a tiered approach based on hazard level and assessment of specific inventory. Excavation will be accomplished using standard excavation methods, unless potential or real hazards dictate remote handling. Empty cylinders in Pit A will be individually examined and analyzed for disposal. Following excavation of waste, no maintenance is required.

SVE is a well-developed technology, presenting minimal installation and construction difficulties. Operation of the SVE system may require a modification to the Laboratory's air permit.

8.2.4.5 Cost

The capital cost for installation of site fencing as part of institutional controls is estimated to be $163,000. The total capital costs for installation of the multilayer cover are estimated to be $1,382,000. Total capital

costs for installation of the SVE and monitoring systems are estimated to be $1,169,000. The total capital costs for the excavation of the pit and impoundments are estimated to be $18,058,000, of which $13,739,000 is estimated for disposal of waste materials. Annual SVE operational and monitoring costs are estimated to be $706,000. The total O&M costs for SVE and the multilayer cover are estimated to be $4,495,000.

The indirect capital costs are estimated to be $39,718,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $4,568,000, which includes professional management and contingency.

The total PV cost is estimated to be $73,612,000 (Table 8.2-3). Assumptions and cost estimates are provided in Appendix F.

8.2.5 Alternative 3B: ET Cover (Shafts), Excavation (Pit and Impoundments), SVE, and Institutional Controls

This alternative is described in section 7.3.5.

8.2.5.1 Long-Term Reliability and Effectiveness

Installation of an ET cover will reduce erosion, biointrusion, and infiltration, as well as the potential for future exposure from the pit and impoundments. The ET cover is reliable over the long-term, and it does not suffer from desiccation issues associated with standard RCRA covers. Long-term maintenance requirements for ET covers include visual inspection, removal of unwanted debris and large woody plants, erosion control, and mowing. ET covers have demonstrated effectiveness in arid and semiarid climates and the possibility of failure is relatively low (Dwyer et al. 2007, 098276).

Removal of the waste in the pit and impoundments will eliminate that source and the potential for future exposure. Uncertainties will be managed by collecting confirmatory samples to determine the extent of the excavation. After the waste has been removed, the excavation will be backfilled and the area regraded, revegetated, and maintained to establish the vegetation. This alternative transfers the potential impact of the waste to the permitted off-site disposal facility.

Operation of an SVE system will remove vapor-phase VOCs from the source area as well as from the vadose zone and will manage future releases and exposure. Some uncertainty and long-term risk are associated with the continuing release of VOCs from the source area. This uncertainty is managed by performance monitoring to evaluate the effectiveness of the SVE system. Long-term maintenance requirements for the SVE system include regular inspections of the system.

Residual uncertainty and long-term risk will be associated with waste that remains in the shafts. Institutional controls will be used to manage this uncertainty by restricting site access.

8.2.5.2 Reduction of Toxicity, Mobility, or Volume

The ET cover will reduce mobility of waste by controlling erosion and infiltration but will have no impact on reduction of toxicity or volume. The ET cover will not reduce mobility associated with vapor transport.

The removal of waste in the pit and impoundments will reduce toxicity and mobility of contaminants from the current site. However, the sorting and segregation of the excavated materials will increase the volume of waste to be disposed of by increasing the amount of packaging materials necessary for transport and disposal.

SVE will be effective in reducing the mobility and volume of VOC contamination. SVE will have an immediate impact on vapor-phase VOC concentrations.

8.2.5.3 Short-Term Effectiveness

An ET cover can be constructed for the shafts in a short time frame (i.e., approximately 1 yr). This cover poses relatively low risk to the community, workers, and the environment during construction because it does not involve any waste excavation or management. The greatest impacts to human health during cover installation are associated with the physical hazards of construction activities and traffic risks while transporting raw materials to the site. Workers will not be exposed to buried waste during cover construction.

Excavation, sorting, segregation, analysis, waste determination, transport, and disposal of the waste in the pit and impoundments would be conducted over a 2-yr period. Removal activities have a higher risk for injuries and accidents. Disturbance and excavation of the units increase the possibility of accidental release of hazardous materials. The possibility of release upon disturbance of the units containing unknown chemical waste increases the short-term risk of contaminant dispersal.

Potential accidents resulting from excavation and associated waste handling include industrial hazards/accidents, fires with release of hazardous materials, spills of hazardous materials, and transportation accidents.

SVE equipment is commercially available and extraction boreholes can be constructed within a 3-mo time frame. The SVE system poses relatively low risk to community, workers, and the environment during construction as demonstrated by the SVE pilot study.

This alternative is effective in the short-term, as waste is removed; however, additional risk is created as a result of excavating and transporting waste materials.

8.2.5.4 Implementability

The ET cover is installed using standard construction techniques and presents minimal installation and construction difficulties. Following installation, low to moderate maintenance is required.

The pit and impoundments will be excavated using a tiered approach based on hazard level and assessment of specific inventory. Excavation will be accomplished using standard excavation methods, unless potential or real hazards dictate remote handling. Empty cylinders in Pit A will be individually examined and analyzed for disposal. Following excavation of waste, no maintenance is required.

SVE is a well-developed technology, presenting minimal installation and construction difficulties. Operation of the SVE system may require a modification to the Laboratory's air permit.

8.2.5.5 Cost

The capital cost for installation of site fencing as part of institutional controls is estimated to be $163,000. The total capital costs for installation of the ET cover are estimated to be $1,398,000. The total capital costs for installation of the SVE and monitoring systems are estimated to be $1,169,000. The total capital costs for the excavation of the pit and impoundments are estimated to be $18,058,000, of which $13,739,000 is estimated for disposal of waste materials.

Annual SVE operational and monitoring costs are estimated to be $706,000. The total O&M costs for SVE and the ET cover (including moisture monitoring) are estimated to be $4,967,000.

The indirect capital costs are estimated to be $39,708,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $4,804,000, which includes professional management and contingency.

The total PV cost is estimated to be $74,305,000 (Table 8.2-4). Assumptions and cost estimates are provided in Appendix F.

8.2.6 Alternative 4: Excavation, SVE, and Institutional Controls

This alternative is described in section 7.3.6.

8.2.6.1 Long-Term Reliability and Effectiveness

Removal of the waste in the pit, impoundments, and shafts will eliminate the source and the potential for future exposure. Uncertainties will be managed by collecting confirmatory samples to determine the required extent of the excavation. After the waste has been removed, the excavation will be backfilled and the area regraded, revegetated, and maintained to establish the vegetation. This alternative transfers the potential impact of the waste to the permitted off-site disposal facility.

Operation of an SVE system will remove vapor-phase VOCs from the vadose zone. Pore-gas monitoring will be used to evaluate the effectiveness of the system. Long-term maintenance requirements for the SVE system include regular inspections of the system.

Institutional controls will be used to manage residual uncertainty associated with the alternative by restricting site access.

8.2.6.2 Reduction of Toxicity, Mobility, or Volume

The removal of waste in the pit, impoundments, and shafts will reduce toxicity and mobility of contaminants from the current site. However, the sorting and segregation of the excavated materials will increase the volume of waste to be disposed of by increasing the amount of packaging materials necessary for transport and disposal.

SVE will be effective in reducing the mobility and volume of VOC contamination. SVE will have an immediate impact on vapor-phase VOC concentrations.

8.2.6.3 Short-Term Effectiveness

Excavation, sorting, segregation, analysis, waste determination, transport, and disposal of the waste would be conducted over a 2-yr period. Removal activities have a higher risk for injuries and accidents. Disturbance and excavation of the units increase the possibility of accidental release of hazardous materials. The possibility of release upon disturbance of the units containing unknown chemical waste increases the short-term risk of contaminant dispersal.

Potential accidents resulting from excavation and associated waste handling include industrial hazards/accidents, fires with release of hazardous materials, spills of hazardous materials, and transportation accidents.

SVE equipment is commercially available and extraction boreholes can be constructed within a 3-mo time frame. The SVE system poses relatively low risk to the community, workers, and the environment during construction as demonstrated by the SVE pilot study.

This alternative is effective in the short-term, as waste is removed; however, additional risk is created as a result of excavating and transporting waste materials.

8.2.6.4 Implementability

The pit, impoundments, and shafts will be excavated using a tiered approach based on hazard level and assessment of specific inventory. Excavation will be accomplished using standard excavation methods, unless potential or real hazards dictate remote handling. Empty cylinders in Pit A will be individually examined and analyzed for disposal. Following excavation of waste, no maintenance is required.

SVE is a well-developed technology, presenting minimal installation and construction difficulties. Operation of the SVE system may require a modification to the Laboratory's air permit.

8.2.6.5 Cost

The capital cost for installation of site fencing as part of institutional controls is estimated to be $163,000. The total capital costs for installation of the SVE and monitoring systems are estimated to be $1,169,000. The total capital costs for the excavation of the pit, impoundments and shafts are estimated to be $55,662,000, of which $37,375,000 is estimated for disposal of waste materials.

Annual SVE operational and monitoring costs are estimated to be $706,000. A 3-yr O&M time frame is assumed for the SVE system for a total O&M cost of $2,119,000.

The indirect capital costs are estimated to be $109,141,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $2,479,000, which includes professional management and contingency.

The total PV cost is estimated to be $181,863,000 (Table 8.2-5). Assumptions and cost estimates are provided in Appendix F.

9.0 SELECTION OF THE RECOMMENDED CORRECTIVE MEASURES ALTERNATIVE

The purpose of this CME is to identify, develop, and evaluate corrective measures alternatives and recommend the corrective measure for MDA L. Alternatives that met the threshold criteria in section 7 were evaluated against the remedial alternative evaluation criteria (i.e., the balancing criteria) in section 8. A comparative analysis of the alternatives and their relative ranking for each of the balancing criteria is provided in section 9.1. The recommended alternative is discussed in section 9.2.

9.1 Comparative Analysis of the Alternatives for MDA L

Alternatives were evaluated against the five balancing criteria in section 8. Each alternative has been rated per the rating system shown in Table 9.1-1. The relative rating for each alternative against the balancing criteria is provided in Table 9.1-2.

9.1.1 Long-Term Reliability and Effectiveness

Alternative 4, excavation with SVE and institutional controls, provides the highest degree of long-term reliability and effectiveness because all the waste materials at the site are removed (rating = 5 on a 1 to 5 scale). Alternative 1, no action, provides the least degree of long-term reliability and effectiveness because no action is taken and therefore is rated the lowest, 1. SVE is a component of each of the action alternatives and therefore does not impact the rating when determining long-term reliability and effectiveness. Alternatives that include excavation of the pit and impoundments are rated higher than the alternatives that do not because the source is removed and therefore is more protective of human health and the environment in the long-term.

An ET cover provides a higher degree of long-term reliability and effectiveness compared with the multilayer cover because of the potential desiccation in the clay layers of the multilayer cover. Therefore, Alternative 3B, ET cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, is rated higher, 4, than Alternative 3A, multilayer cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, which is rated 3. While Alternative 2B, ET cover (shafts, pit, and impoundments) with SVE and institutional controls, is rated higher, 3, than Alternative 2A, multilayer cover (shafts, pit, and impoundments) with SVE and institutional controls, which is rated 2.

9.1.2 Reduction of Toxicity, Mobility, or Volume

Alternative 4, excavation with SVE and institutional controls, provides the highest degree of reduction of toxicity, mobility, or volume because all wastes at the site are removed (rating = 5 on a 1 to 5 scale). Alternative 1, no action, provides the least degree of reduction of toxicity, mobility, or volume because no action is taken and therefore is rated the lowest, 1. SVE is a component of each of the action alternatives, and therefore does not impact the rating when determining reduction of toxicity, mobility, or volume. Alternatives that include excavation of the pit and impoundments are rated higher than the alternatives that do not because the source is removed and therefore toxicity, mobility, and volume are reduced.

Each type of cover provides similar performance and is rated equally. Therefore, Alternatives 3A, multilayer cover (shafts), excavation (pit and impoundments) with SVE and institutional controls, and 3B, ET cover (shafts), excavation (pit and impoundments) with SVE and institutional controls, are rated higher, 4, than Alternatives 2A, multilayer cover (shafts, pit, and impoundments) with SVE and institutional controls, and 2B, ET cover (shafts, pit, and impoundments) with SVE and institutional controls, which are rated 3.

9.1.3 Short-Term Effectiveness

SVE is a component of each of the action alternatives and therefore does not impact the rating when determining short-term effectiveness. Excavation of waste materials achieves risk reduction by removing the source material but adds short-term risk due to the hazards associated with performing the tasks. For this reason, alternatives that include excavation are rated lower than alternatives that do not include excavation. Because Alternative 4, excavation with SVE and institutional controls, includes excavation of all waste materials, it is rated lowest (rating = 1 on a 1 to 5 scale). Alternatives 3A, multilayer cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, and 3B, ET cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, are both rated 2.

Each type of cover provides similar performance as potential exposure pathways are broken. Because excavation is not required as part of Alternatives 2A, multilayer cover (shafts, pit, and impoundments) with SVE and institutional controls, and 2B, ET cover (shafts, pit, and impoundments) with SVE and

institutional controls, they are rated equally, 4. No action is taken under Alternative 1 and, while no additional risk is generated, there is also no risk reduction. For these reasons, Alternative 1 is rated a 3.

9.1.4 Implementability

Alternative 1, no action, is the easiest to implement because no remedy is required, so it is rated the highest (rating = 5 on a 1 to 5 scale). SVE is a component of each of the action alternatives and therefore does not impact the rating when determining implementability. Excavation of waste materials adds complexity to implementability because of safety controls for performing the tasks and handling the waste. For this reason, alternatives that include excavation are rated lower than other alternatives. Because Alternative 4, excavation with SVE and institutional controls, includes excavation of all waste materials, it is rated the lowest, 1. Alternatives 3A, multilayer cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, and 3B, ET cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, are rated slightly higher, 2.

Since each type of cover has similar design and construction requirements shown to be implementable, and excavation is not required as part of Alternatives 2A, multilayer cover (shafts, pit, and impoundments) with SVE and institutional controls, and 2B, ET cover (shafts, pit, and impoundments) with SVE and institutional controls, they are rated equally, 3.

9.1.5 Cost

Alternative 1, no action, has no cost, so it is rated the highest (rating = 5 on a 1 to 5 scale). SVE is a component of each of the action alternatives and therefore does not impact the rating when costs are compared. The cost criterion is impacted most by the excavation of waste materials, handling of the waste, and disposal of the waste. For this reason, alternatives that include excavation are rated lower than the alternatives that do not include excavation. Because Alternative 4, excavation with SVE and institutional controls, includes excavation of all waste materials and has the highest cost, it is rated the lowest, 1. Alternatives 3A, multilayer cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, and 3B, ET cover (shafts), excavation (pit and impoundments) with SVE, and institutional controls, are rated slightly higher, 2.

Capital costs associated with the excavation and cover alternatives (Alternatives 3A/3B) are significantly higher than the cover-only alternatives (Alternatives 2A/2B). Since each type of cover has similar cost requirements and because excavation is not required as part of Alternatives 2A, multilayer cover (shafts, pit, and impoundments) with SVE and institutional controls, and 2B, ET cover (shafts, pit, and impoundments) with SVE and institutional controls, they are rated equally, 4.

9.2 Selection of Recommended Corrective Measure

Based on the alternative evaluation, the recommended alternative for MDA L is Alternative 2B: ET cover, SVE, and institutional controls.

The recommended alternative effectively addresses the RAOs developed from the CSM and from the uncertainty associated with unlined pit and impoundments. The RAOs include the following:

- prevent human and ecological exposure to the waste through excavation, biointrusion, and erosion
- prevent human and ecological exposure to the contaminated surface soils and/or subsurface soils through excavation and biointrusion

- prevent groundwater from being impacted above a regulatory standard by the transport of VOCs through soil vapor
- prevent the creation of contaminated leachate by restricting the infiltration of water into the waste

An ET cover can be constructed in a short time frame (i.e., approximately 1 yr). This cover poses relatively low risk to the community, workers, and the environment during construction because it does not involve any waste excavation or management. SVE equipment is commercially available, and extraction boreholes can be constructed within a 3-mo time frame. The SVE system poses relatively low risk to the community, workers, and the environment during construction as demonstrated by the SVE pilot study. This alternative achieves cleanup in a timely manner.

An ET cover will provide protection against erosion, direct contact, biointrusion, and moisture infiltration. The ET cover puts a minimum of 6.5 ft of varying soil layers between a potential human or ecological receptor and the top of the disposal pit, thereby breaking the exposure pathway. The ET cover is designed to restrict infiltration of water, thereby breaking the contaminant transport pathway (via leaching) to groundwater. SVE will remove soil-vapor contaminants and will restrict the downward migration of VOC-contaminated soil vapors, thereby breaking the contaminant transport pathway (via volatilization) to groundwater. Institutional controls will be implemented to provide access controls, thereby restricting human exposure. This alternative is protective of human health and the environment.

An ET cover will minimize or eliminate infiltration of precipitation that could otherwise mobilize subsurface contaminants. An ET cover will also limit exposure to waste and contaminated surface and subsurface soils and will reduce the potential for erosion and dust generation of contaminated surface soils. The potential exists for continued release of VOCs to the vadose zone that may diffuse to the groundwater. However, these releases would be controlled by SVE, which removes vapor-phase contaminants and prevents their diffusion to groundwater. This alternative will control sources and the migration of released contaminants.

No waste is expected to be generated during the construction of the ET cover. The off-gas waste stream generated from the operation of the SVE system can be effectively managed to comply with waste management standards. Remediation wastes will be managed in accordance with state and federal regulations under this alternative.

The CSMs have been refined to illustrate the impact of the recommended alternative on the source areas and release mechanisms, and the resulting reduction in exposure potential (e.g., incomplete pathways) and future risk. The refined CSMs are shown in Figures 9.2-1 and 9.2-2.

10.0 DESIGN CRITERIA TO MEET CLEANUP OBJECTIVES

This section presents a preliminary plan and key specifications for design and implementation of the recommended alternative.

10.1 Design Approach

Selection of the recommended alternative requires designing an ET cover and finalizing the design of an SVE system during the CMI phase for MDA L. The design process will include the following.

ET Cover

The ET cover at MDA L will consist of two parts. The first part of the cover, approximately 0.15 acres, will be on the western end of MDA L above Shafts 29–34. The second part of the cover, approximately 0.75 acres, will be on the eastern end of MDA L above Shafts 1–28 and the pit and impoundments. The preliminary cover design includes

- 1 ft of angular cobbles with a minimum diameter of 4 to 6 in. to act as a biointrusion barrier;
- 0.5 ft of sand and gravel mixture to prevent the mixing of soil layers;
- 3.5 ft of natural or amended soil meeting the water storage capacity of a typical sandy loam; and
- 1.5 ft of natural or amended soil and vegetation to ensure a desired stand of vegetation is maintained.

The preliminary ET cover design may be modified based on further evaluation of the critical design requirements. The critical design requirements include the following:

- identifying critical infiltration events, including identification of the design precipitation event (i.e., maximum precipitation event that the design can endure) or series of events.
- determining the minimum required thickness and contours required to ensure the ET cover can control erosion and infiltration over the 100-yr maintenance period (per DOE guidance) based on precipitation events identified above. Also, determining the minimum soil thickness required to establish and maintain vegetation.
- determining the minimum required water-storage capacity of MDA L soil based on design infiltration events identified above.
- identifying the seed mixture to be used, meeting with representatives of San Ildefonso Pueblo to ensure the mixture has no adverse effect on adjacent Pueblo lands, and identifying the surface treatment to be employed before seeding and the frequency of watering necessary to establish vegetation on the cover.
- planning for long-term maintenance requirements of the ET cover that includes annual inspection and repair for erosion and subsidence, removal of debris and large woody plants, removal of burrowing animals, and mowing as needed to maintain the ET cover.

SVE

The preliminary SVE design includes the following principal assumptions and components:

- Installation of six SVE boreholes (Figure 7.3-3), each to a depth of approximately 200 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened 40 to 200 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA L to provide effective extraction of VOC vapors in the vadose zone (see section 3 and Appendix B).
- Installation of three SVE boreholes (Figure 7.3-3) into the Cerro Toledo interval (Qct unit) (approximately 250 to 300 ft bgs). These boreholes will be screened within the Qct unit to take advantage of its high permeability. This unit can provide a wider ROI quantity for the SVE system. The purpose of these boreholes is to provide a barrier against farther downward migration of vapor-phase contaminants in the vadose zone.

- Two portable, skid-mounted SVE units will be cycled between the six upper zone extraction boreholes during operations. Each SVE unit will utilize a 15 hp blower motor, providing up to 200 scfm at a vacuum of 120 in. of water. The system will be optimized during the initial setup, although a vacuum between 50 and 70 in. of water has been demonstrated to be effective (see section 2.5.3). A third SVE unit, similar to that described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction borehole spacing in the upper units will be based on a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction borehole spacing in the Qct unit is based on a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2 for each borehole.

The preliminary SVE design minimizes the number of extraction boreholes while providing coverage over the majority of the subsurface plume. The preliminary design also allows for the placement of additional extraction boreholes if the predicted ROI is not reached. Permeability testing within each borehole will also be performed to verify design assumptions.

The most efficient means of operating the SVE system is intermittent operation with alternating periods of extraction and rebound. The operational plan for the SVE system is provided in Appendix I. SVE will be conducted at an extraction borehole for 30 d. After 30 d of extraction, the SVE system will be moved to another borehole. Performance monitoring at select pore-gas monitoring wells will be conducted at the end of each 30-d operational period. Two SVE units can complete one active SVE operational cycle of all six extraction boreholes over a 90 to 105-d period. SVE operations in the Qct unit will follow similar operations. Performance monitoring will provide important information on the effectiveness of the removal and the rebound behavior of the VOC plume, allowing for the opportunity to optimize the operation of the system (e.g., extraction run time, vacuum pressure).

10.2 Preliminary Design Criteria and Rationale

Preparation of the CMI plan includes a schedule for design of the recommended alternative, including development of design drawings, calculations, and supporting documentation that will be submitted to NMED according to the CMI schedule. The CMI plan will be written to ensure the following:

- The cover will have sufficient thickness and will be contoured to control erosion resulting from the worst-case precipitation event.
- The cover will have sufficient thickness and incorporate a biointrusion barrier to restrict deep-rooting vegetation and burrowing animals.
- The cover will have sufficient capacity to store the “maximum” infiltration quantity resulting from the worst-case precipitation event until it can be removed through ET.
- The proposed seed mixture used to stabilize the cover with vegetation will closely emulate the local shallow-rooting plant community, will ensure the vegetative cover remains viable, and will have no detrimental effect on neighboring Pueblo lands.
- The surface treatment method will encourage native vegetation establishment and growth and reduce erosion.
- The proposed SVE system will effectively remove VOC mass and limit VOC migration.

10.2.1 Surface Treatment

Surface treatments, such as soil nutrients, a gravel layer, or a soil-gravel admixture, may be warranted in the semiarid climate at the Laboratory to help establish native vegetation and reduce erosion. During the CMI design phase, a seed mix will be specified to stabilize the cover with native vegetation similar to the undisturbed and well-established plant communities inhabiting Mesita del Buey.

The addition of a layer of soil-gravel admixture on the surface of the cover provides erosion protection for the design storm event and promotes ET from native species of grasses. Erosion and water-balance studies at the Laboratory indicate moderate amounts of gravel mixed into the cover topsoil will control both water and wind erosion with little effect on the vegetation or the soil-water balance (Wilson et al. 2005, 092034). The protection from water erosion depends on the depth, velocity, and duration of stormwater flowing across the MDA L cover. Flow values can be established from the physical properties (i.e., slope, convex or concave grading, slope uniformity, and length of flow paths) of the cover and the intensity of the precipitation (i.e., precipitation rates, infiltration versus runoff relationships, snowmelt, and off-site flows). As wind blows and water flows over the cover surface, some winnowing of fines from the admixture is expected, creating a vegetated, erosion-resistant surface.

An ET cover is intended to function in unsaturated conditions; consequently, obtaining very low saturated hydraulic conductivity is not essential to a successful cover. The cover soil moisture characteristics and cover compaction density are crucial parameters. Compaction density requirements will be based on the design criteria used but generally will achieve a density in the upper soil layer that approximates the surrounding undisturbed soil. Uniformity of compaction is critical to avoid creating preferential infiltration pathways.

The recommendation on surface treatment is based on review of site-specific conditions at MDA L and Laboratory data from cover experiments at TA-51 (Nyhan et al. 1996, 063111). The best surface layer will be chosen during the CMI design phase and after discussions with NMED. Additional information and specifications for the surface treatment is provided in Appendix H.

10.2.2 Cover Soil

The performance of the ET cover relies on its thickness, materials, and placement. The ET cover for MDA L will be thick enough to ensure that the water-storage capacity exceeds the maximum infiltration resulting from the design precipitation event. Additional information and specifications for the cover soil are provided in Appendix H.

10.2.3 Filter Media

Inclusion of a filter media layer with a particle size between that of the cover soil and the biointrusion barrier will enhance the water storage of the cover by providing a capillary break. Additional information and specifications for the filter media are provided in Appendix H.

10.2.4 Biointrusion Barrier

When the final cover depth is established in the CMI, the biointrusion barrier requirements will be evaluated to optimize performance. The biointrusion barrier must prevent deep-rooting plants and burrowing animals from encroaching into the waste where they may become exposed, create conduits for water infiltration, or transport waste to the surface. Additional information and specifications for the biointrusion barrier are provided in Appendix H.

10.3 General O&M Requirements

An O&M manual based on the design and monitoring requirements for the ET cover will be prepared and submitted as part of the CMI plan. O&M considerations will include irrigation needs, moisture monitoring, erosion monitoring, biota monitoring, and cover maintenance.

An O&M manual based on the design and monitoring requirements for the SVE system will be prepared and submitted as part of the CMI plan. The SVE system will be operated as described in Appendix I.

Long-Term Monitoring Requirements

Groundwater monitoring of the regional aquifer will be conducted in accordance with requirements in the Laboratory's Hazardous Waste Facility Permit.

Long-term subsurface vapor monitoring will be performed according to the plan in Appendix I or until NMED determines that monitoring is not necessary.

The coupled monitoring network for MDA L uses vapor monitoring in the vadose zone near the disposal units, along with regional aquifer monitoring, to provide a defense-in-depth monitoring approach that will demonstrate the effectiveness of the final remedy and satisfy long-term monitoring requirements.

10.4 Additional Engineering Data Requirements

Before the CMI design is completed, additional data are required, including, but not limited to

- verifying the existing depths to the top of waste in Pit A, the impoundments, and the shafts using ground-penetrating radar to accurately determine the operational cover thickness and
- testing the geotechnical properties of all materials used for the ET cover.

10.5 Additional Requirements

10.5.1 Permits and Regulatory Requirements

NMED will select a final remedy, issue a Statement of Basis for the selected remedy, and designate a period of time for public comment (section 11). The emission source from the SVE system will be evaluated to determine if a permit is required to operate the SVE system.

10.5.2 Access, Easements, Right-of-Way Agreements

Access, easements, and right-of-way agreements are managed through the Laboratory and will be developed as required once the corrective measure is selected.

10.5.3 Health and Safety Requirements

A site-specific health and safety plan will be prepared to describe the health and safety requirements to be followed during construction of the ET cover, construction and installation of the SVE boreholes and system, O&M activities, and monitoring activities.

10.5.4 Community Relations Activities

A community-relations program will be developed in accordance with Section VII.E.4 of the Consent Order to keep Northern New Mexico stakeholders and other interested parties regularly informed of project activities and progress at MDA L.

11.0 SCHEDULE FOR COMPLETION OF ACTIVITIES

The Consent Order requires that a schedule for completion of activities be submitted in the CME report that includes specific and intermediate milestones. Activities leading to completion of the remedy include submittal, approval, and completion of activities specified in a Class 2 Permit Modification for closure of the aboveground CSU; planning, design, and construction of the ET cover; planning, design, installation, testing and operation of the SVE system and monitoring systems. Several milestones for completion of the corrective measure at MDA L are presented in the Consent Order, along with schedule updates. In addition to these milestones, the Consent Order requires the CME report to include a proposed schedule for remedy-related activities, such as bench tests, pilot tests, and other remedial actions. The schedule identifies the duration of corrective action operations, the frequency of monitoring and sampling activities, and the dates for submitting inspection and monitoring reports to NMED, including all status reports and preliminary data.

Proposed Milestones

Proposed milestones include the following.

- NMED will prepare a Statement of Basis for remedy selection and issue the statement for public comment.
- NMED will receive public comments on the Statement of Basis for at least 60 d following public notice and will select a final remedy and issue a response to comments within 90 d of the end of the comment period, or at another appropriate time. NMED will provide an opportunity for a public hearing that may extend the public comment period.
- The Laboratory will request to submit a CMI plan within 1 yr after NMED selects a final remedy. This plan will contain detailed engineering design drawings and system specifications for all elements of the remedy and a schedule for implementation of the corrective action.
- A Class 1 Permit Modification will be submitted to NMED to perform D&D of existing structures on the northern-half of the aboveground CSU.
- A Class 2 Permit Modification for closure of the northern-half of the aboveground CSU will be submitted to NMED and approved before the CMI plan will be implemented.
- The corrective measure will be implemented according to the schedule in the CMI plan.
- The Laboratory will submit a remedy completion report by December 6, 2015.
- Pore-gas monitoring will be conducted as discussed in Appendix I.
- Monitoring and maintenance, including reporting requirements, will be completed according to the CMI plan.
- Following completion of the remedy, groundwater monitoring will be conducted and reported as required by the Laboratory's Hazardous Waste Facility Permit.

12.0 REFERENCES AND MAP DATA SOURCES

12.1 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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12.2 Map Data Sources

Hypsography, 20 and 100 Foot Contour Intervals; Los Alamos National Laboratory, ENV-Environmental Remediation and Surveillance Program; 1991

LANL DOE Boundary; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; Development Edition of 05 January 2005

LANL Technical Areas; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; Development Edition of 05 January 2005

Materials Disposal Areas; Los Alamos National Laboratory, ENV-Environmental Remediation and Surveillance Program; ER2004-0221; 1:2,500 Scale Data; 23 April 2004

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; Development Edition of 17 January 2006

Waste Storage Features; Los Alamos National Laboratory, ENV-Environmental Remediation and Surveillance Program, ER2005-0748; 1:2,500 Scale Data; 06 October 2005

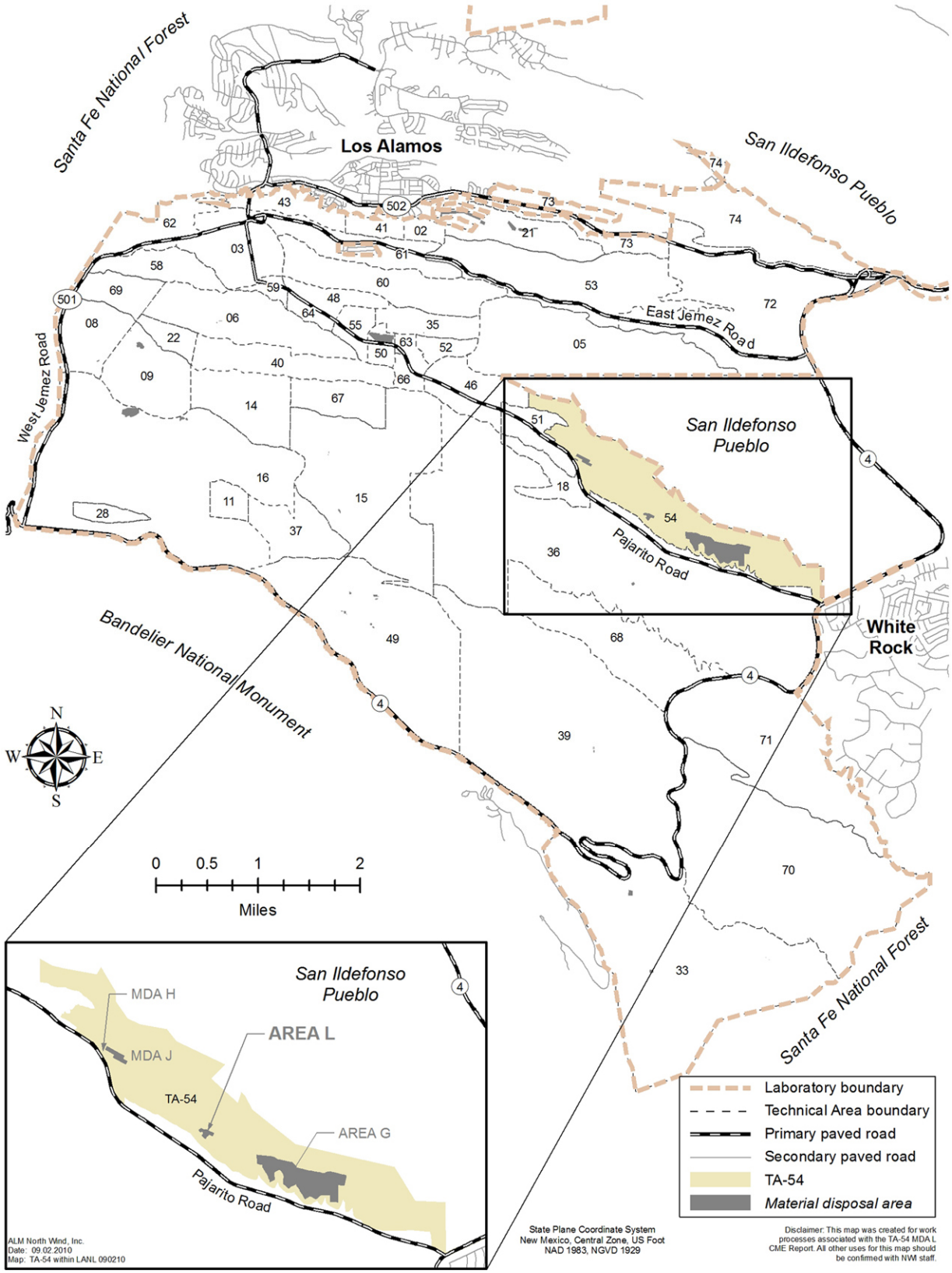
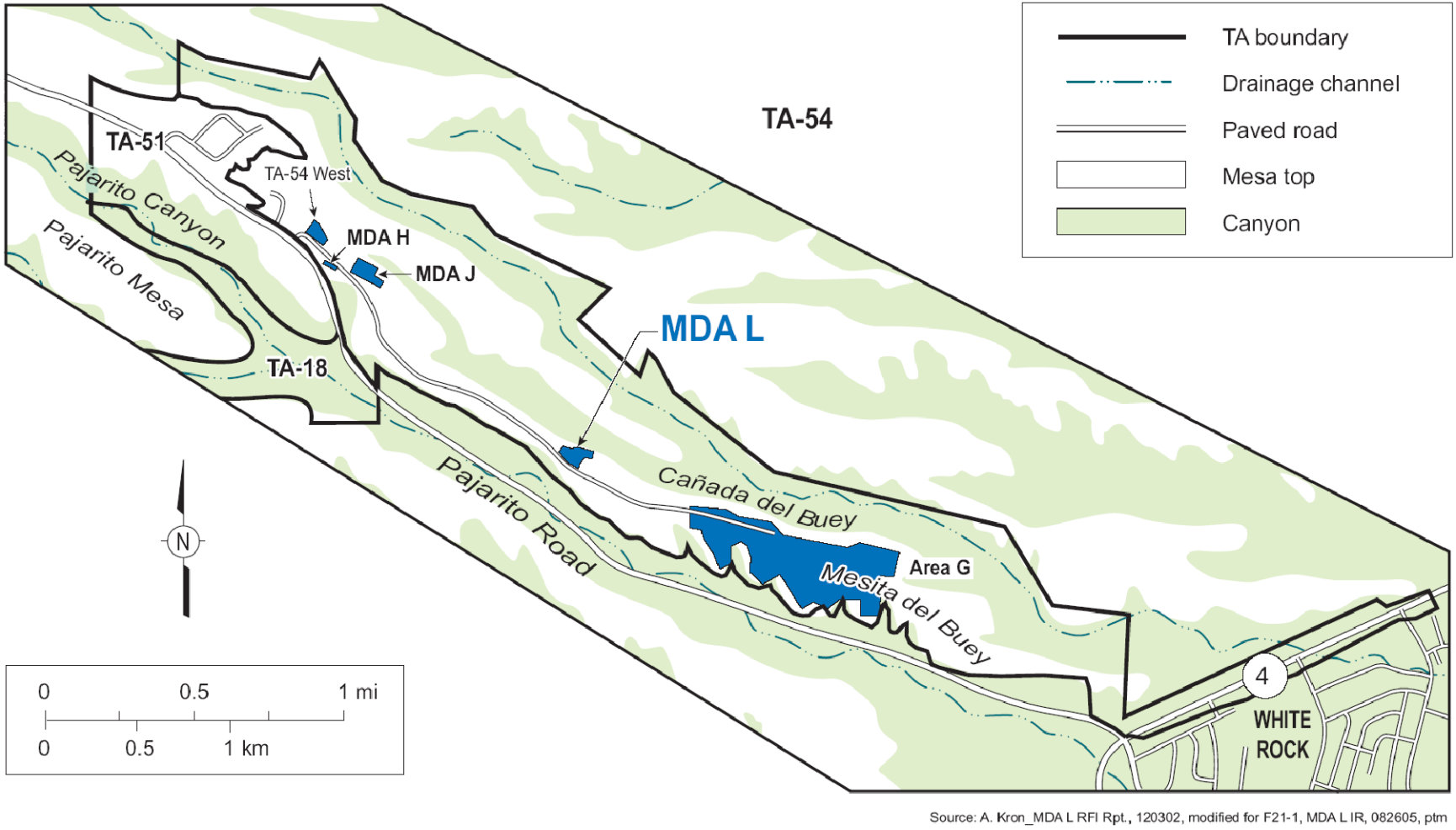


Figure 1.0-1 Location of MDA L in TA-54 with respect to Laboratory technical areas and surrounding landholdings



Source: A. Kron_MDA L RFI Rpt., 120302, modified for F21-1, MDA L IR, 082605, ptm

Figure 1.0-2 Location of MDA L in TA-54

Figure 2.0-1 Inactive subsurface disposal units and existing surface structures at MDA L

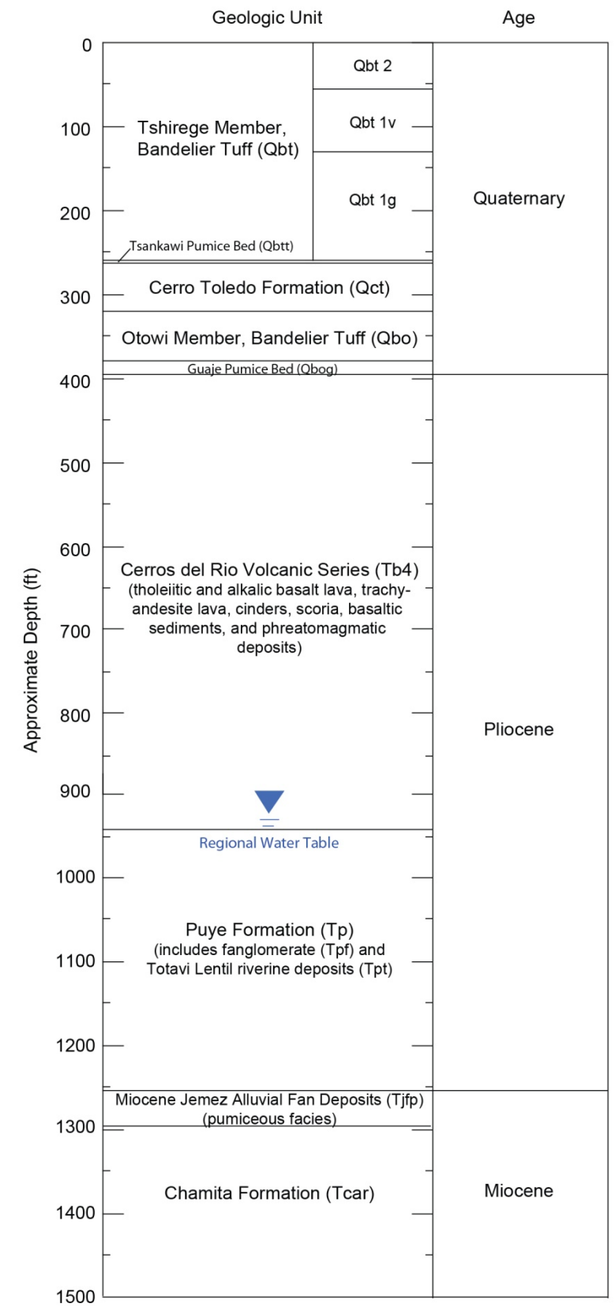


Figure 2.2-1 Generalized stratigraphy beneath MDA L

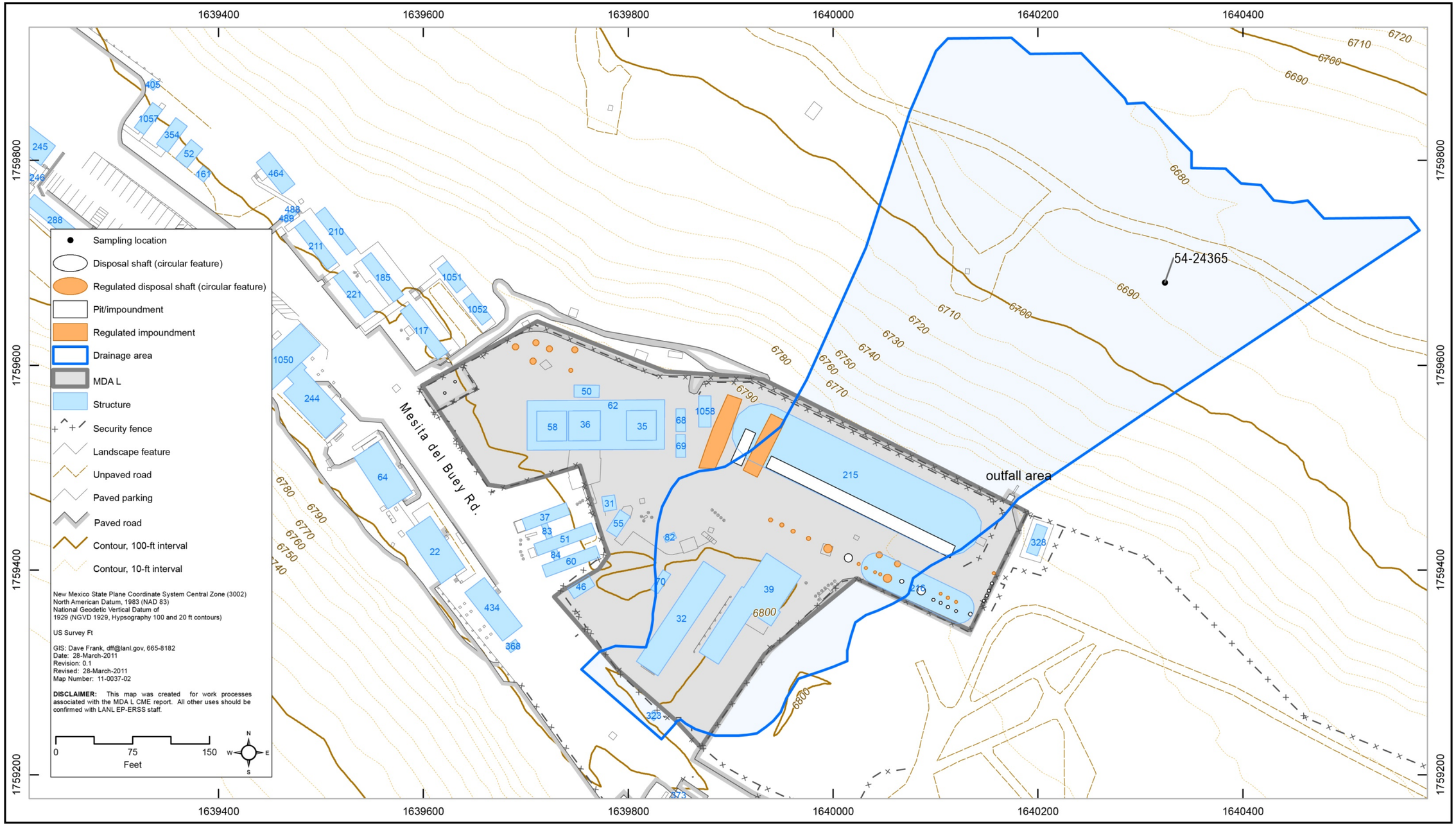


Figure 2.2-2 MDA L drainage area and 2004–2005 channel sediment sampling locations

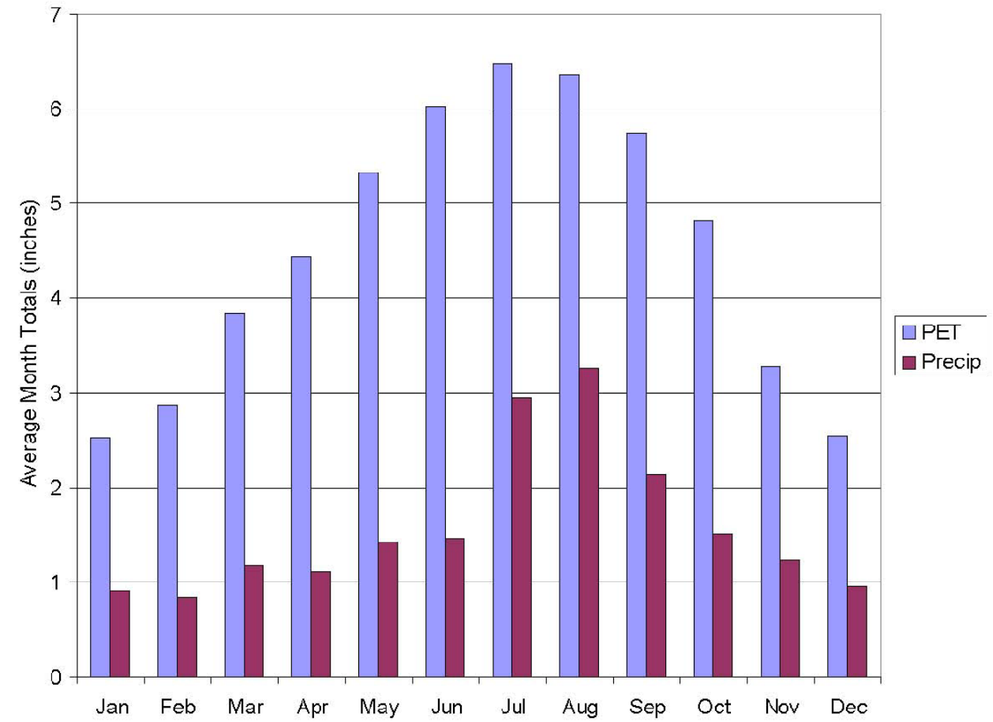
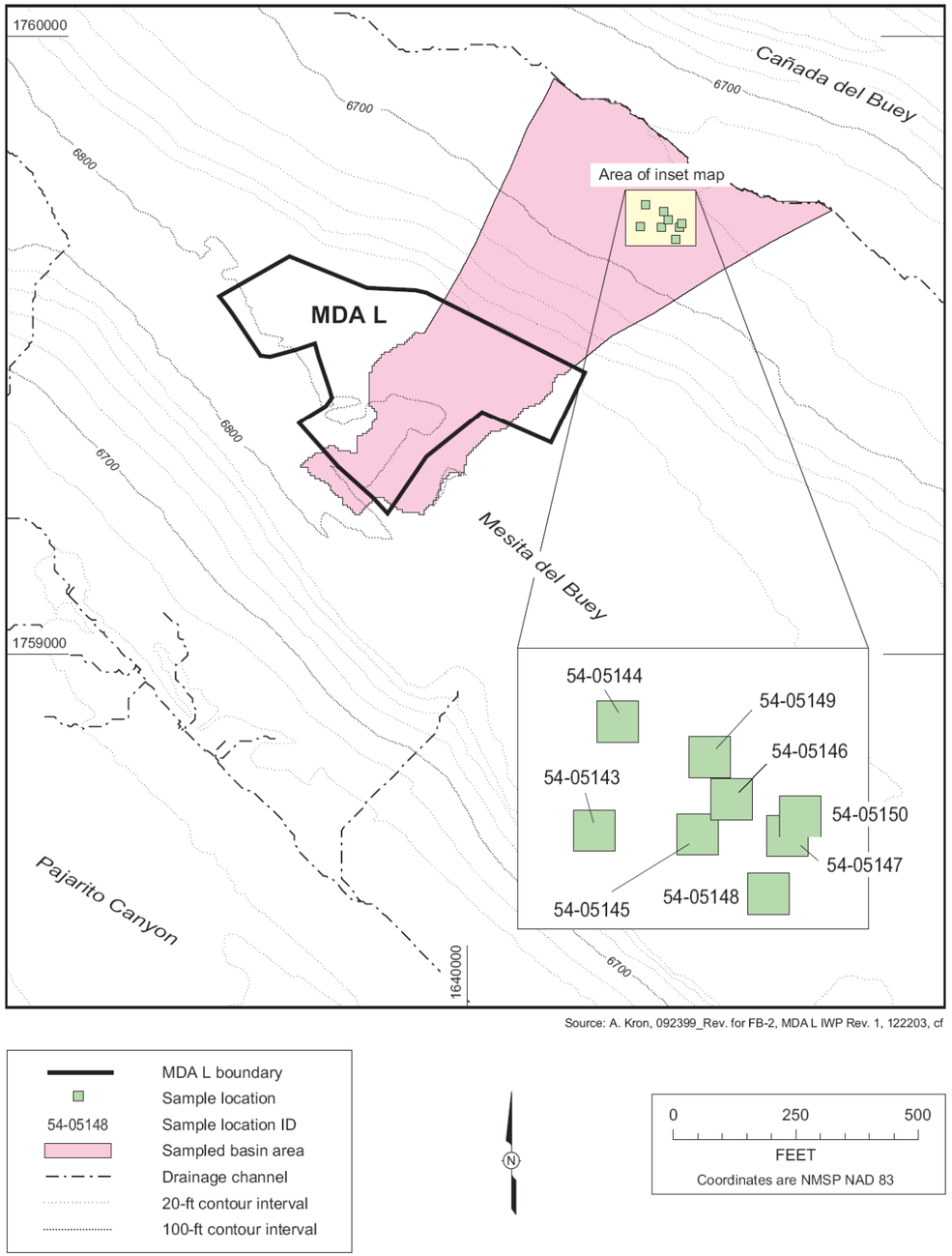


Figure 2.2-3 Climate's demand for water (potential ET) versus supply of water (precipitation) for Los Alamos, New Mexico



Source: A. Kron, 092399_Rev. for FB-2, MDA L IWP Rev. 1, 122203, cf

Figure 2.5-1 Sediment sampling locations at MDA L during the Phase I RFI

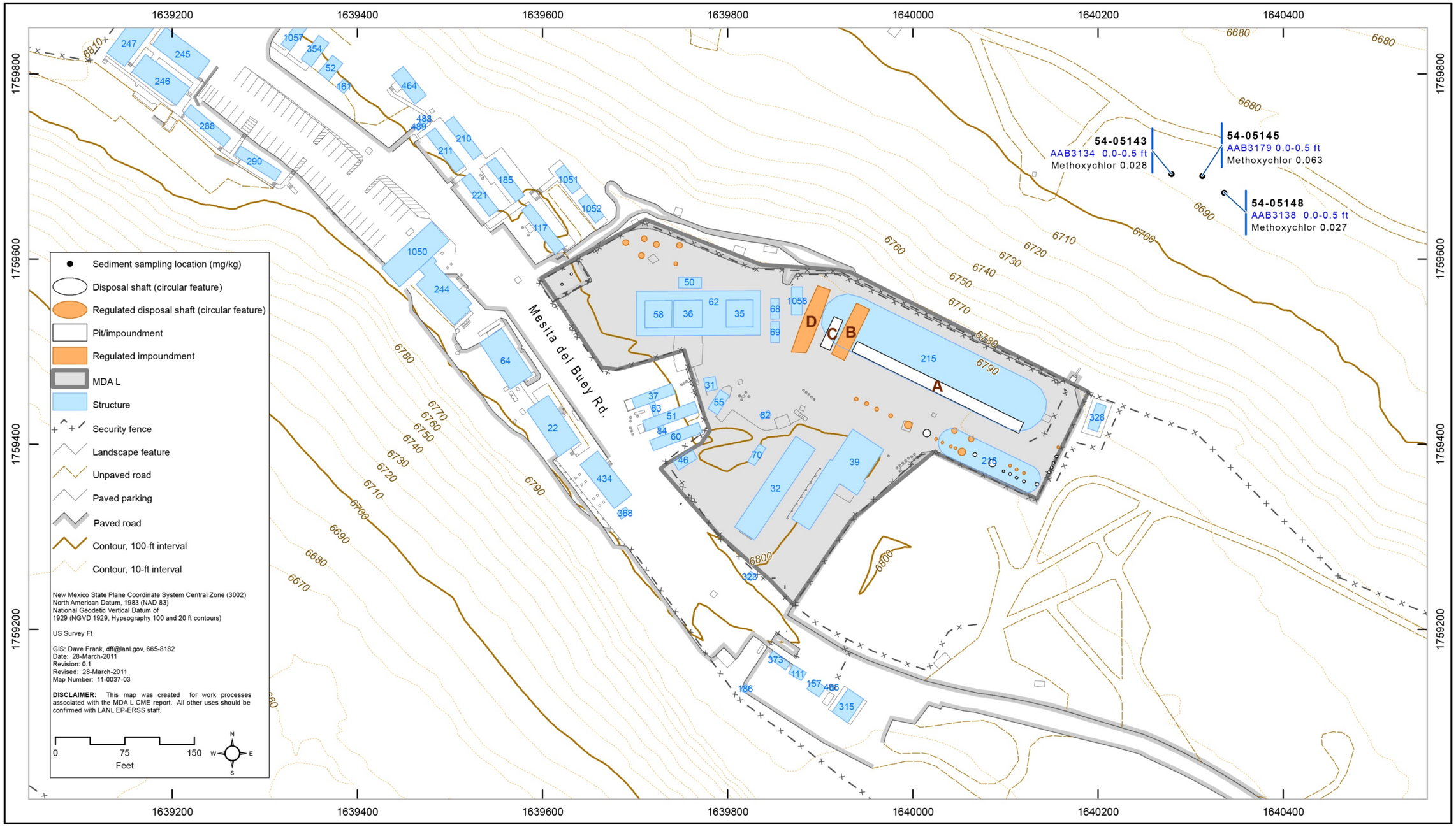


Figure 2.5-2 Organic chemicals detected in channel sediments at MDA L during the Phase I RFI

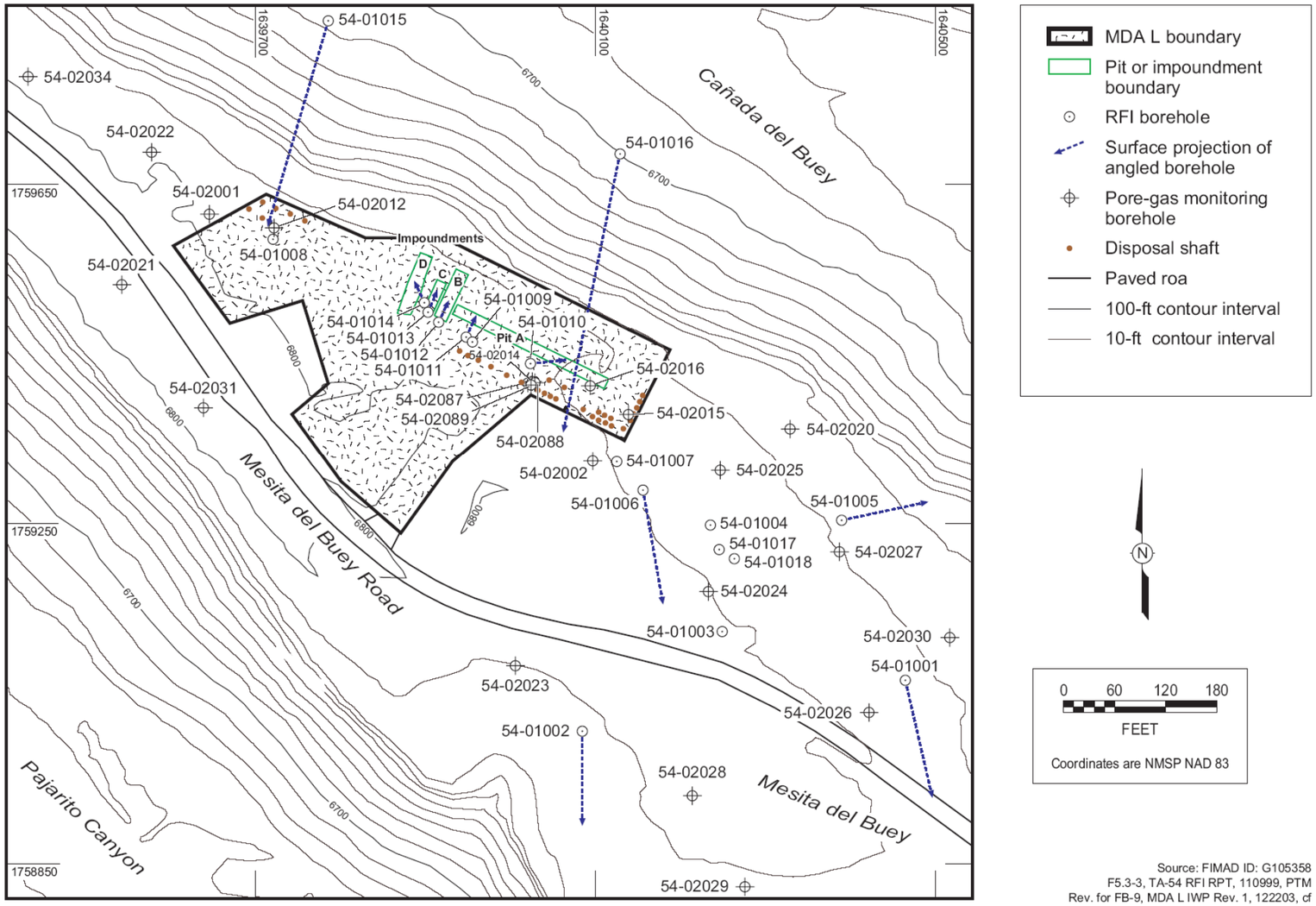


Figure 2.5-3 Locations of Phase I RFI boreholes at MDA L

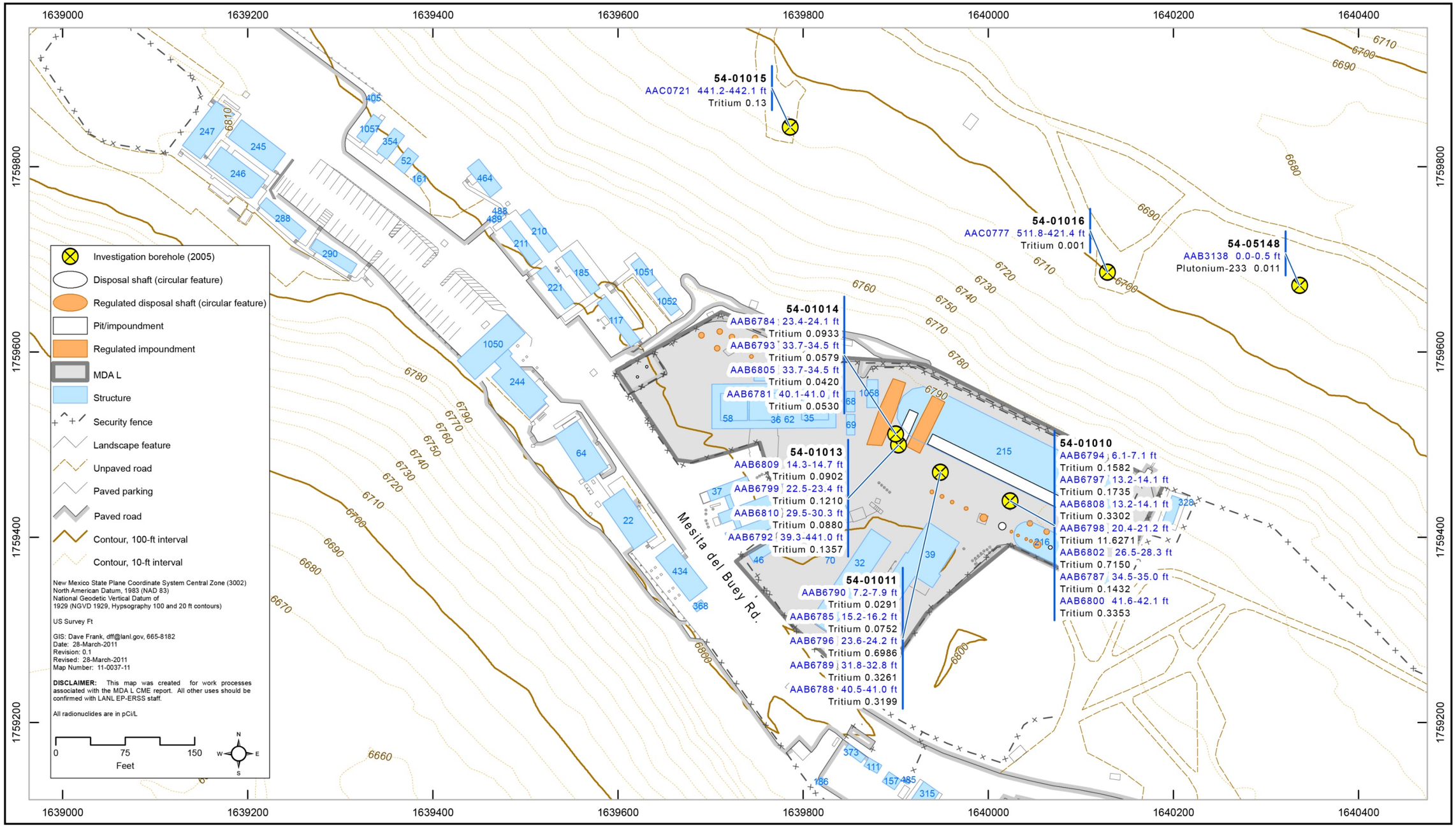
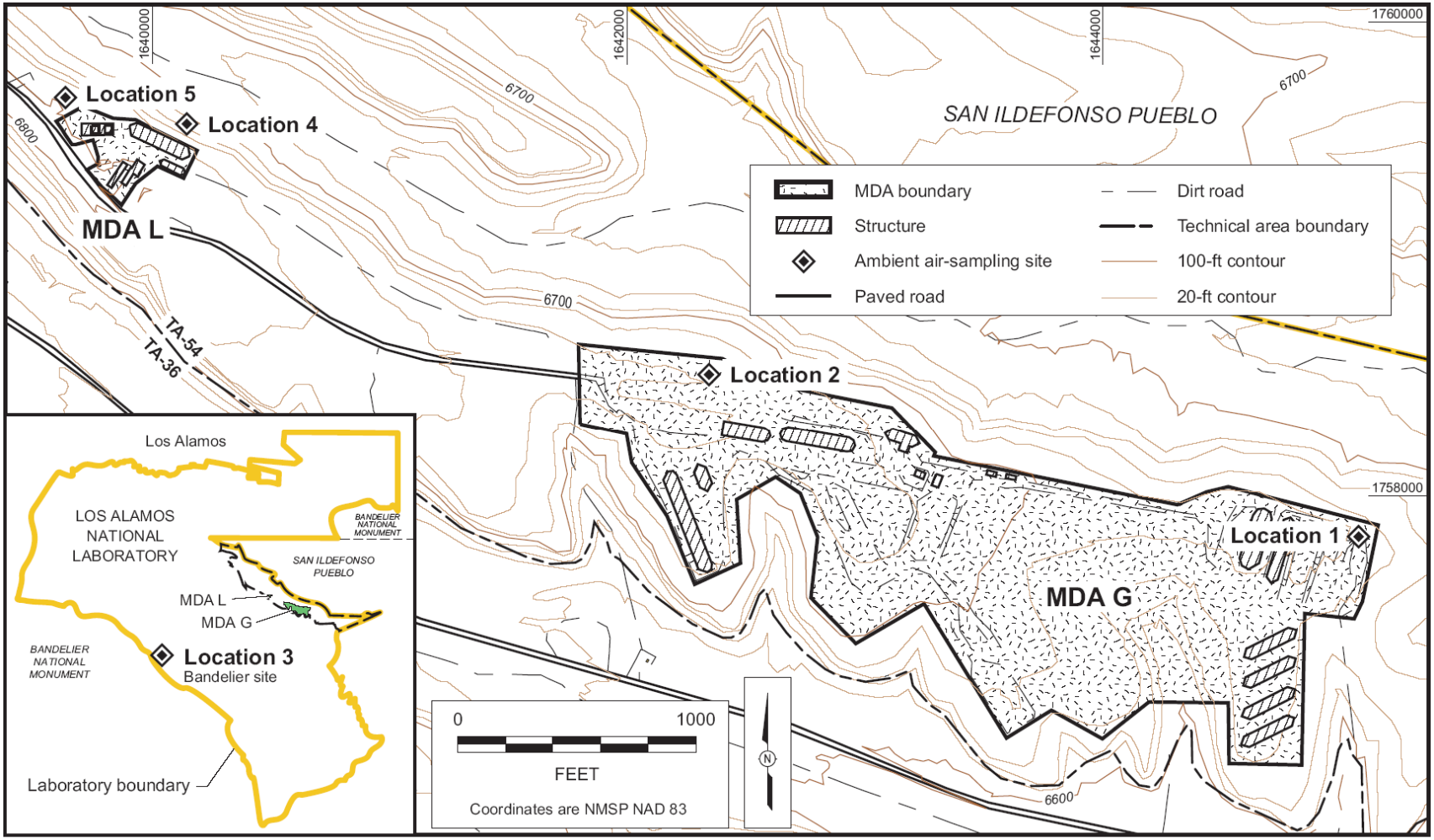
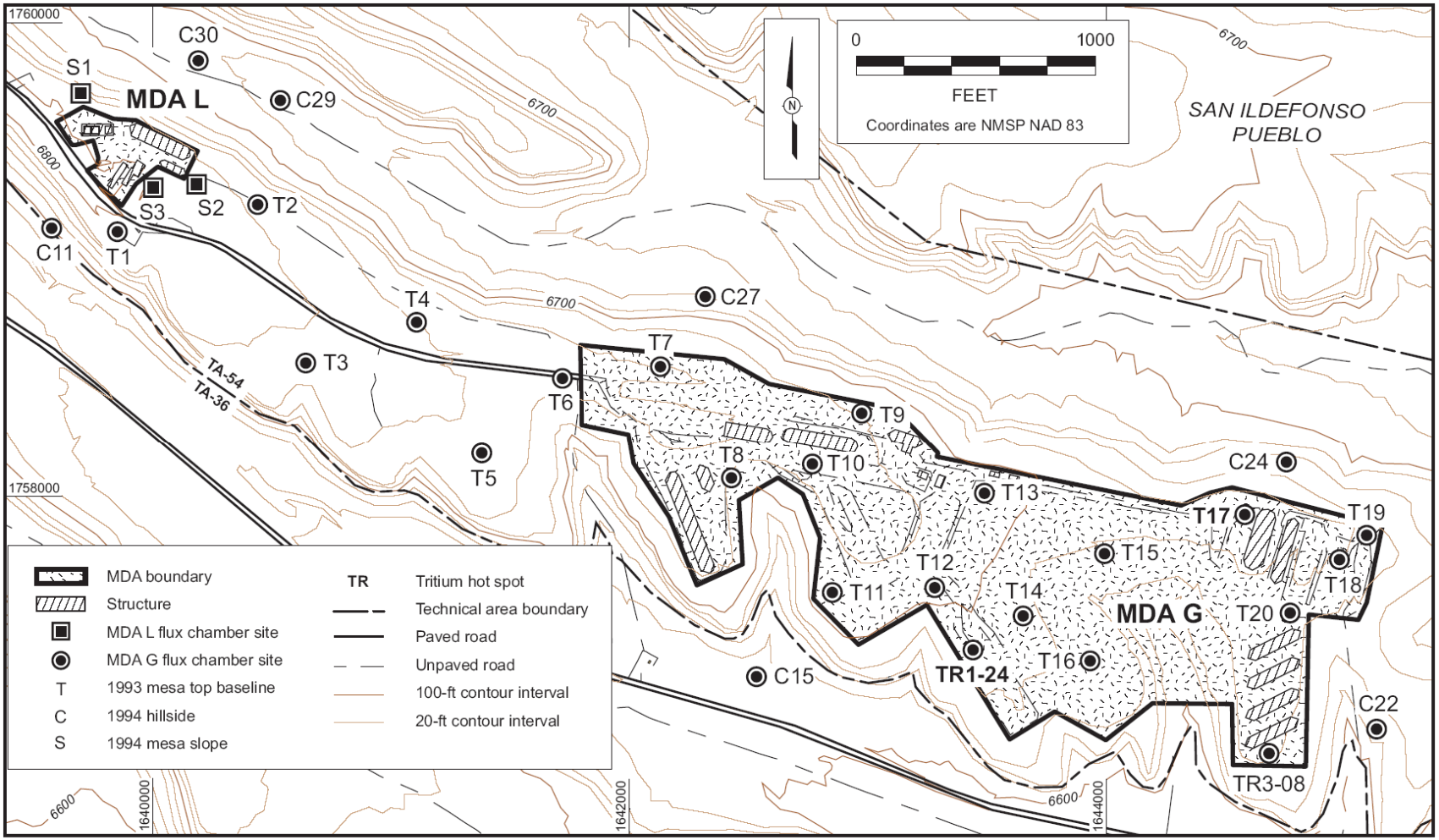


Figure 2.5-4 Radionuclide detections above BVs/FVs at MDA L during the Phase I RFI



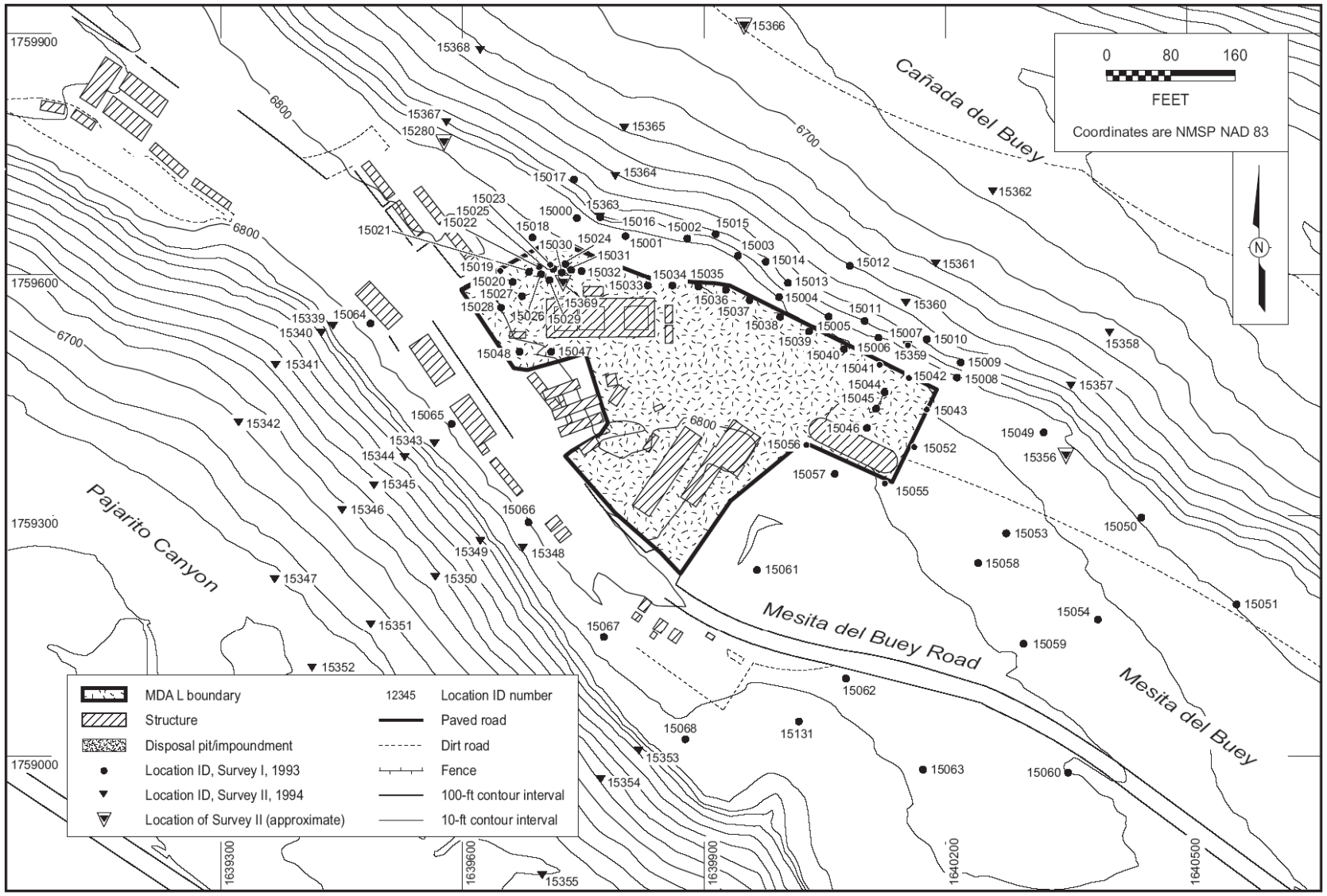
Source: FIMAD map G107980, 072999_MDA L RFI r, 120302, PTM_Rev. for FB-5, MDA L IWP Rev. 1, 121903, cf

Figure 2.5-5 Ambient-air VOC sampling locations at MDAs G and L during the Phase I RFI



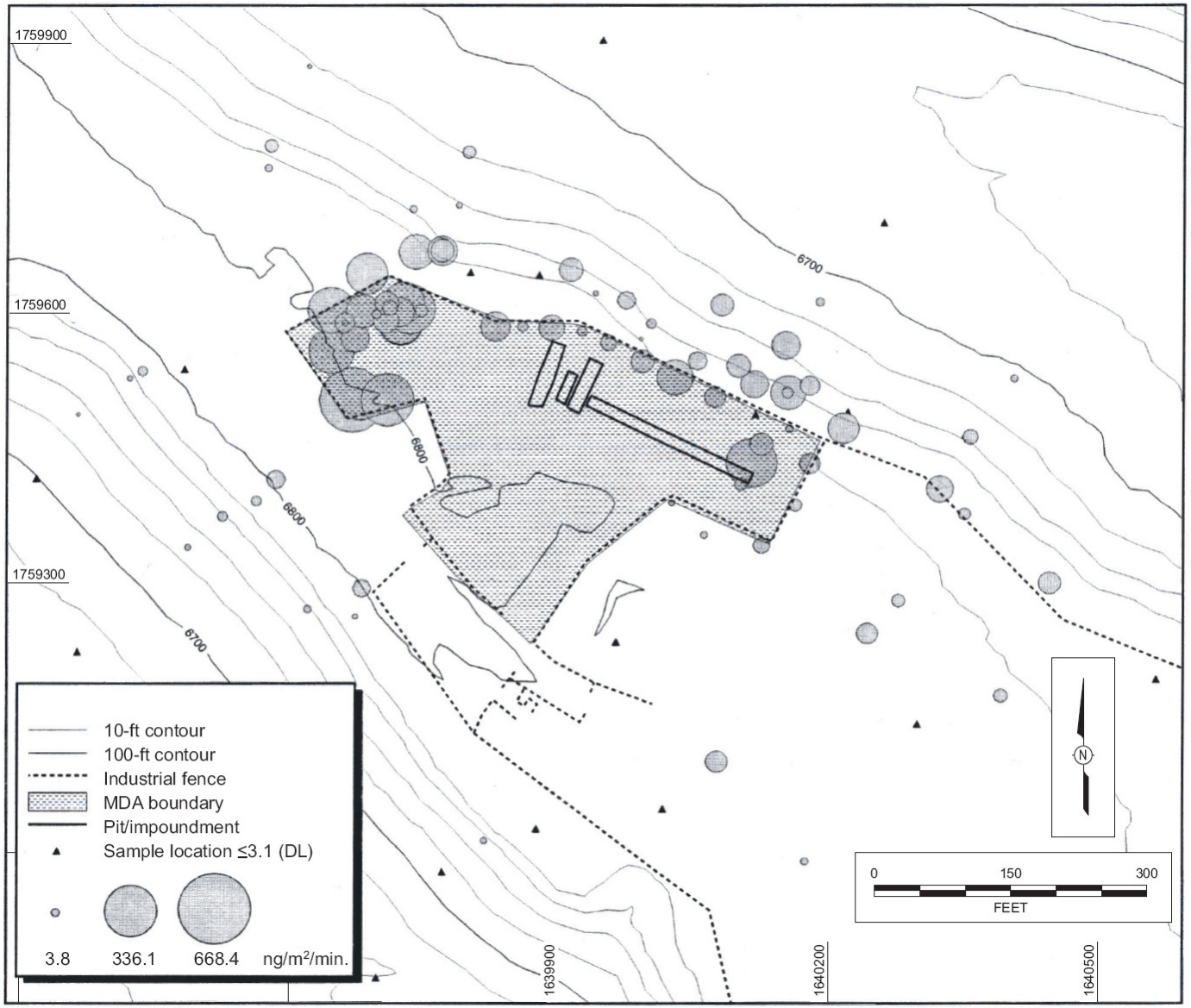
Source: FIMAD map G107980, 072999
MDA L RFI rpt, 121902, PTM_Rev. for FB-6, MDA L IWP Rev. 1, 122203, cf

Figure 2.5-6 Locations of VOC and tritium flux chamber samples at MDAs G and L during the Phase I RFI



Source: FIMAD map G104040, 011396
F5.3-2, TA-54 RFI Rpt., 11299, PTM
Rev. for FB-7, MDA L IWP Rev.1, 121903, cf

Figure 2.5-7 EMFLUX sampling locations at MDA L during the Phase I RFI



MDA L RFI rpt, 120402, PTM_Rev. for MDA L IWP Rev. 1, 082503, cf

Figure 2.5-8 Phase I RFI surface flux concentrations of TCA at MDA L

Figure 2.5-9 Locations of boreholes drilled during the 2004–2005 investigation at MDA L

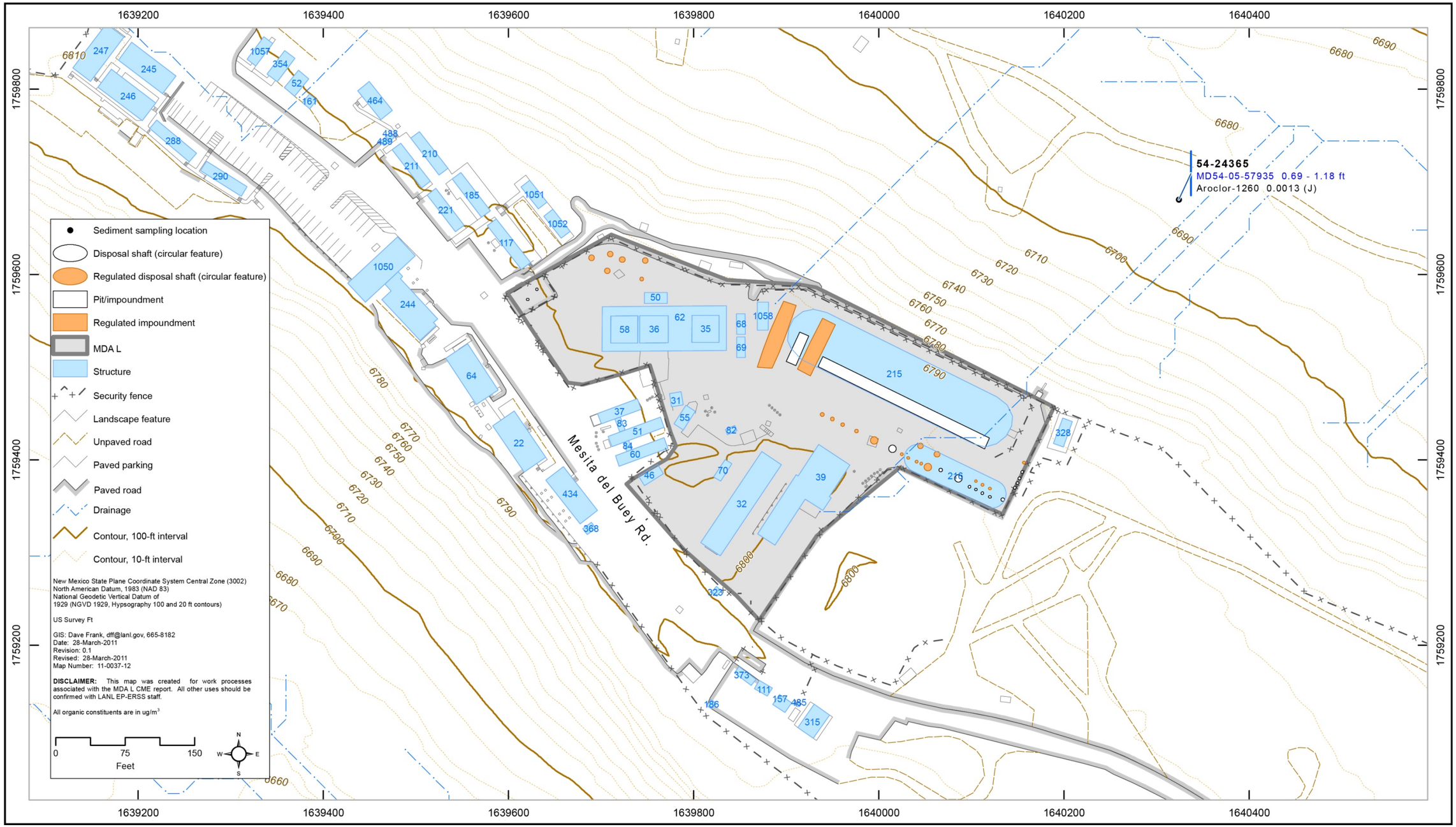


Figure 2.5-10 Organic chemical (mg/kg) detected in channel sediments at MDA L in 2004 and 2005

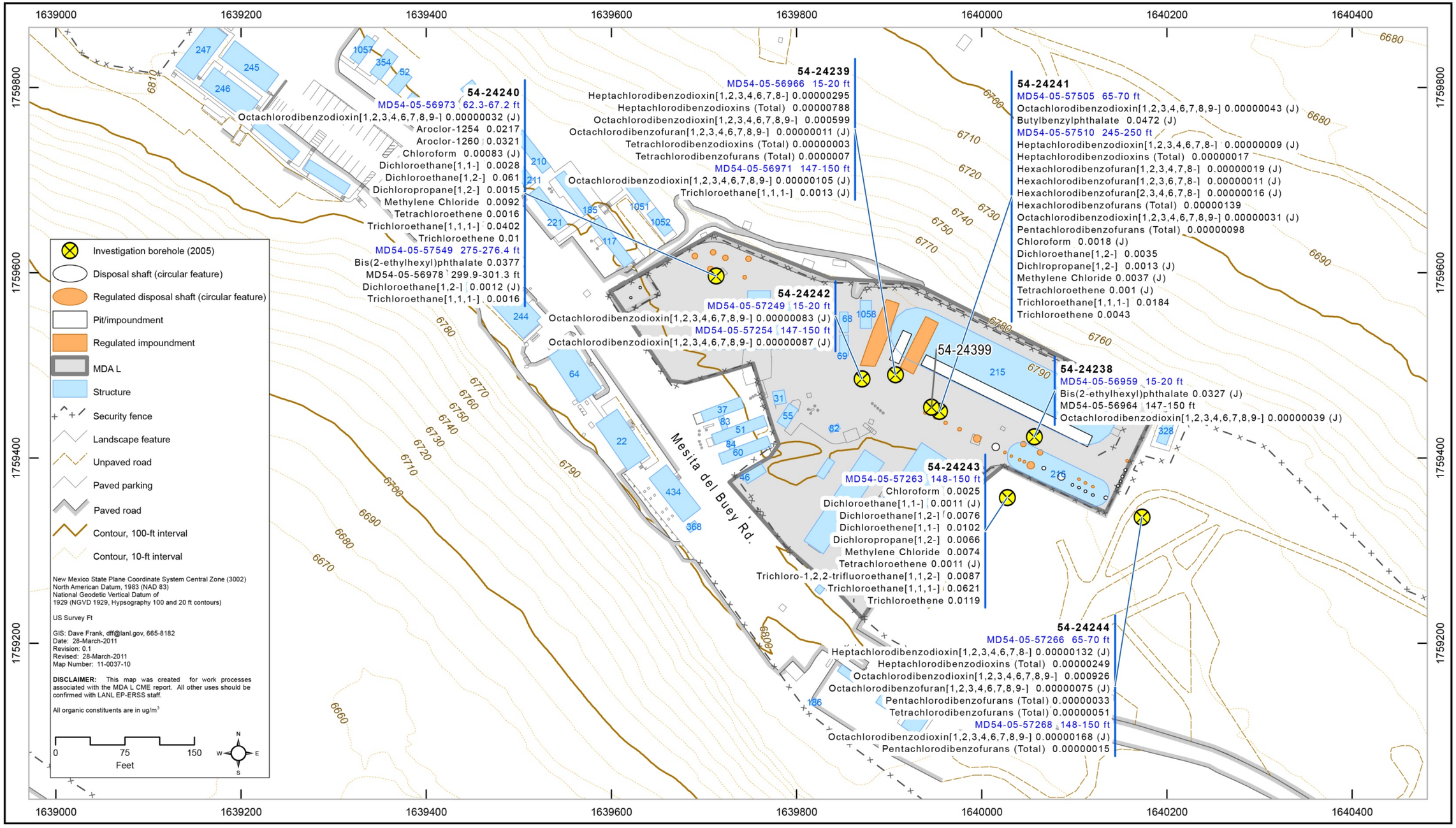


Figure 2.5-11 Organic chemicals (mg/kg) detected in subsurface tuff at MDA L in 2004 and 2005

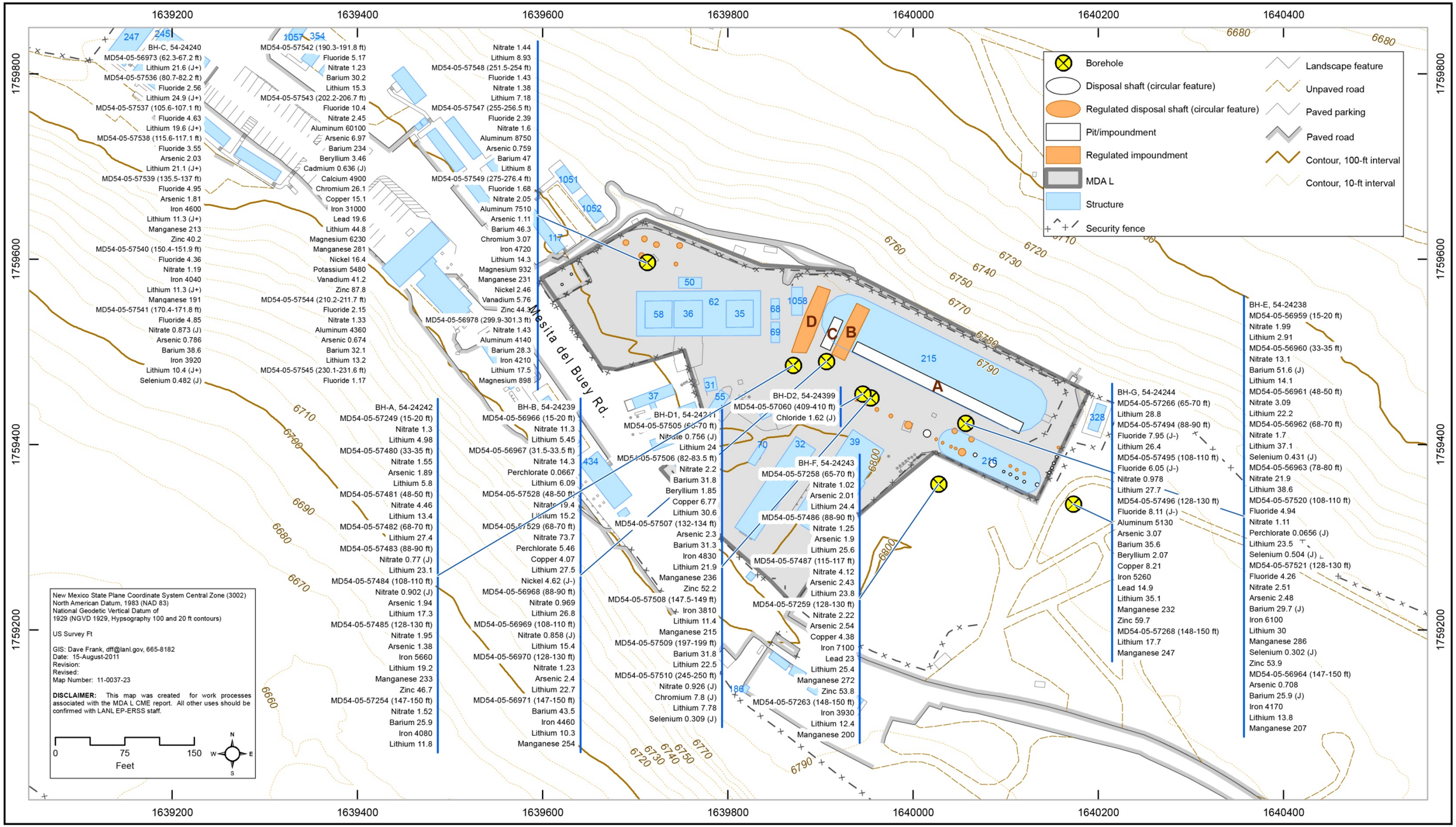


Figure 2.5-12 Inorganic chemicals (mg/kg) detected above BVs in subsurface tuff at MDA L in 2004 and 2005

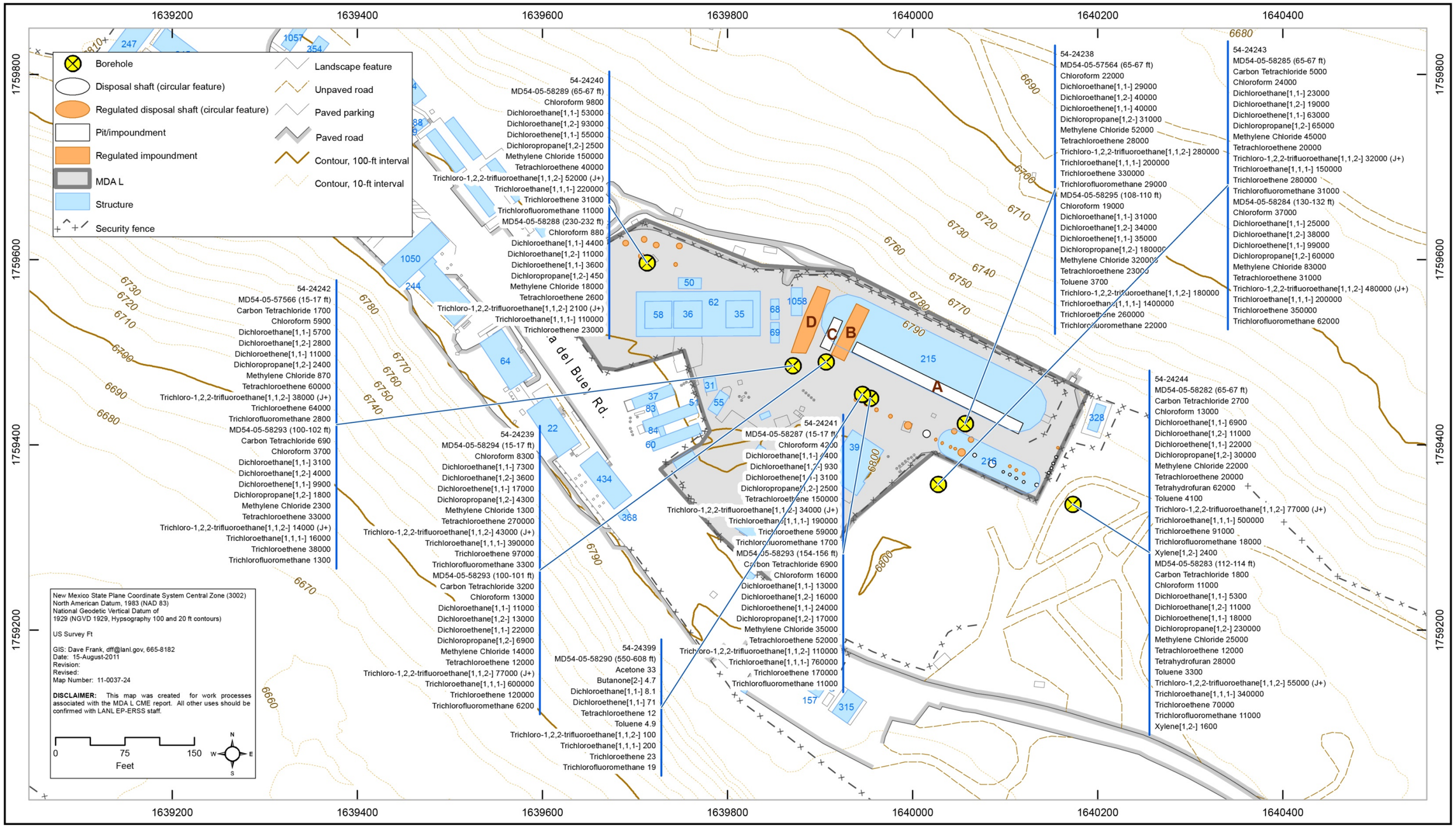


Figure 2.5-13 Organic chemicals (µg/m^3) detected in subsurface pore gas at MDA L in 2004 and 2005

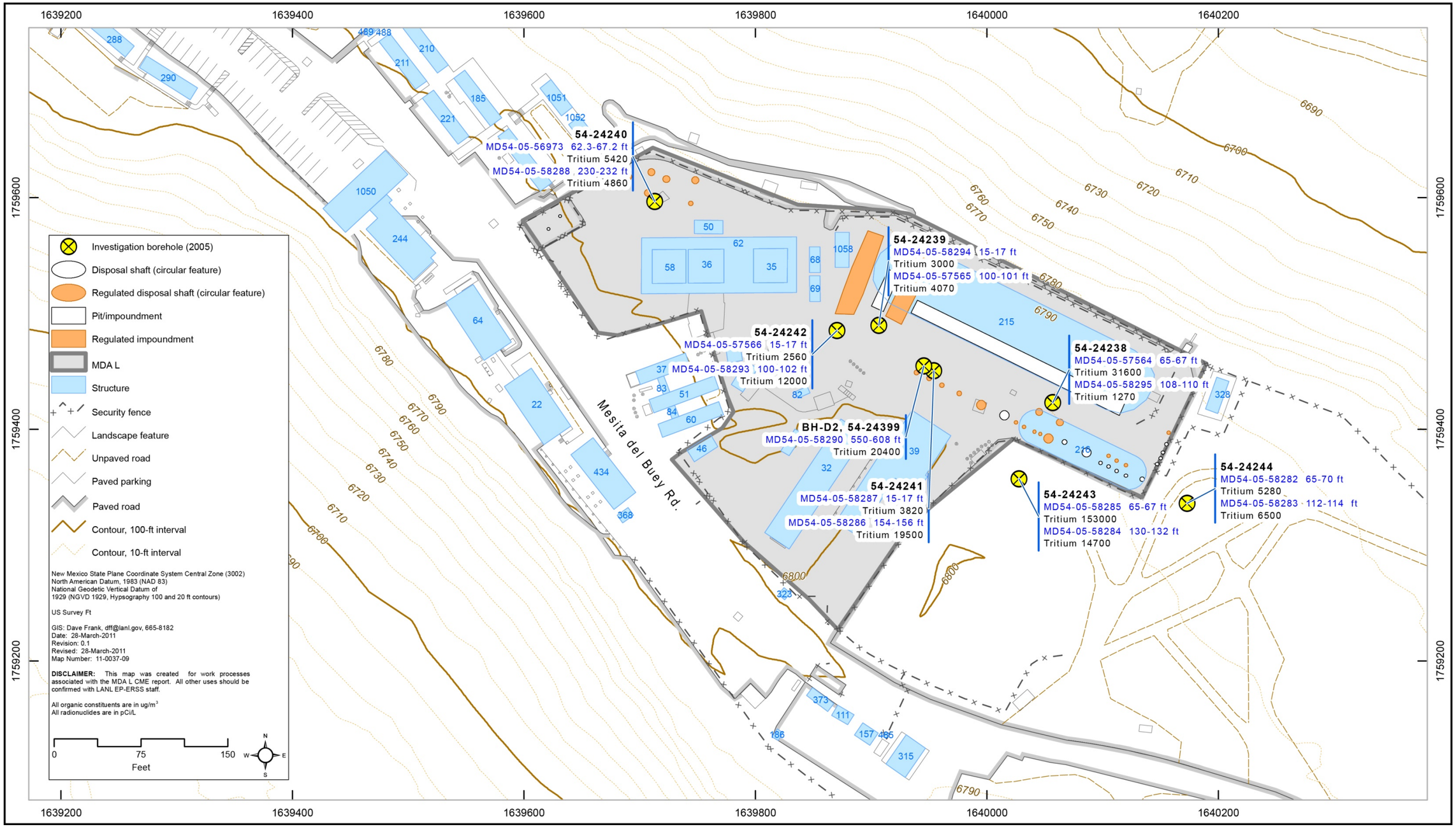


Figure 2.5-14 Tritium (pCi/L) detected in subsurface pore gas at MDA L in 2004 and 2005

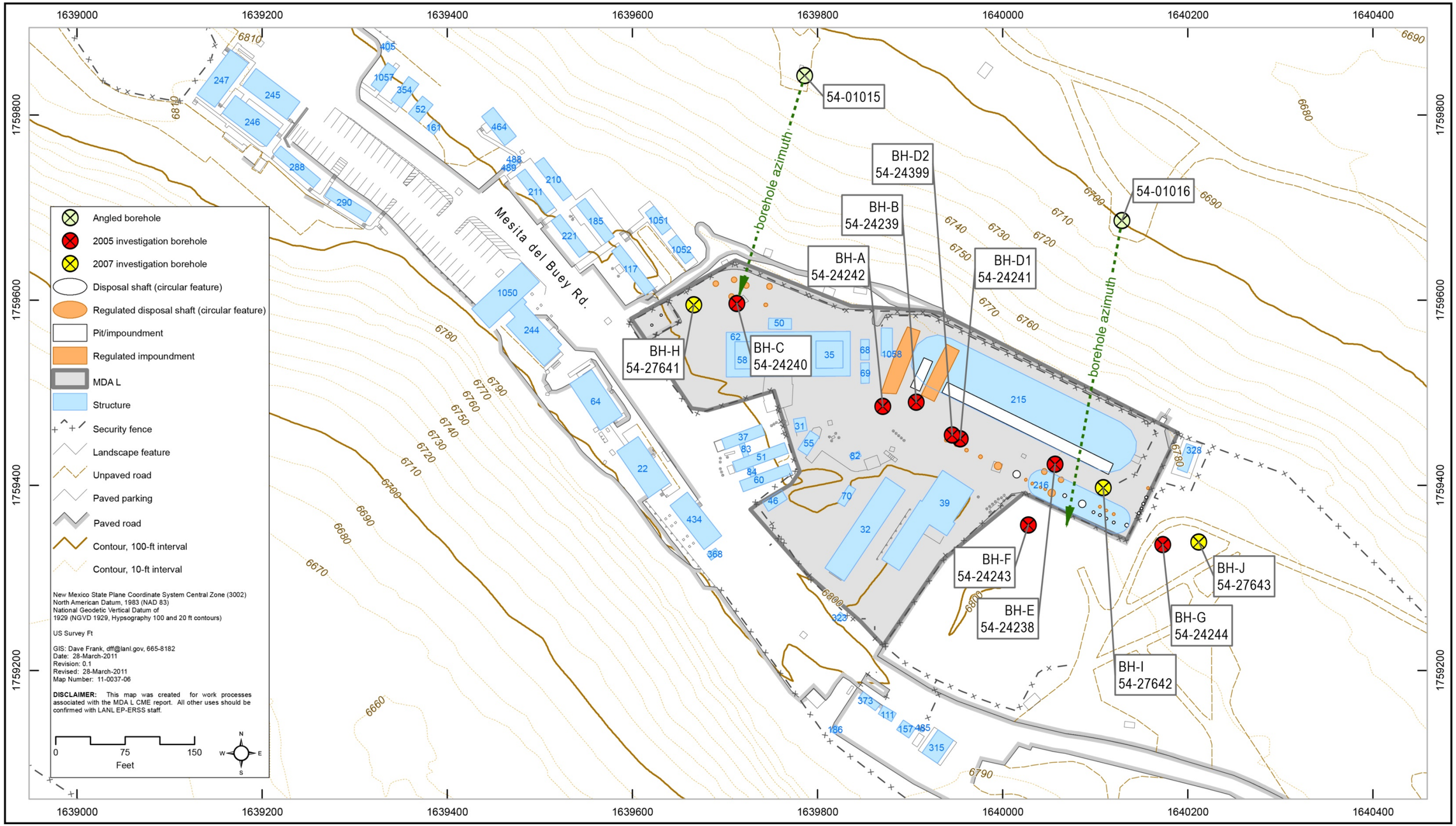


Figure 2.5-15 Locations of existing and supplemental investigation boreholes at MDA L

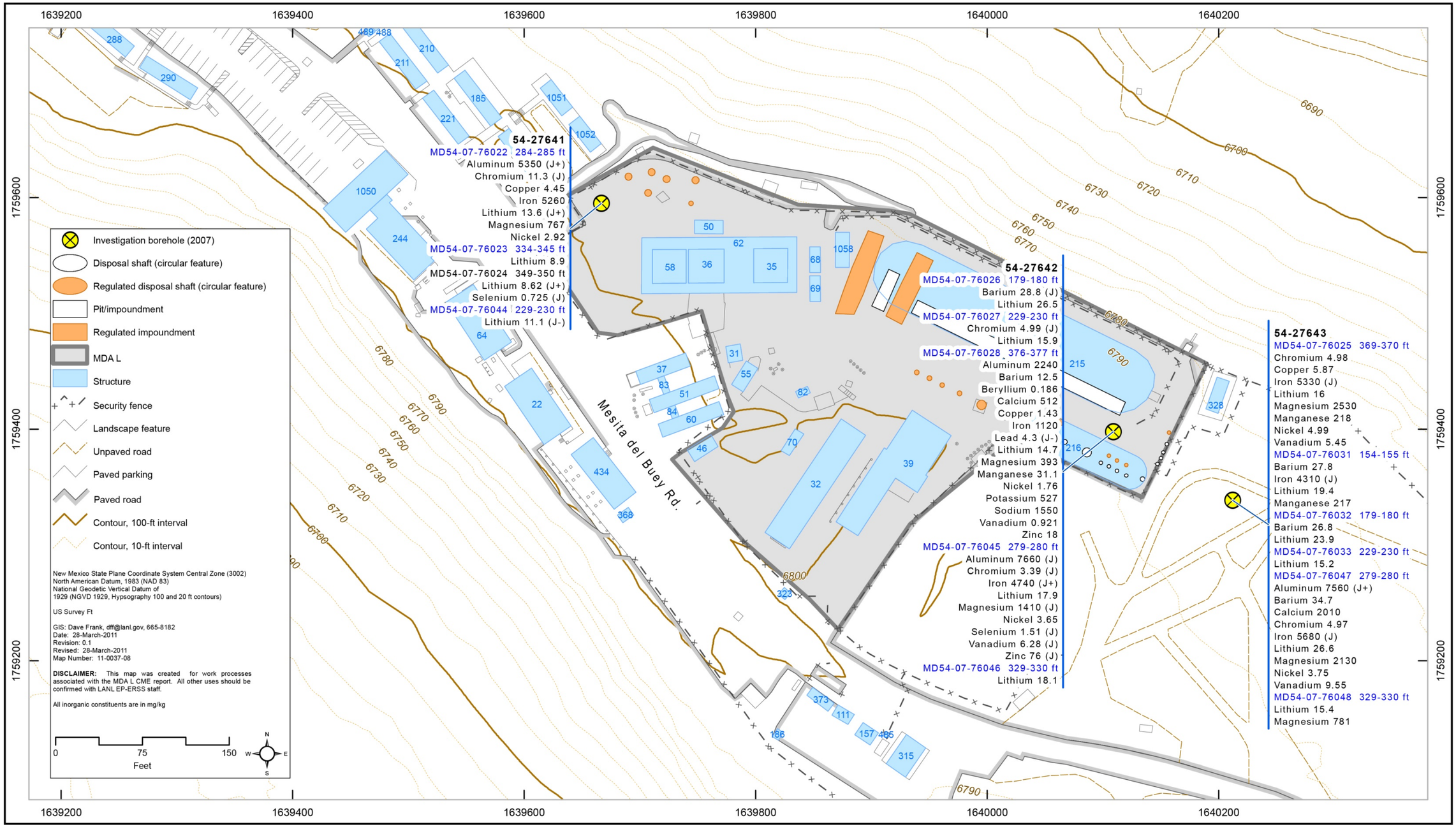


Figure 2.5-16 Inorganic chemicals (mg/kg) detected above BV in tuff during the supplemental investigation at MDA L

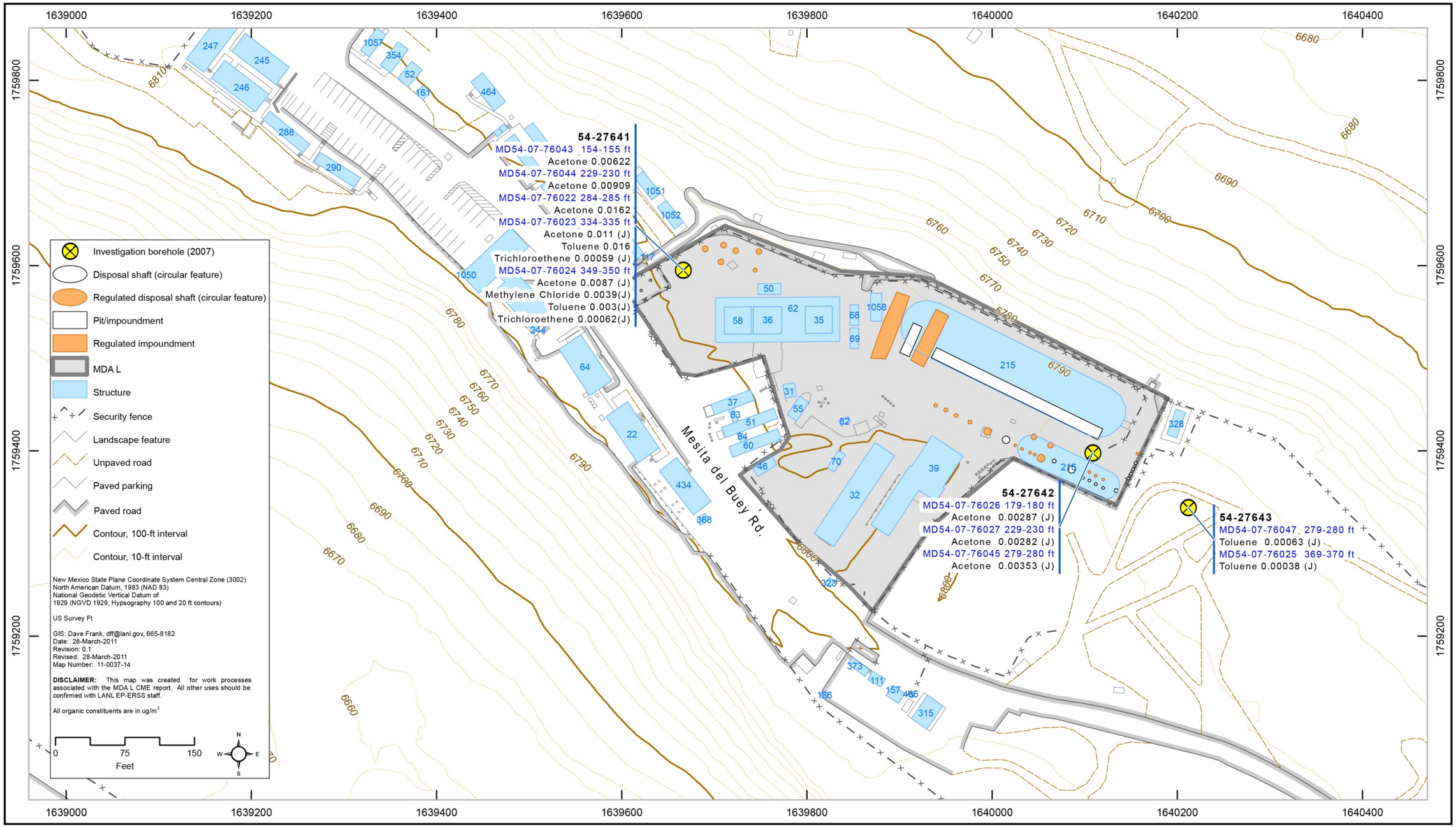


Figure 2.5-17 VOCs (mg/kg) detected in tuff during the supplemental investigation at MDA L

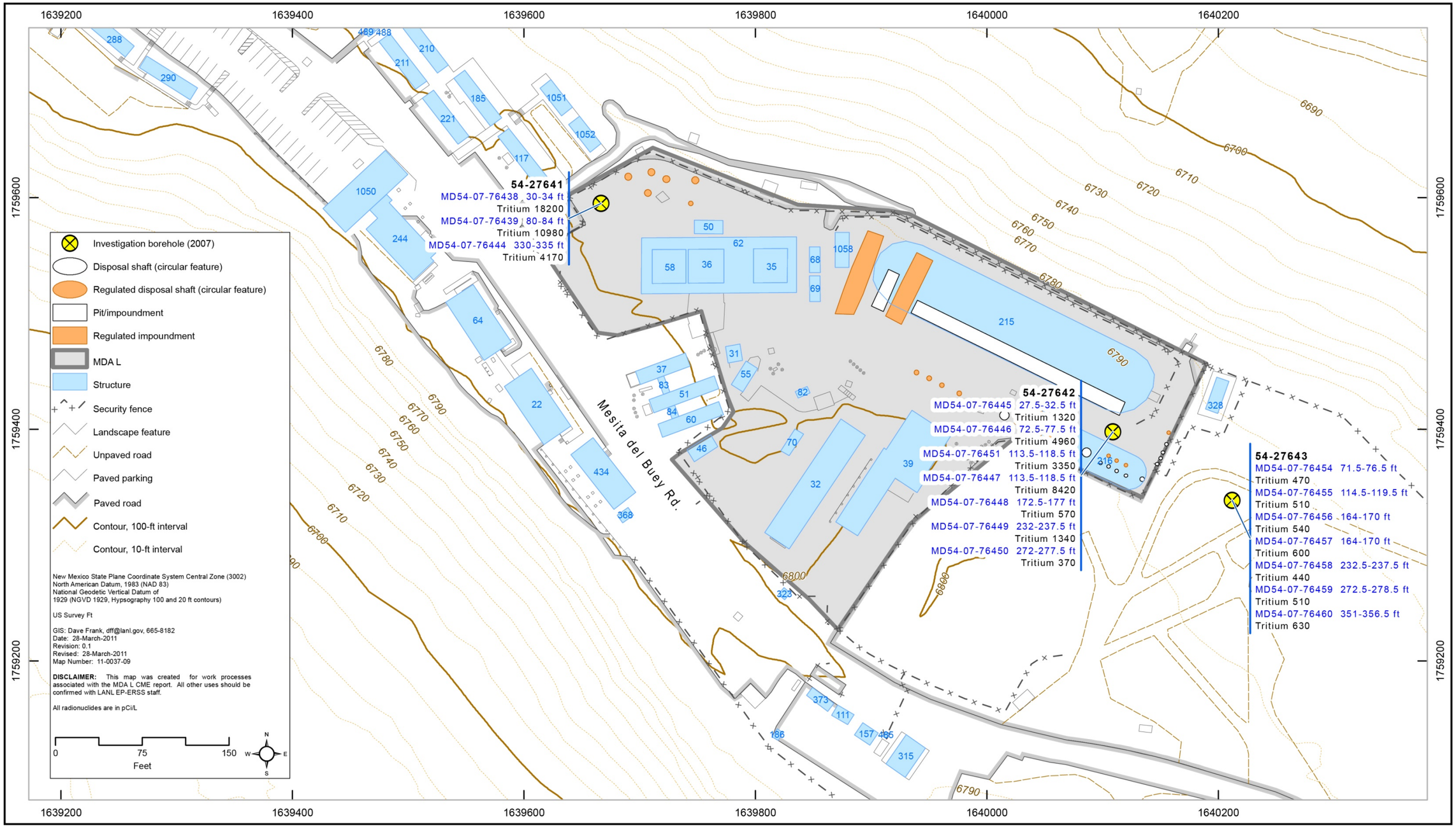


Figure 2.5-18 Tritium (pCi/L) detected in subsurface pore gas during the supplemental investigation at MDA L

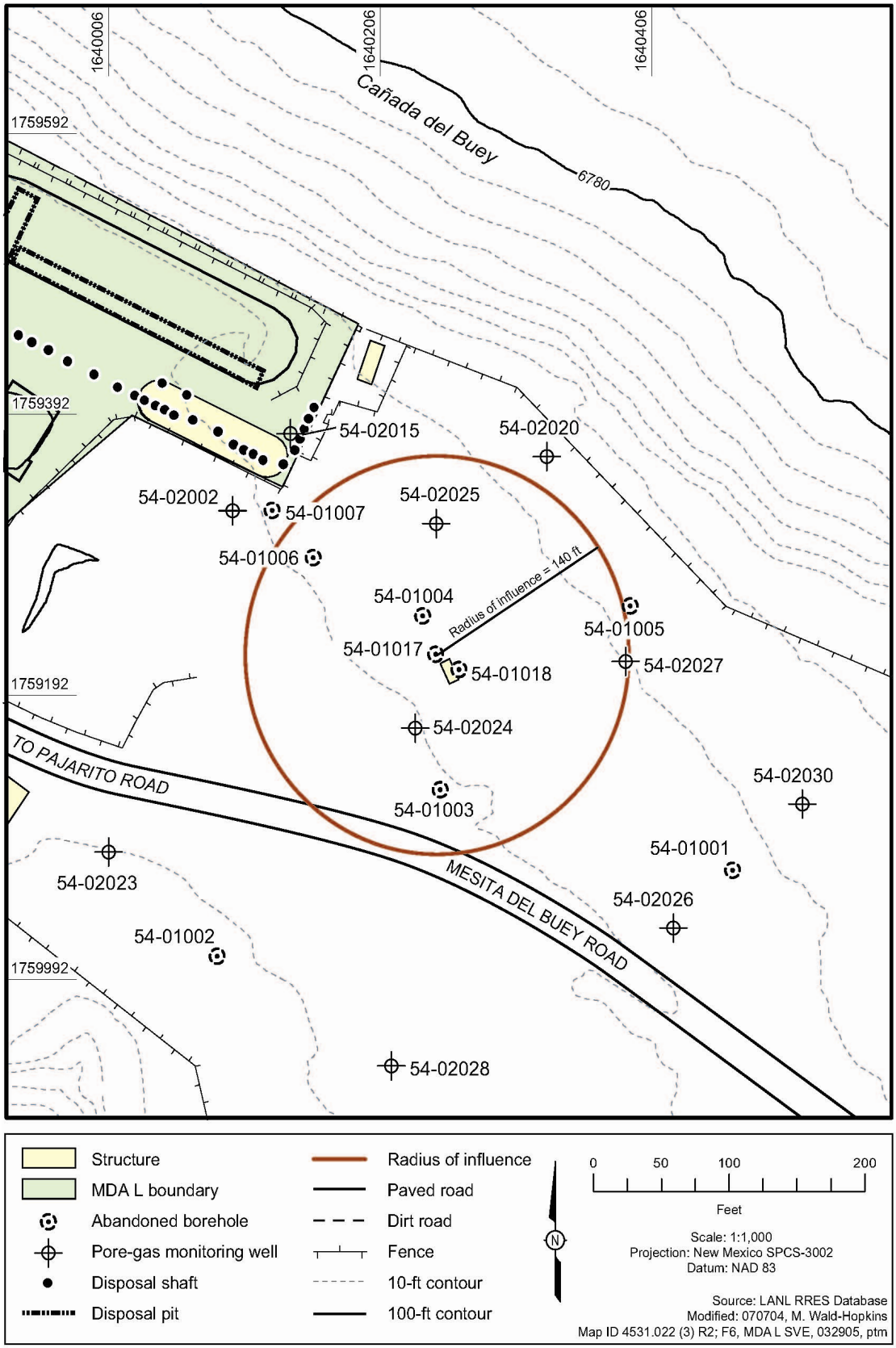


Figure 2.5-19 Location of 1995 SVE pilot test

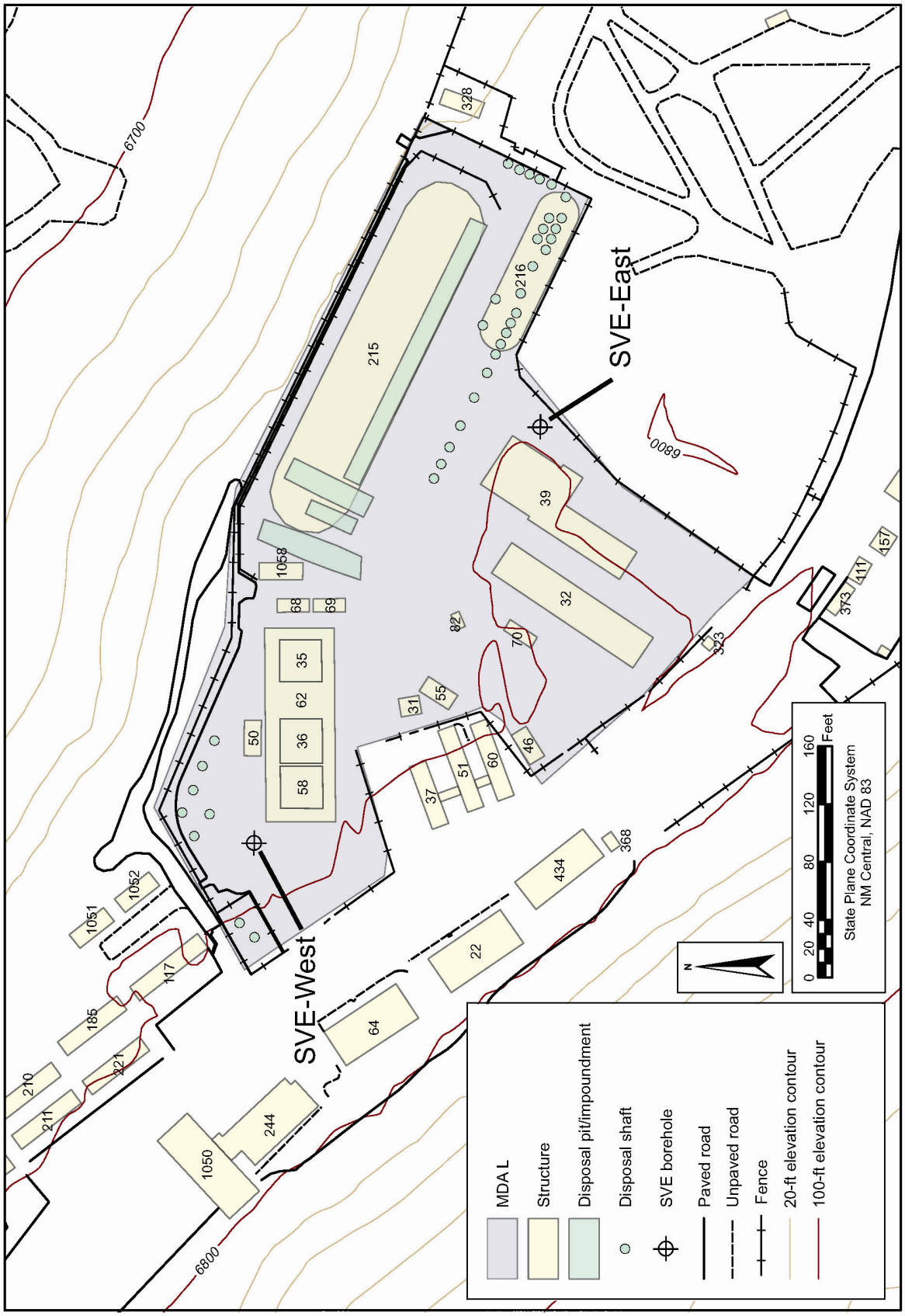


Figure 2.5-20 Locations of 2006 MDA L SVE pilot test vapor extraction boreholes

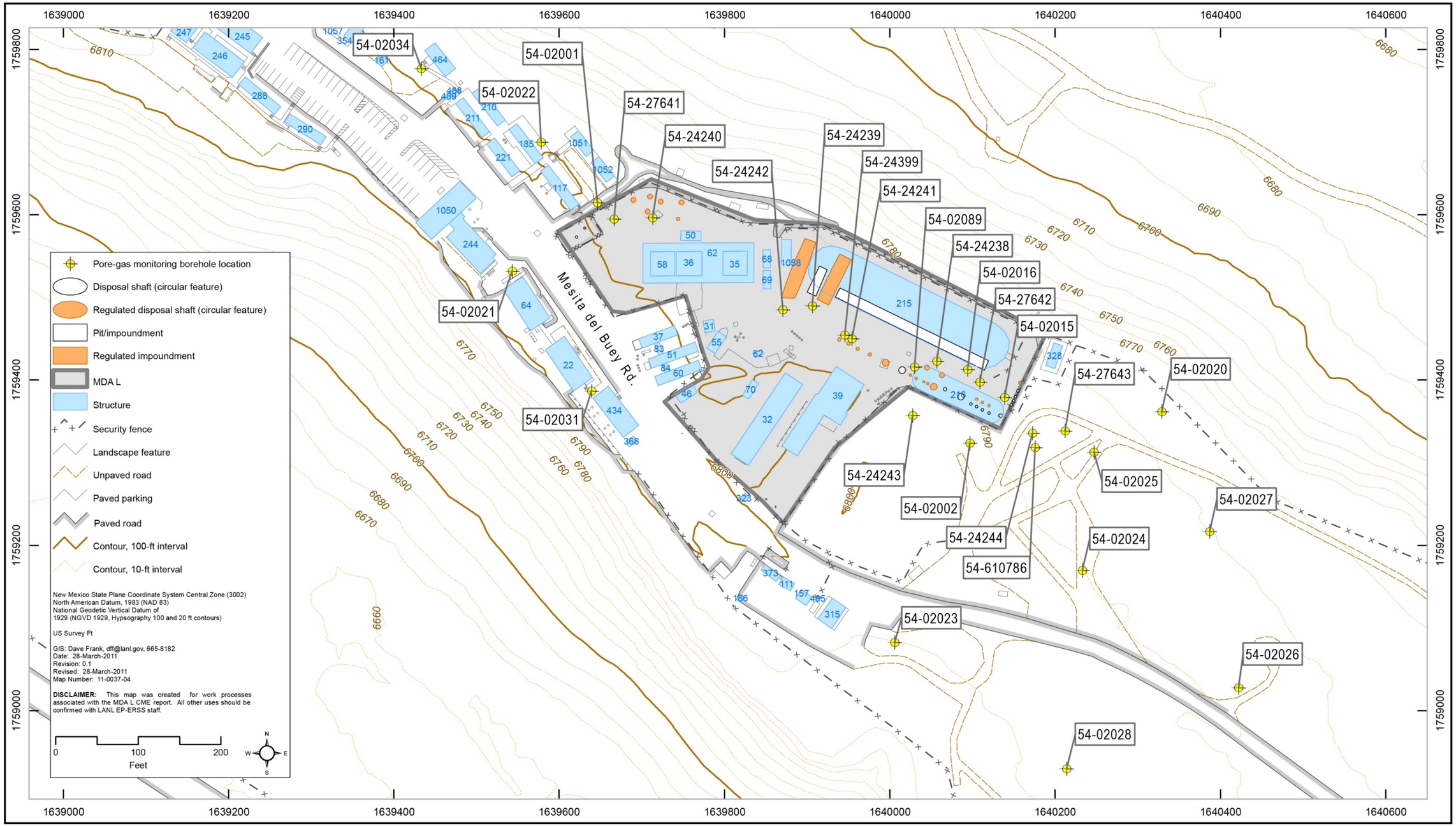


Figure 2.5-21 MDA L pore-gas monitoring borehole locations

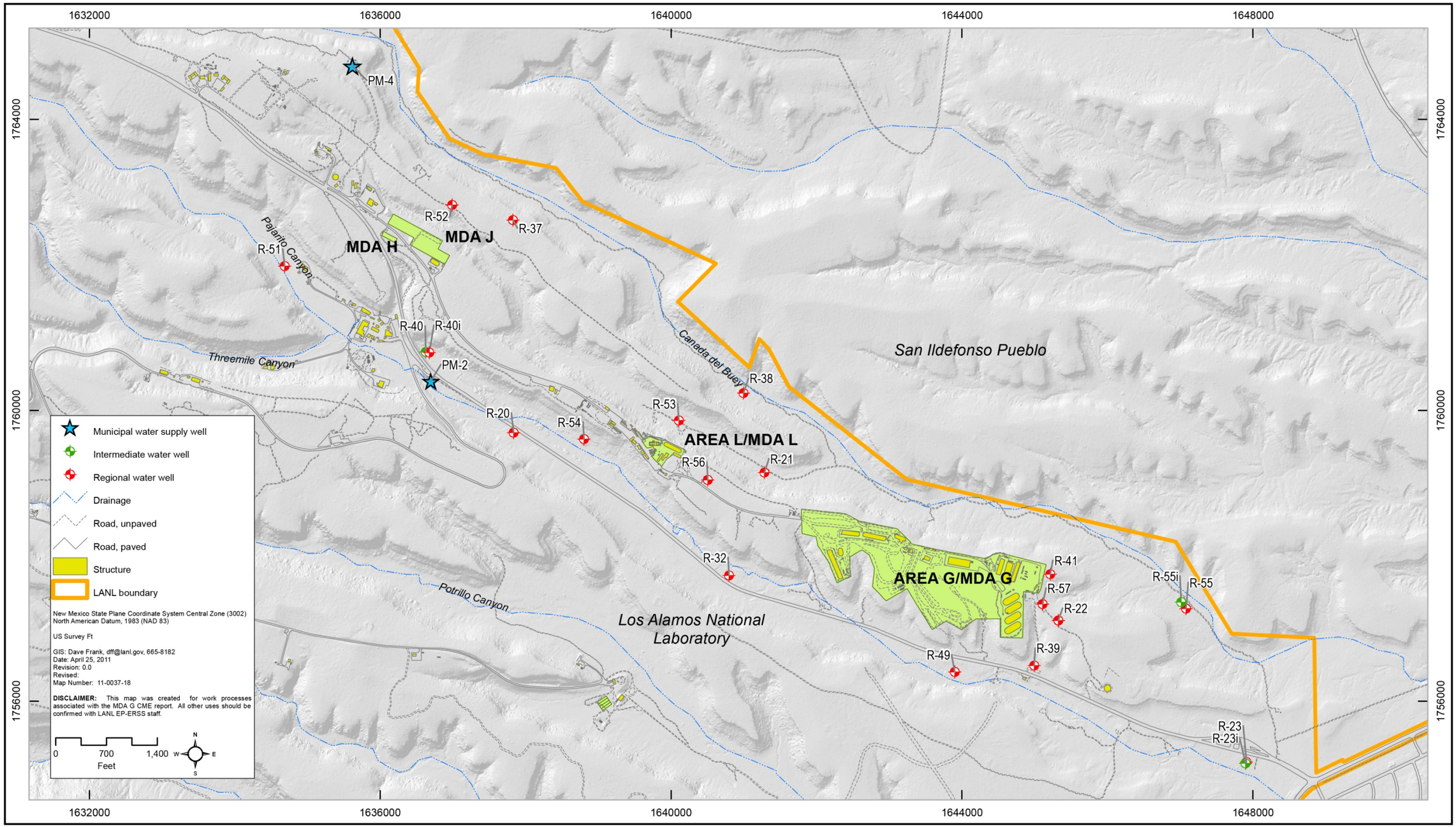


Figure 2.6-1 TA-54 groundwater-monitoring network

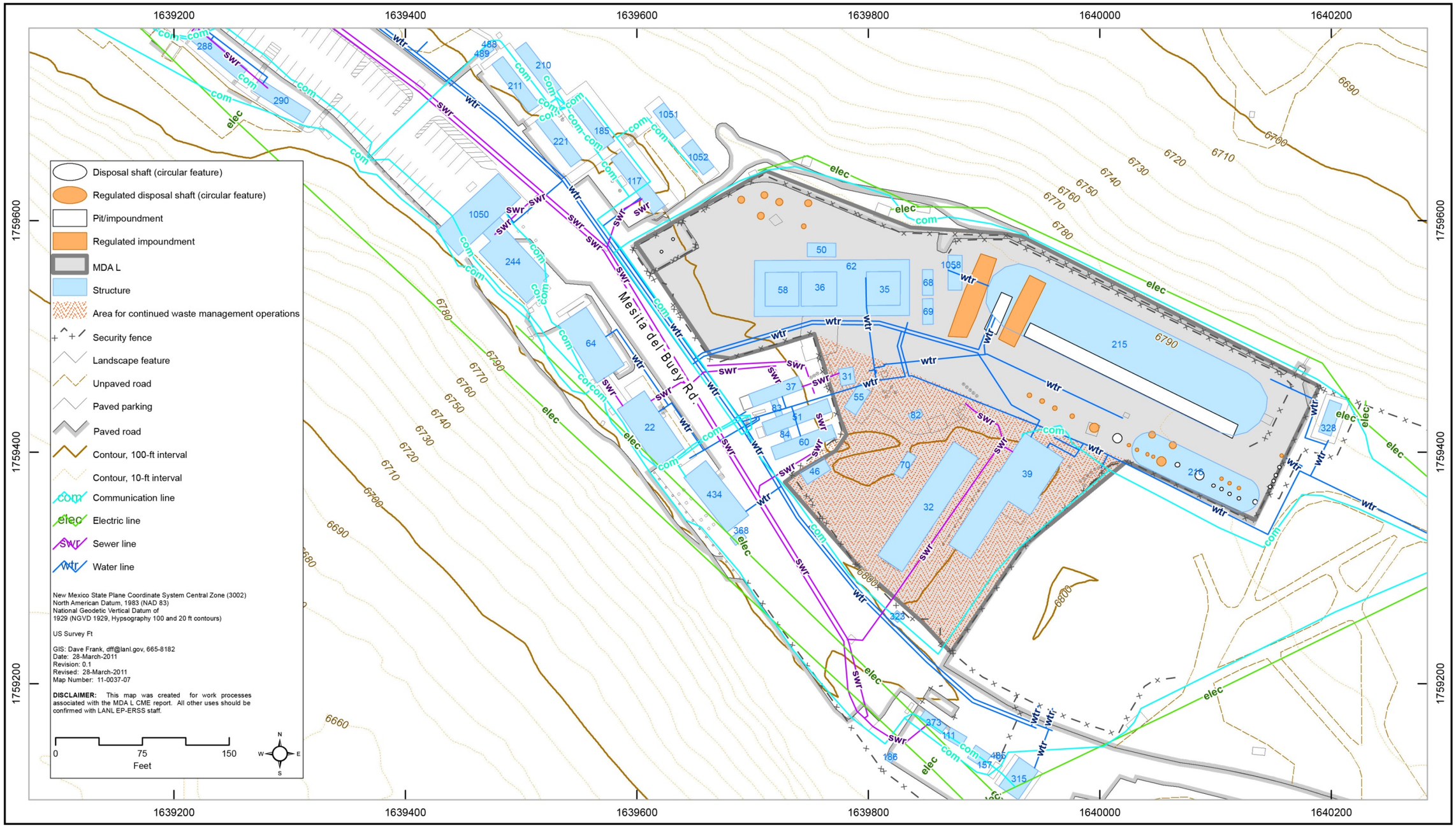


Figure 3.2-1 Locations of subsurface disposal units and utilities at MDA L in TA-54

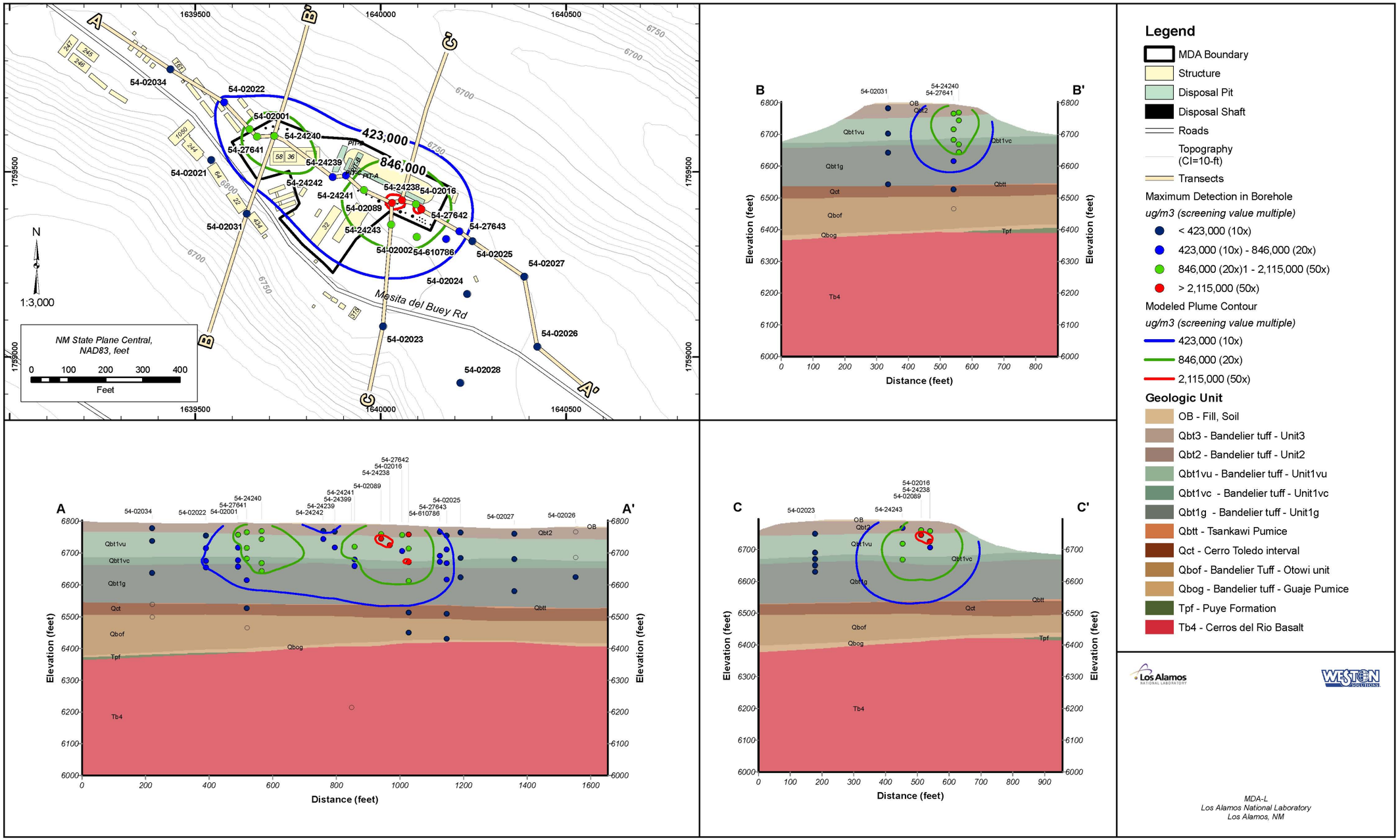


Figure 3.2-2 Subsurface distribution of TCA vapors at MDA L based on the average of four quarters of monitoring (third quarter FY2009 to second quarter FY2010)

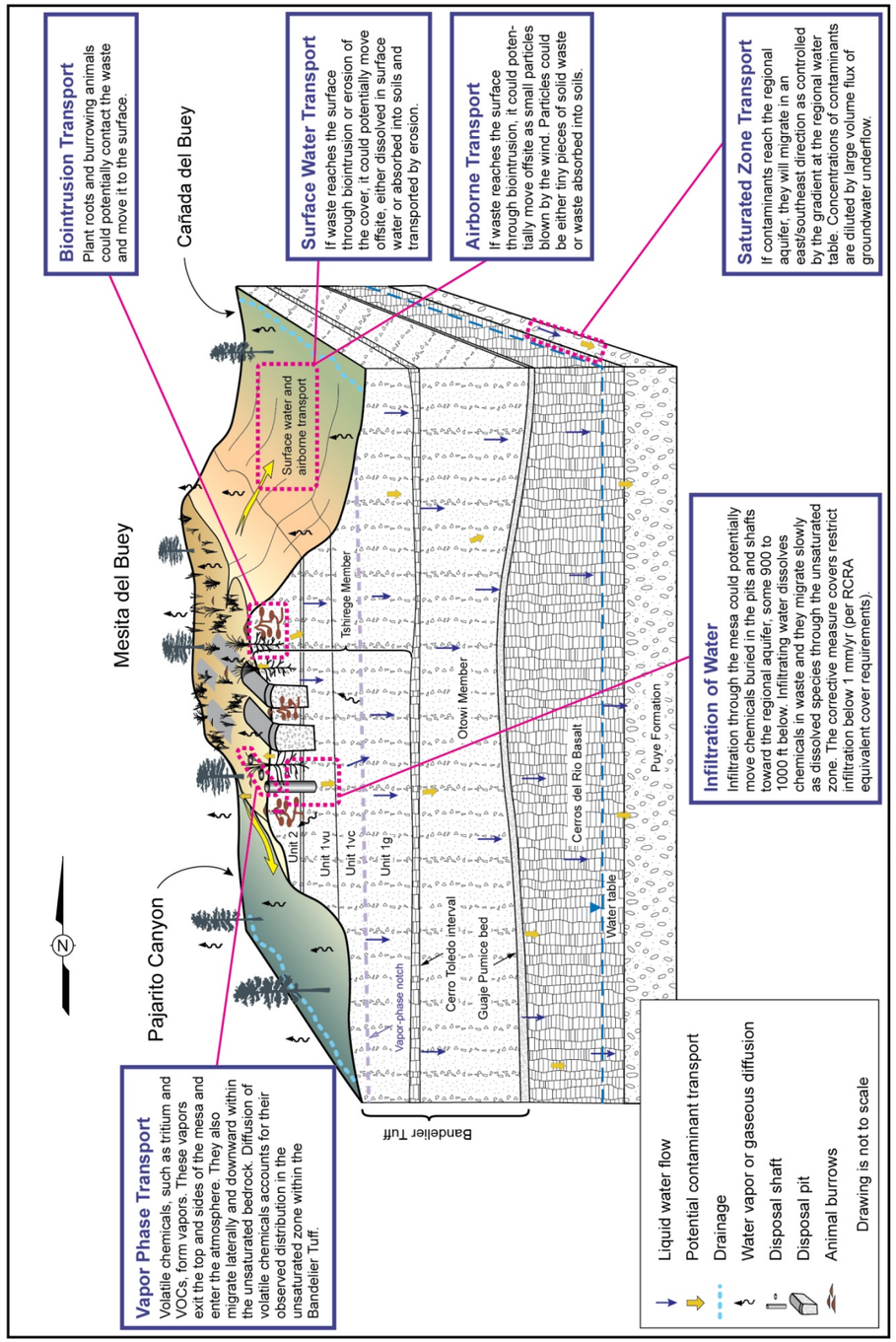
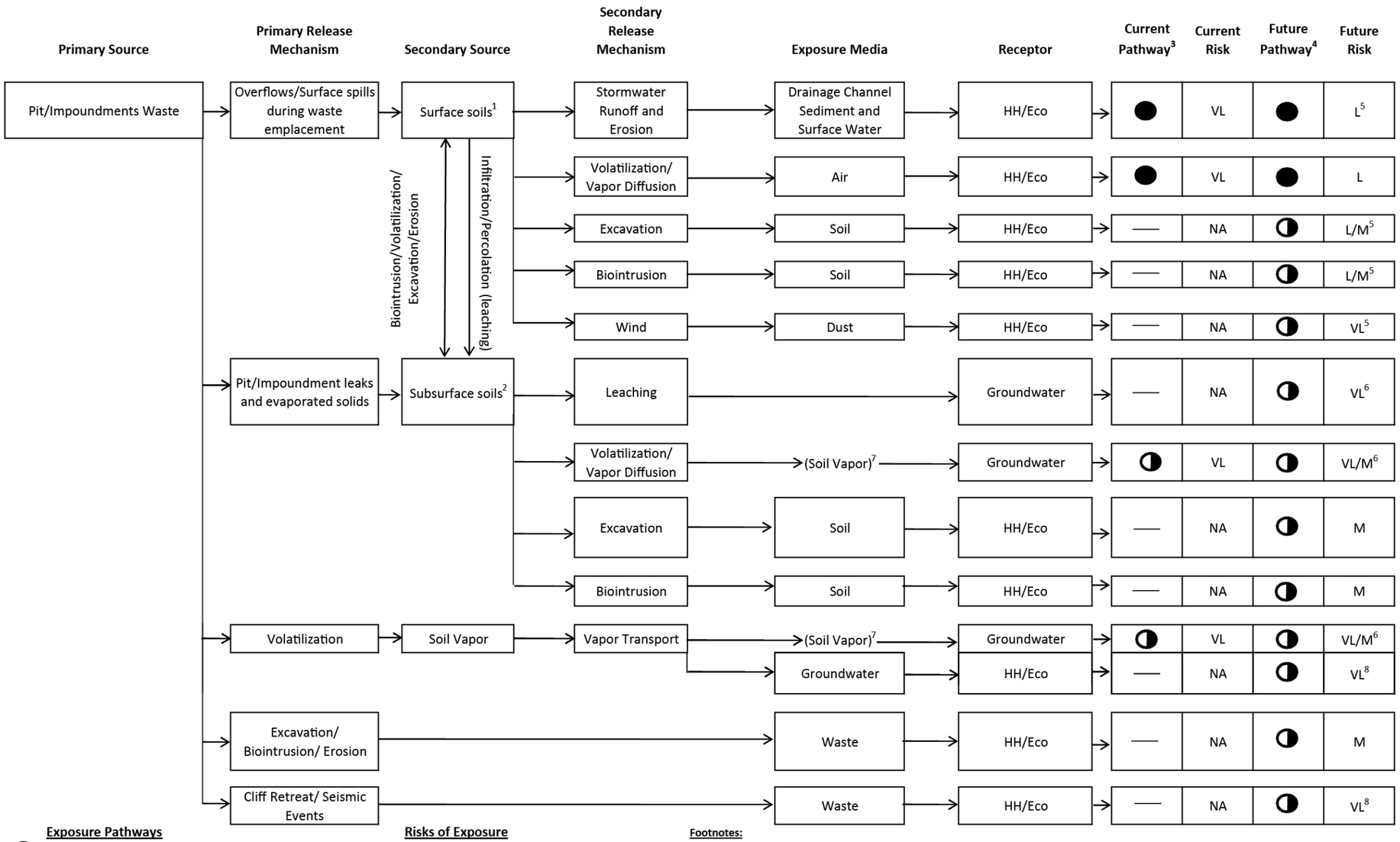


Figure 4.0-1 Hydrogeologic conceptual site model for MDA L



Exposure Pathways

● = Complete pathway

◑ = Potentially complete pathway

— = Incomplete pathway

Risks of Exposure

VL = Very Low

L = Low

M = Medium

NA = Not Applicable

Footnotes:

[1] = Surface soil is defined as 0 to 1 ft bgs.

[2] = Subsurface soil is defined as deeper than 1 ft bgs.

[3] = Current scenario assumes presence of existing asphalt paving.

[4] = Future scenario assumes the removal of existing asphalt paving under the LANL Hazardous Waste Permit Closure Plan for Technical Area 54, Area L Outdoor Container Storage Unit.

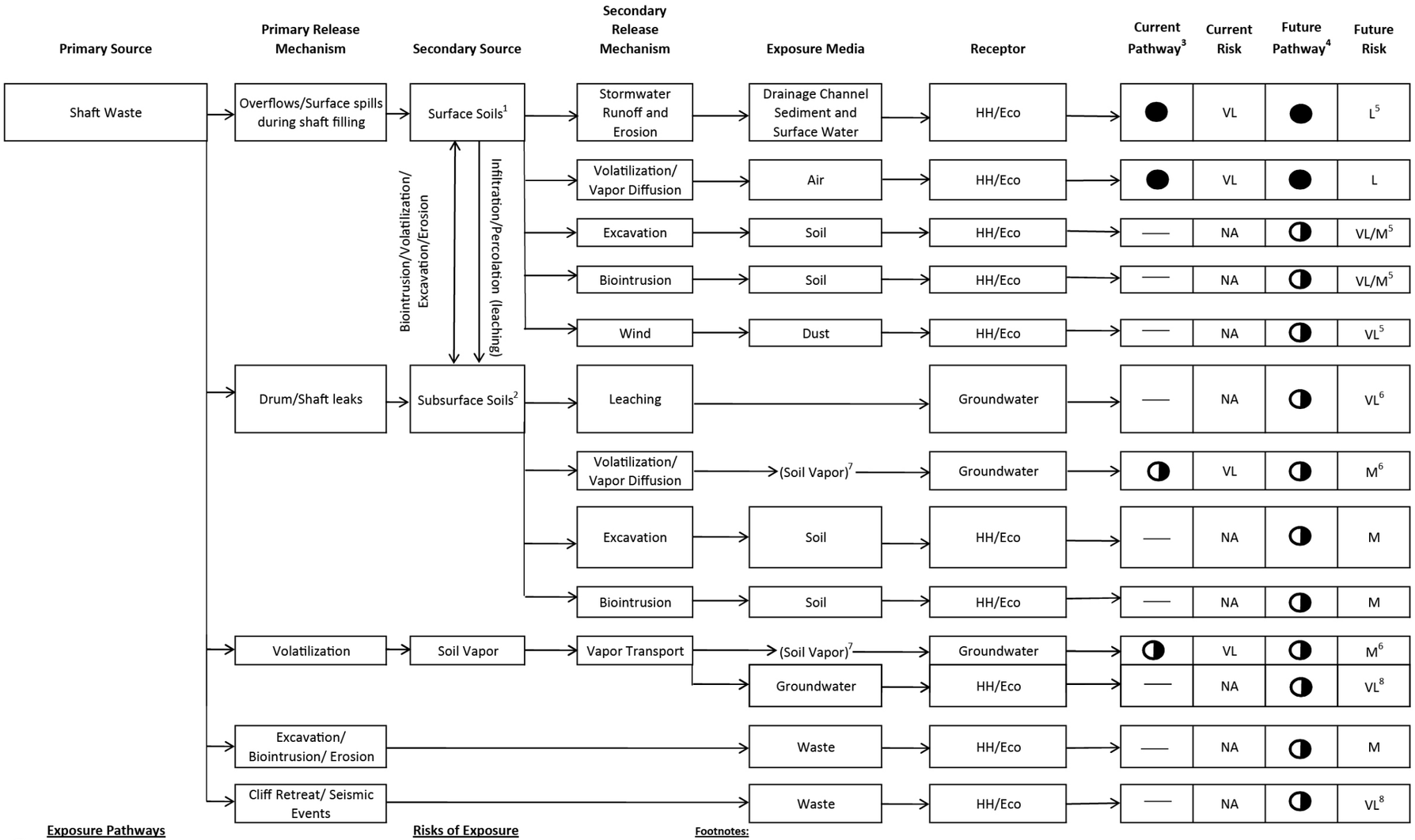
[5] = Soil samples will be collected throughout the area upon removal of the asphalt paving, per the LANL Hazardous Waste Permit Closure Plan for Technical Area 54, Area L Outdoor Container Storage Unit. It is expected that future risk will be managed by the Closure Performance standards of the Closure Plan.

[6] = There is uncertainty associated with the contaminant transport to groundwater. This uncertainty will be managed by the final action.

[7] = This is not an exposure media but a potential source to groundwater.

[8] = The risk associated with this pathway is quantified as very low due to the low potential of this pathway becoming complete.

Figure 4.0-2 Conceptual site model for pit and impoundments waste



Exposure Pathways

● = Complete pathway

◑ = Potentially complete pathway

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Risks of Exposure

VL = Very Low

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M = Medium

NA = Not Applicable

Footnotes:

[1] = Surface soil is defined as 0 to 1 ft bgs.

[2] = Subsurface soil is defined as deeper than 1 ft bgs.

[3] = Current scenario assumes presence of existing asphalt paving.

[4] = Future scenario assumes the removal of existing asphalt paving under the LANL Hazardous Waste Permit Closure Plan for Technical Area 54, Area L Outdoor Container Storage Unit.

[5] = Soil samples will be collected throughout the area upon removal of the asphalt paving, per the LANL Hazardous Waste Permit Closure Plan for Technical Area 54, Area L Outdoor Container Storage Unit. There is uncertainty associated with the potential levels of COPCs that may be detected in surface soils remaining after asphalt removal. It is expected that any future risk will be managed by the Closure Performance standards of the Closure Plan.

[6] = There is uncertainty associated with the contaminant transport to groundwater. This uncertainty will be managed by the final action.

[7] = This is not an exposure media but a potential source to groundwater.

[8] = The risk associated with this pathway is quantified as very low due to the low potential of this pathway becoming complete.

Figure 4.0-3 Conceptual site model for shaft waste

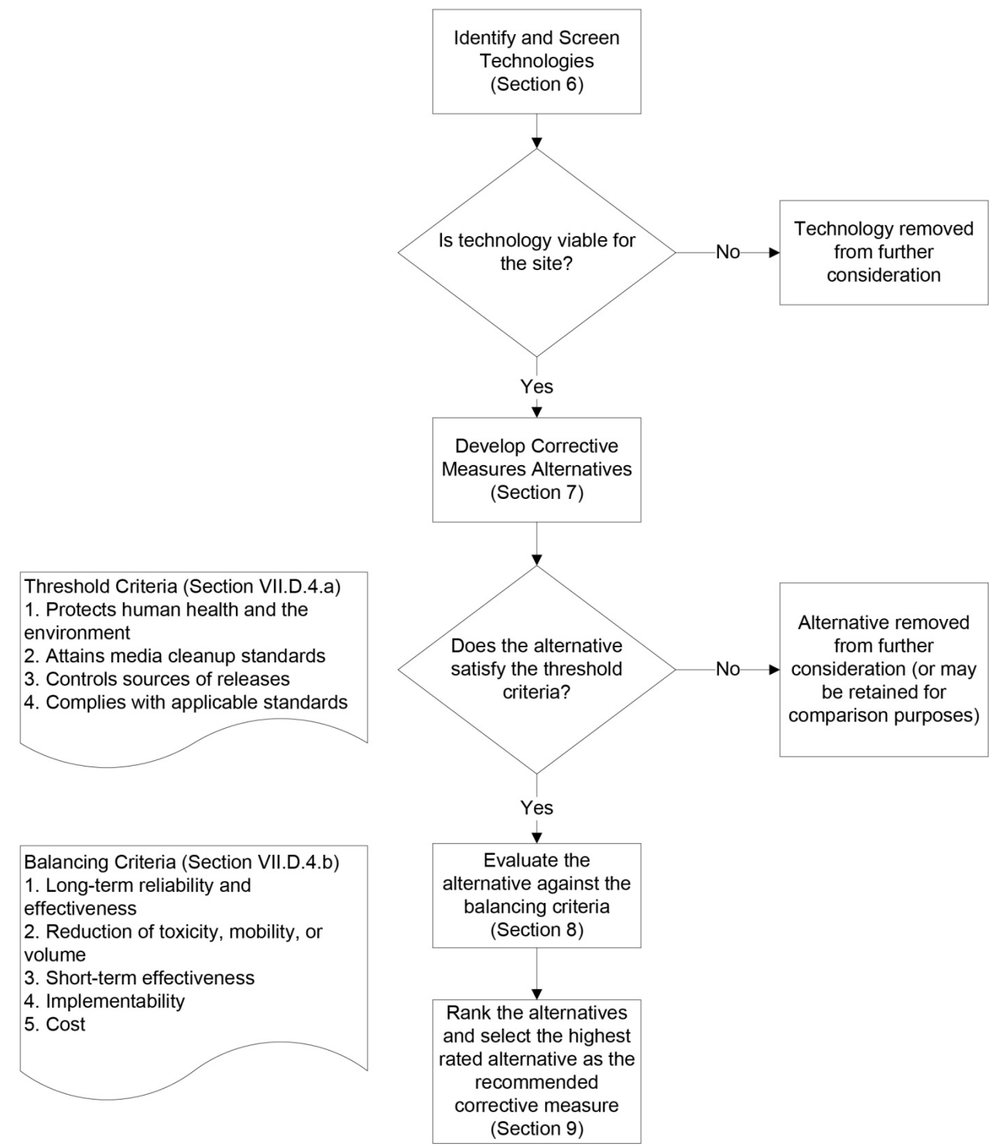


Figure 5.3-1 The selection process for the preferred corrective measure alternative

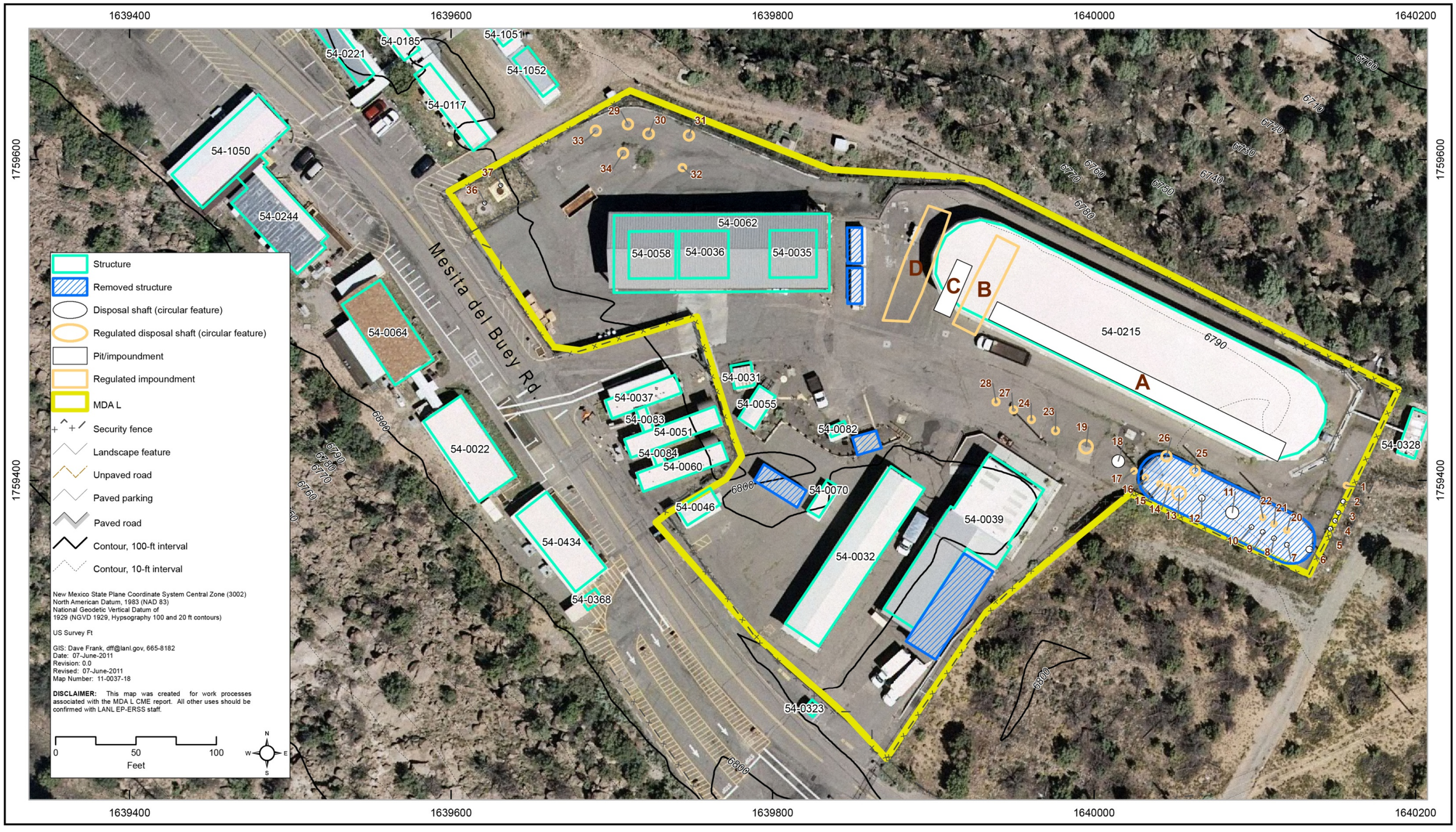


Figure 7.1-1 Site layout of MDA L

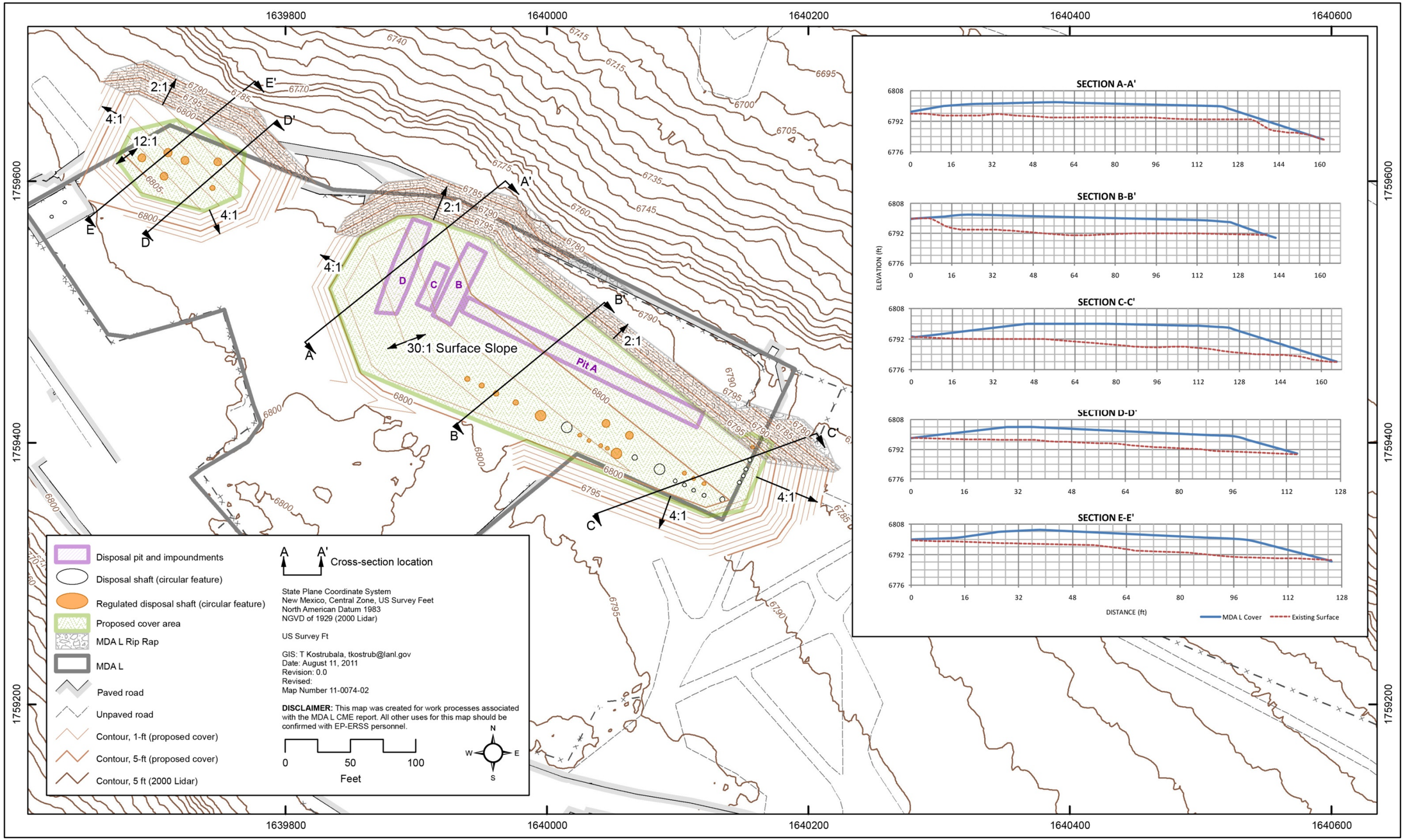


Figure 7.3-1 Conceptual cover layout for Alternatives 2A and 2B

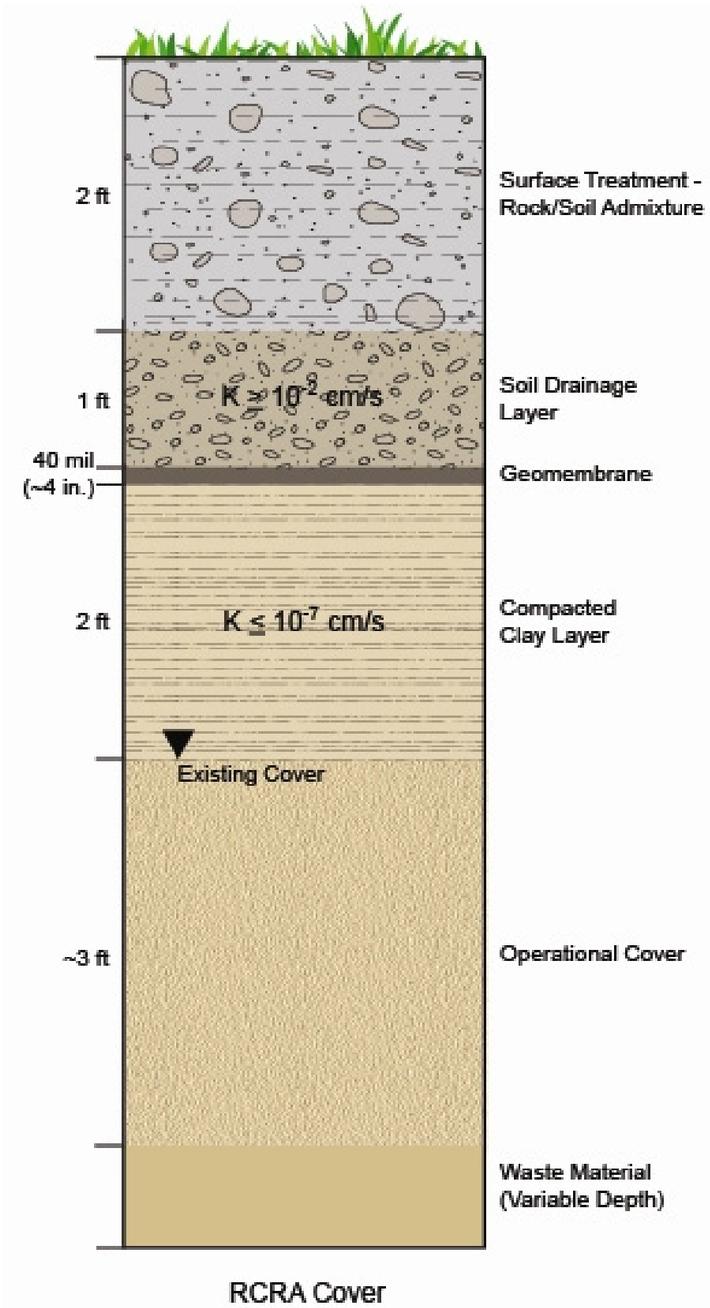


Figure 7.3-2 Cross-section of RCRA cover

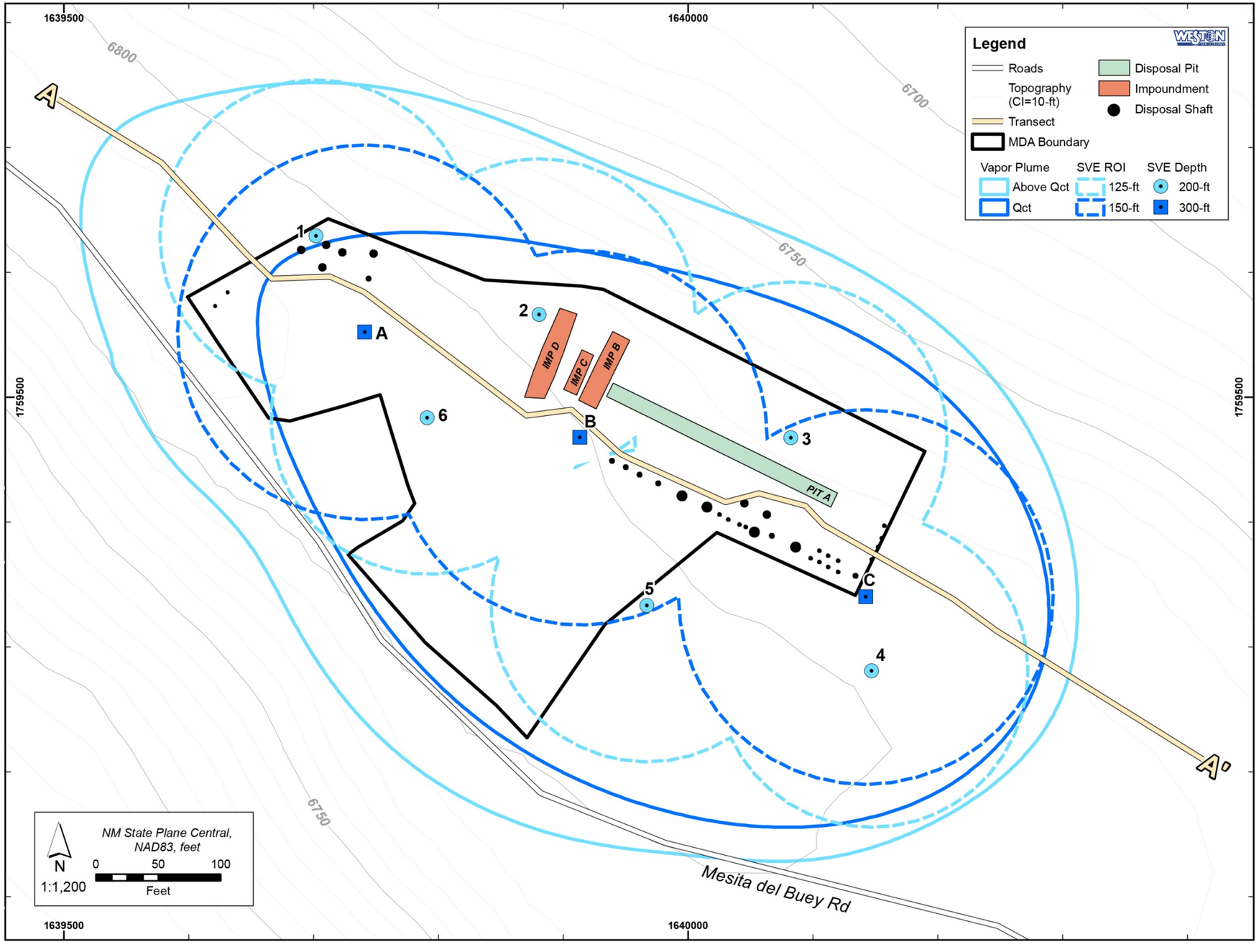


Figure 7.3-3 SVE layout for Alternatives 2A, 2B, 3A, 3B, and 4

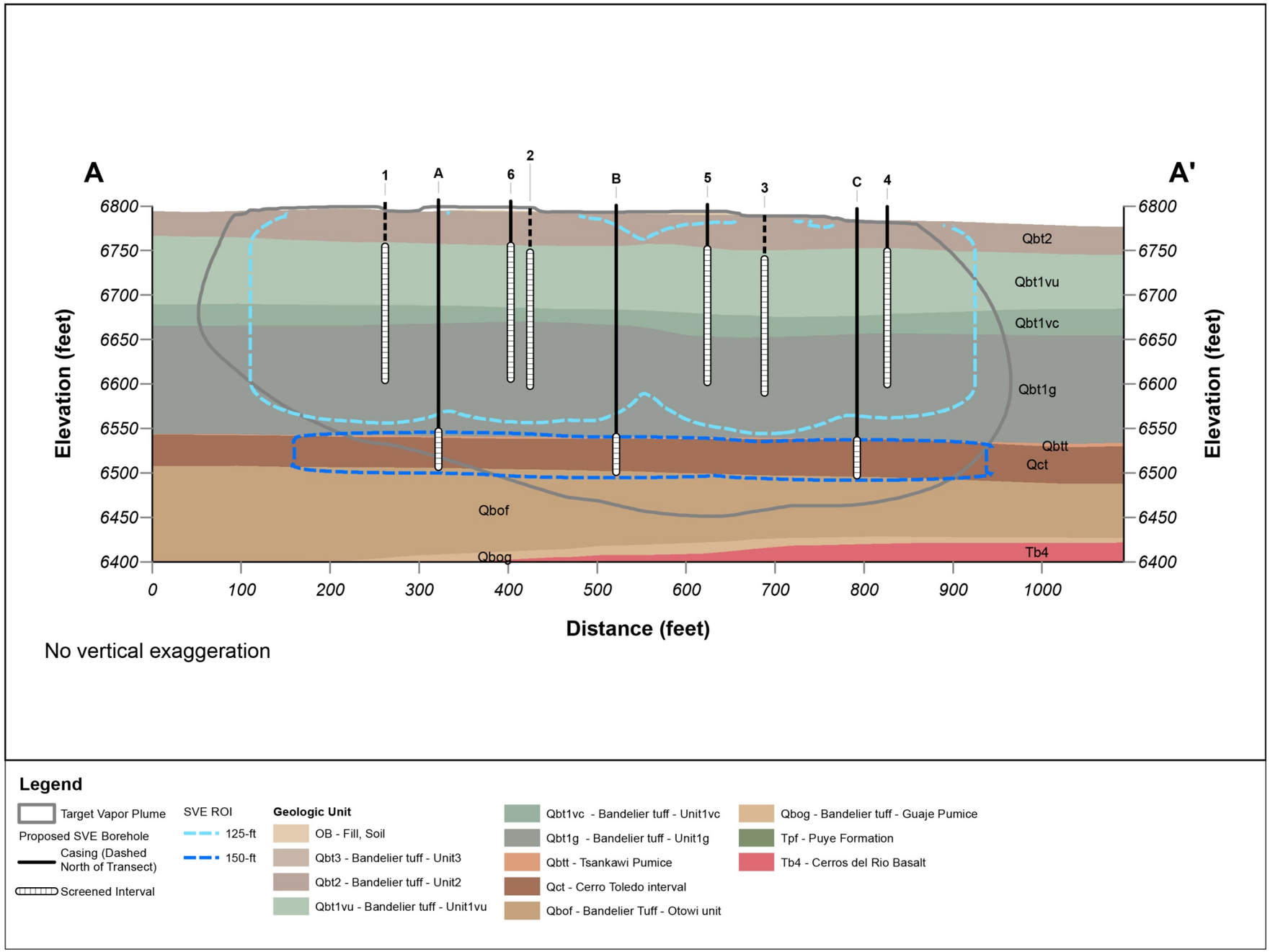


Figure 7.3-4 SVE cross-section

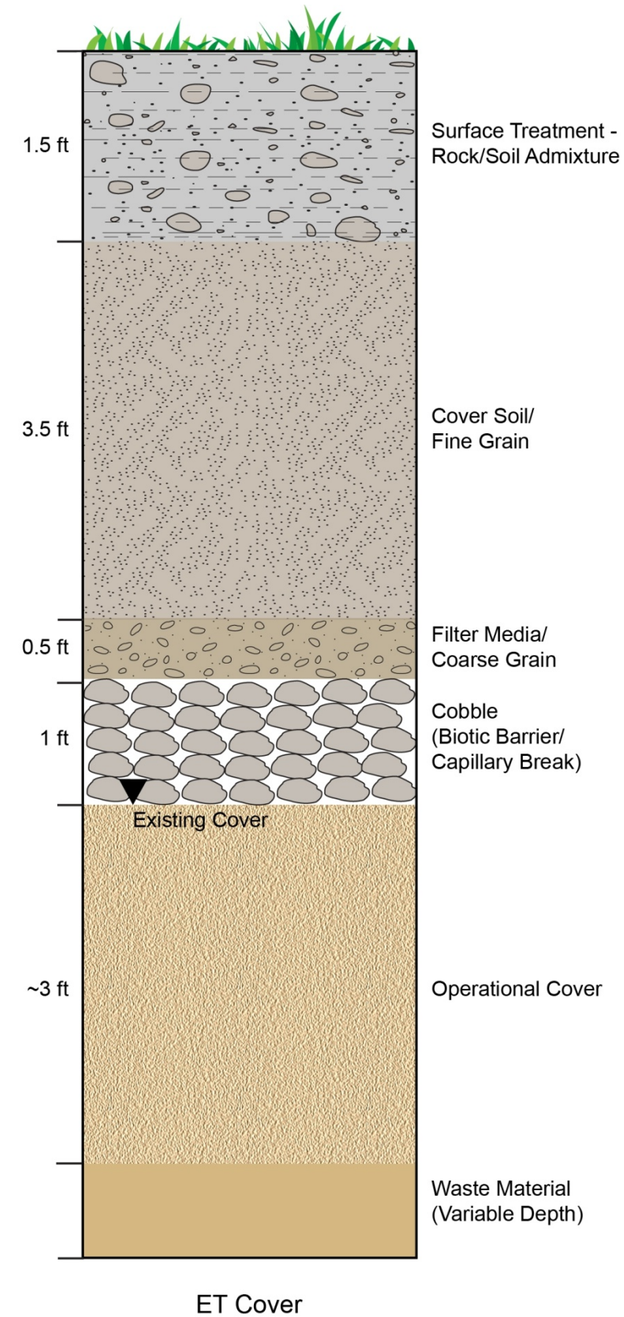


Figure 7.3-5 Cross-section of ET cover

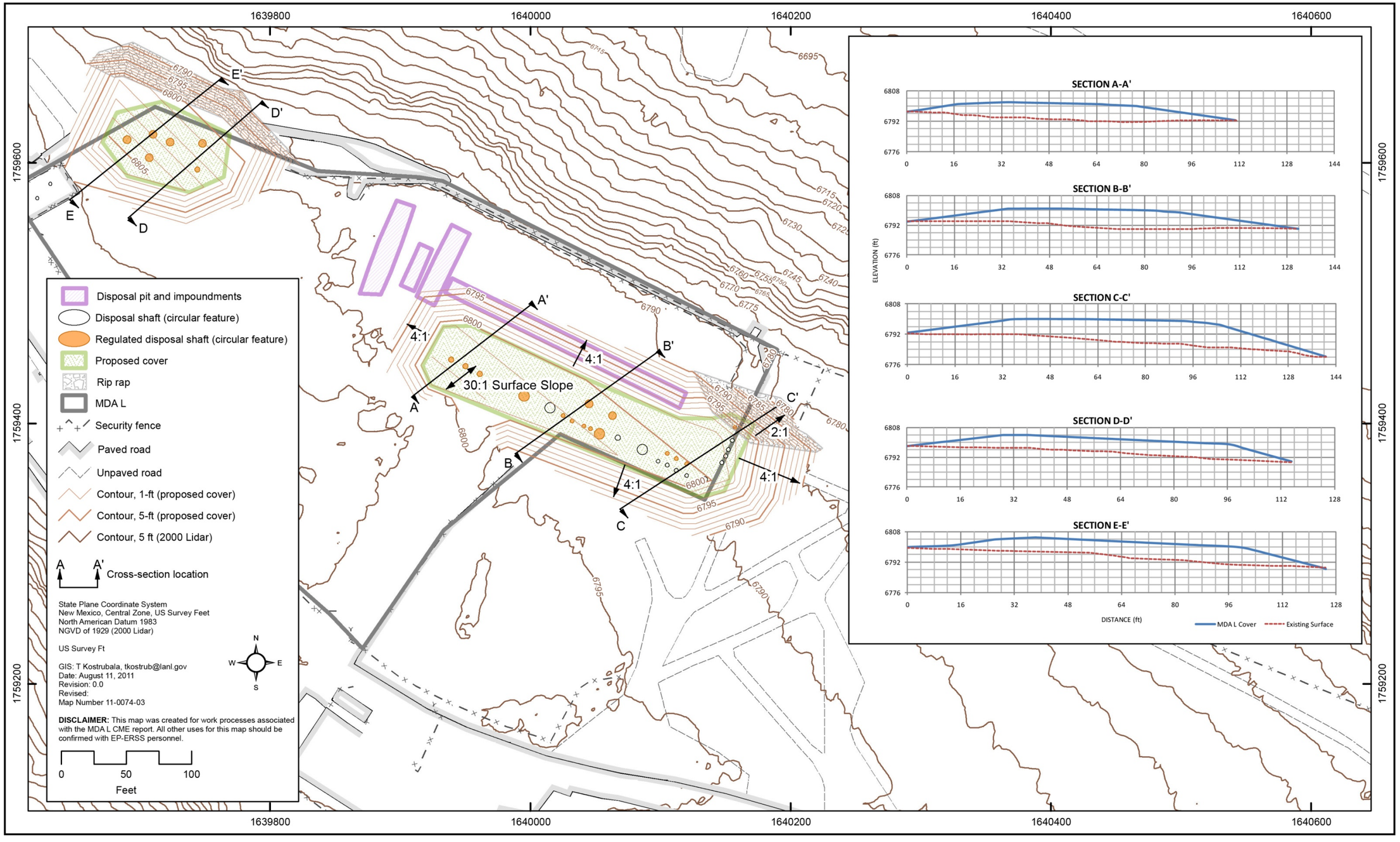


Figure 7.3-6 Conceptual cover layout for Alternatives 3A and 3B

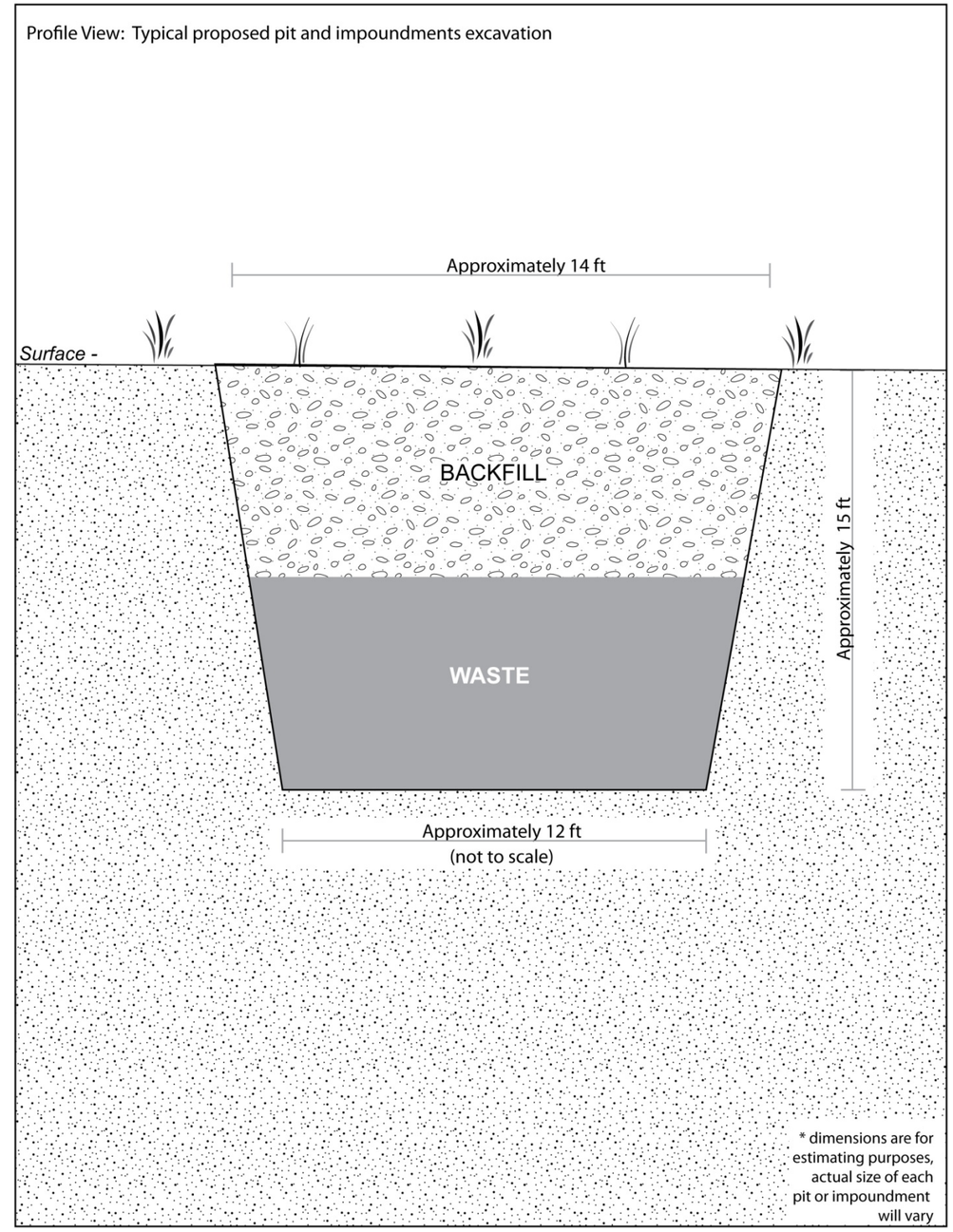


Figure 7.3-7 Typical cross-section of pit and impoundment excavation

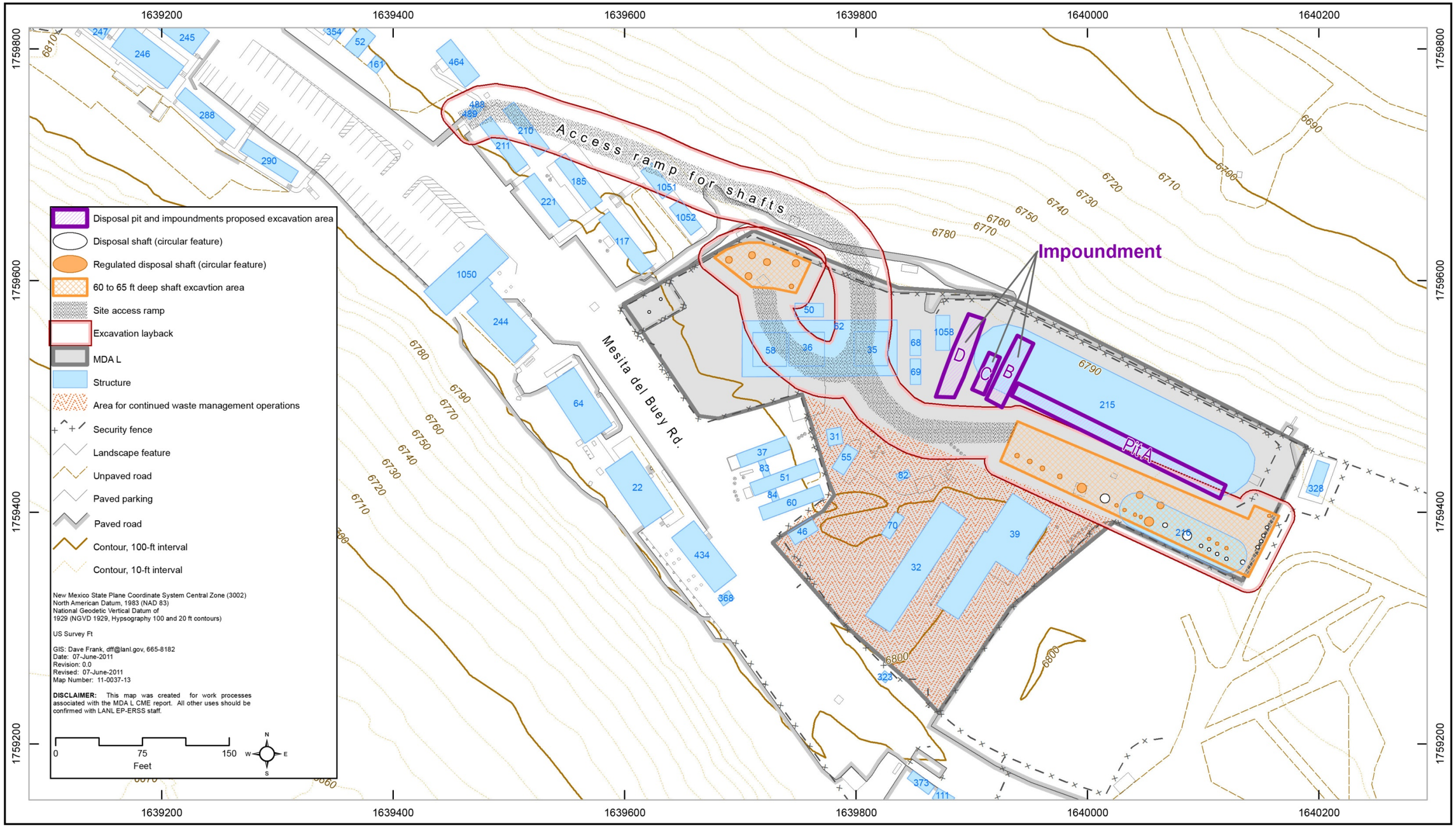


Figure 7.3-8 Proposed excavation areas for pit and impoundments areas (Alternatives 3A and 3B) and for total excavation (Alternative 4)

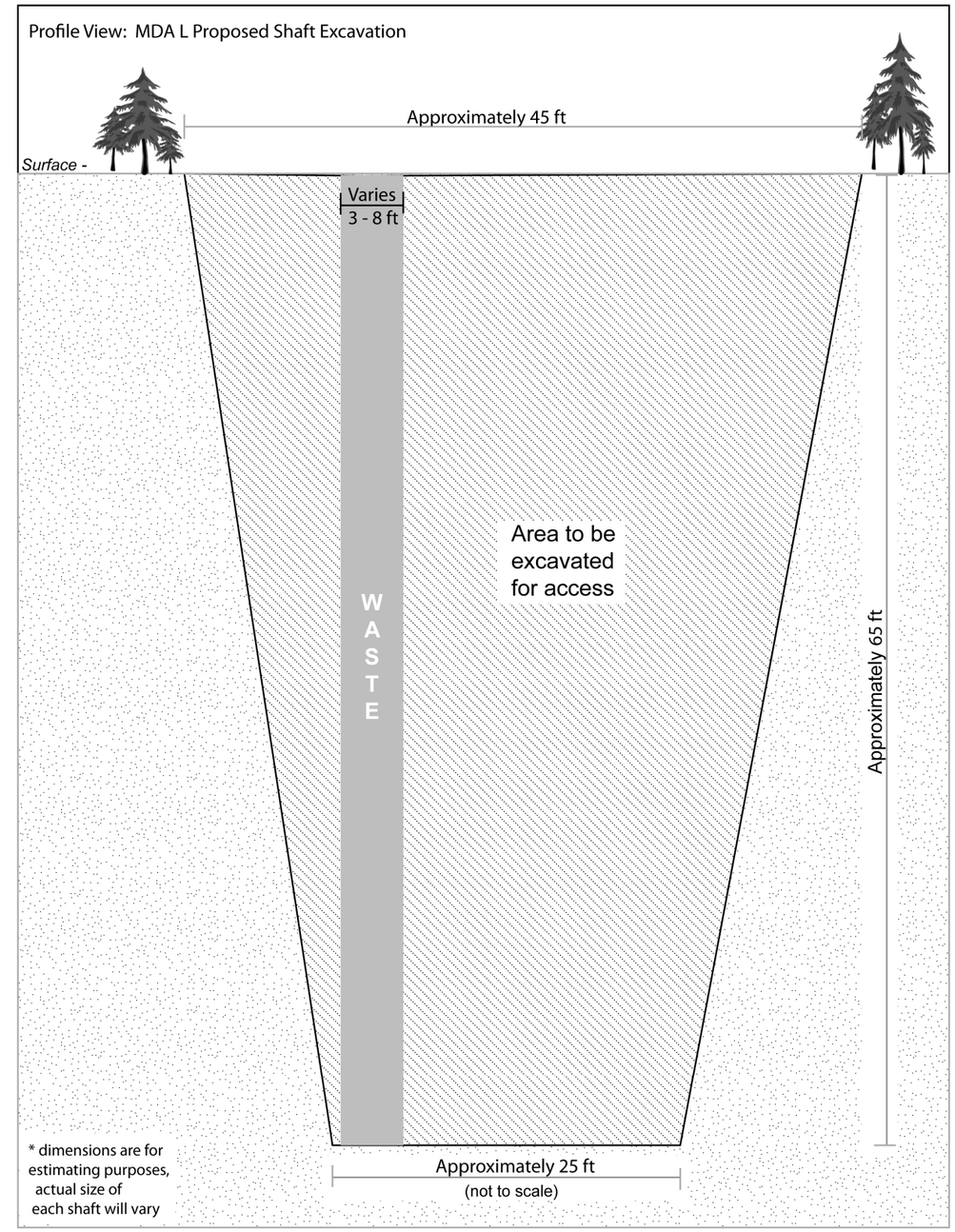
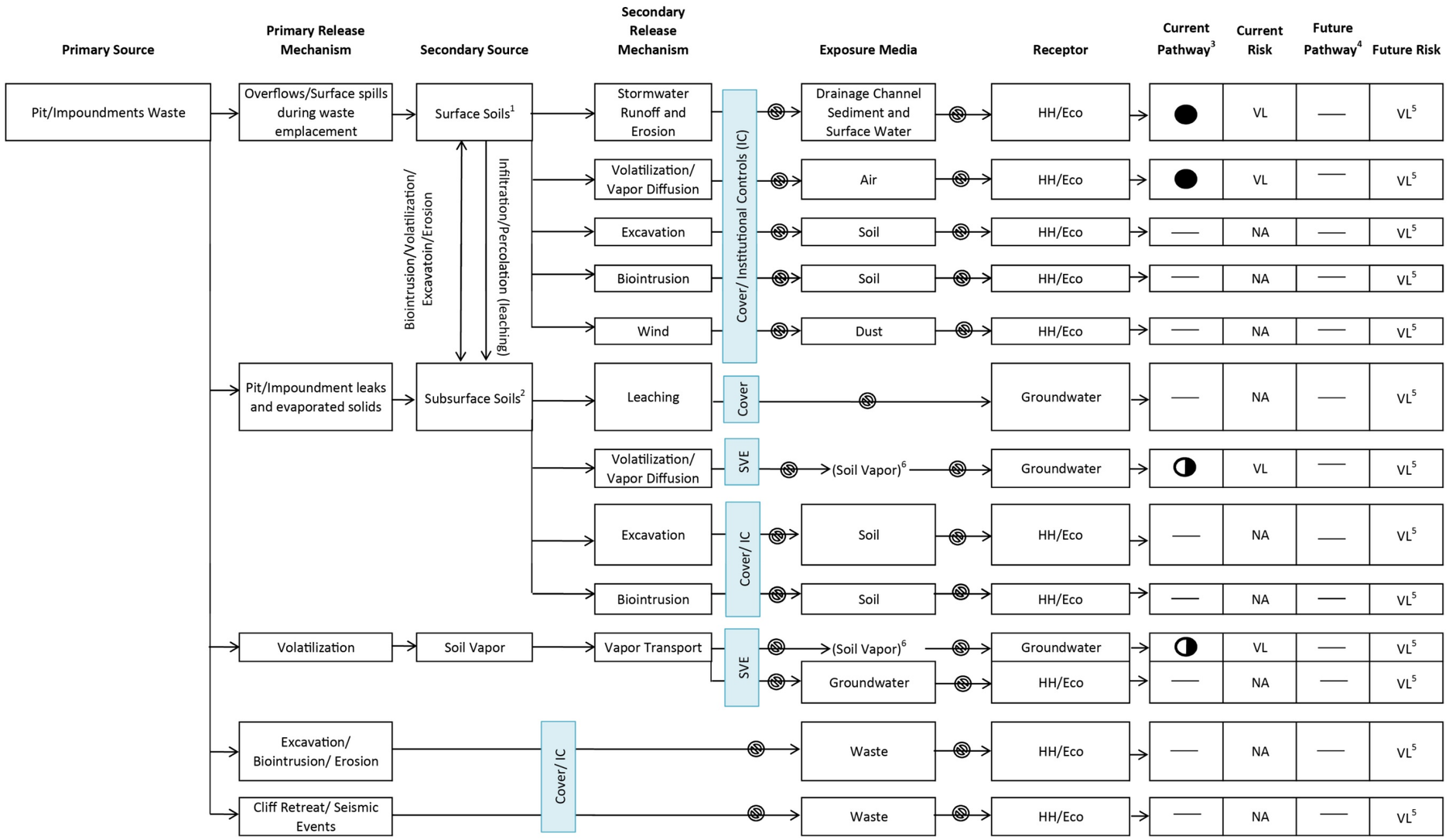


Figure 7.3-9 Typical cross-section of shaft excavation



Exposure Pathways

- ● = Complete pathway
- ◑ = Potentially complete pathway
- — = Incomplete pathway
- ⊘ = Pathway broken by corrective measure remedy

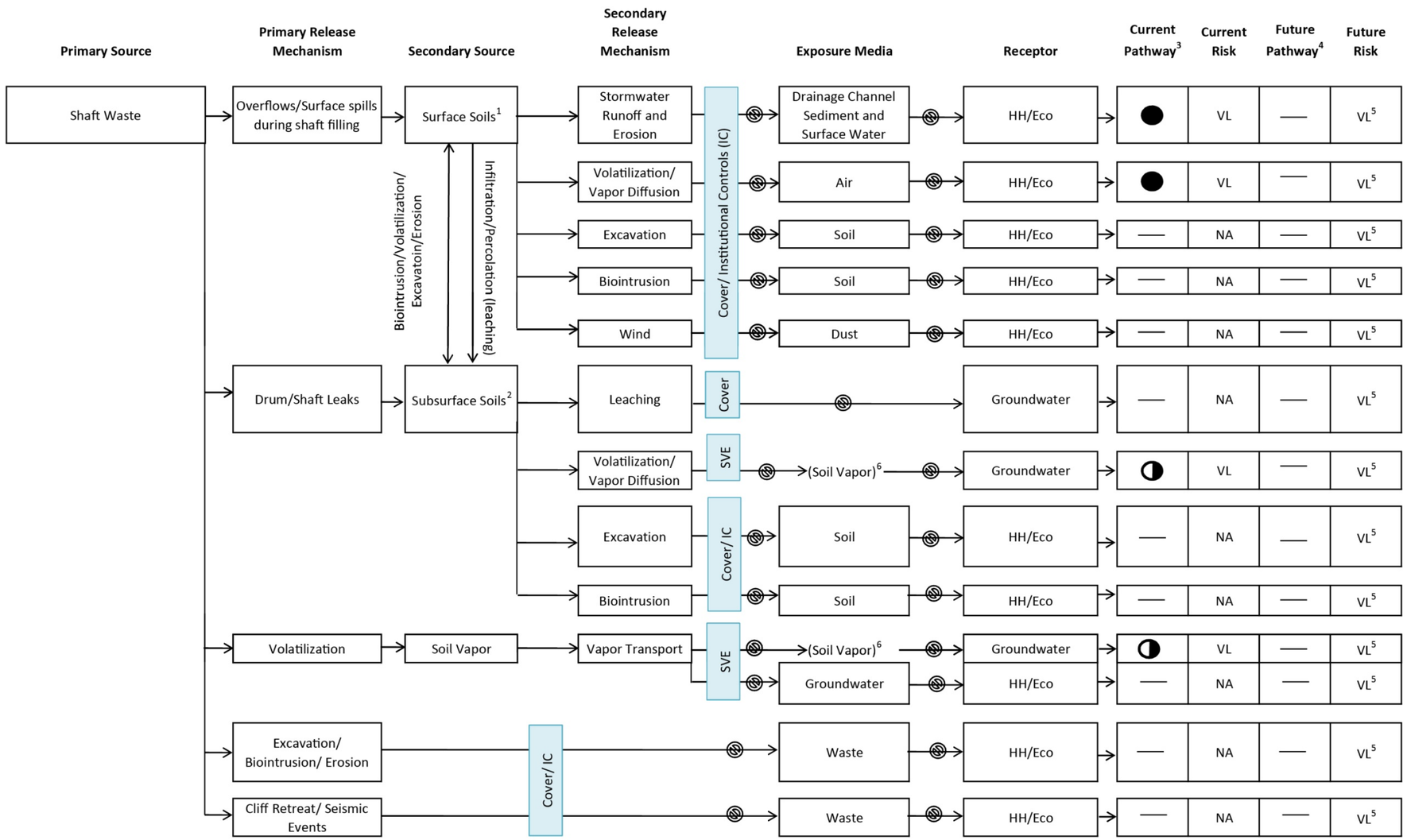
Risks of Exposure

VL = Very Low
L = Low
M = Medium
NA = Not Applicable

Footnotes:

[1] = Surface soil is defined as 0 to 1 ft bgs.
[2] = Subsurface soil is defined as deeper than 1 ft bgs.
[3] = Current scenario assumes presence of existing asphalt paving.
[4] = Future scenario assumes implementing the recommended alternative.
[5] = Future risk is shown as very low because the transport/exposure pathway is incomplete based on implementation of the recommended alternative.
[6] = This is not an exposure media but a potential source to groundwater.

Figure 9.2-1 Refined conceptual site model for pit and impoundment waste



Exposure Pathways

- ● = Complete pathway
- ◑ = Potentially complete pathway
- — = Incomplete pathway
- ⊘ = Pathway broken by corrective measure remedy

Risks of Exposure

VL = Very Low

L = Low

M = Medium

NA = Not Applicable

Footnotes:

[1] = Surface soil is defined as 0 to 1 ft bgs.

[2] = Subsurface soil is defined as deeper than 1 ft bgs.

[3] = Current scenario assumes presence of existing asphalt paving.

[4] = Future scenario assumes implementing the recommended alternative.

[5] = Future risk is shown as very low because the transport/exposure pathway is incomplete based on implementation of the recommended alternative.

[6] = This is not an exposure media but a potential source to groundwater.

Figure 9.2-2 Refined conceptual site model for shaft waste

Table 1.0-1
Summary of Waste Management Units in Area L

	TA-54 Area L Waste Unit Categories			
	Area L Inactive Units		Area L Active Units	
	Area L Landfill (RCRA Disposal Units)	MDA L Corrective Action Disposal Units (SWMU 54-006)	Aboveground CSU	CSU Lead-Stringer Shafts
Unit Identification	Shafts 1, 13–17, and 19–34 Impoundments B and D	Shafts 2–12 and 18 Pit A Impoundment C	54-215, 54-216, 54-31, 54-32, 54-35, 54-36, 54-58, 54-68, 54-69, 54-70, 54-39[a], and Area L paved area	Shafts 36 and 37
Status	Inactive	Inactive	Active	Stringers removed
Closure Approach	Integrate RCRA closure with corrective action units	Take corrective action under Consent Order	Close under RCRA[b]	Closure certification report submitted in 2006

[a] Toxic Substances Control Act unit; included in RCRA Permit Application Renewal.

[b] Implementing the remedy for the subsurface units is expected to require closure of a portion of the existing active units.

Table 1.0-2
Crosswalk with Consent Order Requirements

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
1	The Respondents shall follow the Corrective Measures Evaluation Report format outlined in Section XI.F of this Consent Order.	VII.D.2	Table of Contents
2	The corrective measures evaluation shall evaluate potential remedial alternatives and shall recommend a preferred remedy that will be protective of human health and the environment and attain the appropriate cleanup goals.	VII.D.2	Sections 6 through 9
3	1. A description of the location, status, and current use of the site.	VII.D.2	Sections 1.0, 2.0, 2.1
4	2. A description of the history of site operations and the history of releases of contaminants.	VII.D.2	Section 2.1
5	3. A description of site surface conditions.	VII.D.2	Section 2.2 and 3.1
6	4. A description of site subsurface conditions.	VII.D.2	Section 2.2 and 3.2
7	5. A description of on- and off-site contamination in all affected media.	VII.D.2	Sections 2.5, 4.1
8	6. An identification and description of all sources of contaminants.	VII.D.2	Sections 2.5, 4.1
9	7. An identification and description of contaminant migration pathways.	VII.D.2	Sections 4.2 through 4.4
10	8. An identification and description of potential receptors.	VII.D.2	Sections 4.5, and 4.6
11	9. A description of cleanup standards or other applicable regulatory criteria.	VII.D.2	Section 5
12	10. An identification and description of a range of remedy alternatives.	VII.D.2	Sections 6 through 8
13	11. Remedial alternative pilot or bench scale testing results.	VII.D.2	Section 2.5.3
14	12. A detailed evaluation and rating of each of the remedy alternatives, applying the criteria set forth in Section VII.D.4.	VII.D.2	Section 8 and associated tables
15	13. An identification of a proposed preferred remedy or remedies.	VII.D.2	Section 9
16	14. Design criteria of the selected remedy or remedies.	VII.D.2	Section 10
17	15. A proposed schedule for implementation of the preferred remedy.	VII.D.2	Section 11
18	The Respondents shall select corrective measures that are capable of achieving the cleanup standards and goals outlined in Section VIII of this Consent Order including, as applicable, approved alternate cleanup goals established by a risk assessment.	VII.D.3	Sections 5 and 9

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
19	The Respondents shall evaluate each of the remedy alternatives for the following threshold criteria. To be selected, the remedy alternative must: 1. Be protective of human health and the environment. 2. Attain media cleanup standards. 3. Control the source or sources of releases so as to reduce or eliminate, to the extent practicable, further releases of contaminants that may pose a threat to human health and the environment. 4. Comply with applicable standards for management of wastes.	VII.D.4.a	Sections 7 and 8
20	The remedy shall be evaluated for long-term reliability and effectiveness. This factor includes consideration of the magnitude of risks that will remain after implementation of the remedy; the extent of long-term monitoring, or other management that will be required after implementation of the remedy; the uncertainties associated with leaving contaminants in place; and the potential for failure of the remedy. Respondents shall give preference to a remedy that reduces risks with little long-term management, and that has proven effective under similar conditions.	VII.D.4.b.i	Section 8
21	The remedy shall be evaluated for its reduction in the toxicity, mobility, and volume of contaminants. Respondents shall give preference to remedy that uses treatment to more completely and permanently reduce the toxicity, mobility, and volume of contaminants.	VII.D.4.b.ii	Section 8
22	The remedy shall be evaluated for its short-term effectiveness. This factor includes consideration of the short-term reduction in existing risks that the remedy would achieve; the time needed to achieve that reduction; and the short-term risks that might be posed to the community, workers, and the environment during implementation of the remedy. Respondents shall give preference to a remedy that quickly reduces short-term risks, without creating significant additional risks.	VII.D.4.b.iii	Section 8
23	The remedy shall be evaluated for its implementability or the difficulty of implementing the remedy. This factor includes consideration of installation and construction difficulties; operation and maintenance difficulties; difficulties with cleanup technology; permitting and approvals; and the availability of necessary equipment, services, expertise, and storage and disposal capacity. Respondents shall give preference to a remedy that can be implemented quickly and easily, and poses fewer and lesser difficulties.	VII.D.4.b.iv	Section 8

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
24	The remedy shall be evaluated for its cost. This factor includes a consideration of both capital costs, and operation and maintenance costs. Capital costs shall include, without limitation, construction and installation costs; equipment costs; land development costs; and indirect costs including engineering costs, legal fees, permitting fees, startup and shakedown costs, and contingency allowances. Operation and maintenance costs shall include, without limitation, operating labor and materials costs; maintenance labor and materials costs; replacement costs; utilities; monitoring and reporting costs; administrative costs; indirect costs; and contingency allowances. All costs shall be calculated based on their net present value. Respondents shall give preference to a remedy that is less costly, but does not sacrifice protection of health and the environment.	VII.D.4.b.v	Section 8

Table 2.5-1
Frequency of Detected Radionuclides above BVs in 1994 Channel Sediment Samples at MDA L

Analyte	Number of Analyses	Number of Detects	Concentration Range[a] (pCi/g)	BV[b] (pCi/g)	Frequency of Detects above BV
Americium-241	4	4	0.004 to 0.009	0.04	0/4
Cesium-137	4	2	[0.09] to 0.38	0.9	0/4
Cobalt-60	4	0	[0.02 to 0.09]	na[c]	0/4
Plutonium-238	4	4	0.003 to 0.011	0.006	1/4
Plutonium-239	4	4	0.01 to 0.017	0.068	0/4
Strontium-90	4	4	-0.04 to 0.12	1.04	0/4
Technitium-99	4	0	[0.2] to [0.2]	na	0/4
Thorium-228	4	4	1.26 to 1.92	2.28	0/4
Thorium-230	4	4	1.12 to 1.69	2.29	0/4
Thorium-232	4	4	1.28 to 1.84	2.33	0/4
Tritium	4	4	6.84E-03 to 3.30E-02	0.093	0/4
Uranium-234	4	4	1.12 to 1.81	2.59	0/4
Uranium-235	4	4	0.07 to 0.1	0.2	0/4
Uranium-238	4	4	1.37 to 2.03	2.29	0/4

[a] Values in square brackets indicate reporting limit for contaminants.

[b] Sediment BVs and FVs from LANL (1998, 059730).

[c] na = Not available.

Table 2.5-2
Inorganic Chemicals Detected or Detected above BVs in Phase I RFI Subsurface Core Samples at MDA L

Location ID	Sample ID	Depth (ft)	Media	Aluminum	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)
Qbt 2 Background Value[a]				**7340**	**46**	**1.21**	**na[b]**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**
Qbt 1v Background Value[a]				**8170**	**26.5**	**1.70**	**na**	**0.40**	**3700**	**2.24**	**1.78**	**3.26**	**0.5**
Qbt 1g Background Value[a]				**3560**	**25.7**	**1.44**	**na**	**0.40**	**1900**	**2.60**	**8.89**	**3.96**	**0.5**
54-01007	AAA6034	5.5–6.5	Qbt 2	—[c]	83	—	—	—	79000	—	—	7.7	—
54-01007	AAA6035	15–16.5	Qbt 2	10000	—	—	4.0	—	—	—	—	370	—
54-01007	AAA6036	35–36	Qbt 2	—	55	—	—	—	—	—	—	15	—
54-01007	AAA7415	31–32	Qbt 2	—	—	—	—	—	—	—	—	52	—
54-01007	AAA7409	49–50	Qbt 1v	—	43	—	—	—	—	—	—	11	—
54-01007	AAA7408	60–62.5	Qbt 1v	—	—	—	—	—	—	3.4	—	—	—
54-01007	AAA7420	68–69.8	Qbt 1v	—	—	—	—	—	—	—	—	64	—
54-01007	AAA7421	75.5–77	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7446	87.8–89	Qbt 1v	—	—	—	—	—	—	3.9	—	46	—
54-01007	AAA7450	98.5–99.6	Qbt 1v	—	—	—	—	—	—	4.1	—	—	—
54-01007	AAA7451	106.4–107.5	Qbt 1v	—	—	—	—	—	—	4.3	—	81.4	—
54-01007	AAA7447	130.8–132	Qbt 1g	—	—	—	—	—	—	—	—	17.3	—
54-01007	AAA7449	145.5–146.7	Qbt 1g	—	—	—	—	—	—	4.3	—	34.9	—
54-01008	AAA7413	5.5–6.3	Qbt 2	—	—	—	—	—	—	—	—	8.3	—
54-01008	AAA7400	20.5–22	Qbt 2	—	—	—	—	—	—	—	—	21	—
54-01008	AAA7405	38–39	Qbt 1v	—	—	—	—	—	—	—	1.8	40	—
54-01008	AAA7423	45–46.2	Qbt 1v	—	—	—	—	—	—	—	6.1	37	—
54-01008	AAA7422	55.5–57	Qbt 1v	—	—	—	—	—	—	2.4	—	4.5	—
54-01008	AAA7448	66–67	Qbt 1v	—	—	—	—	—	—	3.8	—	33	—

Table 2.5-2 (continued)

Location ID	Sample ID	Depth (ft)	Media	Aluminum	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)
Qbt 2 Background Value[a]				**7340**	**46**	**1.21**	**na[b]**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**
Qbt 1v Background Value[a]				**8170**	**26.5**	**1.70**	**na**	**0.40**	**3700**	**2.24**	**1.78**	**3.26**	**0.5**
Qbt 1g Background Value[a]				**3560**	**25.7**	**1.44**	**na**	**0.40**	**1900**	**2.60**	**8.89**	**3.96**	**0.5**
54-01008	AAA7414	76.5–77.5	Qbt 1v	—	—	—	—	—	—	2.6	—	110	—
54-01008	AAA7398	85.5–89	Qbt 1v	—	—	—	—	—	—	2.3	—	110	—
54-01008	AAA7445	107–108	Qbt 1v	—	—	—	—	—	—	3.8	1.8	190	—
54-01008	AAA7419	125–126.5	Qbt 1v	—	34	3.3	—	—	—	—	1.8	12	—
54-01008	AAA7411	146–147	Qbt 1g	—	—	—	—	—	—	—	—	100	—
54-01009	AAA7406	6–7.5	Qbt 2	—	—	—	—	—	—	—	—	21	—
54-01009	AAA7417	15.7–17	Qbt 2	—	—	—	—	—	—	—	—	14	—
54-01009	AAA7410	26–27.5	Qbt 2	—	—	—	—	—	—	—	—	66	—
54-01009	AAA7401	38–40	Qbt 1v	—	27	—	—	—	—	—	—	11	—
54-01009	AAA7397	45.5–46.8	Qbt 1v	—	—	—	—	—	—	3.5	—	12	—
54-01009	AAA7412	59–60	Qbt 1v	—	33	—	—	—	—	—	—	13	—
54-01009	AAA7404	65–66	Qbt 1v	—	44	—	—	—	—	—	—	6.3	—
54-01009	AAA7407	83.3–84.5	Qbt 1v	—	32	—	—	—	—	—	—	21	—
54-01009	AAA7402	95–100	Qbt 1v	—	31	—	—	—	—	—	—	54	—
54-01009	AAA7403	115.5–117	Qbt 1v	—	—	—	—	—	—	—	—	100	—
54-01009	AAA7399	135–137	Qbt 1g	—	44	1.6	—	—	—	—	—	180	—
54-01010	AAB6797	13.2–14.1	Qbt 2	—	—	—	—	—	—	7.8	—	—	—
54-01010	AAB6798	20.4–21.2	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01010	AAB6787	34.5–35	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01010	AAB6800	41.6–42.1	Qbt 1v	—	—	—	—	—	—	4.8 (J)	—	—	—
54-01011	AAB6796	23.6–24.1	Qbt 2	—	138	—	—	—	—	—	—	—	—

Table 2.5-2 (continued)

Location ID	Sample ID	Depth (ft)	Media	Aluminum	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)
Qbt 2 Background Value[a]				**7340**	**46**	**1.21**	**na[b]**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**
Qbt 1v Background Value[a]				**8170**	**26.5**	**1.70**	**na**	**0.40**	**3700**	**2.24**	**1.78**	**3.26**	**0.5**
Qbt 1g Background Value[a]				**3560**	**25.7**	**1.44**	**na**	**0.40**	**1900**	**2.60**	**8.89**	**3.96**	**0.5**
54-01012	AAB6807	7.5–8.2	Qbt 2	—	—	1.5	—	—	—	57.8	—	105 (J)	—
54-01012	AAB6791	15.8–16.4	Qbt 2	—	—	—	—	—	—	47.9	—	36.5 (J)	—
54-01012	AAB6780	23.6–24.1	Qbt 2	—	—	—	—	—	—	13.5	—	38.2 (J)	0.96 (J)
54-01012	AAB6782	40–40.7	Qbt 1v	—	—	—	—	1.7	—	4.2	—	—	—
54-01013	AAB6811	5.7–6.1	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01013	AAB6809	14.3–14.7	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01013	AAB6799	22.5–23.3	Qbt 2	—	—	—	—	—	—	—	—	49.6 (J)	—
54-01013	AAB6810	29.5–30.0	Qbt 2	—	—	—	—	—	—	—	—	48.9	—
54-01013	AAB6792	39.3–41	Qbt 1v	—	—	—	—	—	—	4.6	—	55.7	—
54-01014	AAB6801	5.2–5.3	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01014	AAB6786	15.4–16	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01014	AAB6784	23.4–24.1	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01014	AAB6793	33.7–34.5	Qbt 2	—	—	—	—	—	—	—	—	5.7	—
54-01014	AAB6781	40.1–41	Qbt 1v	—	—	—	—	—	—	3.0	—	—	—

Table 2.5-2 (continued)

Location ID	Sample ID	Depth (ft)	Media	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Uranium	Vanadium	Zinc
Qbt 2 Background Value[a]				**14,500**	**11.2**	**482**	**0.1**	**na**	**6.58**	**0.3**	**2.4**	**17**	**63.5**
Qbt 1v Background Value[a]				**9900**	**18.4**	**408**	**0.1**	**na**	**2.0**	**0.3**	**6.22**	**4.48**	**84.6**
Qbt 1g Background Value[a]				**3700**	**13.5**	**189**	**0.1**	**na**	**2.0**	**0.3**	**0.72**	**4.59**	**40**
54-01007	AAA6034	5.5–6.5	Qbt 2	—	—	—	—	—	—	1.0	—	—	—
54-01007	AAA6035	15–16.5	Qbt 2	—	—	—	—	—	—	—	—	—	240
54-01007	AAA6036	35–36	Qbt 2	—	13	770	—	—	—	—	—	—	64
54-01007	AAA7415	31–32	Qbt 2	—	—	—	—	—	—	—	—	—	82
54-01007	AAA7409	49–50	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7408	60–62.5	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7420	68–69.8	Qbt 1v	—	—	—	—	—	—	—	—	—	94
54-01007	AAA7421	75.5–77	Qbt 1v	—	—	430	—	—	—	—	—	—	—
54-01007	AAA7446	87.8–89	Qbt 1v	—	—	—	—	—	—	—	—	—	99
54-01007	AAA7450	98.5–99.6	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7451	106.4–107.5	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7447	130.8–132	Qbt 1g	—	—	—	—	—	—	—	—	—	52.3
54-01007	AAA7449	145.5–146.7	Qbt 1g	—	—	—	—	—	—	—	—	—	—
54-01008	AAA7413	5.5–6.3	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01008	AAA7400	20.5–22	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01008	AAA7405	38–39	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01008	AAA7423	45–46.2	Qbt 1v	—	—	—	—	3.4	—	—	—	—	—
54-01008	AAA7422	55.5–57	Qbt 1v	—	—	410	—	—	—	—	—	—	—
54-01008	AAA7448	66–67	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01008	AAA7414	76.5–77.5	Qbt 1v	—	—	—	—	—	—	—	—	—	110
54-01008	AAA7398	85.5–89	Qbt 1v	—	—	—	—	—	—	—	—	—	130

Table 2.5-2 (continued)

Location ID	Sample ID	Depth (ft)	Media	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Uranium	Vanadium	Zinc
Qbt 2 Background Value[a]				**14,500**	**11.2**	**482**	**0.1**	**na**	**6.58**	**0.3**	**2.4**	**17**	**63.5**
Qbt 1v Background Value[a]				**9900**	**18.4**	**408**	**0.1**	**na**	**2.0**	**0.3**	**6.22**	**4.48**	**84.6**
Qbt 1g Background Value[a]				**3700**	**13.5**	**189**	**0.1**	**na**	**2.0**	**0.3**	**0.72**	**4.59**	**40**
54-01008	AAA7445	107–108	Qbt 1v	—	—	—	—	—	—	—	—	—	160
54-01008	AAA7419	125–126.5	Qbt 1v	—	20	—	—	—	—	—	—	4.5	—
54-01008	AAA7411	146–147	Qbt 1g	5000	—	—	—	—	—	—	—	—	78
54-01009	AAA7406	6–7.5	Qbt 2	—	—	—	—	0.3	—	—	—	—	—
54-01009	AAA7417	15.7–17	Qbt 2	—	—	—	—	0.5	6.6	—	—	—	—
54-01009	AAA7410	26–27.5	Qbt 2	—	—	—	—	0.4	—	—	—	—	79
54-01009	AAA7401	38–40	Qbt 1v	—	—	—	—	0.4	3.9	—	—	—	—
54-01009	AAA7397	45.5–46.8	Qbt 1v	—	—	—	—	0.4	3.8	—	—	—	—
54-01009	AAA7412	59–60	Qbt 1v	—	—	—	—	0.5	3.9	—	—	—	—
54-01009	AAA7404	65–66	Qbt 1v	—	—	—	—	0.4	2.5	—	—	—	—
54-01009	AAA7407	83.3–84.5	Qbt 1v	—	—	—	—	0.3	—	—	—	—	—
54-01009	AAA7402	95–100	Qbt 1v	—	—	—	—	0.4	2.5	—	—	—	91
54-01009	AAA7403	115.5–117	Qbt 1v	—	—	—	—	0.8	—	—	—	—	110
54-01009	AAA7399	135–137	Qbt 1g	—	—	210	—	0.7	2.6	—	—	—	140
54-01010	AAB6797	13.2–14.1	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01010	AAB6798	20.4–21.2	Qbt 2	—	—	—	0.16	—	—	—	—	—	—
54-01010	AAB6787	34.5–35	Qbt 2	—	—	—	—	—	—	—	3.71 (J)	—	—
54-01010	AAB6800	41.6–42.1	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01011	AAB6796	23.6–24.1	Qbt 2	—	—	—	—	—	—	—	—	—	—
54-01012	AAB6807	7.5–8.2	Qbt 2	—	—	—	0.15	—	—	—	—	—	—
54-01012	AAB6791	15.8–16.4	Qbt 2	—	—	—	—	—	—	—	9.54	—	—

Table 2.5-2 (continued)

Location ID	Sample ID	Depth (ft)	Media	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Uranium	Vanadium	Zinc
Qbt 2 Background Value[a]				**14,500**	**11.2**	**482**	**0.1**	**na**	**6.58**	**0.3**	**2.4**	**17**	**63.5**
Qbt 1v Background Value[a]				**9900**	**18.4**	**408**	**0.1**	**na**	**2.0**	**0.3**	**6.22**	**4.48**	**84.6**
Qbt 1g Background Value[a]				**3700**	**13.5**	**189**	**0.1**	**na**	**2.0**	**0.3**	**0.72**	**4.59**	**40**
54-01012	AAB6780	23.6–24.1	Qbt 2	—	—	—	—	—	—	—	2.41	—	—
54-01012	AAB6782	40–40.7	Qbt 1v	—	—	—	—	—	—	—	—	—	—
54-01013	AAB6811	5.7–6.1	Qbt 2	—	—	—	—	—	—	—	3.58	—	—
54-01013	AAB6809	14.3–14.7	Qbt 2	—	—	—	—	—	—	—	2.93	—	—
54-01013	AAB6799	22.5–23.3	Qbt 2	—	—	—	—	—	17.3	—	3.14	—	—
54-01013	AAB6810	29.5–30.0	Qbt 2	—	—	—	—	—	—	—	4.90	—	—
54-01013	AAB6792	39.3–41	Qbt 1v	—	—	—	—	—	22.4	—	—	—	—
54-01014	AAB6801	5.2–5.3	Qbt 2	—	—	—	—	—	16.2	—	2.62 (J)	—	—
54-01014	AAB6786	15.4–16	Qbt 2	—	—	—	—	—	—	—	2.56 (J)	—	—
54-01014	AAB6784	23.4–24.1	Qbt 2	—	—	—	—	—	—	—	3.10	—	—
54-01014	AAB6793	33.7–34.5	Qbt 2	—	—	—	—	—	—	—	3.01 (J)	—	—
54-01014	AAB6781	40.1–41	Qbt 1v	—	—	—	—	—	—	—	—	—	—

Note: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] na = Not available.

[c] The concentration was not detected or was not detected above the BV.

Table 2.5-3
Organic Chemicals Detected in Phase I RFI Subsurface Core Samples at MDA L

Location ID	Sample ID	Depth (ft)	Media	Acetone	Aroclor-1260	Bis(2-ethylhexyl)phthalate	Bromobenzene	2-Butanone	n-Butylbenzene	4,4'-DDD	Dibromomethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane
54-01001	AAA5537	89.8–91.1	Qbt 1v	0.022	—*	—	—	—	—	—	—	—	—	—	—
54-01001	AAA4324	268.6–269.3	Qct	0.023	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA4321	37.4–38.1	Qbt 2	0.033	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5373	58–58.8	Qbt 1v	0.025	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5378	75–76.6	Qbt 1v	0.021	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5374	93.5–96	Qbt 1v	0.027	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA4320	96–96.9	Qbt 1v	0.036	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA4322	113–114.4	Qbt 1v	0.098	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5377	131–132.6	Qbt 1v	0.040	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5540	149.8–150.8	Qbt 1g	0.046	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5541	187–187.6	Qbt 1g	0.034	—	—	—	—	—	—	—	—	—	—	—
54-01003	AAA5422	66.5–67.7	Qbt 1v	—	—	—	0.0075	—	—	—	0.0073	0.013	—	—	—
54-01005	AAA7958	22.7–23.3	Qbt 2	0.20 (J)	—	—	—	—	—	—	—	—	—	—	—
54-01006	AAA5480	18.3–19.6	Qbt 2	0.022	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA6034	5.5–6.5	Qbt 2	1.3 (J)	—	—	—	0.050 (J)	—	—	—	—	—	—	—
54-01007	AAA6035	15–16.5	Qbt 2	0.45 (J)	—	—	—	0.026 (J)	—	—	—	—	—	—	—
54-01007	AAA7415	31–32	Qbt 2	1.9 (J)	—	—	—	4.8 (J)	—	—	—	—	—	—	—
54-01007	AAA6036	35–36	Qbt 2	2.1 (J)	—	—	—	0.43 (J)	—	—	—	—	—	—	—
54-01007	AAA7409	49–50	Qbt 1v	0.32 (J)	—	—	—	0.88 (J)	—	—	—	—	—	—	—
54-01007	AAA7408	60–62.5	Qbt 1v	0.055 (J)	—	—	—	0.12 (J)	—	—	—	—	—	—	—
54-01007	AAA7420	68–69.8	Qbt 1v	—	—	—	—	0.035 (J)	—	—	—	—	—	—	—
54-01007	AAA7421	75.5–77	Qbt 1v	0.053 (J)	—	—	—	0.014 (J)	—	—	—	—	—	—	—
54-01008	AAA7423	45–46.2	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—

Table 2.5-3 (continued)

Location ID	Sample ID	Depth (ft)	Media	Acetone	Aroclor-1260	Bis(2-ethylhexyl)phthalate	Bromobenzene	2-Butanone	n-Butylbenzene	4,4'-DDD	Dibromomethane	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane
54-01009	AAA7406	6–7.5	Qbt 2	0.023	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7417	15.7–17	Qbt 2	0.035	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7410	26–27.5	Qbt 2	0.030	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7401	38–40	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7397	45.5–46.8	Qbt 1v	0.071	—	—	—	—	0.012	—	—	—	0.011	—	—
54-01009	AAA7412	59–60	Qbt 1v	0.062	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7404	65–66	Qbt 1v	0.046	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7407	83.3–84.5	Qbt 1v	0.022	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7402	95–100	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7403	115.5–117	Qbt 1v	0.10	—	—	—	—	—	—	—	—	—	0.0093	—
54-01010	AAB6794	6.1–7.1	Qbt 2	—	—	—	—	—	—	—	—	—	—	0.018	0.010
54-01010	AAB6797	13.2–14.1	Qbt 2	0.056	—	—	—	—	—	—	—	—	—	—	—
54-01010	AAB6798	20.4–21.2	Qbt 2	—	0.313	0.80	—	—	—	—	—	—	—	0.006	—
54-01010	AAB6802	26.5–28.3	Qbt 2	—	—	—	—	—	—	—	—	—	—	0.020	—
54-01010	AAB6800	41.6–42.1	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01011	AAB6785	15.2–16.2	Qbt 2	—	—	—	—	—	—	0.00588	—	—	—	—	—
54-01012	AAB6807	7.5–8.2	Qbt 2	0.057	—	—	—	—	—	—	—	—	—	—	—
54-01012	AAB6791	15.8–16.4	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01013	AAB6810	29.5–30.3	Qbt 2	0.12	—	—	—	—	—	—	—	—	—	—	—
54-01013	AAB6792	39.3–41	Qbt 1v	0.70	—	—	—	—	—	—	—	—	—	—	—
54-01014	AAB6781	40.1–41	Qbt 1v	0.044	—	—	—	—	—	—	—	—	—	—	—
54-01016	AAC0734	260.6–261.5	Qbo	0.043	—	—	—	—	—	—	—	—	—	—	—

Table 2.5-3 (continued)

Location ID	Sample ID	Depth (ft)	Media	1,3-Dichloropropane	Di-n-butylphthalate	2-Hexanone	4-Isopropyltoluene	4,4'-Methoxychlor	4-Methy-2-pentanone	Methylene chloride	Pentachlorophenol	Tetrachloroethene	1,1,1-Trichloroethane	Trichloroethene	1,2,3-Trichloropropane
54-01001	AAA5537	89.8–91.1	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01001	AAA4324	268.6–269.3	Qct	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA4321	37.4–38.1	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5373	58–58.8	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5378	75–76.6	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5374	93.5–96	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA4320	96–96.9	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA4322	113–114.4	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5377	131–132.6	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5540	149.8–150.8	Qbt 1g	—	—	—	—	—	—	—	—	—	—	—	—
54-01002	AAA5541	187–187.6	Qbt 1g	—	—	—	—	—	—	—	—	—	—	—	—
54-01003	AAA5422	66.5–67.7	Qbt 1v	0.0068	—	—	0.0052	—	—	—	—	—	—	—	0.014
54-01005	AAA7958	22.7–23.3	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01006	AAA5480	18.3–19.6	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA6034	5.5–6.5	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA6035	15–16.5	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7415	31–32	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA6036	35–36	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7409	49–50	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7408	60–62.5	Qbt 1v	—	—	—	—	—	0.012	—	—	—	—	—	—
54-01007	AAA7420	68–69.8	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01007	AAA7421	75.5–77	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01008	AAA7423	45–46.2	Qbt 1v	—	—	—	—	—	0.015	—	—	—	—	—	—
54-01009	AAA7406	6–7.5	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7417	15.7–17	Qbt 2	—	—	0.021	—	—	—	—	—	—	—	—	—
54-01009	AAA7410	26–27.5	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—

Table 2.5-3 (continued)

Location ID	Sample ID	Depth (ft)	Media	1,3-Dichloropropane	Di-n-butylphthalate	2-Hexanone	4-Isopropyltoluene	4,4'-Methoxychlor	4-Methy-2-pentanone	Methylene chloride	Pentachlorophenol	Tetrachloroethene	1,1,1-Trichloroethane	Trichloroethene	1,2,3-Trichloropropane
54-01009	AAA7401	38–40	Qbt 1v	—	1.0	0.020	—	—	—	—	—	—	—	—	—
54-01009	AAA7397	45.5–46.8	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7412	59–60	Qbt 1v	—	—	—	—	—	0.034	—	—	—	—	—	—
54-01009	AAA7404	65–66	Qbt 1v	—	0.45	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7407	83.3–84.5	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7402	95–100	Qbt 1v	—	0.44	—	—	—	—	—	—	—	—	—	—
54-01009	AAA7403	115.5–117	Qbt 1v	—	0.75	—	0.0060	—	0.078	—	—	—	—	—	—
54-01010	AAB6794	6.1–7.1	Qbt 2	—	—	—	—	—	—	0.010	—	—	0.015	0.008	—
54-01010	AAB6797	13.2–14.1	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01010	AAB6798	20.4–21.2	Qbt 2	—	—	—	—	—	—	0.006	—	—	—	0.008	—
54-01010	AAB6802	26.5–28.3	Qbt 2	—	—	—	—	—	—	0.014	—	—	0.008	0.008	—
54-01010	AAB6800	41.6–42.1	Qbt 1v	—	—	—	—	0.0756	—	—	—	—	—	—	—
54-01011	AAB6785	15.2–16.2	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01012	AAB6807	7.5–8.2	Qbt 2	—	—	—	—	—	—	—	13 (J)	0.009	—	—	—
54-01012	AAB6791	15.8–16.4	Qbt 2	—	—	—	—	—	—	—	3.3 (J)	—	—	—	—
54-01013	AAB6810	29.5–30.3	Qbt 2	—	—	—	—	—	—	—	—	—	—	—	—
54-01013	AAB6792	39.3–41	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01014	AAB6781	40.1–41	Qbt 1v	—	—	—	—	—	—	—	—	—	—	—	—
54-01016	AAC0734	260.6–261.5	Qbo	—	—	—	—	—	—	—	—	—	—	—	—

Note: All values are in mg/kg. See Appendix A for data qualifier definitions.

*— = The concentration was not detected above the reporting limit.

Table 2.5-4
Frequency of Detected Radionuclides Detected or Detected above BV Subsurface Core Samples at MDA L

Analyte	Geologic Unit	Number of Analyses	Number of Detects	Concentration Range[a] (pCi/g)	BV (pCi/g)	Frequency of Detects above BV
Plutonium-238	Qbt 2	1	0	[0.003 to 0.003]	n/a[b]	0/1
Plutonium-238	Qbt 1v	4	0	[0 to 0.004]	n/a	0/4
Plutonium-239	Qbt 2	1	0	[0.001 to 0.001]	n/a	0/1
Plutonium-239	Qbt 1v	4	0	[-0.001 to 0.005]	n/a	0/4
Tritium	Qbt 2	24	16	[-1.95E-02] to 11.63	n/a	16/24
Tritium	Qbo	5	0	[-5.50E-02 to 3.91E-02]	n/a	0/5
Tritium	Qbt 1v	5	4	5.30E-02 to 0.34	n/a	4/5
Tritium	Tb4	14	2	[-9.9E-04] to 0.13	n/a	2/14
Uranium-234	Qbt 2	1	1	1.617 to 1.617	1.98	0/1
Uranium-234	Qbt 1v	4	4	1.953 to 2.479	3.12	0/4
Uranium-235	Qbt 2	1	0	[0.084 to 0.084]	0.09	0/1
Uranium-235	Qbt 1v	4	0	[0.075 to 0.144]	0.14	0/4
Uranium-238	Qbt 2	1	1	1.733 to 1.733	1.93	0/1
Uranium-238	Qbt 1v	4	4	2.24 to 2.777	3.05	0/4

[a] Values in brackets indicate detection limits for nondetects.
[b] n/a = Not applicable.

Table 2.5-5a
Air Concentrations of Selected VOCs at MDA L, Location 4

VOC	Ambient Concentration (ppbv)							
	6/16/94	6/17/94	6/29/94	6/30/94	7/28/94	8/01/94	8/02/94	8/03/94
Chlorodifluoromethane	0.6	0.2	0.3	0.6	ND*	ND	ND	ND
Chloromethane	0.3	0.3	ND	0.6	ND	0.3	ND	ND
Dichlorodifluoromethane	0.4	0.4	0.4	0.4	0.3	0.4	0.06	0.07
n-Hexane	ND	ND	ND	ND	0.2	0.3	0.3	0.5
Trichlorofluoromethane	0.2	0.2	0.1	0.1	0.1	0.2	0.05	0.03
Freon-113	0.04	0.05	0.03	0.06	ND	0.06	ND	ND
TCA	0.7	0.4	0.9	0.4	1.0	0.7	0.5	0.4
Benzene	0.2	0.1	0.2	0.2	0.2	0.4	0.4	0.6
Carbon tetrachloride	0.1	0.06	0.06	ND	0.06	0.07	0.05	0.08
Trichloroethene	ND	0.1	0.06	ND	0.3	0.1	0.07	ND
Toluene	0.2	0.1	0.2	0.2	0.4	1.0	0.8	0.9

*ND = Not detected.

Table 2.5-5b
Air Concentrations of Selected VOCs at MDA L, Location 5

VOC	Ambient Concentration (ppbv)							
	6/16/94	6/17/94	6/29/94	6/30/94	7/28/94	8/01/94	8/02/94	8/03/94
Chloromethane	0.3	0.3	ND*	0.7	ND	0.7	ND	0.2
Dichlorodifluoromethane	0.5	0.3	0.3	0.4	0.2	0.4	0.06	0.4
Trichlorofluoromethane	0.2	0.2	0.2	0.2	0.09	0.3	0.08	0.2
Methylene chloride	1.6	0.4	1.3	1.2	0.6	1.0	1.7	0.9
Freon-113	0.2	0.1	0.1	0.3	0.07	0.4	0.2	ND
TCA	15.2	6.0	8.6	4.0	0.6	1.0	0.8	2.4
Benzene	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2
Carbon tetrachloride	ND	0.1	ND	0.05	0.05	0.1	ND	0.07
Trichloroethene	ND	0.2	0.1	0.03	0.1	ND	0.06	0.1
Toluene	0.3	0.2	0.3	0.6	0.3	0.2	0.3	0.2
Xylene	ND	ND	0.1	0.2	0.2	0.09	0.1	ND

*ND = Not detected.

Table 2.5-5c
Air Concentrations of Selected VOCs at
Bandelier National Monument, Location 3 (Background)

VOC	Background Ambient Concentration (ppbv)							
	6/16/94	6/17/94	6/29/94	6/30/94	7/28/94	8/01/94	8/02/94	8/03/94
Chlorodifluoromethane	ND*	ND	ND	ND	ND	ND	ND	ND
Chloromethane	ND	0.4	ND	0.6	ND	ND	ND	ND
Dichlorodifluoromethane	0.3	0.3	0.3	0.4	0.2	0.3	ND	ND
n-Hexane	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	0.1	0.1	0.1	0.05	0.07	0.09	0.03	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND
Freon-113	ND	ND	ND	0.04	ND	ND	0.03	ND
TCA	0.1	0.1	0.08	ND	0.04	0.03	ND	ND
Benzene	ND	0.2	ND	0.02	ND	0.1	0.1	0.2
Carbon tetrachloride	ND	0.05	0.04	ND	0.04	0.03	ND	ND
Trichloroethene	ND	0.05	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	0.1	ND	0.1	0.1	0.2	0.1
Xylene	ND	ND	ND	ND	ND	0.1	ND	ND

*ND = Not detected.

Table 2.5-6
Calculated Tritium Surface Flux
Concentration for Phase I RFI Samples Collected at MDA L

Sample Location	Collection Date	Emission Flux ($pCi/min/m^2$)
T1	1993	1.65
T2	1993	2.26
C11	1993	3.40
C29	1993	3.69
C30	1993	5.45*
S1	1994	2.90
S2	1994	19,500
S3	1994	28,600

*Higher concentration of two duplicate samples.

Table 2.5-7
Matric Potential and Gravimetric Moisture Content Summary

Borehole Location	Sample ID	Depth (ft)	Matrix (unit)	Matric Potential		Gravimetric Moisture Content (%, g/g)
				(-bars)	(-cm)	
54-24241	MD54-05-57099	14–15	Qbt2	2.1	2142	6.4
	MD54-05-57100	19–20	Qbt2	3	3059	6.2
	MD54-05-57101	24–25	Qbt2	5.1	5201	7.7
	MD54-05-57102	29–30	Qbt2	2.7	2753	7.0
	MD54-05-57103	34–35	Qbt2	4.2	4283	9.2
	MD54-05-57104	39–40	Qbt1v	4.2	4283	5.8
	MD54-05-57105	44–45	Qbt1v	4.6	4691	7.4
	MD54-05-57106	49–50	Qbt1v	3.5	3569	6.6
	MD54-05-57107	54–55	Qbt1v	4.9	4997	9.1
	MD54-05-57108	59–60	Qbt1v	3.4	3467	7.4
	MD54-05-57109	64–65	Qbt1v	5.2	5303	7.9
	MD54-05-57110	70–71	Qbt1v	4.2	4283	6.4
	MD54-05-57111	75–76	Qbt1v	5.1	5201	4.9
	MD54-05-57112	79–80	Qbt1v	6.3	6425	3.5
	MD54-05-57574	88–90	Qbt1v	7.0	7139	2.1
	MD54-05-57113	84–85	Qbt1v	6.9	7037	2.6
	MD54-05-57115	94–95	Qbt1v	8.2	8362	2.5
	MD54-05-57116	99–100	Qbt1v	7.2	7343	3.0
	MD54-05-57117	104–105	Qbt1v	6.8	6935	3.3
	MD54-05-57118	109–110	Qbt1v	5.9	6017	4.0
	MD54-05-57119	114–115	Qbt1v	5.2	5303	5.7

Table 2.5-7 (continued)

Borehole Location	Sample ID	Depth (ft)	Matrix (unit)	Matric Potential		Gravimetric Moisture Content (%, g/g)
				(-bars)	(-cm)	
54-24241 (continued)	MD54-05-57120	119–120	Qbt1v	3.8	3875	6.5
	MD54-05-57121	124–125	Qbt1v	4.5	4589	6.5
	MD54-05-57122	129–130	Qbt1g	5.4	5507	11.3
	MD54-05-57123	134–135	Qbt1g	3.9	3977	9.7
	MD54-05-57124	139–140	Qbt1g	6.0	6119	5.5
	MD54-05-57125	144–145	Qbt1g	2.6	2651	5.9
	MD54-05-57126	149–150	Qbt1g	4.2	4283	6.7
	MD54-05-57127	154–155	Qbt1g	2.8	2855	6.6
	MD54-05-57128	159–160	Qbt1g	4.9	4997	7.0
	MD54-05-57575	162–164	Qbt1g	3.4	3467	6.5
	MD54-05-57130	169–170	Qbt1g	4.5	4589	6.1
	MD54-05-57131	174–175	Qbt1g	4.6	4691	6.4
	MD54-05-57132	179–180	Qbt1g	4.8	4895	6.7
	MD54-05-57133	184–185	Qbt1g	2.8	2855	6.8
	MD54-05-57134	189–190	Qbt1g	5.4	5507	7.5
	MD54-05-57135	194–195	Qbt1g	4.9	4997	7.9
	MD54-05-57136	199–200	Qbt1g	4.5	4589	8.9
	MD54-05-57137	204–205	Qbt1g	4.8	4895	7.8
	MD54-05-57138	209–210	Qbt1g	5.0	5099	7.4
	MD54-05-57139	214–215	Qbt1g	4.4	4487	7.6
	MD54-05-57140	219–220	Qbt1g	3.8	3875	8.1
	MD54-05-57141	224–225	Qbt1g	4.7	4793	8.2
	MD54-05-57142	229–230	Qbt1g	4.2	4283	8.9
	MD54-05-57143	234–235	Qbt1g	4.3	4385	9.6
	MD54-05-57144	239–240	Qbt1g	4.5	4589	10.3
	MD54-05-57145	244–245	Qbt1g	6.2	6323	9.9
	MD54-05-57146	249–250	Qbt1g	5.0	5099	10.3
54-24399*	MD54-05-57174	385–390	ALLH	6.2	6323	27.9
	MD54-05-57175	390–395	ALLH	<648	<660,830	3.1
	MD54-05-57176	395–400	Tb4	7.1	7241	1.3

*54-24399 was advanced 10 ft northwest of 54-24241.

Table 2.5-8
Comparison of VOCs Detected in Pore Gas and Core Samples from New Boreholes at MDA L during the 2007 Field Investigation

Location ID	Core Depth/ Pore-Gas Depth (ft)	Media	VOCs Detected in Core	VOCs Detected in Pore Gas
54-27641	Core depth 149–150 Pore gas depth 180–185	Qbt 1g	Acetone	Acetone Carbon Disulfide Cyclohexane Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethane[1,2-] Dichloroethene[1,1-] Ethanol Hexane Methylene Chloride Tetrachloroethene Toluene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane
54-27641	Core depth 229–230 Pore-gas depth 230–235	Qbt 1g	Acetone	Acetone Carbon Disulfide Cyclohexane Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethane[1,2-] Dichloroethene[1,1-] Methylene Chloride Propanol[2-Propanol[2-] Tetrachloroethene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane
54-27641	Core depth 284–285 Pore-gas depth 269–273	Qct	Acetone	Carbon Tetrachloride Chloroform Cyclohexane Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethene[1,1-] Methylene Chloride Tetrachloroethene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane

Table 2.5-8 (continued)

Location ID	Core Depth/ Pore-Gas Depth (ft)	Media	VOCs Detected in Core	VOCs Detected in Pore Gas
54-27641	Core depth 334–335 Pore-gas depth 330–335	Qbo	Acetone Toluene Trichloroethene	Carbon Tetrachloride Chloroform Cyclohexane Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethane[1,2-] Dichloroethene[1,1-] Hexane Methylene Chloride Tetrachloroethene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane
54-27641	Core depth 349–350 Pore-gas depth 330–335	Qbo	Acetone Toluene Trichloroethene Methylene Chloride	Carbon Tetrachloride Chloroform Cyclohexane Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethane[1,2-] Dichloroethene[1,1-] Hexane Methylene Chloride Tetrachloroethene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane
54-27642	Core depth 179–180 Pore-gas depth 172.5–177.5	Qbt 1g	Acetone	Acetone Benzene Butanone[2-] Carbon Disulfide Carbon Tetrachloride Chloroform Dichloroethane[1,1-] Dichloroethane[1,2-] Dichloroethene[1,1-] Dichloropropane[1,2-] Hexane Methylene Chloride Tetrachloroethene Toluene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane Xylene[1,3-]+Xylene[1,4-]

Table 2.5-8 (continued)

Location ID	Core Depth/ Pore-Gas Depth (ft)	Media	VOCs Detected in Core	VOCs Detected in Pore Gas
54-27642	Core depth 229–230 Pore-gas depth 232–237.5	Qbt 1g	Acetone	Benzene Carbon Tetrachloride Chloroform Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethane[1,2-] Dichloroethene[1,1-] Dichloropropane[1,2-] Hexane Methylene Chloride Tetrachloroethene Toluene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane
54-27642	Core depth 279–280 Pore-gas depth 277–277.5	Qct	Acetone	Benzene Carbon Tetrachloride Chloroform Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethene[1,1-] Dichloropropane[1,2-] Hexane Methylene Chloride Tetrachloroethene Toluene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane
54-27643	Core depth 279–280 Pore-gas depth 272.5–278.5	Qbt 1g	Toluene	Benzene Carbon Tetrachloride Chloroform Cyclohexane Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethene[1,1-] Dichloropropane[1,2-] Hexane Methylene Chloride Tetrachloroethene Toluene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane Xylene[1,3-]+Xylene[1,4-]

Table 2.5-8 (continued)

Location ID	Core Depth/ Pore-Gas Depth (ft)	Media	VOCs Detected in Core	VOCs Detected in Pore Gas
54-27643	Core depth 369–370 Pore-gas depth 351–356.5	Qbo	Toluene	Benzene Carbon Tetrachloride Chloroform Dichlorodifluoromethane Dichloroethane[1,1-] Dichloroethene[1,1-] Hexane Methylene Chloride n-Heptane Tetrachloroethene Toluene Trichloro-1,2,2-trifluoroethane[1,1,2-] Trichloroethane[1,1,1-] Trichloroethene Trichlorofluoromethane

Table 2.5-9
VOCs Detected in Pore Gas at MDA L during the 2007 Field Investigation (µg/m^3)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Cyclohexane	Dichlorodifluoromethane	Dichloroethane[1,1-]
MD54-07-76465	54-24238	43.00–45.00	—*	—	—	5500	—	57000	66000	—	72000
MD54-07-76190	54-24238	63.00–65.00	—	—	—	—	—	58000	69000	—	68000
MD54-07-76191	54-24238	83.00–85.00	—	—	—	—	—	55000	60000	—	58000
MD54-07-76467	54-24239	24.00–26.00	—	—	—	—	4800	20000	12000	—	16000
MD54-07-76192	54-24239	74.00–76.00	8800	—	—	4400	5300	22000	19000	—	20000
MD54-07-76193	54-24239	98.50–100.50	10000	—	—	4300	—	23000	20000	—	22000
MD54-07-76194	54-24240	27.00–29.00	—	—	—	—	—	—	79000	65000	110000
MD54-07-76463	54-24240	52.00–54.00	18000	—	—	9900	—	11000	19000	7000	31000
MD54-07-76195	54-24240	152.00–154.00	22000	—	6000	6200	—	11000	35000	—	40000
MD54-07-76466	54-24242	24.00–26.00	—	—	—	—	3800	14000	8000	—	11000
MD54-07-76196	54-24242	49.00–51.00	—	—	—	—	—	28000	24000	—	22000
MD54-07-76197	54-24242	109.50–111.50	—	—	—	—	—	28000	24000	—	23000
MD54-07-76468	54-24243	24.00–26.00	—	—	—	—	5100	19000	14000	—	19000
MD54-07-76198	54-24243	49.00–51.00	—	—	—	—	—	33000	30000	—	32000
MD54-07-76232	54-24243	74.00–76.00	22000	—	—	21000	—	32000	32000	—	28000
MD54-07-76199	54-24243	124.00–126.00	14000	3400	—	—	—	34000	26000	—	20000
MD54-07-76469	54-24244	24.00–26.00	—	—	—	—	3800	15000	8500	—	7100
MD54-07-76200	54-24244	74.00–76.00	—	—	—	2300	—	21000	13000	—	10000
MD54-07-76201	54-24244	99.00–101.00	7400	—	—	2200	—	19000	13000	—	10000
MD54-07-76470	54-24244	117.50–119.50	—	—	—	—	—	9500	5300	—	4500

Table 2.5-9 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Cyclohexane	Dichlorodifluoromethane	Dichloroethane[1,1-]
MD54-07-76202	54-27641	30.00–34.00	47000	—	7900	14000	—	—	38000	9600	81000
MD54-07-76203	54-27641	80.00–84.00	—	—	—	8500	—	—	27000	—	32000
MD54-07-76204	54-27641	110.00–114.00	—	—	—	7300	—	7000	30000	—	34000
MD54-07-76205	54-27641	180.00–185.00	17000	—	—	9100	—	—	19000	5800	17000
MD54-07-76206	54-27641	230.00–235.00	—	—	—	990	—	1900	8100	4000	6400
MD54-07-76207	54-27641	269.00–273.00	—	—	—	—	620	560	2500	1900	1600
MD54-07-76208	54-27641	330.00–335.00	—	—	—	—	170	59	330	460	120
MD54-07-76209	54-27642	27.50–32.50	—	—	—	—	—	31000	—	—	33000
MD54-07-76210	54-27642	72.50–77.50	17000	—	—	11000	—	43000	—	—	26000
MD54-07-76211	54-27642	113.50–118.50	—	—	—	16000	—	44000	—	—	36000
MD54-07-76212	54-27642	172.50–177.50	18000	4900	3800	12000	7900	35000	—	—	12000
MD54-07-76213	54-27642	232.00–237.50	—	2700	—	—	4700	17000	—	3600	5000
MD54-07-76214	54-27642	272.00–277.50	—	1800	—	—	3400	7700	—	2500	2000
MD54-07-76215	54-27642	335.00–341.00	—	540	—	—	1600	1800	—	1500	480
MD54-07-76216	54-27643	27.50–32.50	—	—	—	2000	1700	8600	5800	—	4200
MD54-07-76217	54-27643	71.50–76.50	—	—	—	1700	—	14000	—	—	6800
MD54-07-76218	54-27643	114.50–119.50	—	1500	—	1200	2700	17000	—	—	6900
MD54-07-76219	54-27643	164.00–170.00	—	1900	—	1300	2400	16000	—	2000	5000
MD54-07-76220	54-27643	232.50–237.50	—	1900	—	1300	3200	13000	—	2200	3200
MD54-07-76221	54-27643	272.50–278.50	—	1800	—	—	2700	8000	4200	1800	1800
MD54-07-76236	54-27643	351.00–356.50	—	390	—	—	1100	820	—	1000	200

Table 2.5-9 (continued)

Sample ID	Location ID	Depth (ft)	Dichloroethane[1,2-]	Dichloroethene[1,1-]	Dichloropropane[1,2-]	Ethanol	Hexane	Methylene Chloride	n-Heptane	Propanol[2-]	Tetrachloroethene
MD54-07-76465	54-24238	43.00–45.00	64000	160000	430000	—	—	25000	—	—	92000
MD54-07-76190	54-24238	63.00–65.00	72000	130000	510000	—	—	300000	—	—	60000
MD54-07-76191	54-24238	83.00–85.00	68000	130000	430000	—	—	120000	—	—	56000
MD54-07-76467	54-24239	24.00–26.00	7800	38000	9400	—	—	—	—	—	280000
MD54-07-76192	54-24239	74.00–76.00	14000	54000	12000	—	—	3400	—	—	220000
MD54-07-76193	54-24239	98.50–100.50	15000	58000	9800	—	—	4200	—	19000	220000
MD54-07-76194	54-24240	27.00–29.00	310000	77000	—	—	—	79000	—	—	310000
MD54-07-76463	54-24240	52.00–54.00	84000	54000	—	—	—	42000	—	—	99000
MD54-07-76195	54-24240	152.00–154.00	59000	51000	—	—	—	24000	—	—	68000
MD54-07-76466	54-24242	24.00–26.00	5000	22000	8100	—	—	—	—	—	490000
MD54-07-76196	54-24242	49.00–51.00	20000	54000	14000	—	—	14000	—	—	400000
MD54-07-76197	54-24242	109.50–111.50	23000	54000	14000	—	—	11000	—	—	390000
MD54-07-76468	54-24243	24.00–26.00	4400	29000	38000	—	—	—	—	—	30000
MD54-07-76198	54-24243	49.00–51.00	8700	67000	110000	—	—	—	—	—	31000
MD54-07-76232	54-24243	74.00–76.00	18000	55000	120000	—	12000	29000	—	19000	28000
MD54-07-76199	54-24243	124.00–126.00	34000	70000	60000	—	—	66000	—	68000	32000
MD54-07-76469	54-24244	24.00–26.00	9000	20000	29000	—	—	9000	—	—	28000
MD54-07-76200	54-24244	74.00–76.00	14000	26000	37000	—	—	24000	—	—	18000
MD54-07-76201	54-24244	99.00–101.00	14000	28000	31000	—	—	22000	—	—	16000
MD54-07-76470	54-24244	117.50–119.50	5900	13000	19000	—	—	6000	—	—	18000
MD54-07-76202	54-27641	30.00–34.00	84000	34000	—	15000	6300	120000	—	190000	66000

Table 2.5-9 (continued)

Sample ID	Location ID	Depth (ft)	Dichloroethane[1,2-]	Dichloroethene[1,1-]	Dichloropropane[1,2-]	Ethanol	Hexane	Methylene Chloride	n-Heptane	Propanol[2-]	Tetrachloroethene
MD54-07-76203	54-27641	80.00–84.00	65000	36000	—	—	—	94000	—	—	67000
MD54-07-76204	54-27641	110.00–114.00	65000	46000	—	—	4600	81000	—	—	42000
MD54-07-76205	54-27641	180.00–185.00	11000	40000	—	8000	4300	43000	—	—	87000
MD54-07-76206	54-27641	230.00–235.00	1100	26000	—	—	—	10000	—	3500	7100
MD54-07-76207	54-27641	269.00–273.00	—	13000	—	—	—	1700	—	—	5000
MD54-07-76208	54-27641	330.00–335.00	34	3000	—	—	56	110	—	—	800
MD54-07-76209	54-27642	27.50–32.50	12000 (J+)	81000	89000	—	—	—	—	—	46000
MD54-07-76210	54-27642	72.50–77.50	39000 (J+)	96000	78000	—	—	140000	—	—	36000
MD54-07-76211	54-27642	113.50–118.50	37000 (J+)	96000	130000	—	—	140000	—	—	39000
MD54-07-76212	54-27642	172.50–177.50	19000 (J+)	88000	33000	—	5500	120000	—	—	25000
MD54-07-76213	54-27642	232.00–237.50	2200	71000	6800	—	3400	53000	—	—	10000
MD54-07-76214	54-27642	272.00–277.50	—	48000	2100	—	2400	22000	—	—	7900
MD54-07-76215	54-27642	335.00–341.00	—	21000	—	—	1400	4000	—	—	2400
MD54-07-76216	54-27643	27.50–32.50	2900	9900	15000	—	—	1900	—	2800	11000
MD54-07-76217	54-27643	71.50–76.50	7800	21000	23000	—	—	16000	—	—	14000
MD54-07-76218	54-27643	114.50–119.50	11000	26000	22000	—	—	34000	—	—	13000
MD54-07-76219	54-27643	164.00–170.00	6800	35000	13000	—	1200	46000	—	—	8200
MD54-07-76220	54-27643	232.50–237.50	1700	41000	5000	—	1900	39000	—	—	6200
MD54-07-76221	54-27643	272.50–278.50	—	34000	2100	—	1600	19000	—	—	9400
MD54-07-76236	54-27643	351.00–356.50	—	14000	—	—	1000	1400	150	—	1400

Table 2.5-9 (continued)

Sample ID	Location ID	Depth (ft)	Tetrahydrofuran	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Xylene[1,3-]+Xylene[1,4-]
MD54-07-76465	54-24238	43.00–45.00	—	—	1000000	3600000	840000	34000	—
MD54-07-76190	54-24238	63.00–65.00	14000	—	820000	3500000	760000	43000	—
MD54-07-76191	54-24238	83.00–85.00	14000	—	700000	3300000	680000	42000	—
MD54-07-76467	54-24239	24.00–26.00	—	—	94000	860000	220000	6500	—
MD54-07-76192	54-24239	74.00–76.00	—	—	110000	1100000	250000	11000	—
MD54-07-76193	54-24239	98.50–100.50	—	4500	120000	1100000	270000	12000	—
MD54-07-76194	54-24240	27.00–29.00	—	—	66000	4900000	740000	—	—
MD54-07-76463	54-24240	52.00–54.00	—	—	36000	1300000	280000	—	—
MD54-07-76195	54-24240	152.00–154.00	—	18000	44000	2000000	350000	—	—
MD54-07-76466	54-24242	24.00–26.00	—	—	61000	560000	190000	4100	—
MD54-07-76196	54-24242	49.00–51.00	—	—	140000	1400000	320000	13000	—
MD54-07-76197	54-24242	109.50–111.50	—	—	130000	1300000	340000	12000	—
MD54-07-76468	54-24243	24.00–26.00	—	—	280000	1000000	230000	10000	—
MD54-07-76198	54-24243	49.00–51.00	—	—	440000	1700000	400000	20000	—
MD54-07-76232	54-24243	74.00–76.00	—	—	360000	1700000	360000	22000	—
MD54-07-76199	54-24243	124.00–126.00	—	4800	270000	1500000	330000	32000	—
MD54-07-76469	54-24244	24.00–26.00	8200	2900	98000	620000	110000	14000	—
MD54-07-76200	54-24244	74.00–76.00	33000	3900	120000	760000	120000	22000	—
MD54-07-76201	54-24244	99.00–101.00	18000	4500	130000	730000	120000	26000	—
MD54-07-76470	54-24244	117.50–119.50	6800	2200	62000	390000	71000	8800	—
MD54-07-76202	54-27641	30.00–34.00	—	11000	35000	2100000	290000	—	—

Table 2.5-9 (continued)

Sample ID	Location ID	Depth (ft)	Tetrahydrofuran	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Xylene[1,3-]+Xylene[1,4-]
MD54-07-76203	54-27641	80.00–84.00	—	5300	24000	1300000	170000	—	—
MD54-07-76204	54-27641	110.00–114.00	—	—	30000	1600000	220000	—	—
MD54-07-76205	54-27641	180.00–185.00	—	3700	28000	990000	160000	6200	—
MD54-07-76206	54-27641	230.00–235.00	—	—	23000	420000	79000	4500	—
MD54-07-76207	54-27641	269.00–273.00	—	—	14000	120000	31000	2400	—
MD54-07-76208	54-27641	330.00–335.00	—	—	5000	14000	4500	940	—
MD54-07-76209	54-27642	27.50–32.50	—	—	270000	2300000	280000	18000	—
MD54-07-76210	54-27642	72.50–77.50	15000	21000	340000	2000000	350000	52000	—
MD54-07-76211	54-27642	113.50–118.50	24000	—	440000	2600000	370000	40000	—
MD54-07-76212	54-27642	172.50–177.50	—	30000	270000	1200000	280000	49000	5600
MD54-07-76213	54-27642	232.00–237.50	—	16000	230000	580000	140000	31000	—
MD54-07-76214	54-27642	272.00–277.50	—	11000	97000	260000	95000	14000	—
MD54-07-76215	54-27642	335.00–341.00	—	2400	43000	82000	31000	5600	—
MD54-07-76216	54-27643	27.50–32.50	—	—	53000	320000	55000	8500	—
MD54-07-76217	54-27643	71.50–76.50	12000	2000	93000	500000	87000	15000	—
MD54-07-76218	54-27643	114.50–119.50	2800	6100	120000	570000	100000	21000	—
MD54-07-76219	54-27643	164.00–170.00	—	9700	140000	450000	91000	22000	—
MD54-07-76220	54-27643	232.50–237.50	—	10000	150000	340000	84000	19000	—
MD54-07-76221	54-27643	272.50–278.50	—	13000	100000	230000	81000	12000	1100
MD54-07-76236	54-27643	351.00–356.50	—	1200	35000	45000	16000	3700	—

*— = Analyte was not detected above the reporting limit.

Table 2.5-10
NMED-Approved MDA L Subsurface Vapor-Monitoring Locations, Port Depths, and Corresponding Sampling Intervals

Borehole ID	VOC and Tritium Sampling Port-Depth Intervals (ft bgs)
54-01015[a]	37.6 (36–46), 165.4 (182–192), 308.3 (340–352), 333.3 (375–385), 377.7 (425–435), 426.5 (480–490), 462.1 (520–530)
54-01016[a]	30.8 (30–40), 162.2 (178–190), 274.7 (318–324), 336.3 (386–396), 414.3 (473–483), 459.5 (530–540), 517.6 (592–602)
54-02001	20 (17.5–22.5), **40 (37.5–42.5)**, 60 (57.5–62.5), **80 (77.5–82.5)**, 100 (97.5–102.5), **120 (117.5–122.5)**, **140 (137.5–142.5)**, 160 (157.5–162.5), 180 (177.5–182.5), 200 (197.5–202.5)
54-02002	20 (17.5–22.5), **40 (37.5–42.5)**, 60 (57.5–62.5), 80 (77.5–82.5), **100 (97.5–102.5)**, **120 (117.5–122.5)**, 140 (137.5–142.5), 157 (154.5–159.5), **180 (177.5–182.5)**, 200 (197.5–202.5)
54-02016	18 (15.5–20.5), **31 (28.5–33.5), 82 (79.5–84.5)**
54-02020	20 (10–30), 40 (30–50), 60 (50–70), 80 (70–90), 95 (90–110), 120 (110–130), 140 (130–150), 160 (150–170), 180 (170–190), 200 (190–210)
54-02021	**20 (10–30)**, 40 (30–50), 60 (50–70), 80 (70–90), **100 (90–110), 120 (110–130)**, **140 (130–150),** 160 (150–170), 180 (170–190), 198 (190–210)
54-02022	20 (17.5–22.5), **40 (37.5–42.5)**, 60 (57.5–62.5), **80 (77.5–82.5)**, 100 (97.5–102.5), **120 (117.5–122.5)**, **140 (137.5–142.5)**, 160 (157.5–162.5), 180 (177.5–182.5), 200 (197.5–202.5)
54-02023	20 (10–30), **40 (30–50)**, 60 (50–70), 80 (70–90), **100 (90–110), 120 (110–130)**, 140 (130–149), **159 (149–169)**, 180 (170–190), 200 (190–210)
54-02024	20 (10–30), **40 (30–50)**, 60 (50–70), 80 (70–90), **100 (90–110)**, **120 (110–130)**, 140 (130–150), **160 (150–170)**, 180 (170–190), 200 (190–210)
54-02025	**20 (20)**, 60 (60), **100 (100)**, **160 (160)**, 190 (190)
54-02026	**20 (20)**, 60 (60), **100 (100)**, **160 (160)**, 200 (200), 215 (215)
54-02027	**20 (20)**, 60 (60), **100 (100)**, 160 (160), **200 (200)**, 220 (220), 250 (250)
54-02028	**20 (20)**, 60 (60), **100 (100)**, **160 (160)**, 200 (200), 220 (220), 250 (250)
54-02031	**20 (20)**, 60 (60), **100 (100)**, **160 (160)**, 200 (200), 220 (220), **260 (260)**
54-02034	**20 (20)**, **60 (60),**100 (100), **160 (160)**, 200 (200), 220 (220), **260 (260)**, **300 (300)**
54-02089	13 (13), **31 (31)**, **46 (46)**, 86 (86)
54-24238	44 (43–45), **64 (63–65)**, 84 (83–85)
54-24239	**25 (24–26)**, 50 (49–51), **75 (74–76)**, 99.5 (98.5–100.5)
54-24240	**28 (27–29)**, **53 (52–54)**, 78 (77–79), 103 (102–104), **128 (127–129)**, **153 (152–154)**
54-24241	**73 (71–74)**, 93 (92–94), **113 (112–114)**, **133 (132–134)**, 153 (152–154), 173 (172–174), 193 (192–194)
54-24242	**25 (24–26)**, **50 (49–51)**, 75 (74–76), 100 (99–101), 110.5 (109.5–111.5)

Table 2.5-10 (continued)

Borehole ID	VOC and Tritium Sampling Port-Depth Interval (ft bgs)
54-24243	**25 (24–26)**, 50 (49–51), **75 (74–76)**, 100 (99–101), **125 (124–126)**
54-24244[b]	**25 (25)**, 50 (50), 75 (75), **100 (100)**, **118.5 (118.5)**
54-24399[c]	**550 (550–608)**
54-27641	**32 (29.5–34.5)**, **82 (79.5–84.5)**, **115 (112.5–117.5)**, **182 (179.5–184.5)**, 232 (229.5–234.5), **271 (268.5–273.5)**, **332.5 (330–335)**
54-27642	**30 (27.5–32.5)**, **75 (71.5–76.5)**, **116 (114.5–119.5)**, **175 (172.5–177.5)**, 235 (232.5–237.5), **275 (272.5–277.5)**, **338 (335.5–340.5)**
54-27643	**30 (27.5–32.5)**, **74 (71.5–76.5)**, **117 (114.5–119.5)**, **167 (164.5–169.5)**, 235 (232.5–237.5), **275 (272.5–277.5)**, **354 (351.5–356.5)**
54-610786[d]	**25 (22.5-27.5),** 50 (47.5-52.5), 75 (72.5-77.5), **100 (97.5-102.5), 118.5 (116-121)**

Notes: All depth intervals are field screened. Depths in bold denote intervals where VOC and tritium samples are collected. If interval is not bolded, only VOC screening is to be conducted.

[a] Boreholes 54-01015 and 54-01016 are angled. Port depths are depth below ground surface. Port-depth intervals are lengths along boreholes.

[b] Borehole 54-24244 was abandoned and plugged on January 14, 2010.

[c] Borehole 54-24399 is an open borehole.

[d] Borehole 54-610786 was drilled in December 2009.

Table 2.6-1
Role of Monitoring Network Wells in the TA-54 Monitoring Group

Location	Aquifer	MDA G	MDA H	MDA L	Comments
R-20 (2 screens)	Regional	n/a*	n/a	Upgradient or downgradient (if PM-2 is pumping)	Potentially downgradient of MDA L if PM-2 is pumping; PM-2 is not currently used for water supply; however, Los Alamos County plans to start using it in Sept 2011.
R-21	Regional	Upgradient	n/a	Downgradient	No comment
R-22 (inactive well)	Regional	Downgradient	n/a	n/a	No comment
R-23	Regional	Downgradient	n/a	n/a	MDA G farfield
R-23i (3 screens)	Intermediate	Downgradient	n/a	n/a	MDA G farfield
R-32	Regional	Upgradient	n/a	Downgradient	No comment
R-37 screen 1	Intermediate	n/a	Downgradient	n/a	No comment
R-37 screen 2	Regional	n/a	Downgradient	n/a	No comment
R-38	Regional	n/a	n/a	Downgradient	No comment
R-39	Regional	Downgradient	n/a	n/a	No comment
R-40 screen 1	Intermediate	n/a	Downgradient	Upgradient	Suspended from sampling because of poor yield.
R-40 screen 2	Regional	n/a	Upgradient (“sidegradient”) or Downgradient (if PM-2 is pumping)	Upgradient	Potentially downgradient of MDA H if PM-2 is pumping; PM-2 is not currently used for water supply; however, Los Alamos County plans to start using it in Sept 2011.
R-40i	Intermediate	n/a	Downgradient	Upgradient	No comment
R-41 screen 2	Regional	Downgradient	n/a	n/a	No comment
R-49 (2 screens)	Regional	Downgradient	n/a	n/a	No comment
R-51 (2 screens)	Regional	n/a	Upgradient	n/a	No comment
R-52 (2 screens)	Regional	n/a	Downgradient	n/a	No comment
R-53 (2 screens)	Regional	n/a	n/a	Downgradient	No comment
R-54 (2 screens)	Regional	n/a	n/a	Upgradient or downgradient (if PM-2 is pumping)	Potentially downgradient of MDA L if PM-2 is pumping; PM-2 is not currently used for water supply; however, Los Alamos County plans to start using it in Sept 2011.
R-55 (2 screens)	Regional	Downgradient	n/a	n/a	MDA G farfield
R-55i	Intermediate	Downgradient	n/a	n/a	MDA G farfield
R-56 (2 screens)	Regional	Upgradient	n/a	Downgradient	No comment
R-57 (2 screens)	Regional	Downgradient	n/a	n/a	No comment

*n/a = Well not applicable to MDA.

Table 2.6-2
2010 IFGMP for Regional Wells in the TA-54 Monitoring Group, MDA L

Well	TAL Metals[a]	VOCs[b]	SVOCs[b]	Pesticides	PCB	HEXP[c]	Dioxins/Furans	RAD[d]	Low-Level Tritium[e]	Gen Inorganics[f]	Perchlorate	Stable Isotopes[g]	Field Parameters[h]
R-20 screen 1	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-20 screen 2	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-21	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-32	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-38	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-40i[i]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-40 screen 1[i]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-40 screen 2[j]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-53 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-53 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-54 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-54 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-56 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-56 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q

Source: Table 5.4-1 of the 2010 IFGMP (LANL 2010, 109830).

Notes: Sampling suites and frequencies: Q = quarterly (4 times/yr); S = semiannual (2 times/yr); A = annual (1 time/yr); Nonfiltered and filtered samples will be collected for general inorganics (excluding anions) and metals. Anions and perchlorate samples will be filtered. Samples collected for radionuclide analysis will be nonfiltered only for all water media. Organic and HEXP constituents are nonfiltered for all water media. Stable isotope samples for nitrogen isotopes are filtered; stable isotope samples for deuterium and oxygen isotopes are not filtered.

[a] Metals analysis includes the 23 TAL metals, plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[b] VOCs = Volatile organic compounds; SVOCs = semivolatile organic compounds.

[c] HEXP = High explosive (compounds). The HEXP analytical suite includes the Consent Order list of the normal SW-846:8330 analytes plus pentaerythritol tetranitrate; triaminotrinitrobenzene; 3,5-dinitroaniline, tri(o-cresyl)phosphate; 2,4-diamino-6-nitrotoluene; and 2,6-diamino-4-nitrotoluene. These additional analytes are analyzed by SW-846:8321A.

[d] The radionuclide (RAD) suite includes gross alpha, gross beta, alpha spectroscopy, gamma spectroscopy, and strontium-90.

[e] Low-level tritium is analyzed using electrolytic enrichment or direct counting.

[f] General inorganic analysis includes major anions (bromide, chloride, fluoride, sulfate); major cations (calcium, magnesium, sodium, potassium); nitrate plus nitrite (as N); total Kjeldahl nitrogen; ammonia; total phosphorus, total organic carbon; total dissolved solids; alkalinity; specific conductivity; pH; and hardness.

[g] Analysis for stable nitrogen, deuterium, and oxygen isotopes.

[h] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential will be measured if a flow-through cell is used. Alkalinity will be measured for all samples either in the field or at the on-site Earth and Environmental Sciences14 laboratory.

[i] The gradient in the perched intermediate zone is not known with sufficient accuracy to determine whether or not wells R-40i and R-40 screen 1 are downgradient of MDA H.

[j] Wells R-20 and R-54 are generally upgradient of MDA L. However, these wells potentially could be downgradient of MDA L if pumping at water-supply well PM-2 affects the local gradient. Similarly, well R-40 screen 2 is generally upgradient of MDA H but could potentially be downgradient of this MDA if pumping at PM-2 affects the local gradient.

Table 5.1-1
Summary of Regulatory Criteria and Clean-up Levels

Media	Regulatory Standard
Groundwater*	NMWQCC standards Safe Drinking Water Act standards EPA regional tap water screening levels
Surface water	NMWQCC standards Clean Water Act standards State of New Mexico Standards for Interstate and Intrastate Surface Waters
Soil	NMED "Technical Background Document for Development of Soil Screening Levels" EPA Region 6 Human Health Medium Specific Screening Level

* If both an NMWQCC standard and an MCL have been established for an individual substance, then the lower of the two levels is considered the cleanup level for the substance.

Table 7.0-1
Summary of Potential Remedial Action Alternatives

Area	No Action	Containment Technologies	In Situ Treatment	Excavation
Pit and Impoundments Exposure pathways of concern include • direct exposure to waste via erosion, biointrusion or excavation • exposure to contaminated surface and/or subsurface soils via excavation or biointrusion • creation of contaminated leachate from infiltration of water into the waste • volatilization of VOCs from waste or contaminated subsurface soils with vapor transport through pore gas to groundwater	Alternative 1 No action	Alternative 2A–Multilayer cover Alternative 2B– ET cover	Alternatives 2A, 2B, 3A, 3B, 4 – Source area SVE	Alternatives 3A, 3B, 4–Excavation
Shafts Exposure pathways of concern include • direct exposure to waste via erosion, biointrusion or excavation • exposure to contaminated surface and/or subsurface soils via excavation or biointrusion • creation of contaminated leachate from infiltration of water into the waste • volatilization of VOCs from waste or contaminated subsurface soils with vapor transport through pore gas to groundwater	Alternative 1 No action	Alternatives 2A, 3A–Multilayer cover Alternatives 2B, 3B– ET cover	Alternatives 2A, 2B, 3A, 3B, 4–Source area SVE	Alternative 4–Excavation
Vadose Zone Exposure pathway includes • volatilization of VOCs from waste or contaminated subsurface soils with vapor transport through pore gas to groundwater	Alternative 1 No action	n/a*	Alternatives 2A, 2B, 3A, 3B, 4–Source area SVE	n/a

Note: Pore-gas monitoring and institutional controls will be implemented in conjunction with all technologies other than no-action alternative.
*n/a = Not applicable.

Table 7.3-1
Screening of Alternatives against the Threshold Screening Criteria

Alternative	Description	Threshold Screening Criteria			
		Protective of HH&E*	Attains Media Cleanup Standards	Controls Source and Releases	Complies with Waste Management Standards
Alternative 1 No Action	This technology includes no monitoring of pore gas, no maintenance, and no institutional controls.	**No** Potential remains for exposure through erosion, direct contact and biointrusion.	**No** Does not comply with the EPA guidance for attaining media cleanup standards when waste is left in place.	**No** No source removal or control Continued VOC release	**Yes** No waste will be generated.
Alternative 2A Multilayer cover, SVE, and institutional controls	• A multilayer cover will be constructed over the pit/shafts/impoundments. • An SVE system will be installed and operated remove VOC vapors from the vadose zone. • Pore-gas monitoring will be conducted for 30 yr. • Institutional controls will be implemented for 100 yr.	**Yes** The multilayer cover provides protection against erosion, direct contact, biointrusion, and moisture infiltration. SVE breaks the contaminant transport pathway to groundwater. Institutional controls restrict site access.	**Yes** Complies with the EPA guidance for attaining media cleanup standards when waste is left in place. SVE will be conducted to attain media cleanup standards.	**Yes** The cover will minimize/eliminate moisture infiltration. The cover will provide protection from exposure to waste, soils, and reduce erosion. SVE will remove vapor phase contaminants.	**Yes** Any waste generated under this technology will comply with all applicable regulatory requirements.

Table 7.3-1 (continued)

Alternative	Description	Threshold Screening Criteria			
		Protective of HH&E*	Attains Media Cleanup Standards	Controls Source and Releases	Complies with Waste Management Standards
Alternative 2B ET cover, SVE, and institutional controls	• An ET cover will be constructed over the pit/shafts/impoundments. • An SVE system will be installed and operated to remove VOC vapors from the vadose zone. • Pore-gas monitoring will be conducted for 30 yr. • Institutional controls will be implemented for 100 yr.	**Yes** The ET cover provides protection against erosion, direct contact, biointrusion, and moisture infiltration. SVE breaks the contaminant transport pathway to groundwater. Institutional controls restrict site access.	**Yes** Complies with the EPA guidance for attaining media cleanup standards when waste is left in place. SVE will be conducted to attain media cleanup standards.	**Yes** The cover will minimize/eliminate moisture infiltration. The cover will provide protection from exposure to waste, soils, and reduce erosion. SVE will remove vapor phase contaminants.	**Yes** Any waste generated under this technology will comply with all applicable regulatory requirements.
Alternative 3A Multilayer cover (shafts), excavation (pit and impoundments), SVE, and institutional controls	• The pit and impoundments will be excavated. • The excavated areas will be backfilled with clean fill material. Some treated waste may be returned to the unit if it meets the media clean-up standards. • A multilayer cover will be constructed over the shafts. • An SVE system will be installed and operated to remove VOC vapors from the vadose zone. • Pore-gas monitoring will be conducted for 30 yr. • Institutional controls will be implemented for 100 yr.	**Yes** The multilayer cover provides protection against erosion, direct contact, biointrusion, and moisture infiltration. Partial waste excavation reduces potential for exposure. SVE breaks the contaminant transport pathway to groundwater. Institutional controls restrict site access.	**Yes** Complies with the EPA guidance for attaining media cleanup standards when waste is left in place. The pit and impoundments will be excavated. SVE will be conducted to attain media cleanup standards.	**Yes** Excavation will partially remove source area. The cover will minimize/eliminated moisture infiltration. The cover will provide protection from exposure to waste, soils, and reduce erosion. SVE will remove vapor phase contaminants.	**Yes** Any waste generated under this technology will comply with all applicable regulatory requirements. This includes complying with WAC for off-site disposal of excavated wastes.

Table 7.3-1 (continued)

Alternative	Description	Threshold Screening Criteria			
		Protective of HH&E*	Attains Media Cleanup Standards	Controls Source and Releases	Complies with Waste Management Standards
Alternative 3B ET cover (shafts), Excavation (pit and impoundments), SVE, and institutional controls	• The pit and impoundments will be excavated. • The excavated areas will be backfilled with clean fill material. Some treated waste may be returned to the unit if it meets the media clean-up standards. • An ET cover will be constructed over the shafts. • An SVE system will be installed and operated to remove VOC vapors from the vadose zone. • Pore-gas monitoring will be conducted for 30 yr. • Institutional controls will be implemented for 100 yr.	**Yes** The ET cover provides protection against erosion, direct contact, biointrusion, and moisture infiltration. Partial waste excavation reduces potential for exposure. SVE breaks the contaminant transport pathway to groundwater. Institutional controls restrict site access.	**Yes** Complies with the EPA guidance for attaining media cleanup standards when waste is left in place. The pit and impoundments will be excavated. SVE will be conducted to attain media cleanup standards.	**Yes** Excavation will partially remove source area. The cover will minimize/eliminated moisture infiltration. The cover will provide protection from exposure to waste, soils, and reduce erosion. SVE will remove vapor phase contaminants.	**Yes** Any waste generated under this technology will comply with all applicable regulatory requirements. This includes complying with WAC for off-site disposal of excavated wastes.

Table 7.3-1 (continued)

Alternative	Description	Threshold Screening Criteria			
		Protective of HH&E*	Attains Media Cleanup Standards	Controls Source and Releases	Complies with Waste Management Standards
Alternative 4 Waste excavation, SVE, and institutional controls	• Waste from the shafts, pit, and impoundments will be excavated and sent off-site for treatment and/or disposal. • The excavated areas will be backfilled with clean fill material. Some treated waste may be returned to the unit if it meets the media clean-up standards. • An SVE system will be installed and operated to remove VOC vapors from the vadose zone. • Pore-gas monitoring will be conducted for 30 yr. • Institutional controls will be implemented for 100 yr.	**Yes** Removal of the waste will be protective of HH&E by eliminating the source.	**Yes** The shafts, pit, and impoundments will be excavated. SVE will be conducted to attain media cleanup standards.	**Yes** Excavation will remove the source material and prevent future releases. SVE will remove any residual VOC contamination in the vadose zone.	**Yes** Any waste generated under this technology will comply with all applicable regulatory requirements. This includes complying with WAC for off-site disposal of excavated wastes.

*HH&E = Human health and the environment.

Table 8.2-1
Cost Estimate for Alternative 2A

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Alt. 2A Multilayer RCRA Cover, SVE, Institutional Controls											
Direct Costs	Site Fencing										
		Site Fencing	$37,167	$119,958	$5,710			$162,835	1450	LF	$112
		Fencing Total						**$162,835**	1450	LF	$112
	RCRA Cover										
		Site Prep	$53,409	$109,854	$44,604	$2,396		$210,263	1	LS	$210,263
		Cover Prep	$57,946	$397,854	$43,570			$499,371	5671	CY	$88
		Compacted Clay (2 ft)	$99,117	$248,454	$123,981			$471,551	2904	CY	$162
		Geomembrane (40-mil HDPE)	$17,950	$57,557	$5,259			$80,766	0.9	AC	$89,740
		Drainage Layer (1 ft)	$14,837	$60,871	$11,156			$86,864	1452	CY	$60
		Cover Soil/Surface Treatment (2 ft)	$39,434	$120,252	$32,772			$192,458	2904	CY	$66
		Shoulder Fill	$124,716	$44,205	$6,299			$175,220	630	CY	$278
		Cover Armoring	$50,624	$15,248	$1,118			$66,991	322	CY	$208
		Vegetation	$3,147	$97,717	$1,459			$102,322	0.9	AC	$113,691
		RCRA Cover Total						**$1,885,806**			
	SVE										
		SVE Unit				$210,468		$210,468	3	EA	$70,156
		Extraction Boreholes & SVE Installation	$454,031	$55,865	$10,226	$89,936		$610,059	9	EA	$67,784
		Monitoring Boreholes	$207,918	$69,706	$12,298	$47,227		$337,150	5	EA	$67,430
		Removal of FLUTe Boreholes	$4,314	$542	$6,855			$11,711	4	EA	$2,928
		SVE Total						**$1,169,387**			
	Distributables										
		Distributables Total	$506,540	$35,742				**$542,282**			
	O&M										
		Active SVE Operation (3 yr)				$1,256,365		$1,256,365	3	YR	$418,788
		Active SVE Monitoring (3 yr)				$179,740		$179,740	3	YR	$59,913
		Rebound SVE Monitoring (3 yr)				$683,011		$683,011	3	YR	$227,670
		Subsurface VOC Monitoring (27 yr)				$1,931,215		$1,931,215	27	YR	$71,526
		Cover Inspections and Maintenance (100 yr)				$216,166		$216,166	100	YR	$2,162
		Annual Long-Term Monitoring Report (100 yr)				$228,758		$228,758	100	YR	$2,288
		O&M Total						**$4,495,254**			

Table 8.2-1 (continued)

	Item Description		Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Indirect Costs	Indirect Capital Costs										
		Design				$875,941		$875,941			
		Professional Management	$2,641,242					$2,641,242			
		Contingency					$3,638,745	$3,638,745			
		Indirect Total						**$7,155,928**			
	Indirect O&M										
		Professional Management	$1,546,856					$1,546,856			
		Contingency					$3,021,055	$3,021,055			
		Indirect O&M Total						**$4,567,911**			
Total Costs Alt. 2A Multilayer RCRA Cover, SVE, Institutional Controls								**$19,979,404**			

Notes: Labor costs are RS Mean's determination of the proper craft mix and productivity rate to complete the specific task in the detailed cost estimate in Appendix F. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix F. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix F. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix F. This includes material, labor, and equipment to perform the task. Craft distributables include a $7 per direct job hour cost to account for the nonlabor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. Costs included in the above table are burdened including (New Mexico gross receipts tax, general and administrative, infrastructure, and Associate Directorate support taxes). The specific costs listed in the detailed cost estimate in Appendix F do not include this burden. Contingency costs are calculated at 50% of all other costs and have been separated by capital and O&M costs to produce two separate contingencies. LF = Linear feet; LS = lump sum; CY = cubic yards; AC = acres; EA = each; YR = yearly.

Table 8.2-2
Cost Estimate for Alternative 2B

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Alt. 2B ET Cover, SVE, Institutional Controls											
Direct Costs	Site Fencing										
		Site Fencing	$37,167	$119,958	$5,710			$162,835	1450	LF	$112
		Fencing Total						**$162,835**	1450	LF	$112
	ET Cover										
		Site Prep	$53,409	$109,854	$44,604	$2,396		$210,263	1	LS	$210,263
		Cover Prep	$57,946	$397,854	$43,570			$499,371	5671	CY	$88
		Biobarrier (1 ft)	$3,159	$68,760	$5,044			$76,962	1452	CY	$53
		Filter Layer (0.5 ft)	$5,405	$55,157	$5,517			$66,079	726	CY	$91
		Fine-Grained Cover Layer (3.5 ft)	$23,542	$356,532	$36,224			$416,299	5082	CY	$82
		Cover Soil/Surface Treatment (1.5 ft)	$29,576	$90,189	$24,579			$144,343	2178	CY	$66
		Shoulder Fill	$124,716	$44,205	$6,299			$175,220	630	CY	$278
		Cover Armoring	$50,624	$15,248	$1,118			$66,991	322	CY	$208
		Vegetation	$3,147	$97,717	$1,459			$102,322	0.9	AC	$113,691
		TDR Moisture Monitoring	$7,566	$64,167				$71,733	1	LS	$71,733
		ET Cover Total						**$1,829,583**			
	SVE										
		SVE Unit				$210,468		$210,468	3	EA	$70,156
		Extraction Boreholes & SVE Installation	$454,031	$55,865	$10,226	$89,936		$610,059	9	EA	$67,784
		Monitoring Boreholes	$207,918	$69,706	$12,298	$47,227		$337,150	5	EA	$67,430
		Removal of FLUTe Boreholes	$4,314	$542	$6,855			$11,711	4	EA	$2,928
		SVE Total						**$1,169,387**			
	Distributables										
		Distributables Total	$447,509	$31,574				**$479,082**			
	O&M										
		Active SVE Operation (3 yr)				$1,256,365		$1,256,365	3	YR	$418,788
		Active SVE Monitoring (3 yr)				$179,740		$179,740	3	YR	$59,913
		Rebound SVE Monitoring (3 yr)				$683,011		$683,011	3	YR	$227,670
		Subsurface VOC Monitoring (27 yr)				$1,931,215		$1,931,215	27	YR	$71,526
		TDR Moisture Monitoring				$471,563		$471,563	100	YR	$4,716
		Cover Inspections and Maintenance (100 yr)				$216,166		$216,166	100	YR	$2,162
		Annual Long-Term Monitoring Report (100 yr)				$228,758		$228,758	100	YR	$2,288
		O&M Total						**$4,966,817**			

Table 8.2-2 (continued)

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Indirect Costs	Indirect Capital Costs										
		Design				$848,121		$848,121			
		Professional Management	$2,574,448					$2,574,448			
		Contingency					$3,546,726	$3,546,726			
		Indirect Total						**$6,969,295**			
	Indirect O&M										
		Professional Management	$1,327,743					$1,327,743			
		Contingency					$3,147,280	$3,147,280			
		Indirect O&M Total						**$4,475,023**			
Total Costs 2B ET Cover, SVE, Institutional Controls								**$20,052,023**			

Notes: Labor costs are RS Mean's determination of the proper craft mix and productivity rate to complete the specific task in the detailed cost estimate in Appendix F. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix F. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix F. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix F. This includes material, labor, and equipment to perform the task. Craft distributables include a $7 per direct job hour cost to account for the nonlabor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. Costs included in the above table are burdened including (New Mexico gross receipts tax, general and administrative, infrastructure, and Associate Directorate support taxes). The specific costs listed in the detailed cost estimate in Appendix F do not include this burden. Contingency costs are calculated at 50% of all other costs and have been separated by capital and O&M costs to produce two separate contingencies. LF = Linear feet; LS = lump sum; CY = cubic yards; AC = acres; EA = each; YR = yearly.

Table 8.2-3
Cost Estimate for Alternative 3A

	Item Description		Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Alt. 3A Multilayer RCRA Cover (Shafts), Excavation (Pit and Impoundments), SVE, Institutional Controls											
Direct Costs	Site Fencing										
		Site Fencing	$37,167	$119,958	$5,710			$162,835	1450	LF	$112
		Fencing Total						**$162,835**	1450	LF	$112
	RCRA Cover										
		Site Prep	$53,409	$109,854	$44,604	$2,396		$210,263	1	LS	$210,263
		Cover Prep	$55,666	$382,188	$41,856			$479,709	5447	CY	$88
		Compacted Clay (2 ft)	$44,063	$110,453	$55,117			$209,633	1291	CY	$162
		Geomembrane (40-mil HDPE)	$8,470	$24,587	$2,237			$35,295	0.4	AC	$88,236
		Drainage Layer (1 ft)	$6,591	$27,040	$4,956			$38,586	645	CY	$60
		Cover Soil/Surface Treatment (2 ft)	$17,517	$53,418	$14,558			$85,493	1290	CY	$66
		Shoulder Fill	$119,748	$42,465	$6,048			$168,261	630	CY	$267
		Cover Armoring	$39,462	$11,891	$872			$52,225	251	CY	$208
		Vegetation	$3,147	$97,717	$1,459			$102,322	0.9	AC	$113,691
		RCRA Cover Total						**$1,381,787**			
	SVE										
		SVE Unit				$210,468		$210,468	3	EA	$70,156
		Extraction Boreholes & SVE Installation	$454,031	$55,865	$10,226	$89,936		$610,059	9	EA	$67,784
		Monitoring Boreholes	$207,918	$69,706	$12,298	$47,227		$337,150	5	EA	$67,430
		Removal of FLUTe Boreholes	$4,314	$542	$6,855			$11,711	4	EA	$2,928
		SVE Total						**$1,169,387**			
	Excavation										
		Excavation of Pit and Impoundments	$1,165,154	$615,268	$519,634		$167,330	$2,467,386	3250	CY	$759
		Confirmatory Sampling of Pit and Impoundments	$56,827		$158	$1,533,207		$1,590,191	254	EA	$6,261
		Backfill of Pit and Impoundments	$30,852	$114,910	$23,547			$169,309	1008	CY	$168
		Disposal of Waste	$5,015,682	$2,338,101	$1,050,696	$4,416,317	$918,060	$13,738,856	2243	CY	$6,125
		Equipment Decon	$14,953	$77,000				$91,954	1	LS	$91,954
		Excavation Total						**$18,057,695**			
	Distributables										
		Distributables	$3,791,580	$267,525				**$4,059,105**			
	O&M										
		Active SVE Operation (3 yr)				$1,256,365		$1,256,365	3	YR	$418,788
		Active SVE Monitoring (3 yr)				$179,740		$179,740	3	YR	$59,913
		Rebound SVE Monitoring (3 yr)				$683,011		$683,011	3	YR	$227,670
		Subsurface VOC Monitoring (27 yr)				$1,931,215		$1,931,215	27	YR	$71,526
		Cover Inspections and Maintenance (100 yr)				$216,166		$216,166	100	YR	$2,162
		Annual Long-Term Monitoring Report (100 yr)				$228,758		$228,758	100	YR	$2,288
		O&M Total						**$4,495,254**			

Table 8.2-3 (continued)

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Indirect Costs	Indirect Capital Costs										
		Design				$2,583,805		$2,583,805			
		Professional Management	$15,617,928					$15,617,928			
		Contingency					$21,516,266	$21,516,266			
		Indirect Total						**$39,717,999**			
	Indirect O&M										
		Professional Management	$1,546,856					$1,546,856			
		Contingency					$3,021,055	$3,021,055			
		Indirect O&M Total						**$4,567,911**			
Total Costs Alt 3A Multilayer RCRA Cover,, Excavation, SVE, Institutional Controls								**$73,611,974**			

Notes: Labor costs are RS Mean's determination of the proper craft mix and productivity rate to complete the specific task in the detailed cost estimate in Appendix F. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix F. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix F. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix F. This includes material, labor, and equipment to perform the task. Craft distributables include a $7 per direct job hour cost to account for the nonlabor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. Costs included in the above table are burdened including (New Mexico gross receipts tax, general and administrative, infrastructure, and Associate Directorate support taxes). The specific costs listed in the detailed cost estimate in Appendix F do not include this burden. Contingency costs are calculated at 50% of all other costs and have been separated by capital and O&M costs to produce two separate contingencies. LF = Linear feet; LS = lump sum; CY = cubic yards; AC = acres; EA = each; YR = yearly.

Table 8.2-4
Cost Estimate for Alternative 3B

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Alt. 3B ET Cover (Shafts), Excavation (Pit and Impoundments), SVE, Institutional Controls											
Direct Costs	Site Fencing										
		Site Fencing	$37,167	$119,958	$5,710			$162,835	1450	LF	$112
		Fencing Total						**$162,835**	1450	LF	$112
	ET Cover										
		Site Prep	$53,409	$109,854	$44,604	$2,396		$210,263	1	LS	$210,263
		Cover Prep	$55,666	$382,188	$41,856			$479,709	5448	CY	$88
		Biobarrier (1 ft)	$1,403	$30,553	$2,240			$34,196	645	CY	$53
		Filter Layer (0.5 ft)	$2,402	$24,514	$2,452			$29,369	322	CY	$91
		Fine Grained Cover Layer (3.5 ft)	$10,867	$158,482	$16,744			$186,093	2259	CY	$82
		Cover Soil/Surface Treatment (1.5 ft)	$13,145	$40,084	$10,924			$64,153	968	CY	$66
		Shoulder Fill	$119,748	$42,479	$6,048			$168,275	630	CY	$267
		Cover Armoring	$39,462	$11,891	$872			$52,225	251	CY	$208
		Vegetation	$3,147	$97,717	$1,459			$102,322	0.9	AC	$113,691
		TDR Moisture Monitoring	$7,566	$64,167				$71,733	1	LS	$71,733
		ET Cover Total						**$1,398,338**			
	SVE										
		SVE Unit				$210,468		$210,468	3	EA	$70,156
		Extraction Boreholes & SVE Installation	$454,031	$55,865	$10,226	$89,936		$610,059	9	EA	$67,784
		Monitoring Boreholes	$207,918	$69,706	$12,298	$47,227		$337,150	5	EA	$67,430
		Removal of FLUTe Boreholes	$4,314	$542	$6,855			$11,711	4	EA	$2,928
		SVE Total						**$1,169,387**			
	Excavation										
		Excavation of Pit and Impoundments	$1,165,154	$615,268	$519,634		$167,330	$2,467,386	3250	CY	$759
		Confirmatory Sampling of Pit and Impoundments	$56,827		$158	$1,533,207		$1,590,191	254	EA	$6,261
		Backfill of Pit and Impoundments	$30,852	$114,910	$23,547			$169,309	1008	CY	$168
		Disposal of Waste	$5,015,682	$2,338,101	$1,050,696	$4,416,317	$918,050	$13,738,846	2243	CY	$6,125
		Equipment Decon	$14,953	$77,000				$91,954	1	LS	$91,954
		Excavation Total						**$18,057,685**			
	Distributables										
		Distributables	$3,771,402	$266,100				**$4,037,501**			
	O&M										
		Active SVE Operation (3 yr)				$1,256,365		$1,256,365	3	YR	$418,788
		Active SVE Monitoring (3 yr)				$179,740		$179,740	3	YR	$59,913
		Rebound SVE Monitoring (3 yr)				$683,011		$683,011	3	YR	$227,670
		Subsurface VOC Monitoring (27 yr)				$1,931,215		$1,931,215	27	YR	$71,526
		TDR Moisture Monitoring				$471,563		$471,563	100	YR	$4,716
		Cover Inspections and Maintenance (100 yr)				$216,166		$216,166	100	YR	$2,162
		Annual Long-Term Monitoring Report (100 yr)				$228,758		$228,758	100	YR	$2,288
		O&M Total						**$4,966,817**			

Table 8.2-4 (continued)

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Indirect Costs	Indirect Capital Costs										
		Design				$2,582,624		$2,582,624			
		Professional Management	$15,614,368					$15,614,368			
		Contingency					$21,511,362	$21,511,362			
		Indirect Total						**$39,708,354**			
	Indirect O&M										
		Professional Management	$1,546,856					$1,546,856			
		Contingency					$3,256,837	$3,256,837			
		Indirect O&M Total						**$4,803,693**			
Total Costs Alt. 3B ET Cover, Excavation, SVE, Institutional Controls								**$74,304,611**			

Notes: Labor costs are RS Mean's determination of the proper craft mix and productivity rate to complete the specific task in the detailed cost estimate in Appendix F. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix F. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix F. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix F. This includes material, labor, and equipment to perform the task. Craft distributables include a $7 per direct job hour cost to account for the nonlabor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. Costs included in the above table are burdened including (New Mexico gross receipts tax, general and administrative, infrastructure, and Associate Directorate support taxes). The specific costs listed in the detailed cost estimate in Appendix F do not include this burden. Contingency costs are calculated at 50% of all other costs and have been separated by capital and O&M costs to produce two separate contingencies. LF = Linear feet; LS = lump sum; CY = cubic yards; AC = acres; EA = each; YR = yearly.

Table 8.2-5
Cost Estimate for Alternative 4

	Item Description		Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Alt. 4 Excavation, SVE, and, Institutional Controls											
Direct Costs	**Site Fencing**										
		Site Fencing	$37,167	$119,958	$5,710			$162,835	1450	LF	$112
		Fencing Total						**$162,835**	1450	LF	$112
	SVE										
		SVE Unit				$210,468		$210,468	3	EA	$70,156
		Extraction Boreholes & SVE Installation	$454,031	$55,865	$10,226	$89,936		$610,059	9	EA	$67,784
		Monitoring Boreholes	$207,918	$69,706	$12,298	$47,227		$337,150	5	EA	$67,430
		Removal of FLUTe Boreholes	$4,314	$542	$6,855			$11,711	4	EA	$2,928
		SVE Total						**$1,169,387**			
	Excavation										
		Excavation Site Prep	$1,645,965	$2,708,181	$232,624	$2,396		$4,589,165	1	LS	$4,589,165
		Excavation of Shafts	$2,474,619	$3,183	$2,719,297		$101,446	$5,298,545	32019	CY	$165
		Confirmatory Sampling of Shafts	$153,477		$426	$4,140,865		$4,294,768	686	CY	$6,261
		Backfill of Shafts	$303,958	$162,709	$231,980			$698,648	28176	CY	$25
		Disposal of Waste Shafts	$8,539,532	$3,982,024	$1,788,089	$7,558,984	$1,767,246	$23,635,874	3842	CY	$6,152
		Excavation of Pit and Impoundments	$795,850	$12,731	$476,039		$167,330	$1,451,949	3250	CY	$447
		Confirmatory Sampling of Pit and Impoundments	$56,827		$158	$1,533,207		$1,590,191	254	EA	$6,261
		Backfill of Pit and Impoundments	$30,852	$114,910	$23,547			$169,309	1008	CY	$168
		Disposal of Waste Pit and Impoundments	$5,015,682	$2,338,101	$1,050,696	$4,416,317	$918,050	$13,738,846	2243	CY	$6,125
		Equipment Decon	$14,953	$77,000				$91,954	1	LS	$91,954
		Revegetation	$3,147	$97,717	$1,459			$102,322	0.9	AC	$113,691
		Excavation Total						**$55,661,569**			
	Distributables										
		Distributables	$10,396,077	$733,523				**$11,129,600**			
	O&M										
		Active SVE Operations (3 yr)				$1,256,365		$1,256,365	3	YR	$418,788
		Active SVE Monitoring (3 yr)				$179,740		$179,740	3	YR	$59,913
		Rebound SVE Monitoring (3 yr)				$683,011		$683,011	3	YR	$227,670
		O&M Total						**$2,119,115**			

Table 8.2-5 (continued)

		Item Description	Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Indirect Costs	Indirect Capital Costs										
		Design				$7,162,718		$7,162,718			
		Professional Management	$42,890,019					$42,890,019			
		Contingency					$59,088,062	$59,088,062			
		Indirect Total						**$109,140,799**			
	Indirect O&M										
		Professional Management	$946,430					$946,430			
		Contingency					$1,532,773	$1,532,773			
		Indirect O&M Total						**$2,479,202**			
Total Costs Alt. 4 Excavation, SVE, Institutional Controls								**$181,862,508**			

Notes: Labor costs are RS Mean's determination of the proper craft mix and productivity rate to complete the specific task in the detailed cost estimate in Appendix F. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix F. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix F. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix F. This includes material, labor, and equipment to perform the task. Craft distributables include a $7 per direct job hour cost to account for the nonlabor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. Costs included in the above table are burdened including (New Mexico gross receipts tax, general and administrative, infrastructure, and Associate Directorate support taxes). The specific costs listed in the detailed cost estimate in Appendix F do not include this burden. Contingency costs are calculated at 50% of all other costs and have been separated by capital and O&M costs to produce two separate contingencies. LF = Linear feet; LS = lump sum; CY = cubic yards; AC = acres; EA = each; YR = yearly.

Table 9.1-1
Explanation of Ranking System Used for Evaluating Remedial Alternative Evaluation Criteria

Balancing Criteria	Rating				
	1	2	3	4	5
Long-Term Reliability and Effectiveness	Not demonstrated as effective; potential for remedy failure	→			Reduces risk with little long-term management, and has proven effective under similar conditions
Reduction of Toxicity Mobility, or Volume	No reduction of toxicity, mobility, or volume of contaminants	→			Completely and permanently reduces the toxicity, mobility, and volume of contaminants
Short-Term Effectiveness	Provides no short-term risk reduction and may create significant additional risks to the community, workers, and the environment	→			Quickly reduces short-term risk without creating significant additional risks
Implementability	Difficult to implement. Significant amount of time needed for implementation	→			Can be implemented quickly and easily and poses few difficulties
Cost	Highest costs	→			Less costly and does not sacrifice protection of human health and the environment

Table 9.1-2
Rating of Alternatives against the Balancing Criteria

Alternative	Balancing Criteria	Rating Justification	Rating
Alternative 1 No Action	Long-Term Reliability and Effectiveness	This alternative is rated lowest in long-term reliability and effectiveness since there is high long-term risk, high uncertainty with leaving waste in place, potentially high amount of long-term management and monitoring, and high potential for remedy failure.	1
	Reduction of Toxicity, Mobility, or Volume	This alternative is rated lowest in reduction of toxicity, mobility, or volume since there is no reduction.	1
	Short-Term Effectiveness	This alternative is mid-rated for short-term effectiveness because no additional risk is generated, although no risk reduction is achieved.	3
	Implementability	This alternative is rated highest in implementability because it easiest to implement as no remedy is required.	5
	Cost	This alternative is rated highest in the cost criteria because it has no associated costs.	5
	Total		**15**
Alternative 2A Multilayer cover, SVE, and institutional controls	Long-Term Reliability and Effectiveness	A multilayer cover with SVE is more reliable in the long-term compared with Alternative 1. However, because of the potential for desiccation in the clay layers, it is rated as less reliable than Alternative 2B and all alternatives that include excavation.	2
	Reduction of Toxicity, Mobility, or Volume	SVE will reduce volume and downward mobility of VOCs. The multilayer cover reduces infiltration, therby reducing mobility. This alternative is comparable with Alternative 2B but is rated lower than alternatives that include excavation.	3
	Short-Term Effectiveness	This alternative is comparable with Alternative 2B but is rated higher than alternatives that include excavation because of the risks associated with excavation and waste handling.	4
	Implementability	This alternative uses standard construction techniques. This alternative is comparable with Alternative 2B but is rated higher than alternatives that include excavation because of the additional difficulty with performing excavation and waste handling.	3
	Cost	This alternative is comparable in cost with Alternative 2B but is rated higher than alternatives that include excavation because of their additional costs for excavation and waste handling.	4
	Total		**16**

Table 9.1-2 (continued)

Alternative	Balancing Criteria	Rating Justification	Rating
Alternative 2B ET cover, SVE, and institutional controls	Long-Term Reliability and Effectiveness	This alternative is more reliable in the long-term compared with Alternative 1. This alternative is rated higher than Alternative 2A because it does not have the desiccation issue associated with the clay layer. Excavation provides more long-term reliability; therefore, Alternatives 3B and 4 are rated higher. However Alternative 3A is comparable with this alternative in ratings because of the conflicting impact of excavation with clay desiccation.	3
	Reduction of Toxicity, Mobility, or Volume	SVE will reduce volume and downward mobility of VOCs. The ET cover reduces infiltration, thereby reducing mobility. This alternative is comparable with Alternative 2A but is rated lower than alternatives that include excavation.	3
	Short-Term Effectiveness	This alternative is comparable with Alternative 2A but is rated higher than alternatives that include excavation because of the risks associated with excavation and waste handling.	4
	Implementability	This alternative uses standard construction techniques. This alternative is comparable with Alternative 2A but is rated higher than alternatives that include excavation because of the additional difficulty with performing excavation and waste handling.	3
	Cost	This alternative is comparable in cost with Alternative 2A but is rated higher than alternatives that include excavation because of the additional costs for excavation and waste handling.	4
	Total		**17**
Alternative 3A Multilayer cover (shafts), excavation (pit and impoundments), SVE, and institutional controls	Long-Term Reliability and Effectiveness	This alternative is more reliable in the long-term compared with Alternative 1. However, because of the potential for desiccation in the clay layers, it is rated as less reliable than Alternatives 3B and 4. Excavation provides more long-term reliability; however, Alternative 2B is rated comparable with this alternative because of the conflicting impact of excavation with clay desiccation.	3
	Reduction of Toxicity, Mobility, or Volume	Excavation reduces volume of waste at the site. SVE will reduce volume and downward mobility of VOCs. The multilayer cover reduces infiltration, thereby reducing mobility. This alternative is rated higher than alternatives that do not include excavation. This alternative is comparable with Alternative 3B but is rated lower than the complete excavation alternative.	4
	Short-Term Effectiveness	This alternative is comparable with Alternative 3B; however, it is rated lower than alternatives that do not include excavation because of the risks associated with excavation and waste handling.	2
	Implementability	This alternative uses standard construction techniques. This alternative is comparable with Alternative 3B but is rated lower than alternatives that do not include excavation because of the additional difficulty with performing excavation and waste handling.	2
	Cost	This alternative is comparable in cost with Alternative 3B. It is rated lower than alternatives that do not include excavation but is rated higher than the complete excavation alternative.	2
	Total		**13**

Table 9.1-2 (continued)

Alternative	Balancing Criteria	Rating Justification	Rating
Alternative 3B ET cover (shafts), excavation (pit and impoundments), SVE, and institutional controls	Long-Term Reliability and Effectiveness	This alternative is more reliable in the long-term compared with Alternative 1. This alternative is rated higher than Alternative 3A because it does not have the desiccation issue associated with the clay layer. Excavation provides more long-term reliability; therefore, Alternative 4 is rated higher.	4
	Reduction of Toxicity, Mobility, or Volume	Excavation reduces volume of waste at the site. SVE will reduce volume and downward mobility of VOCs. The multilayer cover reduces infiltration, thereby reducing mobility. This alternative is rated higher than alternatives that do not include excavation. This alternative is comparable with Alternative 3A but is rated lower than the complete excavation alternative.	4
	Short-Term Effectiveness	This alternative is comparable with Alternative 3A; however, it is rated lower than alternatives that do not include excavation because of the risks associated with excavation and waste handling.	2
	Implementability	This alternative uses standard construction techniques. This alternative is comparable with Alternative 3A but is rated lower than alternatives that do not include excavation because of the additional difficulty with performing excavation and waste handling.	2
	Cost	This alternative is comparable in cost with Alternative 3A. It is rated lower than alternatives that do not include excavation but is rated higher than the complete excavation alternative.	2
	Total		**14**
Alternative 4 Waste excavation, SVE, and institutional controls	Long-Term Reliability and Effectiveness	Excavation with SVE provides the most reliable long-term effectiveness because all wastes are removed. This alternative is rated higher than all other alternatives.	5
	Reduction of Toxicity, Mobility, or Volume	Excavation reduces volume of waste at the site. SVE will reduce volume and downward mobility of VOCs. This alternative provides the greatest reduction in toxicity, mobility, or volume because all waste is removed; therefore, this alternative is rated higher than all other alternatives.	5
	Short-Term Effectiveness	This alternative is rated lower than all other alternatives because of the increased short-term risks associated with excavation and waste handling.	1
	Implementability	This alternative is rated lower than all other alternatives because of the additional difficulty with performing excavation to depths required to retrieve wastes from the shafts.	1
	Cost	This alternative is rated lower than all other alternatives because of the additional costs for excavation to depths required to retrieve wastes from the shafts and for waste handling.	1
	Total		**13**

Appendix A

Acronyms and Abbreviations,
Metric Conversion Table, and Data Qualifier Definitions

A-1.0 ACRONYMS AND ABBREVIATIONS

2-D	two-dimensional
3-D	three-dimensional
ACZ	acceptable compaction zone
AEA	Atomic Energy Act
amsl	above mean sea level
AOC	area of concern
APV	access port valve
ARSL	American Radiation Services Laboratory
asl	above sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
B&K	Brüel and Kjær
BV	background value
CAMU	corrective action management unit
CdRVF	Cerros del Rio volcanic field
CFR	Code of Federal Regulations
CME	corrective measures evaluation
CMI	corrective measure implementation
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
CSM	conceptual site model
CSU	container storage unit
CV	casing volume
D&D	decontaminate and decommission
DCA	dichloroethane
DCE	dichloroethylene (also dichloroethene)
DL	detection limit
DO	dissolved oxygen
DOE	Department of Energy (U.S.)
EPA	Environmental Protection Agency (U.S.)
ET	evapotranspiration
FD	field duplicate
FEHM	Finite Element Heat and Mass transfer code

FLUTe	Flexible Liner Underground Technologies
FV	fallout value
FY	fiscal year
GAC	granular activated carbon
GBIR	Groundwater Background Investigation Report
gpd	gallons per day
gpm	gallons per minute
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance (EPA infiltration model)
HH&E	human health and environment
HI	hazard index
hp	horsepower
IFGMP	Interim Facility-Wide Groundwater Monitoring Plan
IR	investigation report
IWP	investigation work plan
JMVF	Jemez Mountain volcanic field
LANL	Los Alamos National Laboratory
LDR	land disposal restriction
Ma	million years ago
MCL	maximum contaminant level
MDA	material disposal area
MDD	maximum dry density
MDL	method detection limit
meq	millaequivalent(s)
MLLW	mixed low-level waste
msl	mean sea level
MTR	minimum technology requirement
NAD	North American Datum
NCRS	Natural Resources Conservation Service
ND	nondetect
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission

NNSS	Nevada National Security Site
NTU	nephelometric turbidity unit(s)
O&M	operations and maintenance
OMB	Office of Management and Budget
ORP	oxygen-reduction potential
P&A	plugged and abandoned
PCB	polychlorinated biphenyl
PCE	perchloroethene (also tetrachloroethene)
PET	potential evapotranspiration
PLS	pure live seed
PQL	practical quantitation limit
PV	present value
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RETC	RETention Curve Computer Code
RFI	RCRA facility investigation
ROI	radius of influence
RPF	Records Processing Facility
scfm	standard cubic feet per minute
SL	screening level
SOP	standard operating procedure
SSD	saturated surface dry
SSL	soil screening level
SV	screening value
SVE	soil-vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list (EPA)
TCA	1,1,1-trichloroethane
TCE	trichloroethene

TD	total depth
TDR	time-domain reflectometer
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TSD	treatment, storage, and disposal
UMTL	University of Miami Tritium Laboratory
UTL	upper tolerance limit
VOC	volatile organic compound
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant

A-3.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

A-4.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
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+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
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.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B

Volatile Organic Compound Contaminant Screening Method and Soil-Vapor Plume Characteristics

B-1.0 INTRODUCTION

This appendix describes the methodology used to screen vapor-phase volatile organic compounds (VOCs) detected in the vadose zone beneath Material Disposal Area (MDA) L. The Compliance Order on Consent (the Consent Order) does not specifically address cleanup standards, screening levels (SLs), or other regulatory criteria for soil vapor. A screening method that compares vapor-phase concentrations to screening values (SVs) is presented in the periodic monitoring reports for vapor-sampling activities at the Los Alamos National Laboratory (the Laboratory) (e.g., LANL 2010, 109955) and discussed below as a Tier I screening evaluation. Although VOCs fall below these SVs at some sites (e.g., at MDA H), many VOCs exceed the SV at MDA L. Therefore, a two-tiered screening approach is applied at MDA L to further identify vapor-phase VOCs and vadose-zone concentrations that could potentially affect groundwater at concentrations exceeding applicable cleanup levels (Figure B-1.0-1). The screening process utilizes all data from a select period of record and is initially inclusive of constituents with low frequency of detection or other variables that are considered later in the screening process as part of an uncertainty analysis. The screening approach is demonstrated using recently reported soil-vapor monitoring data from MDA L. The Tier I methodology is extremely conservative and does not consider dilution or attenuation. If Tier I SLs are not exceeded, VOCs would not be able to contaminate groundwater above cleanup levels, and no further screening is necessary. If Tier I SLs are exceeded, less conservative, more realistic screening using the Tier II method should be performed.

- For the Tier I screen, the method uses Henry's law to identify the vapor-phase VOC concentration threshold that would have to be exceeded for a given VOC to potentially impact the groundwater at concentrations exceeding applicable groundwater standards. If the Tier I SL is exceeded for a given VOC, the Tier II screen is applied.
- For the Tier II screen, the analysis considers the migration of the VOCs to the water table and subsequent mixing with groundwater. This analysis includes migration of VOCs through the vadose zone in both the pore water and vapor phases. The resulting groundwater concentration following mixing immediately beneath the site is calculated and compared with applicable groundwater standards. If that calculated groundwater concentration exceeds a standard, further evaluation of the soil-vapor data is required to assess the potential impact that the particular VOC may have on groundwater.

The screening approach is presented below in section B-2.0 using soil-vapor data collected during the second quarter of fiscal year (FY) 2010 and presented in the MDA L periodic monitoring report for vapor-sampling activities (LANL 2010, 109955). The results of the screening process are that seven VOCs of potential concern and 1,4-dioxane were identified. These seven VOCs are 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, methylene chloride, perchloroethene (PCE), 1,1,1-trichloroethane (TCA), and trichloroethene (TCE) (LANL 2010, 109955). In addition, Tier II screening concentrations are calculated for all VOCs that were detected at MDA L from the third quarter of FY2009 through the second quarter of FY2010. More recent soil-vapor data from MDA L collected during the first quarter of FY2011 identify the same seven VOCs as exceeding Tier II screening concentrations (LANL 2011, 202268). In section B-3.0, the characteristics of the seven VOCs within the subsurface vapor plume at MDA L are summarized based on recent distributions and their behavior with time. Section B-4.0 compares the list of VOCs detected in the vadose zone below MDA L with those detected in groundwater in regional wells near MDA L and presents analyses to test whether vapor transport from the VOC vapor plume at MDA L is a likely source of VOCs detected in regional groundwater.

B-2.0 SCREENING METHODOLOGY

B-2.1 Tier I Soil-Vapor Screen Based on Henry's Law Partitioning

As part of ongoing quarterly soil-vapor monitoring activities, the proposed Tier I screening analysis is conducted to evaluate the potential for contamination of groundwater by VOCs in soil vapor using SLs based on groundwater cleanup levels in the Consent Order. The analysis evaluates the groundwater concentration that would be in equilibrium with the maximum soil-vapor concentrations of VOCs detected at MDA L if the soil-vapor concentration were in equilibrium with ground water according to Henry's law partitioning. The equilibrium between air and water concentrations is described by the following equation:

$$C_{water} = C_{air}/H \qquad \textbf{Equation B-2.1-1}$$

where C_{water} = the volumetric concentration of the contaminant in water,

C_{air} = the volumetric concentration of the contaminant in air (or soil vapor), and

H = the dimensionless Henry's law constant.

If the predicted concentration of a particular VOC in groundwater is less than the SL, then no potential exists for exceedances of groundwater cleanup levels.

Because there are no SLs for soil vapor that address the potential for groundwater contamination, the screening evaluation is based on groundwater standards or tap water SLs and the Henry's law constant that describe the equilibrium between vapor and water concentrations. The source of Henry's law constant is the NMED technical background document (NMED 2009, 106420) or the U.S. Environmental Protection Agency (EPA) regional screening tables (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/ressoil_sl_table_run_MAY2010.pdf). The preceding link contains the most current Henry's law constant. The following dimensionless form of Henry's law constant is used:

$$H = \frac{C_{air}}{C_{water}} \qquad \textbf{Equation B-2.1-2}$$

Equation B-2.1-2 can be used to calculate the following SV:

$$SV = \frac{C_{air}}{1000 \times H \times SL} \qquad \textbf{Equation B-2.1-3}$$

where C_{air} = the concentration of a particular VOC in the soil-vapor sample (µg/m^3),

SL = the screening level (µg/L), and,

1000 = a conversion factor [to convert liters (L) to cubic meters (m^3)].

The SLs are the groundwater standards or tap water SLs. The groundwater standards are either the EPA maximum contaminant levels (MCL) or New Mexico Water Quality Control Commission (NMWQCC) groundwater standards, whichever are lower. If there are no MCLs or NMWQCC standards, the EPA regional tap water SL (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/ressoil_sl_table_run_MAY2010.pdf) is used and adjusted to 10^{-5} risk for carcinogens. The numerator in Equation B-2.1-3 represents the actual concentration of the VOC in soil vapor, and the denominator represents the concentration of the VOC in soil vapor needed to exceed the SL. Therefore, if the SV is less than 1, the concentration of the VOC in soil vapor will not exceed the SL, even if the VOC plume is in direct contact with groundwater.

Table B-2.1-1 presents the calculated concentrations of contaminants in soil vapor corresponding to groundwater SLs for the Tier I screening. Table B-2.1-2 presents the results of the Tier I screen for the second quarter FY2010 soil-vapor data (LANL 2009, 109955). Thirteen VOCs were identified with the Tier I screen.

B-2.2 Tier II Soil-Vapor Screen Based on Mixing and Dilution in the Regional Aquifer

Constituents identified in the Tier I screen are further evaluated using a Tier II screening analysis. The Tier I SVs presented in Table B-2.1-1 basically assume that vapors present in the vadose zone located several hundred feet above the water table are in equilibrium with groundwater. However, the vapors must actually migrate downward to the water table and then mix with groundwater. When contaminants reach the water table of the regional aquifer, they mix with the clean groundwater flowing under ambient flux conditions, and contaminants are diluted. The resulting contaminant concentration in the groundwater is therefore lower than at the source in the vadose zone. A dimensionless dilution factor is used to account for this process, and its application is described by EPA and in other regulatory documents (EPA 1996, 059902; NMED 2006, 092513). The factor can be used to estimate the groundwater impact in the process of evaluating and selecting remedies.

When contaminants migrate through the vadose zone in the water phase, the following equation can be applied to calculate the dimensionless dilution factor for water-phase transport (F_{dw}):

$$F_{dw} = \frac{C_{wt}^{w}}{C_{aq}^{w}} = 1 + \frac{kId_m}{RL} \qquad \textbf{Equation B-2.2-1}$$

where C_{wt}^{w} is the contaminant concentration in the infiltrating water [M/L^3], C_{aq}^{w} is the contaminant concentration in the regional aquifer within the mixing zone [M/L^3], *I* is the hydraulic gradient in the regional aquifer [L/L], *R* is the infiltration rate through the vadose zone [L/T], *L* is the length of the source at the top of the regional aquifer parallel to groundwater flow, [L], *k* is the aquifer hydraulic conductivity [L/T], d_m is aquifer mixing zone depth [L], which is calculated as

$$d_m = \begin{cases} if\ d_a \le d_c & d_a \\ if\ d_a > d_c & d_c \end{cases} \qquad \textbf{Equation B-2.2-2}$$

where

$$d_c = 0.105830052L + d_a\left(1 - \exp\left(-\frac{RL}{kId_a}\right)\right) \qquad \textbf{Equation B-2.2-3}$$

and d_a [L] is the aquifer thickness where the mixing is expected to occur (e.g., well-screen length) and d_c [L] is the computed depth within which the contaminants are expected to migrate. If $d_a > d_c$, a conservative assumption is made that the mixing zone is equal to the well screen. Equations B-2.2-1, B-2.2-2, and B-2.2-3 are based on EPA guidance document (EPA 1996, 059902; Equations 37 and 45, respectively). They account for the impact of infiltration, which carries the contaminants, on the structure of groundwater flow in the regional aquifer.

If the contaminants migrate through the vadose zone in the vapor phase, then diffusion of contaminants through the vadose zone and partitioning of the contaminants at the water table should be taken into account. In the case of contaminant diffusion through the vadose zone, the water table can be viewed as a boundary at which contaminants leave the vadose zone and migrate into the regional aquifer. The diffusive flux depends on the contaminant concentrations at the vadose-zone source and at the water table. When the groundwater flux along the water table is relatively slow compared with diffusive vapor

flux in the vadose zone, it is important to account for the contaminant concentration at the water table (the concentration is initially equal to zero but increases with time).

Diffusion coefficients [L^2/T] in air, D_a, and water, D_w, are available to characterize migration of contaminants at MDA L in the free air and water phases, respectively (section B-4.0Table B-4.0-1). These coefficients can be modified to account for diffusion through a porous medium using the following equation (Millington and Quirk 1961, 110521):

$$D_{ap} = D_a \frac{(n-\theta)^{10/3}}{n^2}$$ **Equation B-2.2-4**

$$D_{wp} = D_w n^{4/3}$$ **Equation B-2.2-5**

where n is porosity of the porous medium [L^3/L^3], and θ [L^3/L^3] is the volumetric water content.

Henry's law defines the amount of the gas-phase (soil-vapor) contaminant that will be dissolved in the regional groundwater, as defined by Equation B-2.1-1. At the water table, Henry's law is expressed using the concentrations of the gas, C_{wt}^g [M/L^3] and the water, C_{wt}^w [M/L^3], phases along the regional water table at equilibrium:

$$C_{wt}^w = \frac{C_{wt}^g}{H}$$ **Equation B-2.2-6**

where H is the dimensionless Henry's law constant. Henry's law constant depends on the properties of the VOC, and on the temperature and pressure.

Truex et al. (2009, 108331) have proposed a technique to compute the dimensionless dilution factor of the vapor-phase contaminants (F_{dg}) adjacent to the water table into the regional aquifer:

$$F_{dg} = \frac{C_{wt}^a}{C_{aq}^w} = \frac{2Hd_a}{d_m}$$ **Equation B-2.2-7**

where the mixing zone depth is calculated as

$$d_m = \sqrt{\frac{2d_a D_{wp}}{kI}}$$ **Equation B-2.2-8**

It is important to note that the mixing zone is created by molecular diffusion only. Truex et al. (2009, 108331) also proposed an approach to compute the dilution factor of the vapor-phase contaminants into the regional aquifer taking into account diffusion of the contaminant in the vadose zone under steady-state conditions:

$$F_{dg} = \frac{C_{vz}^a}{C_{aq}^w} = \frac{2Hd_a\left[1+\frac{d_{vz}}{Hd_a D_{ap}}\sqrt{\frac{kId_a D_{wp}}{2}}\right]}{d_m}$$ **Equation B-2.2-9**

where d_{vz} is the vertical distance between the contaminant source and the regional water table (if the contaminant source is at the ground surface, it will be the thickness of the vadose zone), C_{vz}^a is the source concentration in the vadose zone. A steady-state condition is a conservative assumption for the expected values for diffusion coefficients (0.1–0.01 m^2/d), vadose-zone thickness (~280 m; the basalt section of the vadose zone is about 160 m), and available time for contaminant migration through the vadose zone (less than 35 yr). Equation B-2.2-9 takes into account the impact of the contaminant concentration at the water table on the diffusive flux occurring through the vadose zone. However, it does

not account for aquifer dispersion. If vertical dispersion causes the plume to exceed the aquifer thickness under consideration in this analysis, the dispersion will increase mixing in the regional aquifer. However, this is not expected to occur within the current range of aquifer thickness values considered (aquifer thickness greater than 3 m). On the other hand, dispersion may increase the vapor-phase contaminant flux since it will decrease the contaminant concentrations near the regional water table. As a result, it is not expected that the vertical dispersion will increase vertical mixing of contaminants in the regional aquifer.

The analysis presented above follows the methodology of Truex et al (2009, 108331), which is based on an assumption that the considered thickness of the regional aquifer (d_a above; U in Truex et al [2009, 108331]) is equal to the lateral length of the source area parallel to groundwater flow (L). However, this is not the case in the present analyses where the considered thickness of the regional aquifer is 3 m (~10 ft), representing the length of a typical monitoring screen in the regional aquifer beneath MDA L, and the source length is considered to be on the order of 30 m (based on spatial analyses of the observed concentrations presented in section B-3.1). As a result, Equation B-2.2-9 is modified accordingly:

$$F_{dg} = \frac{d_a}{L} \frac{2Hd_a\left[1+\frac{d_{vz}}{Hd_aD_{ap}}\sqrt{\frac{kId_aD_{wp}}{2}}\right]}{d_m} \qquad \textbf{Equation B-2.2-10}$$

Equations B-2.2-1 and B-2.2-10 are used to calculate the dilution factors for various VOCs at MDA L. The dilution factors are applied to compute SVs for each VOC representing the contaminant concentrations in the vapor phase at the source that produce concentrations in the regional aquifer equal to the groundwater SLs for both the pore water and the vapor-phase pathways. The SV is then chosen using the lower of the two values for a given VOC. Tier II specific SVs for MDA L are presented in Table B-2.1-1. If the currently observed contaminant concentration in the vapor phase is higher than the SV for a given VOC, this VOC fails the Tier II analysis, and it is a chemical of potential concern (COPC).

The Tier I analyses identified13 VOCs are COPCs (Tables B-2.1-1 and B-2.1-2). These 13 VOCs are analyzed using the Tier II methodology for the pore water and vapor migration (Table B-2.2-1). The table summarizes all the information about the regional aquifer, vadose zone, and contaminants applied in the Tier II analysis. It is important to note that “Equivalent contaminant concentration in the water phase in the vadose zone at the source” (Line 4 in Table B-2.2-1) reproduces the screening concentrations applied under the Tier I analyses. Based on the obtained SLs, eight chemicals are COPCs after the Tier II analysis: 1,2-dichloroethane; 1,1-dichloroethene; 1,2-dichloropropane; 1,4-dioxane; methylene chloride; PCE; TCA; and TCE, as shown in Tables B-2.1-2 and B-2.2-1.

B-2.3 Additional Data Analysis and Uncertainty Evaluation

For those VOCs that do not pass the Tier II screen, additional data analysis and uncertainty evaluation are warranted (Figure B-1.0-1). This is the last step in the analysis and helps determine if a corrective measure is warranted.

Additional data analysis may include determining the frequency of detection of the particular chemical (i.e., is the problem persistent?) and/or the number of ports where the contaminant concentration exceeds the SL (i.e., how large is the affected area?). Additionally, more thorough evaluation of the data to determine the extent of the vapor-phase plume (is it approaching the regional aquifer?) and of time trends (are concentrations increasing or decreasing?) may provide additional information on the potential for impacting the regional aquifer. These sorts of analyses are presented below in section B-3.0. Finally, data analyses using a calibrated numerical model of the vapor-phase plume can be employed to estimate potential plume growth and associated uncertainties. A three-dimensional (3-D) model for TCA is

presented in Appendix C, and that analysis includes uncertainty associated with the potential concentrations of TCA vapors approaching the water table with time. Some or all of these types of analyses might be performed depending on the vapor-plume characteristics.

B-3.0 CHARACTERISTICS OF THE SUBSURFACE VAPOR PLUME

This section investigates the characteristics of the VOC vapor plumes at MDA L. Seven VOCs were identified as having the potential to impact groundwater during the Tier II screen: 1,2-dichloroethane; 1,1-dichloroethene; 1,2-dichloropropane; methylene chloride; PCE; TCA; and TCE. These same constituents also had the highest reported SVs in a recent periodic monitoring report for vapor-sampling activities at MDA L (LANL 2010, 109955). According to the screening process (Figure B-1.0-1), additional data and uncertainty analysis for these constituents are warranted.

The data are interpreted using two methods. First, the current distributions of soil-vapor concentrations for the VOCs are assessed in section B-3.1. In addition, the current contaminant masses for TCA and TCE in the subsurface beneath MDA L are estimated based on the available field sampling. Defining both the distribution and the mass of VOCs is an important part of the design process for a soil-vapor extraction (SVE) system because these characteristics dictate the number and placement of extraction wells required to effectively capture the volatile contaminants, inform the proper placement of vapor-monitoring wells, and provide design criteria for an off-gas treatment system, if required.

Second, time-history concentration data for six of the seven VOCs that exceed their Tier II SVs are presented in section B-3.2 for several vapor-monitoring locations near the two shaft fields and in lower concentration areas: 1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; PCE; TCA; and TCE. The time histories illustrate the long-term nature near the source areas, the extent of plume growth, and concentration rebound following the 2006 SVE pilot test. Data available from 1997 to the most current sampling event are used. Dichloroethene(1,1-) has the lowest SVs of the seven VOCs identified, and during some sampling events its maximum concentration does not exceed the Tier I SV. Therefore, only its spatial distribution is considered in the discussion below.

B-3.1 DISTRIBUTIONS AND MASS ESTIMATES OF VOCS IN THE SUBSURFACE

This section presents estimates for the distributions of the contaminants from the Tier II screen and contaminant masses for TCA and TCE in the subsurface beneath MDA L. These estimates are calculated using soil-vapor data collected from vapor-monitoring wells shown in Figure 2.5-21 of the corrective measures evaluation (CME) and based on statistical averaging of four recent sampling quarters, which span the period from the third quarter FY2009 through second quarter of FY2010 (LANL 2010, 109955). VOC data for 85 ports in 24 pore-gas monitoring boreholes and 1 open borehole are used in the analyses (Table 2.5-10 of the CME).

The VOC mass calculations estimate the VOC mass included in soil vapor, dissolved into pore water, and adsorbed onto solid media, based on chemical partitioning as described in section B-3.1.1. The Tier II screening criteria were being developed concurrently with this data analysis and were unavailable. Multiples of the Tier I screening criteria (e.g., 10, 50, and 100 times the Tier I criteria) are used for many of the figures and in the discussion that follows.

The method estimates the TCE and TCA contaminant mass contained within area volume defined by 10 times the Tier I, vapor-phase concentration SV (Table B-2.1-1). The Tier I SV is the equivalent vapor

concentration that would be in equilibrium with a water concentration at the maximum contaminant level based on Henry's law partitioning. The SV comparison is described in detail in the periodic monitoring reports for vapor-sampling activities at the Laboratory (e.g., LANL 2010, 108496). The vapor concentrations that are equivalent to 10 times the screening limits are 423,000 µg/m^3 for TCA and 20,000 µg/m^3 for TCE (LANL 2010, 108496).

B-3.1.1 Mathematical Approach

VOCs present in subsurface media will be in pore gas as vapors, dissolved into pore water, and adsorbed onto solid media. Detected concentrations of VOCs in pore gas are orders of magnitude less than the vapor pressures of these chemicals, which is evidence that VOCs are not present as a separate, nonaqueous liquid phase. Several equilibrium partitioning constants describe the relationship between the concentrations of chemicals in these various phases. These constants can be used to develop an expression for the overall concentration of VOC in the bulk medium (i.e., tuff) as a function of the concentration in the vapor phase. Measured vapor-phase concentrations can then be used to calculate the bulk concentration in tuff, which can be used to estimate the overall mass of the inventory based on an assumed volume of affected media.

The first partitioning constant used is the Henry's law constant. The dimensionless form of Henry's law constant describes the equilibrium relationship between the volumetric concentrations of chemicals in air and in water, Equation B-2.1-1.

The second partitioning constant used is the distribution coefficient. The distribution coefficient describes the equilibrium relationship between the concentrations of chemicals dissolved in water and adsorbed on solids assuming a linear-sorption model:

$$K_d = C_{solid} / C_{water}$$

Equation B-3.1-1

where K_d = the distribution coefficient (L^3/M) and

C_{solid} = the mass concentration of contaminant in soil or tuff (M/M).

For organic chemicals, the adsorption of chemicals onto the solid phase is strongly influenced by the amount of organic carbon present in the solid. The distribution coefficient can be estimated from the organic carbon distribution coefficient and the fraction of organic carbon in tuff:

$$K_d = K_{oc} f_{oc}$$

Equation B-3.1-2

where K_{oc} is the organic carbon distribution coefficient (L^3/M) and

f_{oc} is the fraction of organic carbon in tuff (M/M).

Rearranging Equation B-3.1-1 and substituting Equation B-2.1-2 and Equation B-3.1-2 gives

$$C_{solid} = K_{oc} f_{oc} C_{air} / H$$

Equation B-3.1-3

The bulk concentration of chemical in tuff is equal to the total mass of chemical in all three phases per unit mass of tuff:

$$C_{bulk} = \frac{M_{air} + M_{water} + M_{solid}}{M_{soil}}$$

Equation B-3.1-4

where C_{bulk} = the bulk concentration of chemical in tuff (M/M),

M_{air} = the mass of chemical present in the vapor phase in pore gas (M),

M_{water} = the mass of chemical present in the liquid phase in pore water (M),

M_{solid} = the mass of chemical present in the solid phase in tuff (M), and

M_{soil} = the mass of the soil or tuff (M).

The mass of chemical present in the vapor phase in pore gas is equal to the product of the concentration in air and the volume of air. The latter is equal to the product of the volumetric air-filled porosity and the volume of tuff. The mass of contaminant present in the liquid phase in pore water is equal to the product of the concentration in water and the volume of water. The latter is equal to the product of the volumetric water-filled porosity and the volume of tuff. The mass of contaminant present in the solid phase in tuff is equal to the product of the concentration in the solid phase and the mass of tuff. The latter is equal to the product of the volume of tuff and the bulk density of tuff. Using the relationships described above, Equation B-3.1-4 can be rewritten as

$$C_{bulk} = \frac{\left(C_{air} V_{soil} \theta_{air}\right) + \left(C_{air} V_{soil} \theta_{water} / H\right) + \left(C_{air} K_{oc} f_{oc} V_{soil} \rho_{soil} / H\right)}{V_{soil} \rho_{soil}}$$

Equation B-3.1-5

where V_{soil} = the volume of tuff (L^3),

θ_{air} = the volumetric air-filled porosity (L^3/L^3),

θ_{water} = the volumetric water-filled porosity (L^3/L^3), and

ρ_{soil} = the bulk density of tuff (M/L^3).

Equation B-3.1-5 can be simplified to

$$C_{bulk} = \frac{C_{air}\left(\theta_{air} + \theta_{water}/H + \left(K_{oc} f_{oc} \rho_{soil}\right)/H\right)}{\rho_{soil}}$$

Equation B-3.1-6

Equation B-3.1-6 gives the bulk concentration of VOC in tuff as a function of the pore-gas concentration and properties of the chemical and tuff. The sources of the data used in Equation B-3.1-6 and any associated assumptions are described below.

- C_{air} – The pore-gas monitoring results provide the concentration of a particular VOC measured at each sampling point. In these examples, the concentrations of TCA and TCE measured during third quarter FY2009 through second quarter FY2010 vapor sampling at MDA L were used (LANL 2010, 109955).
- θ_{air} – The volumetric air-filled porosity depends on the total porosity and moisture content of the tuff ($\theta_{air} = porosity - \theta_{water}$), both of which vary depending on geologic unit and depth. The

porosity and volumetric moisture content used in this analysis are presented in Table B-3.1-1. These values were selected as being representative of tuff at MDA L (Hollis et al. 1997, 063131).

- θ_{water} – The volumetric water content varies depending on the physical properties of the geologic unit (Table B-3.1-1).
- H and K_{oc} – The Henry's law constant and organic carbon distribution coefficient are physical properties of the VOC and were obtained from the New Mexico Environment Department (NMED) soil screening level technical background document (NMED 2009, 106420). The values used for H' are 0.705 and 0.4 for TCA and TCE, respectively. The values used for K_{oc} are 48.6 and 107 L/kg for TCA and TCE, respectively.
- f_{oc} – The fraction of organic carbon depends on the amount of organic matter present in the tuff and varies depending on the amount of weathering and biological activity. A single value of 0.0005 (0.05%) was assumed to be representative of tuff in the subsurface beneath MDA L. This value is a factor of 3 less than the representative value for soil presented in NMED (2009, 106420) and reflects the lower organic content of tuff.
- ρ_{soil} – The bulk density depends on the total porosity of the tuff and the density of the solids composing the tuff and varies depending on geologic unit. Table B-3.1-1 lists the values used for MDA L (Hollis et al. 1997, 063131).

B-3.1.2 Methodology

Pore-gas concentrations were input into Equation B-3.1-6 to estimate the mass of TCA and TCE in the vadose zone beneath MDA L using the two approaches described in section B-3.1. The following steps and assumptions were used to calculate the estimates:

1. Analytical data (pore-gas samples collected with SUMMA canisters and analyzed at an analytical laboratory) contained on the data CD from a recent MDA L vapor PMR (LANL 2010, 109955) were used in the analysis. VOC data for 85 ports are used in the analyses (Table 2.5-10).
2. The analytical data were first averaged over four recent quarters of sampling (third quarter FY2009 to second quarter FY2010) and then interpolated to 3-D grids representing the current average 3-D subsurface vapor-phase distributions beneath MDA L. The 3-D analysis was performed using the EarthVision software package by Dynamic Graphics (2009). A series of manipulations was performed to examine the sensitivity of the estimated 3-D contaminant distributions to changes in data-selection criteria and data-analysis methods, such as the following:
    a. Different forms of data averaging
    b. Discrete treatment of incorporating nondetect (ND) values
    c. Different power function transformations of the data
    d. Changing grid resolution (horizontal and vertical) and vertical bias

    Data averaging and 3-D contaminant distributions were developed for six of the analytes.
3. The total mass estimates for TCA and TCE account for all three phases utilizing partitioning analysis methods and were calculated by utilizing the estimated 3-D contaminant plume distribution within the 3-D geologic framework model for MDA L as input to Equation B-3.1-6. Each 3-D plume was discretized into a series of concentration isosurfaces defined for each geologic zone. The intersections of these contaminant plumes with the two cylinders representing the estimated SVE capture zones were defined so that the potential quantity of contaminant mass

to be removed by SVE can be estimated for establishing remedial performance goals. The volumes of each contaminant concentration isosurface were assigned values for average contaminant concentration and the strata-specific physiogeochemical parameters that influence subsurface contaminant distributions and transport as listed in Table B-3.1-1, and the product of these unit-converted values was used to estimate the total mass of TCA and TCE in kilograms. Plume extent and contaminant mass estimates were based on the conservative 3-D distributions that best matched the measured field chemical data most representative of site conditions. The sensitivity results from approximately 160 spatial interpolation models for each analyte were used to quantify the uncertainty associated with the mass estimates for TCA and TCE.

B-3.1.3 Summary of Current VOC Distributions

This section includes several illustrations of the modeled 3-D vapor-plume distributions for TCA and TCE as well as the mass estimates derived from the combination of those distributions with the overlapping geologic framework. Plan-view maps that illustrate the lateral extents of TCA and TCE are presented in Figures B-3.1-1 and B-3.1-2, respectively. The concentration contours shown in the plan views define the maximum extents of the plumes within the Tshirege Member of the Bandelier Tuff, where the highest concentrations were detected, rather than showing the contours at a specific elevation or depth. Each map also illustrates the locations of three section lines used to produce orthogonal cross-sections through the VOC plume centers for viewing vertical extents of each plume. Figures B-3.1-3 and B-3.1-4 present the east-west cross-section through each plume while Figures B-3.1-5 and B-3.1-6 present the north-south cross-sections.

Figure B-3.1-1 shows two areas where elevated TCA concentrations exist; each area is proximal to a cluster of disposal shafts and defined by two to four vapor monitoring wells with maximum concentrations of approximately 50 times the Tier I SV of 42,300 µg/m^3. Figure B-3.1-2 shows a TCE distribution very similar to that of TCA, with maximum concentrations in excess of 250 times the Tier I SV of 2000 µg/m^3. The TCA and TCE plumes are collocated so any SVE remedial actions will effectively treat both contaminants with extraction wells optimally located within the plumes. Figures B-3.1-3 through B-3.1-6 show similar distributions of the two VOC plumes in cross-section. The TCA and TCE plume configurations take the form of an ellipsoidal shape with lateral extents being greater than vertical. The plumes are almost entirely contained within the Bandelier Tuff with the majority of the plume mass constrained to the Tshirege Member, which makes up the upper 250 ft of the Bandelier Tuff at MDA L.

Mass estimates were calculated for the current plume distributions depicted in Figures B-3.1-1 through B-3.1-6 and are presented in Table B-3.1-2. These estimates account for all three phases (pore gas, pore water, and adsorbed) and exclude regions where vapor-phase plumes were predicted to be less than 10 times the respective Tier I vapor-phase screening. The estimated subsurface VOC masses are 428 kg and 245 kg for TCA and TCE, respectively, within 10 times the Tier I concentrations (Table B-2.1-1). The overall mass of TCA is approximately twice that determined for TCE. The distribution of contaminant mass within each of the geologic units indicates that approximately 80% of the mass for each contaminant is within the Tshirege Member of the Bandelier Tuff.

Table B-3.1-2 shows the breakdown of the TCA and TCE masses within the different phases of the vadose zone. The information is also given in percentages of the total mass. This information indicates that the mass distribution within the Tshirege units is dominantly present in the vapor phase, 80% for TCA and 65% for TCE, because these units are very dry (Table B-3.1-1). A greater percentage of TCE partitions into the pore water because its Henry's law constant is higher than TCA's (Table B-2.1-1). The 10-times contour for TCE extends below the Tshirege units into Qct, Qbof, and Qbog (Figure B-3.1-6). These units have higher moisture content than the Tshirege units (Table B-3.1-1), and consequently, a

greater percentage of the TCE mass is present in pore water in these lower units (42%) than within the Tshirege (19%). In these lower units, the TCE mass partitions almost equally between the vapor and water phases. The 10-times contour for TCA does not extend below the Tshirege units into Qct, Qbof, and Qbog (Figure B-3.1-5). Therefore, very little mass is calculated for TCA in these lower units simply because the concentrations are less than the 423,000 µg/m^3 value that is equivalent to 10 times the Tier I SV contour. If the masses of TCA and TCE are estimated within their respective Tier I screening concentrations (rather than within 10 times that value), greater masses of TCA (68 kg with 33% in the pore water) and TCE (31 kg with 40% in the pore water) are calculated for the units below the Tshirege units. This information illustrates that in wetter strata pore water can have a significant storage capacity for VOCs even for volatile constituents such as TCA and TCE.

A detailed analysis of the sensitivity of the 3-D gridding process to a number of factors was performed to determine the most representative 3-D plume distributions for plume illustrations and contaminant mass estimates as well as to determine the uncertainty associated with them. The analysis of 160 interpolation models for each VOC resulted in an uncertainty of ±15% for VOC mass estimates. 93% of TCA estimates and 99% of TCE estimates were within 15% of the values reported in Table B-3.1-2. The majority of VOC mass estimates from the sensitivity analysis were lower than those reported in Table B-3.1-2 because of the relatively conservative parameters used for the final interpolation model.

Figure B-3.1-7 provides a map view of the overlapping plume extents for six VOCs (1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; PCE; TCA; and TCE) based on a contour interval of 100 times the respective Tier I SV for each compound, except for TCA. For TCA, a contour interval of 50 times its Tier I SV is plotted because its highest SV does not exceed 100. Figure B-3.1-8 shows a corresponding cross-sectional view the same information. The data illustrate that the eastern shaft field has higher maximum concentrations for 1,2-dichloropropane, methylene chloride, and TCA; 1,2-dichloroethane and TCE are centered about both shafts fields. PCE is present near the western shaft field, but its highest concentration is south of Impoundment D. In addition to the plume configurations, two radii of influence (ROIs) of 100 and 150 ft are illustrated to show the potential zone that might be swept using SVE at the available extraction boreholes. The figures illustrate that the existing SVE boreholes are well placed to affect the highest concentration areas for five of the six constituents. The gray area in Figure B-3.1-7 is a combined target area that ideally would be remediated to affect the contour intervals presented in the figure, the 50 and 100 Tier I SV cutoffs discussed above. This area is approximately 3.6 acres. The two existing extraction boreholes, even assuming 150-ft ROIs, do not sufficiently cover this combined target area. Therefore, additional extraction wells are recommended if SVE is chosen as a remedial alternative for this site. One of these could be located near the pits to affect the PCE plume.

Dichloroethene(1,1-) was identified in the Tier II screen but was not included in Figures B-3.1-7 and B-3.1-8. Concentration data for 1,1-dichloroethene for the second quarter FY2010 were reviewed (LANL 2010, 109955). Those data show this constituent is also centered near the eastern shaft field with the highest concentrations observed at monitoring wells 54-27642, 54-02089, and 54-24238.

Multipliers of the respective Tier I SVs are used as the contour levels illustrated in the plots in Figures B-3.1-1 through B-3.1-8 and for the mass balance provided in Table B-3.1-2. For example, in Figures B-3.1-3 and B-3.1-4, the interpolated 10-times contour interval (20,000 µg/m^3) for TCE extends into the basalt (although no vapor data are available that show concentrations exceeding 2000 µg/m^3 in the basalt), whereas the 10-times contour (423,000 µg/m^3) for TCA terminates approximately 150 ft higher in the Cerro Toledo interval. Using these contour levels allows for the relative comparison of the extents of the different VOCs in terms of their potential groundwater risk. From the figures, the conclusion can be made that TCE has a greater potential to exceed groundwater standards than does TCA because

TCE's 10-times SV contour extends deeper. However, this does not mean that TCE vapor concentrations exceed TCA vapor concentrations at a given location.

Figure B-3.1-9 illustrates the same data for TCA and TCE provided in Figures B-3.1-3 and B-3.1-4, but the data are illustrated in terms of absolute vapor concentrations (exceeding 2000 $\mu g/m^3$) rather than in terms of multiples of the respective Tier I SVs. In addition, the depth to groundwater is included. These figures show that the maximum TCA concentrations near the shafts exceed the maximum TCE concentrations, the TCA and TCE plumes have similar shapes, and the interpolated leading edge of both plumes extends into the basalt (Tb 4). In fact, regression analysis shows a linear relationship between the TCA and TCE concentrations near the bottom of the plume. For example, for those vapor concentrations measured in the Otowi Member (Qbof) and deeper, the TCE concentrations are 45% of the TCA concentrations (Figure B-3.1-10). This indicates that the two VOCs likely transport similarly within the vadose zone, as would be expected because of their similar vapor diffusion coefficients (0.562 and 0.596 m^2/d, Table B-2.2-1), although the TCE has a greater propensity to partition into pore water, as discussed above (Table B-3.1-2).

B-3.2 Time-History Analyses of Soil-Vapor Concentrations

Time-history soil-vapor concentration data for six VOCs identified during the Tier II screen (TCA; 1,2-dichloroethane; TCE; 1,2-dichloropropane; methylene chloride; and PCE,) are presented for six vapor-monitoring locations. Data from a subset of the monitoring wells are used to qualitatively evaluate trends. To examine behavior near the western shaft field, data from three vapor-monitoring wells are presented: 54-02001 (located just west of the western shafts), 54-02022 (located about 150 ft west of the shafts), and 54-02034 (located about 300 ft northwest of the shafts) (see Figure 2.5-21 of the CME). To examine behavior near Pit A, the impoundments, and the eastern shaft field, data from three vapor-monitoring wells are presented: 54-24239 (located just south of Impoundment B), 54-02089 (located next to the shafts), and 54-02002 (located about 50 ft south of the shafts). These six wells were selected because data from several ports are available. The same period of record is not available for all of these wells. The data are presented in units of ppbv because the earlier records in the database use only those units while the later data are presented in both ppbv and $\mu g/m^3$. Figures B-3.2-1 through B-3.2-6 show time history plots for these six locations and for the six VOCs. Table B-3.2-1 describes the trends observed at these locations for each of the VOCs. The text below summarizes the main observations made for the western and eastern portions of MDA L. An SVE pilot test that used one eastern and one western extraction well was conducted at MDA L during the summer of 2006 (see section 2.5.3 of the CME). The effects of the SVE test on concentrations are assessed as part of this analysis. Data are available from before and after the 2006 SVE test at the six vapor-monitoring wells used for this analysis; the period of record for most of the monitoring wells does not extend to before the SVE test.

B-3.2.1 Western Shaft Field

Figures B-3.2-1, B-3.2-2, and B-3.2-3 show the soil-vapor concentration time histories for the six VOCs at vapor-monitoring wells 54-02001, 54-02022, and 54-02034, respectively, and Table B-3.2-1 describes the concentration trends with time. Data from 54-24240, 54-02012, and 54-02021 also support this discussion. The most important observations that can be made from these data are as follows.

- The 2006 SVE test reduced vapor concentrations of four of six VOCs near the western shaft field at wells 54-02001, 54-24240, and 54-02012, and 150 ft from the shafts at well 54-02022 to near-steady, lower values: 1,2-dichloroethane; 1,2-dichloropropane; TCA; and TCE. At these same locations, SVE lowered the concentrations of methylene chloride, and these concentrations

continue to decline. It does not appear that SVE impacted the concentrations of PCE, which may be increasing at these locations.

- Approximately 300 ft northwest of the western shafts, at well 54-02034, SVE had little to no effect on vapor concentrations. Concentrations of 1,2-dichloroethane; TCA; TCE; and PCE are rising at this location, indicating that the vapor plume is expanding in this low-concentration area at the western edge of the plume. At these same locations, methylene chloride concentrations are declining.
- The western shaft field appears to be a continuing source for four VOCs: 1,2-dichloroethane; 1,2-dichloropropane; TCA; and TCE. Based on its declining concentration at the western wells, the shafts may or may not be a continuing source of methylene chloride. PCE may have a different source from the other five VOCs.

B-3.2.2 Eastern Shaft Field and Impoundment Area

Figures B-3.2-4, B-3.2-5, and B-3.2-6 show the soil-vapor concentration time histories for the six VOCs at vapor-monitoring wells 54-24239, 54-02089, and 54-02002, respectively, and Table B-3.2-1 describes the trends. Data from 54-24241, 54-24242, 54-02023, and 54-02023 also support this discussion. The most important observations that can be made from these data are as follows.

- Soil-vapor concentrations of 5 of 6 VOCs near the impoundments at well 54-24239 decreased after a lag time following the 2006 SVE test. PCE concentrations are highest in this area and did not obviously respond to SVE; it appears that the impoundment area is a source of PCE. Except for PCE, VOC concentrations near the impoundments are lower than near either of the shaft fields.
- Concentrations of TCA, TCE, methylene chloride, and PCE near the eastern shaft field at well 54-02089 were declining before the SVE test, which indicates the eastern shaft field is less of a source than it has been previously. However, TCA, TCE, and 1,2-dichloropropane concentrations in this area remain higher than near the western shaft field or near the impoundments; the eastern shafts are a continuing source of these constituents.
- The 2006 SVE test reduced vapor concentrations somewhat near the shafts at 54-02089, but the effect is not as evident as at 54-02002, which is located approximately 50 ft south of the eastern shaft field. SVE has not impacted the concentrations of PCE as strongly as for other constituents; this may be because its source is not collocated with the source of the other VOCs.
- Soil-vapor concentrations of 1,2-dichloroethane have risen sharply at 54-02089 following the SVE test. This monitoring well is located very close to the vapor-extraction well. Aerobic degradation of a precursor VOC was suspected as a possible source for the formation of 1,2-dichloroethane at this location, but no reactions of this sort were identified during a literature review. In addition, this behavior was only observed at this one well. The nature of this source is uncertain, but the well will continue to be monitored.
- Soil vapor concentrations of methylene chloride decreased following SVE at all locations within the eastern portion of MDA L. Its concentration has dropped to nondetect values near the eastern shafts and the impoundments.
- Soil vapor concentrations for TCA and TCE decreased after a lag time following the 2006 SVE test at monitoring wells 54-02023 (located approximately 300 ft south of the eastern extraction well) and 54-02026 (located approximately 550 ft southeast of the extraction well). This may be

the result of declining concentrations of these constituents even before the SVE test was conducted. At the eastern extent of the vapor plume, the plume appears to be contracting.

- The 1,1-dichloroethene plume is centered near the eastern shaft field; no time series analysis was done to evaluate the effectiveness of SVE on this constituent. However, its relatively high Henry's law constant value (Table B-2.1-1) indicates that SVE should successfully remove this VOC.

B-3.3 Dioxane(1,4-)

Dioxane(1,4-) was identified by the Tier I and Tier II screening because it had an elevated vapor-phase concentration during second quarter FY2010 monitoring (LANL 2010, 109955). Further data analysis showed that 1,4-dioxane has had an extremely low frequency of detection of only 9 times out of 3227 vapor-phase samples at MDA L, so its identification as a vapor-phase VOC is not supported. However, this constituent is commonly used as a stabilizer for TCA, and it may be present in waste at MDA L. When present, it migrates in pore water rather than as a vapor-phase contaminant because of its low volatility. Dioxane(1,4-) is a conservative contaminant that is not expected to react with the subsurface materials. Therefore, if pore water migration through the vadose zone to the regional aquifer occurs, 1,4-dioxane may be a good indicator for this contaminant flow path. Analysis of groundwater data from regional wells near MDA L presented in Appendix D does not indicate the current presence of 1,4-dioxane.

B-3.4 Summary of VOC Soil-Vapor Plume Characteristics

Based on the current distributions and the time history information compiled in this appendix, the characteristics of the MDA L vapor plume are summarized below:

The eastern and western shaft fields act as ongoing sources of VOCs in the subsurface, with maximum concentrations generally occurring near the eastern shafts. TCA and TCE are the primary constituents of the VOC plume. The source of VOCs at the eastern shafts appears to be declining naturally. The data do not support that the source at the western shafts is declining. Most of the VOCs present at MDA L are located within the upper 200 ft within the Tshirege Member of the Bandelier Tuff and are accessible to SVE. Some expansion of the plume is occurring near its western edge, but the plume appears to be contracting on its eastern edge. This contraction may be in response to a decreasing source at the eastern shafts.

The 2006 SVE test had long-term impacts on soil-vapor concentrations at MDA L. Concentrations of 1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; TCA; and TCE all decreased in response to the SVE test, and at most locations the decrease was long-term (into 2010).

The primary PCE source appears to be located near the impoundments. Because it is not collocated with the other VOCs, and its primary source was not located near the two SVE boreholes, the SVE test had less impact on PCE concentrations than on those of the other constituents.

B-4.0 ANALYSIS OF POTENTIAL VAPOR DIFFUSION TO GROUNDWATER

The groundwater analysis presented in Appendix D shows that VOCs have been detected in low concentration in the regional aquifer in groundwater monitoring wells in the vicinity of MDA L. These wells include R-20, R-54, R-53, R-56, R-21, and R-32. Compounds detected in the groundwater (section D-3.0) that are also present in the MDA L plume based on the MDA L second quarter FY2010 periodic

monitoring report (LANL 2010, 109955) include acetone; benzene; 2-butanone; 1,4-dioxane; ethylbenzene; toluene; 1,1,2-TCA; TCE; 1,2,4-trimethylbenzene; 1,2-xylene and 1,3-xylene+1,4-xylene (see Table D-3.0-3). Given the low concentrations and sporadic nature of detections, the source of these compounds is uncertain. Possibilities include sample contamination at the analytical laboratory, the well-construction materials, well drilling and development fluids, the vapor-phase plume beneath MDA L, or other contaminant sources within the Pajarito Canyon watershed. The number of VOCs detected in the groundwater is a fraction of the number of compounds that exist in the vapor plume. Additionally, the dominant compound in the plume is TCA, which has been used to define the extent of the plume (Stauffer et al. 2005, 090537), and this compound has not been detected in the regional aquifer. Thus, the objective of this analysis is to evaluate whether VOC vapor transport from the vapor plume located in the vadose zone beneath MDA L could result in the type and spatial pattern of VOC detections observed in regional aquifer wells near MDA L. Simply stated, this analysis evaluates the likelihood of those VOCs observed in the groundwater to be present in the absence of other VOCs in the vapor plume, such as TCA.

Analytical Approach

To test this hypothesis, a simple one-dimensional diffusion analytical model was applied (Figure B-4.0-1). The migration is assumed to occur in an unbounded domain (i.e., the regional water table and ground surface are not considered to be boundaries that affect contaminant migration). Diffusion from the source is calculated in one direction using the following solution to Fick's second law (Cumbie and McKay 1999, 110700):

$$C(x,t) = C_o \, \mathrm{erfc}[x/(2(Dt)^{0.5})] \qquad \textbf{Equation B-4.0-1}$$

Where C(x,t) is the calculated concentration of a given VOC in the x-direction at time (t) in μg/m^3, C_o is the source concentration of the VOC, x is the distance from the source in meters (vertical distance in this case), D is the diffusion coefficient [m^2/s], t is time [s], and erfc is the complementary error function. The diffusion coefficient depends on the molecular weight of a chemical with lighter chemicals having higher diffusion coefficients. Therefore, constituents in a plume might segregate as a plume diffuses, resulting in lighter molecules migrating further (fractionation of compounds during transport). This solution to Fick's law assumes infinite domain (no boundary conditions), which is a simplification of the subsurface conditions at MDA L.

The MDA L source (C_o) was defined based on the maximum detected pore gas concentrations for each vapor-phase compound between the third quarter FY2009 and the second quarter FY2010 as reported in the second quarter FY2010 MDA L periodic monitoring report (LANL 2010, 109955). For this analysis, this source is assumed to exist at a disposal depth of 18 m (~60 ft) below ground surface (bgs) (Figure B-4.0-1), near the bottom of the disposal shafts. Although not all maximum concentrations are collocated, most are near the bottom of the shafts. These VOCs are assumed to diffuse in the vapor phase in the vertical direction toward the regional aquifer beneath MDA L at a depth of ~283 m bgs. Stauffer et al. (2005, 090537) simulated the diffusion of TCA from 1975 to 2000 and calibrated the model to the measured TCA plume at MDA L. An effective vapor diffusion coefficient for TCA was calculated for each member of the Bandelier Tuff and for the Cerros del Rio basalt. An effective diffusion coefficient (D_{eff}) is related to the diffusion coefficient in air (D_{air}) by the following relationship:

$$D_{eff} = D_{air}\omega \qquad \textbf{Equation B-4.0-2}$$

where ω is an empirical coefficient accounting for media-specific conditions such as the tortuosity of the flow path (Fetter 1994, 070942). To evaluate diffusion of other compounds from MDA L, it was necessary to estimate D_{eff} for the other VOCs. This correction was applied only for the Bandelier Tuff. (Diffusion

through the basalt is treated differently as explained below.) The diffusion coefficient for TCA computed for each unit of the Bandelier Tuff (Stauffer et al. 2005, 090537) was used to develop a correction factor to the air diffusion coefficient, and this correction factor was applied to each compound (x) according to Equation B-4.0-3 (Table B-4.0-1).

$$D_{eff,x} = D_{eff,TCA}(D_{air,x}/D_{air,TCA})$$ **Equation B-4.0-3**

For this analysis, the Bandelier Tuff was considered to be one homogenous unit. Thus, the correction factor used is a weighted average of the contribution from each unit. Because the basalt is highly heterogeneous, including high-permeability fractures, breccias, and cinder zones, the diffusion coefficient in air was used to represent unimpeded diffusion through the basalt.

In addition to pore space properties such as tortuosity, moisture content also impacts diffusion. This analysis does not account for liquid-phase partitioning in the vadose zone that may retard the vapor transport of some compounds. This retardation will lower the predicted concentration at the water table, and it will also impact the fractionation between compounds with dissimilar Henry's law constants (Table B-4.0-1). In this analysis, omitting this phenomenon is conservative for the majority of the compounds detected in the groundwater because they have lower Henry's law constants than TCA. Thus, compared with TCA, they should be retarded to a greater extent by liquid-phase partitioning during transport resulting in lower concentration ratios compared with TCA at the water table than predicted here. This phenomenon is demonstrated through a comparison of TCA and TCE mass partitioning into pore water presented in section B-3.1.

An additional variable in Equation B-4.0-1 is time. Since the maximum concentration of each VOC detected during the third quarter FY2009 to second quarter FY2010 is used to define a source term, it is unrealistic to assume this concentration has remained constant for the last 35 yr (when disposal operations began). Thus, an assumption was made to calibrate the time component of the equation based on current vapor concentrations. The time was calibrated using the current source concentrations near the shafts and the current maximum concentrations observed near the tuff-basalt interface between the third quarter FY2009 and second quarter FY2010 for TCA and TCE. Implicit in this definition of the source term is the simplifying assumption that the ratios between compounds have been constant with time. The computational time that best matches the measured concentrations is 10.5 yr. In this case, the computational time (10.5 yr) defines the time period since a contaminant source with concentrations equal to the current contaminant concentrations has existed in the vadose zone (concentrations at t = 0 are zero in the vadose zone except at the source). The same time period (10.5 yr) also defined the time for which contaminants migrate to the regional aquifer. Since the applied model is one-dimensional (the actual gas diffusion occurs in three dimensions), the time period represents a parameter that has a predominantly computational purpose (i.e., to provide a match between observed and calculated concentrations).

The model places the source term at 18-m bgs (near the bottom of the shafts) and calculates its diffusion to the basalt interface (~118-m bgs) using the tuff-specific diffusion coefficients. Then the calculated interface concentration is used to calculate diffusion through the basalt to the regional aquifer depth (~283 m bgs) using contaminant-specific air diffusion coefficients. Thus, the model is run in two stages; both stages are run for 10.5 yr. The pore-gas concentration at the groundwater is then assumed to equilibrate with a very small volume of groundwater resulting in a concentration in water based on Henry's law (Table B-4.0-1):

$$C_{aq} = C_{air}/ K_H$$ **Equation B-4.0-4**

where C_{aq} is the concentration in water, C_{air} is the concentration in pore gas and K_H is the dimensionless Henry's law constant. Calculating the concentration at the tuff-basalt interface and restarting the analysis for the basalt does not maintain a continuity of mass flux at the interface and overestimates the concentration at the regional water table. With this model solution (a simple spreadsheet model), this is the only way to apply different diffusion coefficients to the tuff and basalt portions of the pathway. For comparison, vapor diffusion was also calculated applying air diffusion coefficients for all geologic units (Figure B-4.0-1), resulting in slightly higher concentrations at the water table. Fractionation between compounds was not significantly changed. Assuming air diffusion coefficients is a bounding case for this analysis (in terms of the calculated regional aquifer concentration) and because the two-stage model does not exceed this calculation, it is not considered overly conservative or unrealistic.

Results and Discussion for Vapor Diffusion Calculation

Table B-4.0-1 summarizes the results of the calculations, including the calculated pore-gas concentration just above the regional aquifer and the resulting equilibrium groundwater concentration. The method detection limit (MDL) in groundwater is also provided. The purpose of the calculation is to test whether diffusive transport from the MDA L VOC plume could result in the observed groundwater concentrations for the 11 analytes of interest (acetone; benzene; 2-butanone; 1,4-dioxane; ethylbenzene; toluene; 1,1,2-TCA; TCE; 1,2,4-trimethylbenzene; 1,2-xylene and 1,3-xylene +1,4-xylene) that have been detected in the regional aquifer monitoring wells near MDA L. Additionally, if these compounds are detected, should others found in the plume also be detected? The absolute concentration reported in Table B-4.0-1 is for comparison purposes only; however, it is important to note that the predicted concentrations with this approach are near or below detectable levels for the major plume constituents. More significantly, the analysis shows that if any of these 11 compounds are present in groundwater, numerous others should also be present at detectable concentrations. Figure B-4.0-1 illustrates this graphically. Xylenes and TCE are detected in R-20. Assuming vertical diffusive transport from MDA L to the aquifer, xylene and TCE should not be present without detectable concentrations of TCA. This statement should also hold even if air-phase dispersion accounts for enhanced vapor transport in the basalt. The simple analysis does not account for all potential uncertainties such as source disposal and release, partitioning into pore water, potential liquid-phase transport in the basalt, 3-D vadose-zone transport, or transport within the regional aquifer.

Uncertainty Related to Processes Other Than Diffusion

Enhanced advective transport from air flow in the basalt may occur, and this process could enhance both lateral and vertical spreading within the basalt beyond that calculated in this analysis. The air diffusion coefficients are used for the basalt, in part to capture this enhanced spreading. However, depending on velocities through the basalt, advective movement of vapor-phase constituents may be a significantly faster process for distribution of VOCs in the subsurface than diffusion, and the process may drive more rapid transport than calculated with the diffusion model. However, although this is a potentially important mechanism, advective transport should not cause additional partitioning of the different vapor-phase constituents along the transport pathways and therefore should not be a mechanism that causes constituents with lower vapor-phase concentrations to be detected in the aquifer without the higher concentration constituents, such as TCA, to be present.

In contrast, if the vapor plume encounters perched water in the basalt, there is a possibility that VOCs could move toward groundwater in the liquid phase. In this instance, preferential transport of TCE and xylenes relative to TCA could occur because of their greater solubility in water (lower Henry's law constants). However, the ratio of concentrations in the water phase would be controlled by the ratio in the vapor phase, and TCA concentrations should still exceed those of TCE and xylenes based on current

vapor-phase concentrations (Figures B-3.1-9 and B-3.1-10). No perched water was observed in the basalt while drilling the regional wells closest to MDA L, but perched water is present at the western end of Technical Area 54 (TA-54) at wells R-40, R-51 and R-52. This transport process is feasible at TA-54.

Uncertainty Related to VOC Disposal and Release

The diffusion calculation presented here uses current vapor-phase concentrations (maximum concentrations near the shafts and maximum concentrations at the tuff/basalt interface) to predict constituents and concentrations that might be observed in the regional aquifer. However, if VOCs have migrated to the regional aquifer from MDA L, current groundwater concentrations would be related to previous conditions in the vapor plume. Therefore, the analysis assumes that the ratios of constituent vapor concentrations have remained constant. This assumption may not be strictly valid.

Uncertainty Related to Well Location

The model calculates vapor transport in one direction, vertically from beneath MDA L to the groundwater. The closest wells (R-53 and R-56) are several hundred meters off this vertical axis, resulting in either (1) a larger distance to the regional water table or (2) longer travel time in the regional aquifer. The ratio between compounds will change from those presented here with changing transport distance. Given the combination of differences in diffusion coefficients and groundwater solubility, it is possible to fractionate compounds as transport distance increases such that lesser plume constituents (e.g., acetone) are enriched compared to more dominant compounds (e.g., TCA). However, this scenario is not supported by the model presented here.

Groundwater from regional well R-20 has had the most detections of VOCs out of the wells considered. Most of the constituents are thought to be from analytical laboratory contamination, from well drilling or construction materials, or from other downhole materials. However, TCE and xylenes have been detected, and these compounds are present in the MDA L plume. Concentrations of TCE and 1,3-xylene +1,4-xylene are similar at R-20 (Figure D-3.0-1), but TCE is found in much higher concentrations than xylenes in the vapor plume (Table B-4.0-1). R-20 is located in Pajarito Canyon over half a kilometer west of MDA L. Given the distance and location of R-20, it is inconsistent with the conceptual model tested here for vapor-phase contaminants derived from MDA L to be present in concentrations greater than at more proximal wells to MDA L.

Uncertainty Related to Well Screen Location

The analysis here assumes that vapors that reach the top of the aquifer equilibrate with the groundwater, resulting in a concentration based on solubility of the compound (Henry's law partitioning). The analysis does not consider dilution in the groundwater. The well screens are not located directly at the static groundwater table of the regional aquifer but several to tens of feet below this depth. Thus, significant dilution is anticipated for any compound entering the groundwater from the vapor phase during transport to a well screen location. Estimates of aquifer dilution are discussed in section B-2.0.

B-5.0 RESULTS

This appendix presents a two-tiered, risk-based screening approach to identify VOCs that could potentially impact the regional aquifer (Figure B-1.0-1). The screening approach is demonstrated using recently reported soil-vapor monitoring data from MDA L. As part of this screen, 13 VOC COPCs were identified using the Tier I screen; 7 VOC COPCs and 1,4-dioxane were identified from applying the Tier II

screen. Also, MDA L–specific Tier II SVs for soil-vapor concentrations were developed to use in future comparison of soil-vapor data.

Further data analysis was performed on contaminant concentration data for the seven VOCs identified during the Tier II screen, including spatial and temporal analyses. The analysis shows that the shaft fields at MDA L act as a continuing source of VOCs to the subsurface, and that SVE is a viable remediation option for cleaning up 1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; TCA; and TCE. PCE was less impacted by SVE, possibly because its source was not located near the extraction boreholes. If SVE is chosen as an alternative, an extraction well near the shafts may be required to decrease PCE concentrations. If the shafts continue as a vapor VOC source, additional plume growth may occur. This remains an uncertainty.

The analysis of existing groundwater monitoring data (Appendix D) and the vapor-transport model presented in this appendix (section B-4) suggest a low probability that the VOCs detected in the regional aquifer in the vicinity of MDA L are from vapor-phase transport from the MDA L VOC vapor plume under the assumption that the current soil-vapor-phase contaminant concentrations are representative of the source contaminant concentrations in the past. The analysis indicates that if the VOCs detected in the groundwater are associated with MDA L, then detectable concentrations of TCA, TCE, and numerous other compounds found in the MDA L plume should also be present. There are uncertainties related to this simple analysis.

B-6.0 REFERENCES

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

Copies of the master reference set are maintained at the 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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Tier I Screening

Use the existing Henry's Law calculation for an initial screen. If contaminant exceeds the Tier I Screen, then carry forward to the Tier II Evaluation. If contaminant does not exceed the Tier I Screen then there is no risk to groundwater and no problem warranting action.

Tier II Evaluation

Use a calculation for vapor-phase transport to the regional aquifer that takes into account unit-specific parameters. Contaminants that exceed the Tier II Evaluation are subjected to additional data analysis and uncertainty evaluation. Contaminants that do not exceed the Tier II Evaluation require no further action.

Additional Data Analysis and Uncertainty Evaluation

Additional data analysis and the uncertainty evaluation may include 3-dimensional modeling, frequency of detection, etc., and is used to support the remedial decision, as warranted.

Pore Gas Decision Analysis Flow-Chart

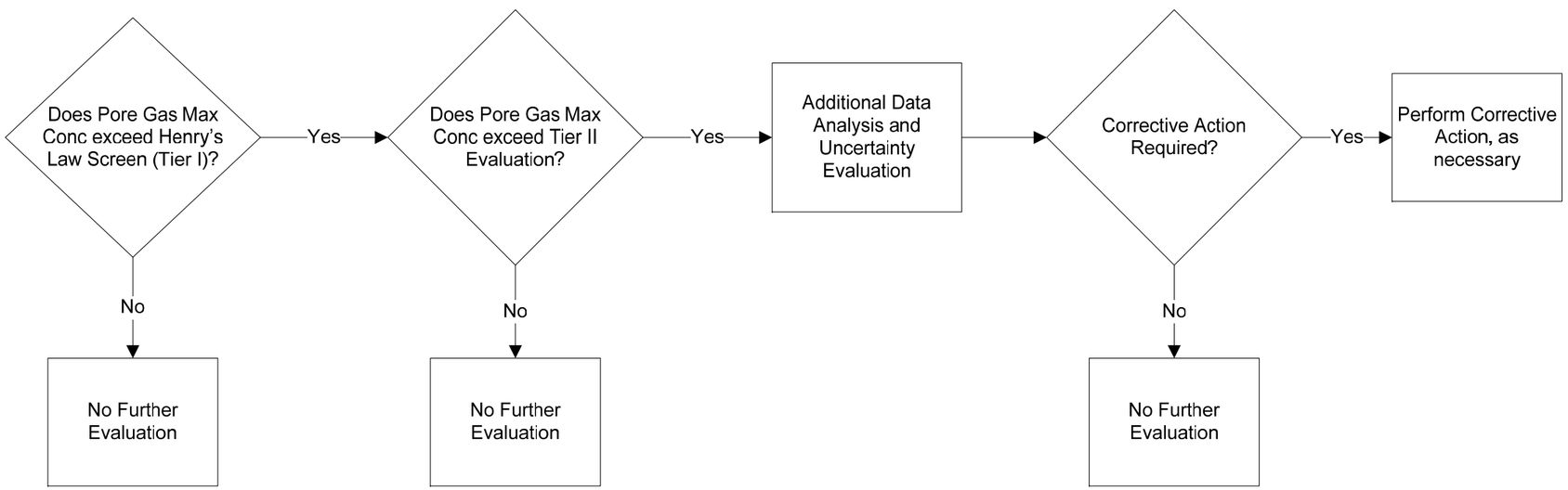
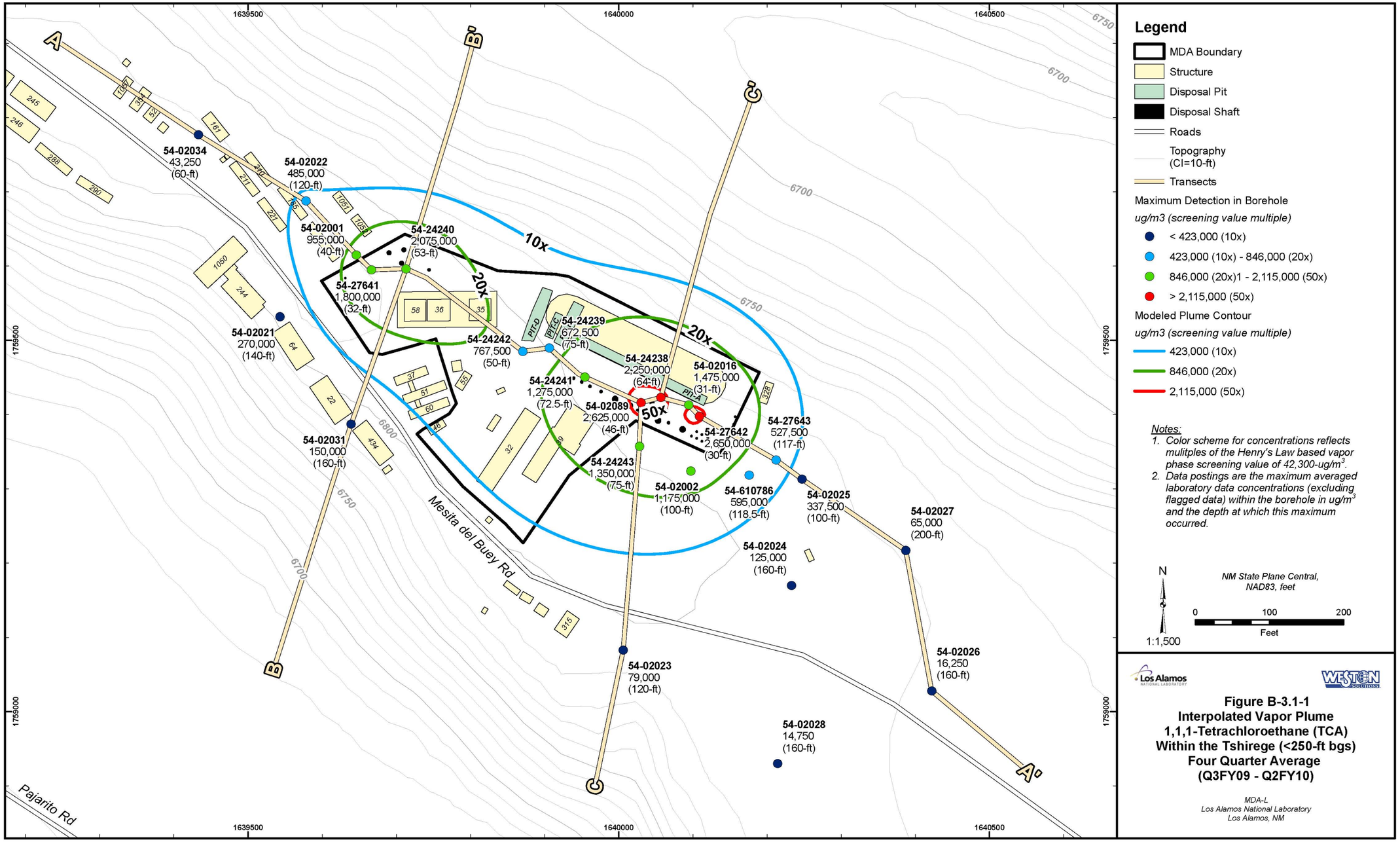
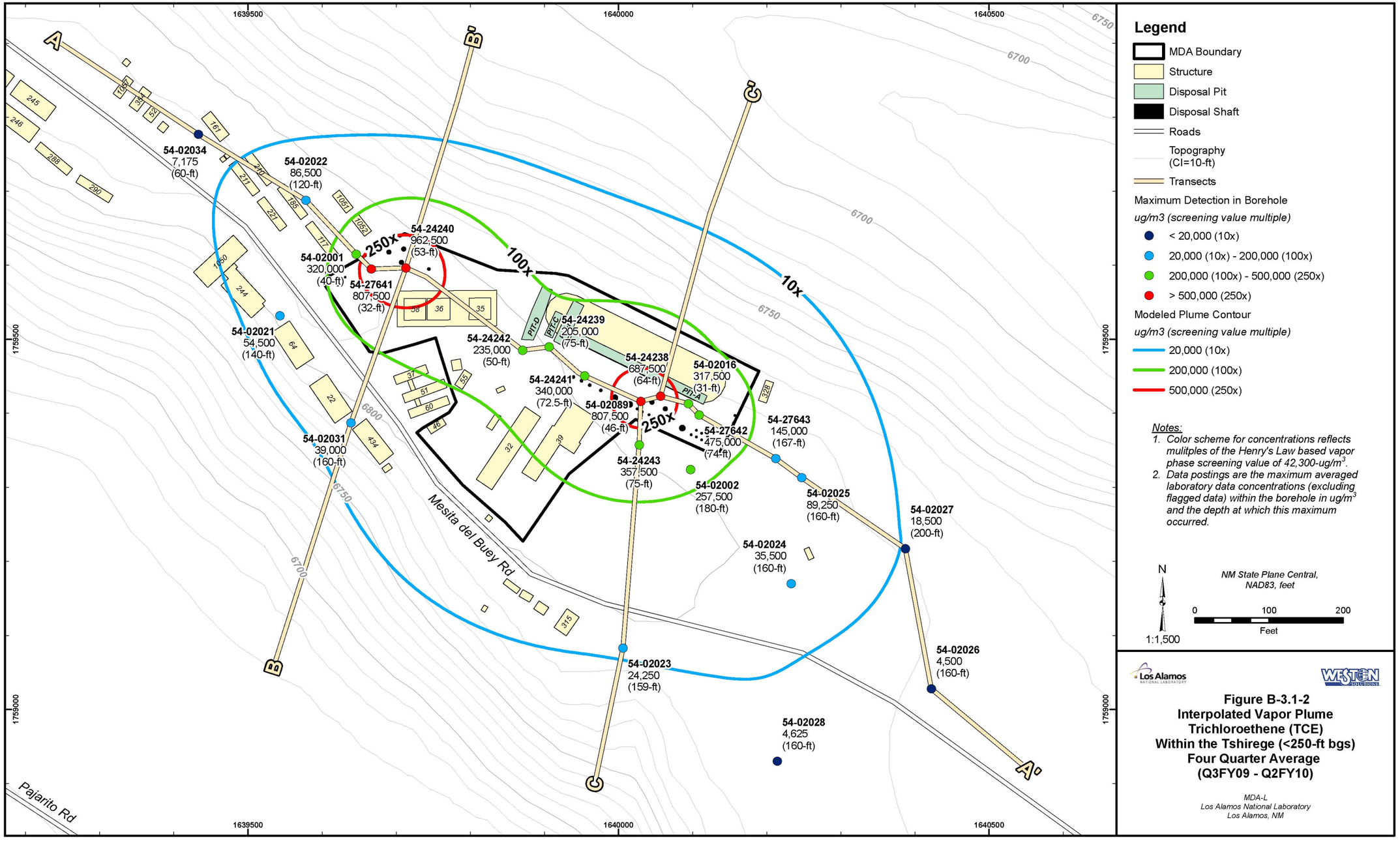


Figure B-1.0-1 Two-tiered screening method to identify vapor-phase VOCs that could potentially affect groundwater



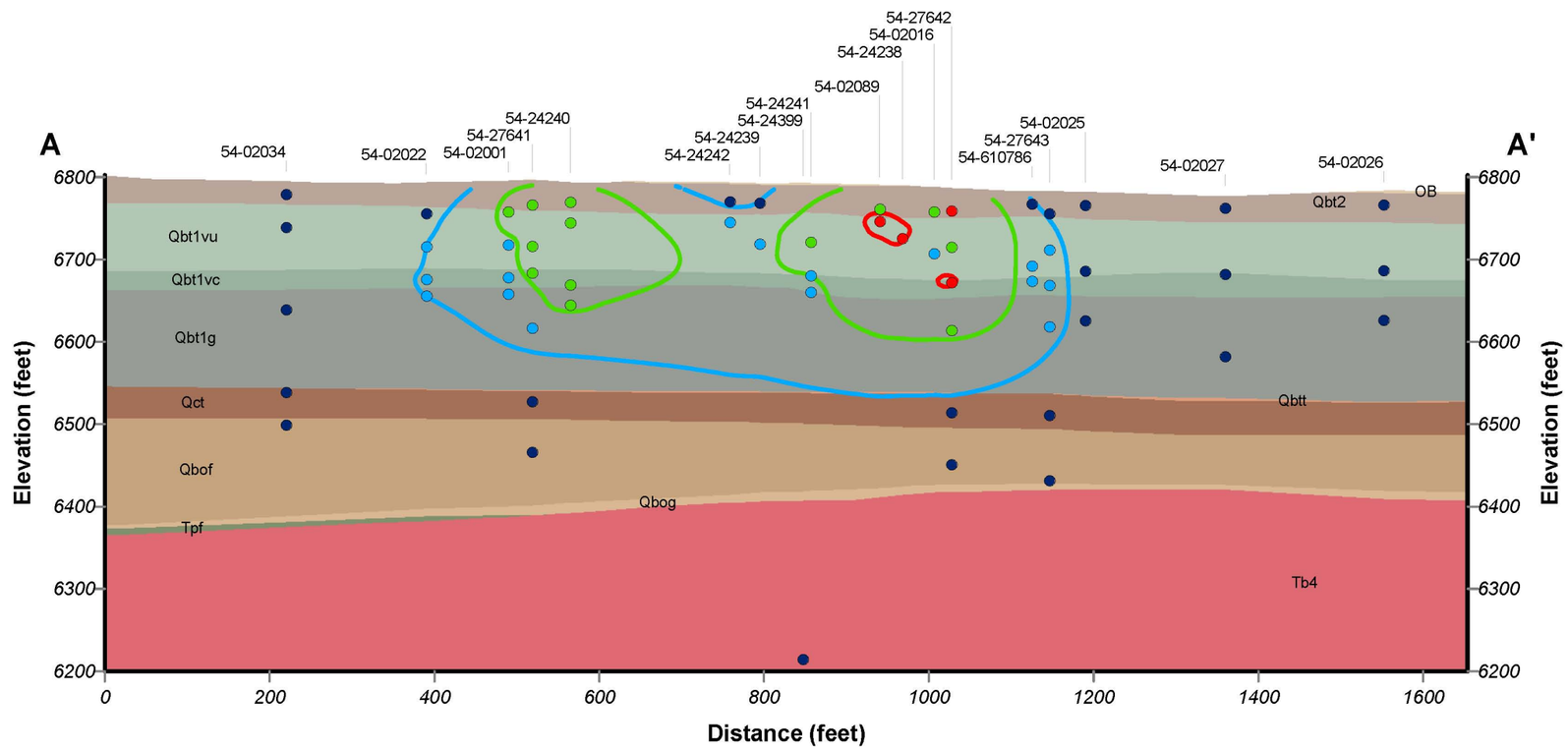
Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-1 Interpolated vapor plume for TCA within the Tshirege (<250 ft bgs), four-quarter average (third quarter FY2009 to second quarter FY2010)



Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-2 Interpolated vapor plume for TCE within the Tshirege Member (<250 ft bgs), four-quarter average (third quarter FY2009 to second quarter FY2010)



No Vertical Exaggeration

Legend

Averaged Laboratory Data
ug/m3 (screening value multiple)
- < 423,000 (10x)
- 423,000 (10x) - 846,000 (20x)
- 846,000 (20x) - 2,115,000 (50x)
- > 2,115,000 (50x)

Modeled Plume Contour
ug/m3 (screening value multiple)
- 423,000 (10x)
- 846,000 (20x)
- 2,115,000 (50x)

Geologic Unit
- OB - Fill, Soil
- Qbt3 - Bandelier tuff - Unit3
- Qbt2 - Bandelier tuff - Unit2
- Qbt1vu - Bandelier tuff - Unit1vu
- Qbt1vc - Bandelier tuff - Unit1vc
- Qbt1g - Bandelier tuff - Unit1g
- Qbtt - Tsankawi Pumice
- Qct - Cerro Toledo interval
- Qbof - Bandelier Tuff - Otowi unit
- Qbog - Bandelier tuff - Guaje Pumice
- Tpf - Puye Formation
- Tb4 - Cerros del Rio Basalt

Notes:
1) *These cross-sections were extracted from a 3D EarthVisions model. The geologic component of the model is a slight edit to the WC09c model that fixes a small localized problem with the Qbt1v surface.*
2) *A 50-ft transect line buffer was used to plot data that exert significant control on plume shape but are slightly off the section line. Contours may not appear to perfectly honor these data as a result.*
3) *The regional water table elevation is 5,860-ft MSL beneath MDA-L.*

Figure B-3.1-3
East-West Cross-Section Through the Interpolated TCA Vapor Plume Four Quarter Average Q3FY09 - Q2FY10

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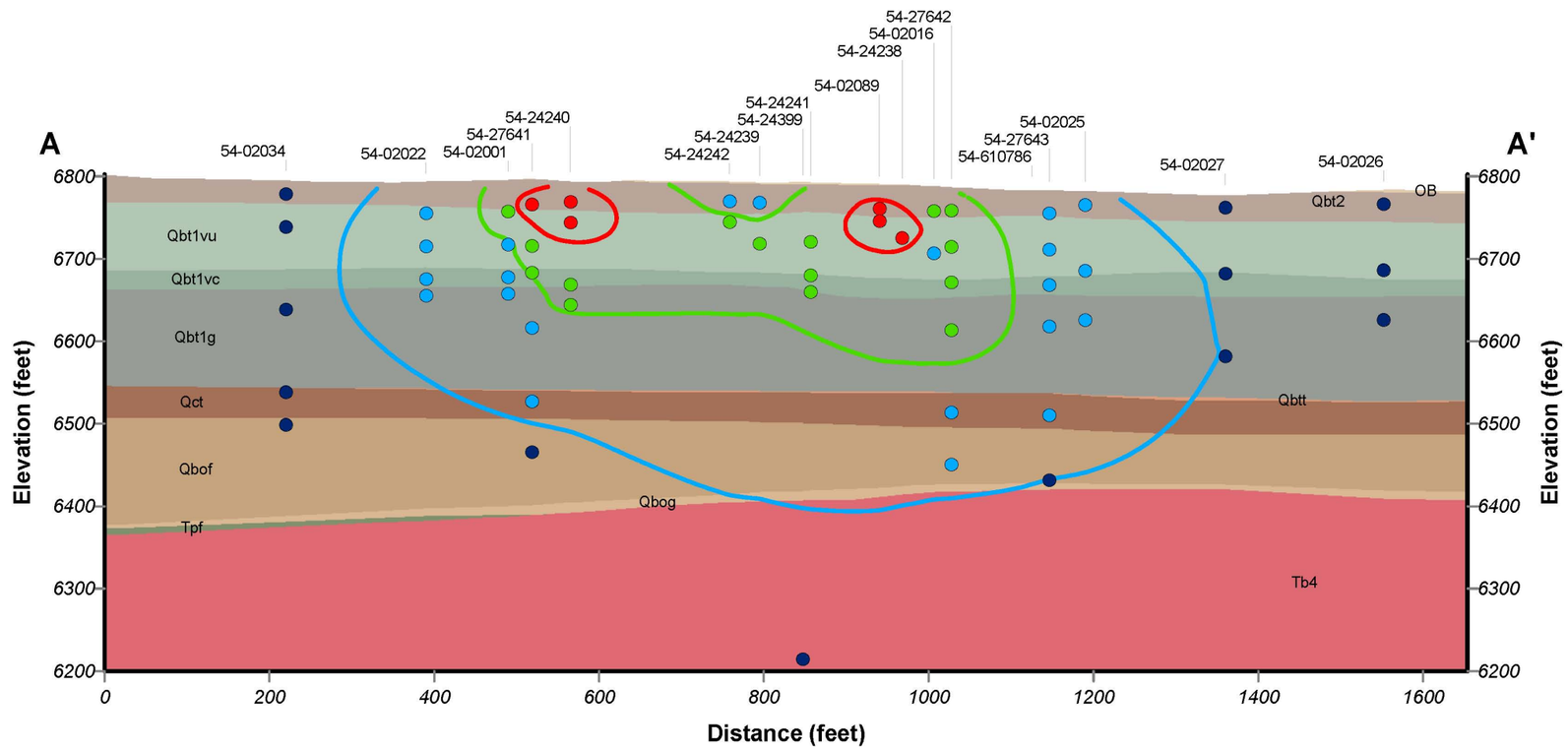
Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-3 East-west cross-section through interpolated vapor plume for TCA, four-quarter average (third quarter FY2009 to second quarter FY2010)



No Vertical Exaggeration

Legend

Averaged Laboratory Data
ug/m3 (screening value multiple)
- < 20,000 (10x)
- 20,000 (10x - 200,000 (100x)
- 200,000 (100x) - 500,000 (250x)
- > 500,000 (250x)

Modeled Plume Contour
ug/m3 (screening value multiple)
- 20,000 (10x)
- 200,000 (100x)
- 500,000 (250x)

Geologic Unit
- OB - Fill, Soil
- Qbt3 - Bandelier tuff - Unit3
- Qbt2 - Bandelier tuff - Unit2
- Qbt1vu - Bandelier tuff - Unit1vu
- Qbt1vc - Bandelier tuff - Unit1vc
- Qbt1g - Bandelier tuff - Unit1g
- Qbtt - Tsankawi Pumice
- Qct - Cerro Toledo interval
- Qbof - Bandelier Tuff - Otowi unit
- Qbog - Bandelier tuff - Guaje Pumice
- Tpf - Puye Formation
- Tb4 - Cerros del Rio Basalt

Notes:
1) *These cross-sections were extracted from a 3D EarthVisions model. The geologic component of the model is a slight edit to the WC09c model that fixes a small localized problem with the Qbt1v surface.*
2) *A 50-ft transect line buffer was used to plot data that exert significant control on plume shape but are slightly off the section line. Contours may not appear to perfectly honor these data as a result.*
3) *The regional water table elevation is 5,860-ft MSL beneath MDA-L.*

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Figure B-3.1-4
North-South Cross-Sections Through the Interpolated TCE Vapor Plume Four Quarter Average Q3FY09 - Q2FY10

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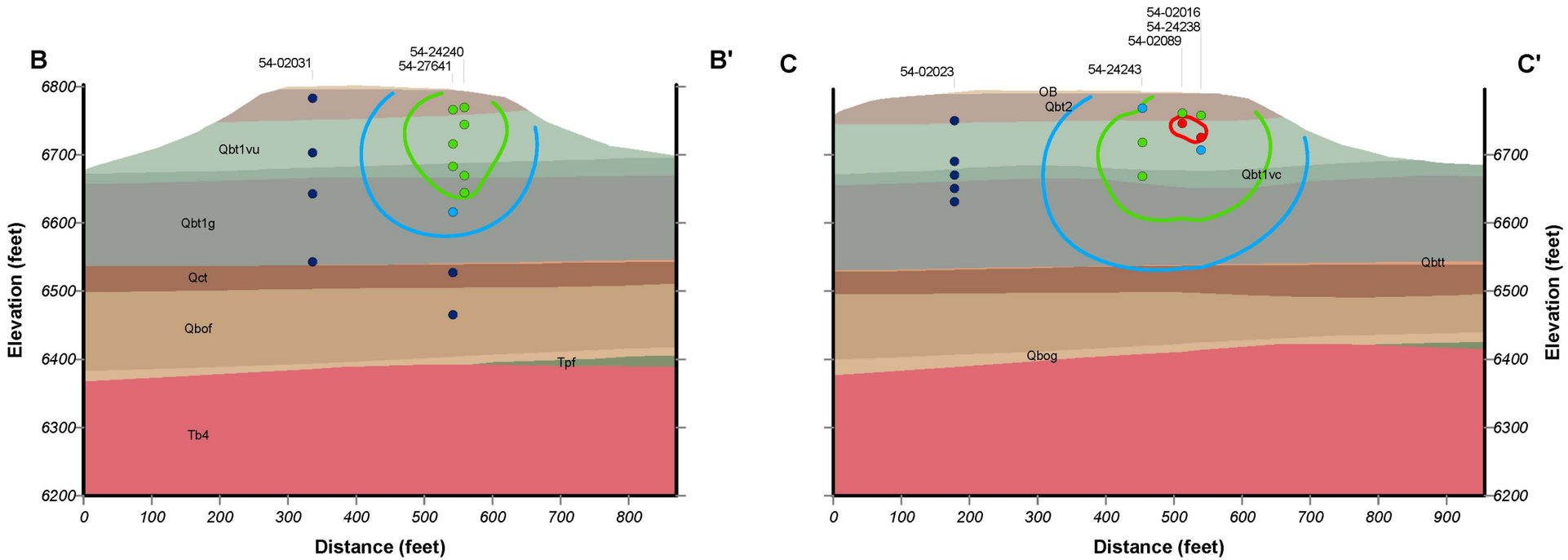
Los Alamos, NM

Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-4 East-west cross-section through interpolated vapor plume for TCE, four-quarter average (third quarter FY2009 to second quarter FY2010)



No Vertical Exaggeration

Legend

Averaged Laboratory Data
ug/m3 (screening value multiple)
- < 423,000 (10x)
- 423,000 (10x) - 846,000 (20x)
- 846,000 (20x) - 2,115,000 (50x)
- > 2,115,000 (50x)

Modeled Plume Contour
ug/m3 (screening value multiple)
- 423,000 (10x)
- 846,000 (20x)
- 2,115,000 (50x)

Geologic Unit
- OB - Fill, Soil
- Qbt3 - Bandelier tuff - Unit3
- Qbt2 - Bandelier tuff - Unit2
- Qbt1vu - Bandelier tuff - Unit1vu
- Qbt1vc - Bandelier tuff - Unit1vc
- Qbt1g - Bandelier tuff - Unit1g
- Qbtt - Tsankawi Pumice
- Qct - Cerro Toledo interval
- Qbof - Bandelier Tuff - Otowi unit
- Qbog - Bandelier tuff - Guaje Pumice
- Tpf - Puye Formation
- Tb4 - Cerros del Rio Basalt

Notes:
1) *These cross-sections were extracted from a 3D EarthVisions model. The geologic component of the model is a slight edit to the WC09c model that fixes a small localized problem with the Qbt1v surface.*
2) *A 50-ft transect line buffer was used to plot data that exert significant control on plume shape but are slightly off the section line. Contours may not appear to perfectly honor these data as a result.*
3) *The regional water table elevation is 5,860-ft MSL beneath MDA-L.*

Figure B-3.1-5
North-South Cross-Sections Through the Interpolated TCA Vapor Plume Four Quarter Average Q3FY09 - Q2FY10

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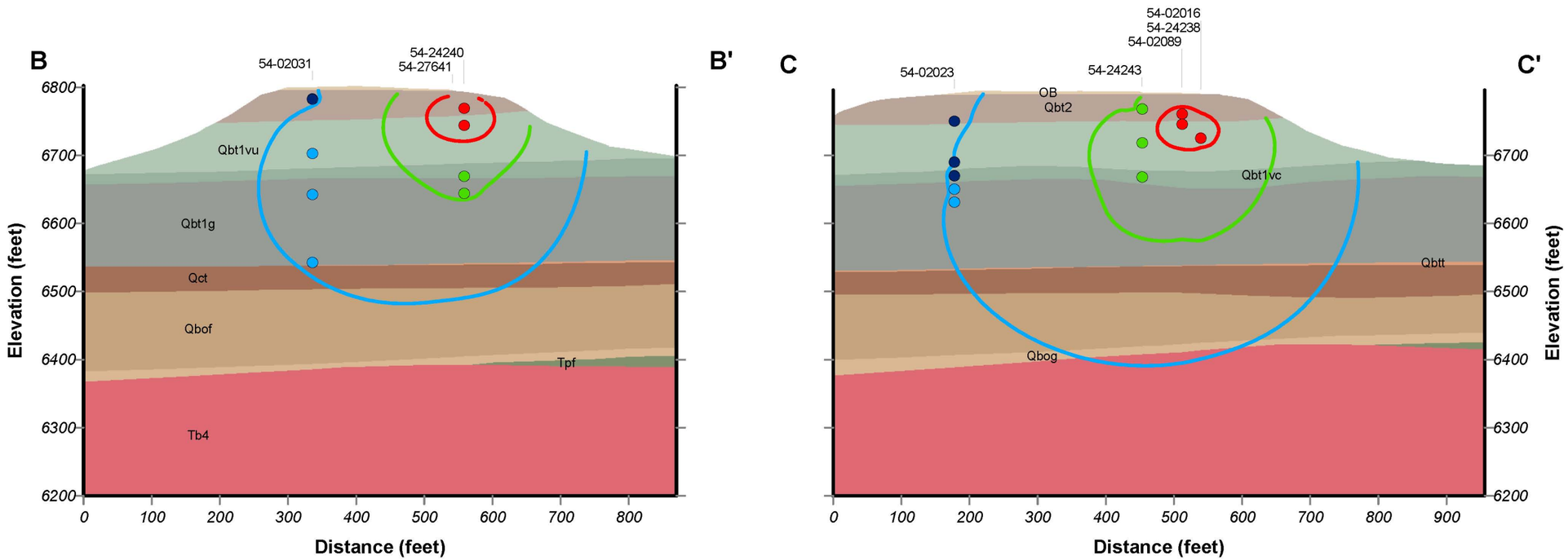
Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-5 North-south cross-sections through interpolated vapor plume for TCA, four-quarter average (third quarter FY2009 to second quarter FY2010)



No Vertical Exaggeration

Legend

Averaged Laboratory Data
ug/m3 (screening value multiple)
- < 20,000 (10x)
- 20,000 (10x - 200,000 (100x)
- 200,000 (100x) - 500,000 (250x)
- > 500,000 (250x)

Modeled Plume Contour
ug/m3 (screening value multiple)
- 20,000 (10x)
- 200,000 (100x)
- 500,000 (250x)

Geologic Unit
- OB - Fill, Soil
- Qbt3 - Bandelier tuff - Unit3
- Qbt2 - Bandelier tuff - Unit2
- Qbt1vu - Bandelier tuff - Unit1vu
- Qbt1vc - Bandelier tuff - Unit1vc
- Qbt1g - Bandelier tuff - Unit1g
- Qbtt - Tsankawi Pumice
- Qct - Cerro Toledo interval
- Qbof - Bandelier Tuff - Otowi unit
- Qbog - Bandelier tuff - Guaje Pumice
- Tpf - Puye Formation
- Tb4 - Cerros del Rio Basalt

Notes:
1) *These cross-sections were extracted from a 3D EarthVisions model. The geologic component of the model is a slight edit to the WC09c model that fixes a small localized problem with the Qbt1v surface.*
2) *A 50-ft transect line buffer was used to plot data that exert significant control on plume shape but are slightly off the section line. Contours may not appear to perfectly honor these data as a result.*
3) *The regional water table elevation is 5,860-ft MSL beneath MDA-L.*

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Figure B-3.1-6
North-South Cross-Sections
Through the Interpolated
TCE Vapor Plume
Four Quarter Average
Q3FY09 - Q2FY10

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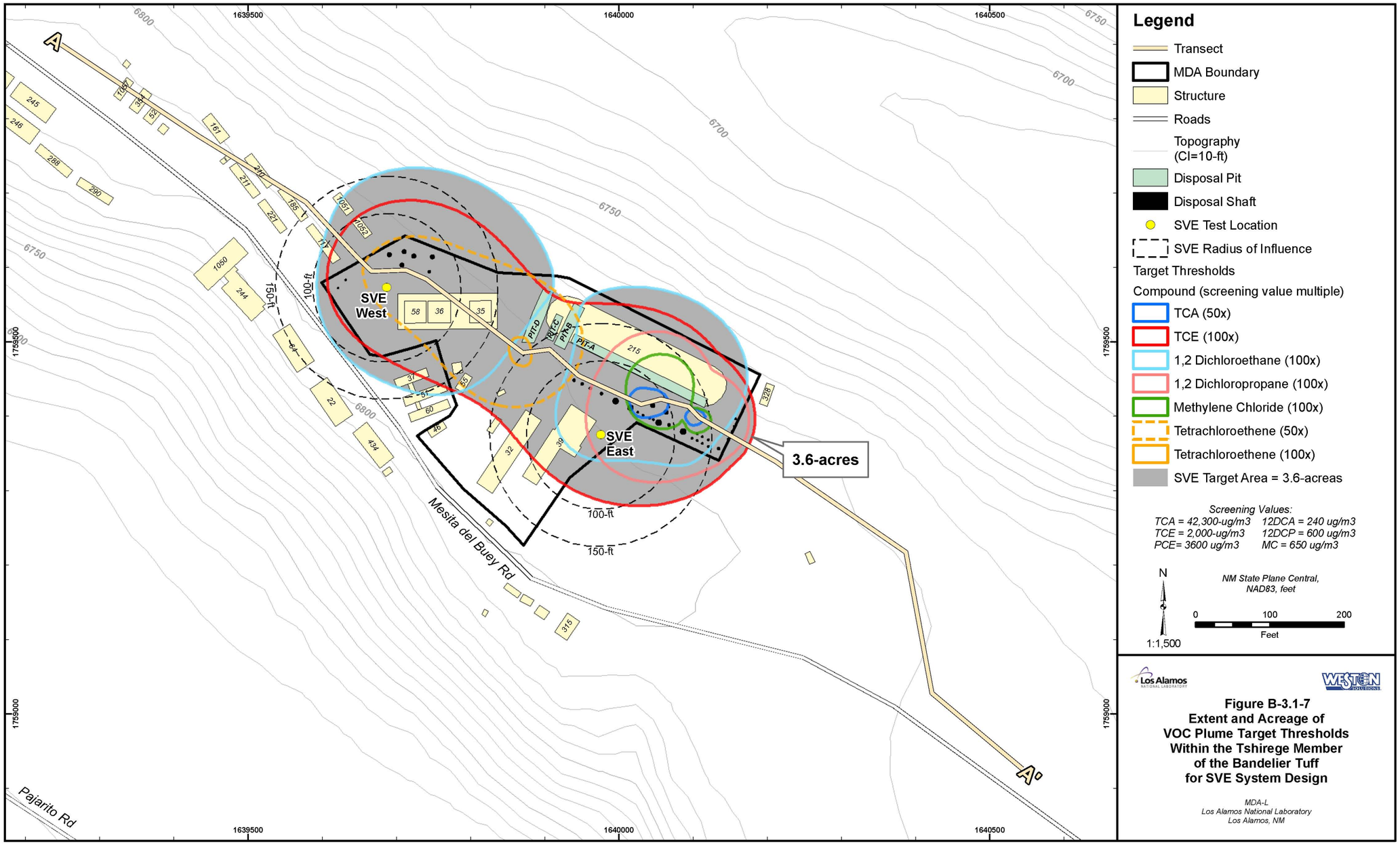
Los Alamos, NM

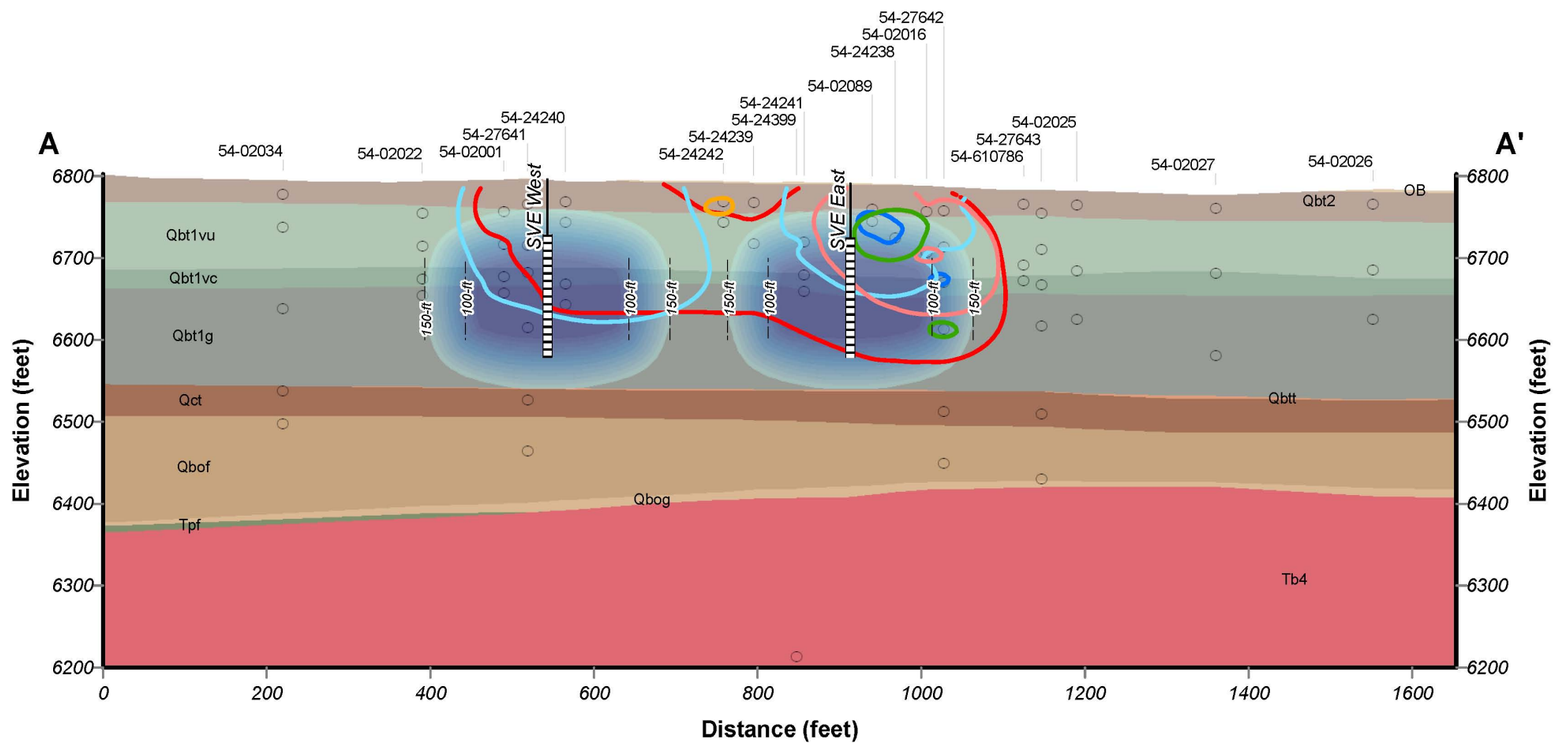
Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-6 North-south cross-sections through interpolated vapor plume for TCE, four-quarter average (third quarter FY2009 to second quarter FY2010)



Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-7 Extent and acreage of VOC plume thresholds within the Tshirege Member of the Bandelier Tuff for SVE system design. VOCs include 1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; tetrachloroethene; TCA; and TCE.



No Vertical Exaggeration

Legend

SVE System
- Casing
- Screen
- Radius of Influence

Modeled Plume Contour
- TCA (50x)
- TCE (100x)
- 1,2 Dichloroethane (100x)
- 1,2 Dichloropropane (100x)
- Methylene Chloride (100x)
- Tetrachloroethene (100x)

Geologic Unit
- OB - Fill, Soil
- Qbt3 - Bandelier tuff - Unit3
- Qbt2 - Bandelier tuff - Unit2
- Qbt1vu - Bandelier tuff - Unit1vu
- Qbt1vc - Bandelier tuff - Unit1vc
- Qbt1g - Bandelier tuff - Unit1g
- Qbtt - Tsankawi Pumice
- Qct - Cerro Toledo interval
- Qbof - Bandelier Tuff - Otowi unit
- Qbog - Bandelier tuff - Guaje Pumice
- Tpf - Puye Formation
- Tb4 - Cerros del Rio Basalt

Notes:
1) *These cross-sections were extracted from a 3D EarthVisions model. The geologic component of the model is a slight edit to the WC09c model that fixes a small localized problem with the Qbt1v surface.*
2) *A 50-ft transect line buffer was used to plot data that exert significant control on plume shape but are slightly off the section line. Contours may not appear to perfectly honor these data as a result.*
3) *The regional water table elevation is 5,860-ft MSL beneath MDA-L.*

Figure B-3.1-8
East-West Cross Section Through the Portion of Interpolated Vapor Plumes Targeted by the Pilot Vapor Extraction System

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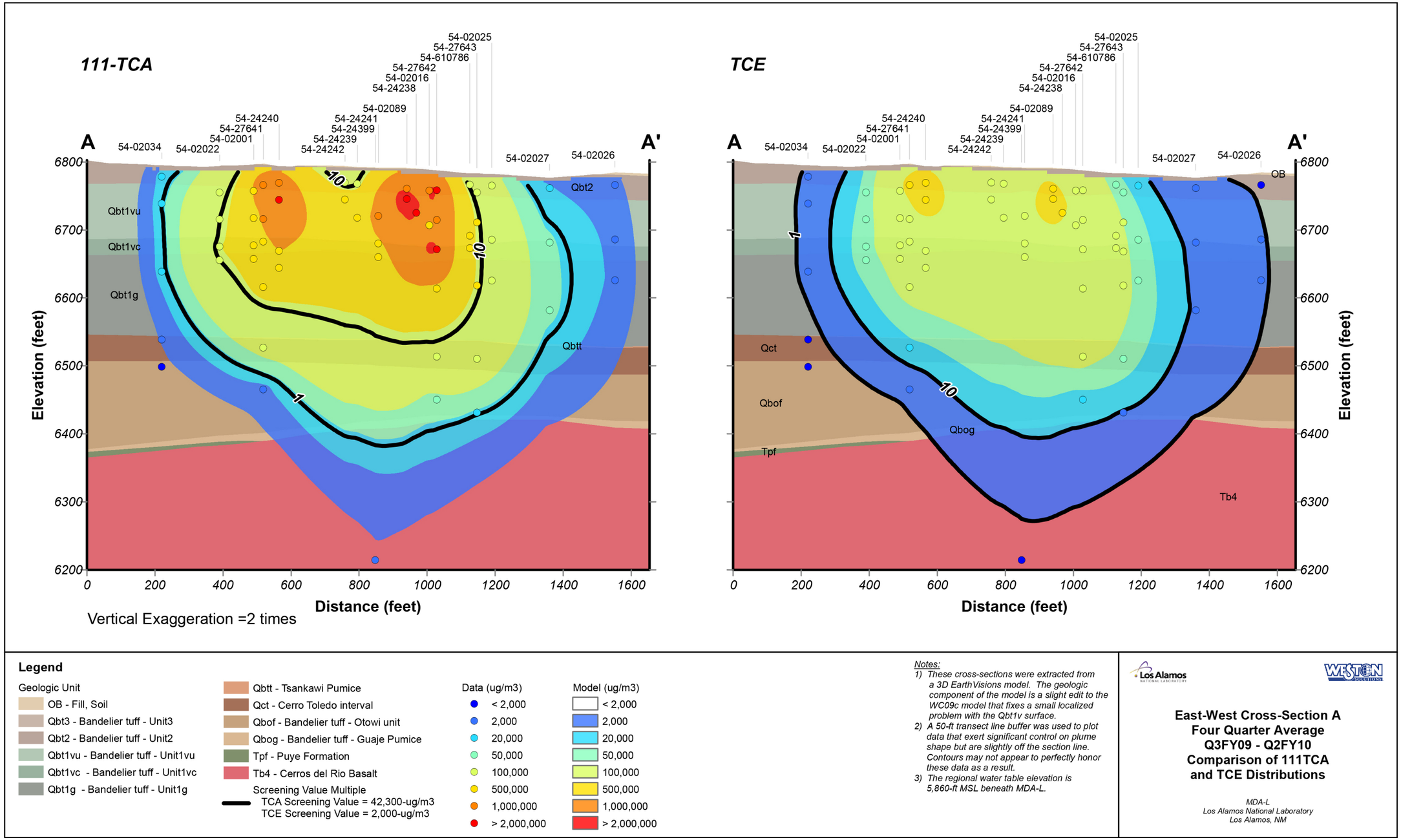
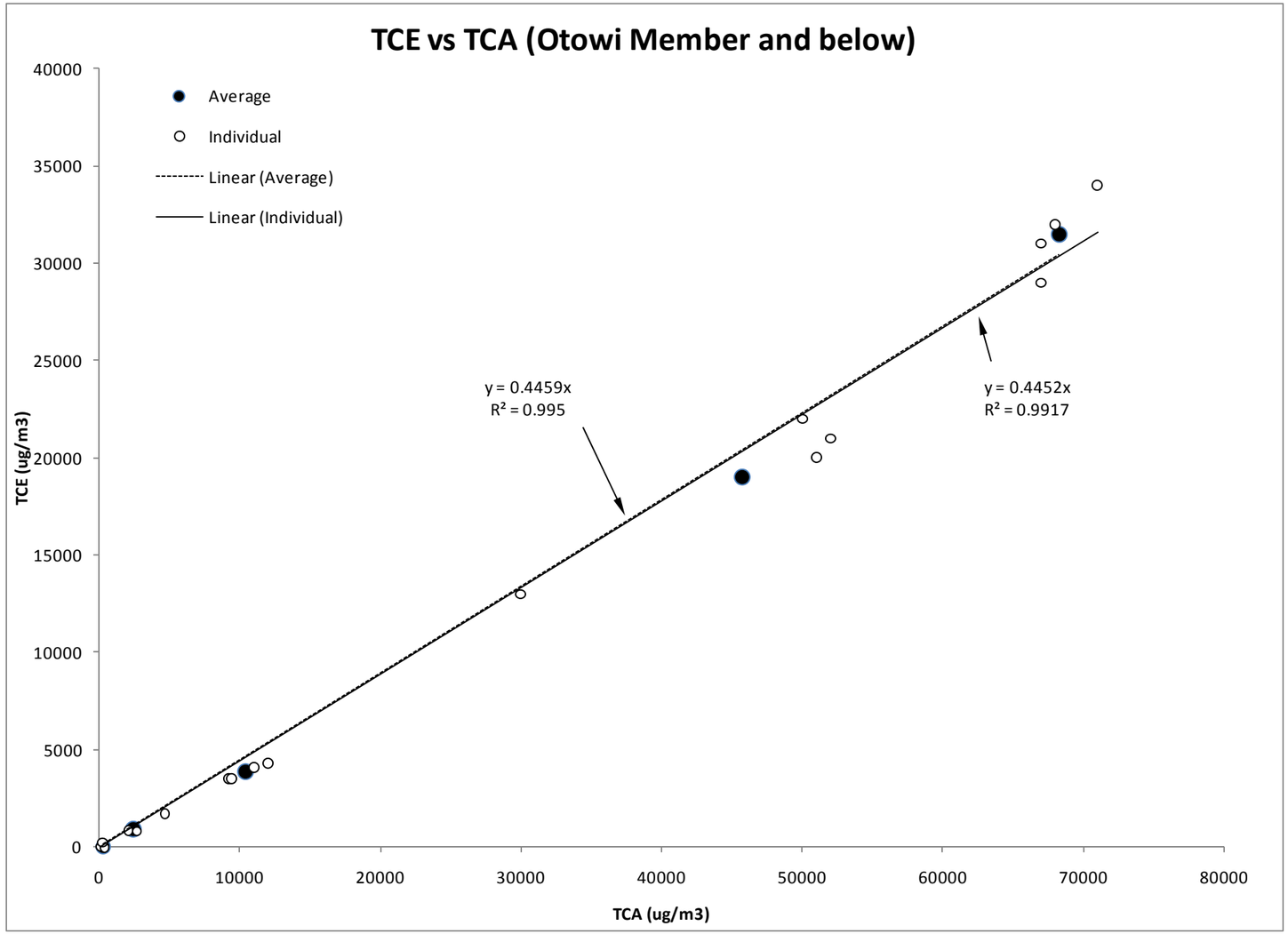
Note: Contour lines based on multiples of Tier I SVs.

Figure B-3.1-8 East-west cross-section of VOC plume thresholds, including 1,2-dichloroethane; 1,2-dichloropropane; methylene chloride; tetrachloroethene; TCA; and TCE



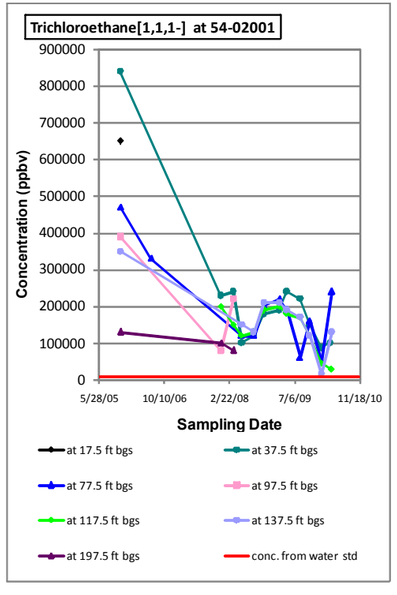
Note: Colored contours based on vapor concentrations; numbered contour lines based on multiples of Tier I SVs.

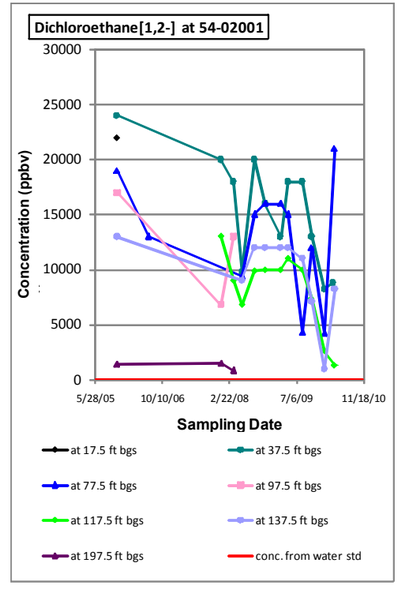
Figure B-3.1-9 East-west cross-section through interpolated vapor plumes for TCA and TCE, four-quarter average (third quarter FY2009 to second quarter FY2010)

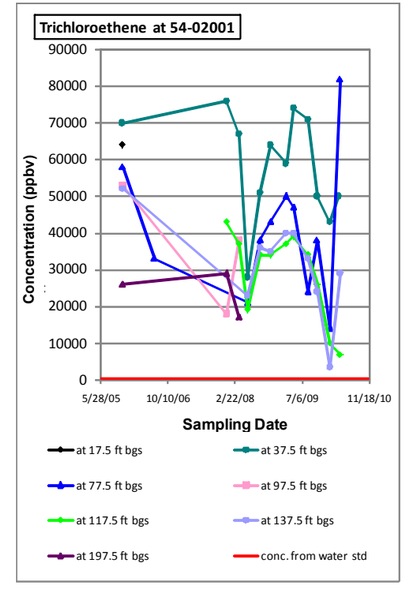


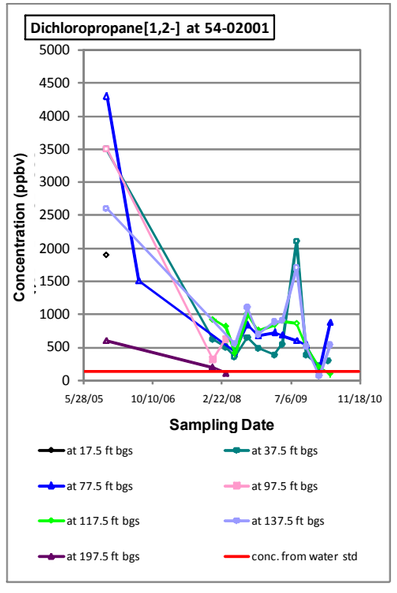
Note: Average values represent four-quarter average (third quarter FY2009 to second quarter FY2010; individual values include all samples from those four quarters.

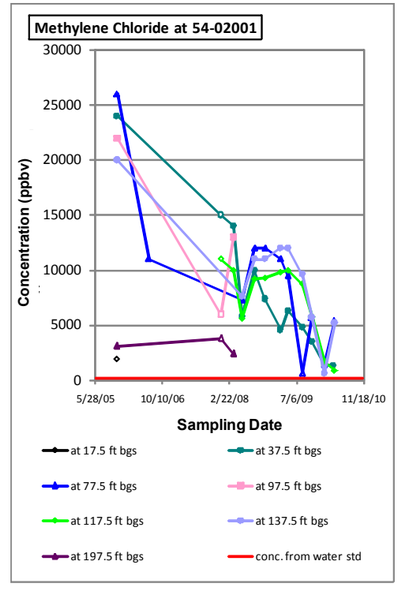
Figure B-3.1-10 Relationship between TCE and TCA concentrations for vapor samples collected in the Otowi Member (Qbof) or deeper units











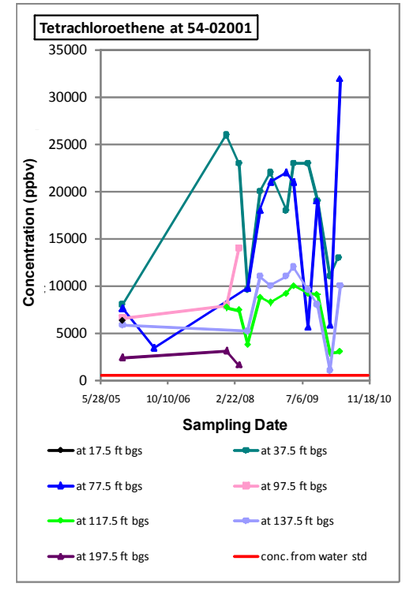
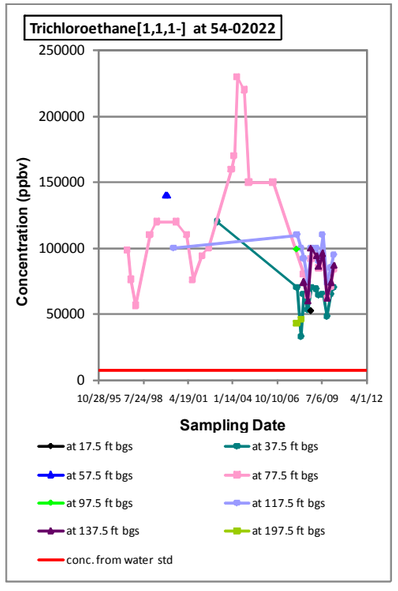
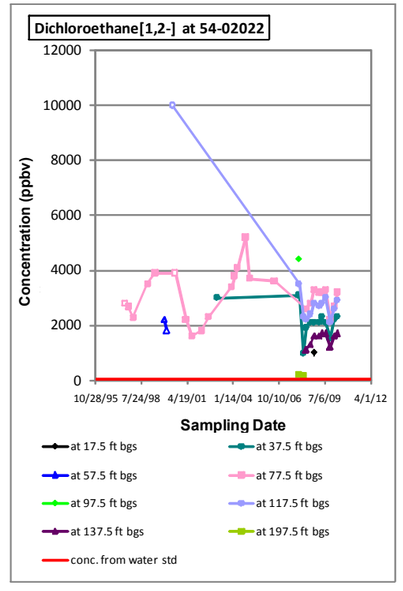
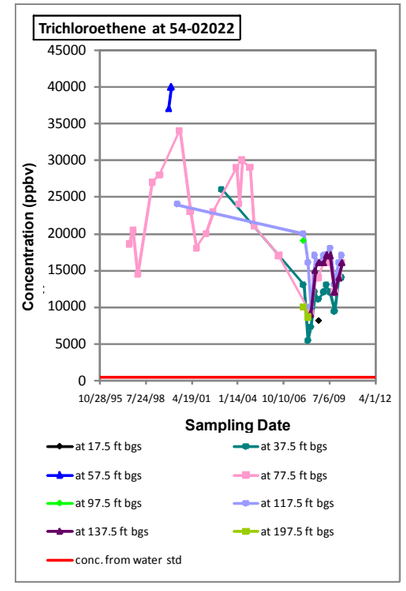
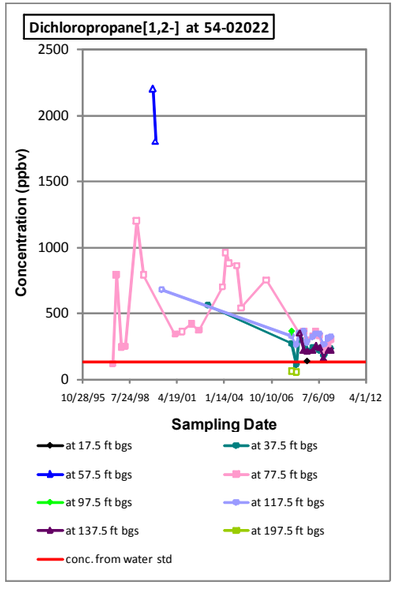


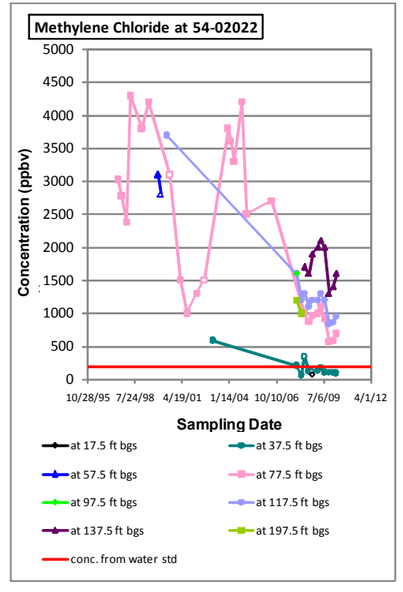
Figure B-3.2-1 Soil-vapor concentration time history plots for TCA; 1,2-dichloroethane; TCE; 1,2-dichloropropane; methylene chloride; and PCE at vapor-monitoring well 54-02001











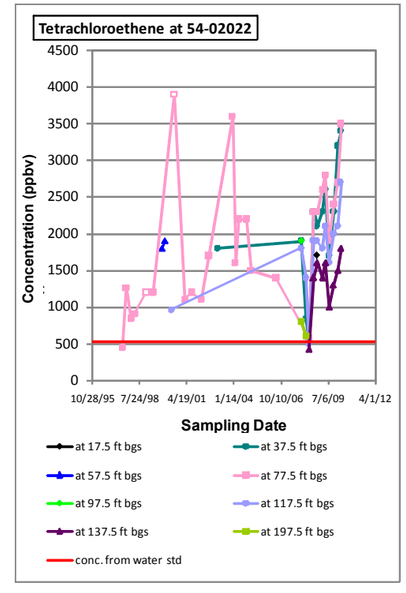
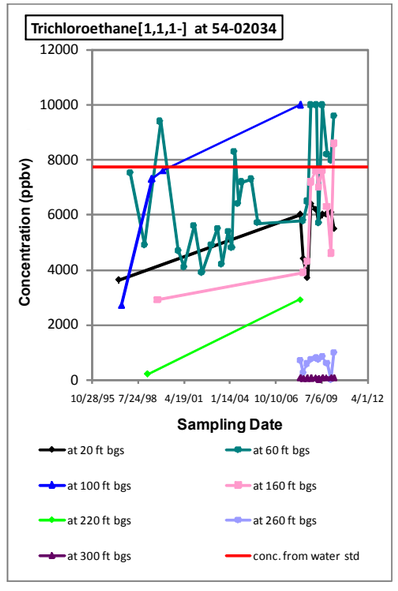
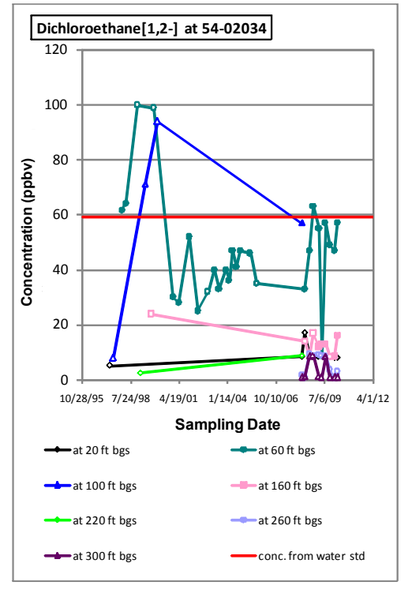
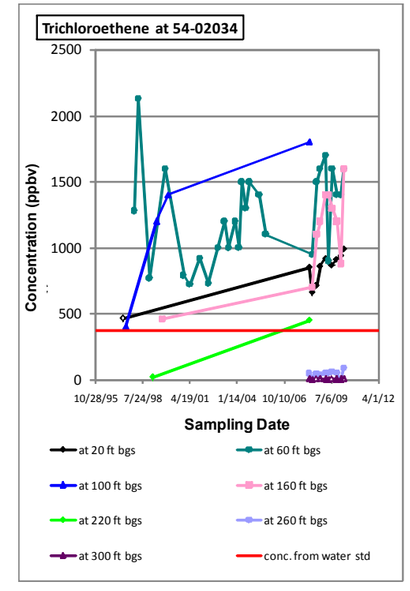
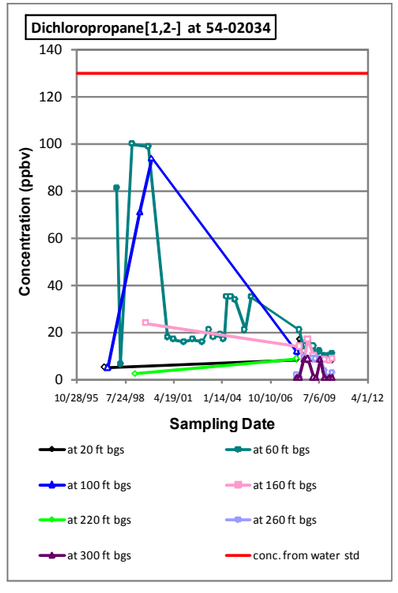


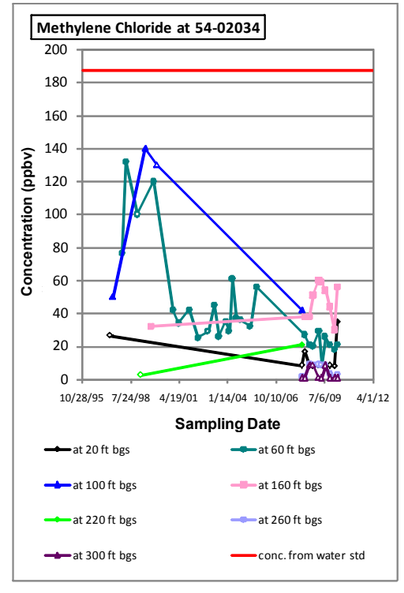
Figure B-3.2-2 Soil-vapor concentration time history plots for TCA; 1,2-dichloroethane; TCE; 1,2-dichloropropane; methylene chloride; and PCE at vapor-monitoring well 54-02022











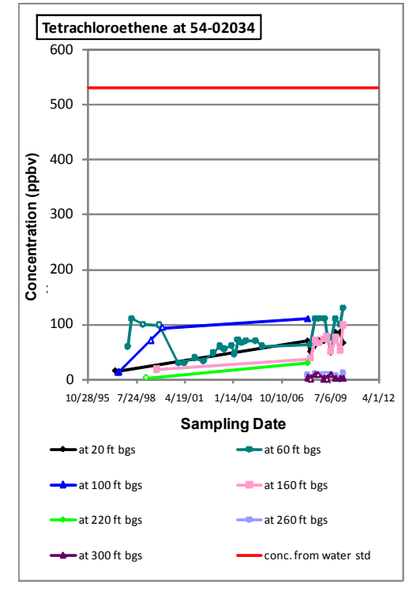


Figure B-3.2-3 Soil-vapor concentration time history plots for TCA; 1,2-dichloroethane; TCE; 1,2-dichloropropane; methylene chloride; and PCE at vapor-monitoring well 54-02034

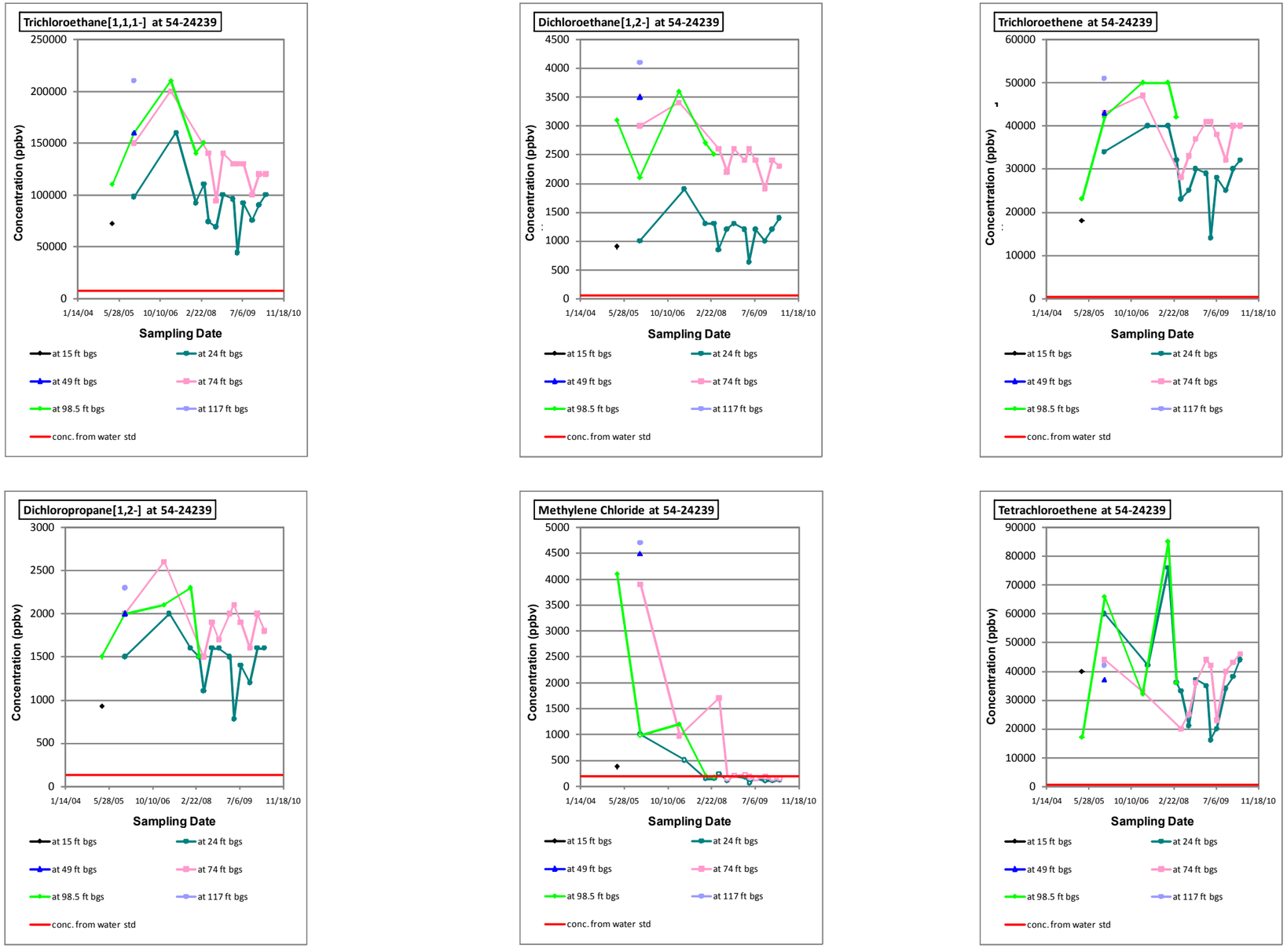
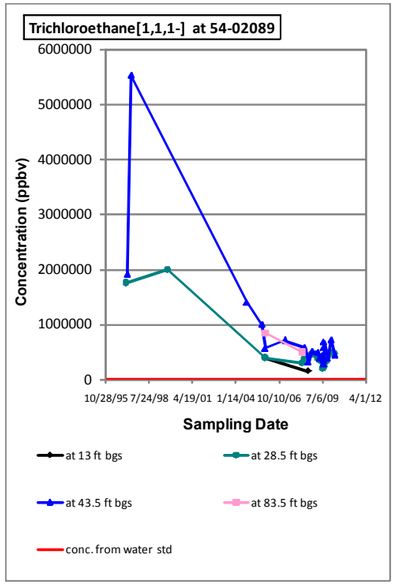
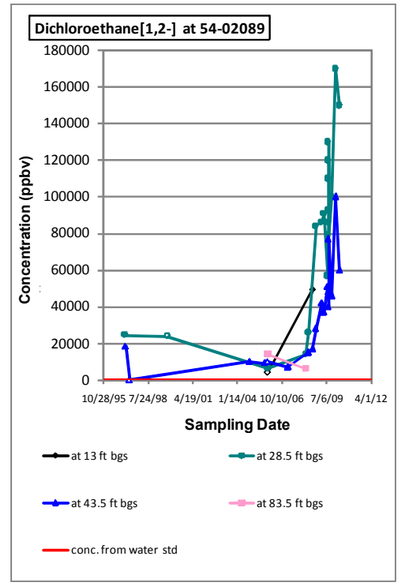
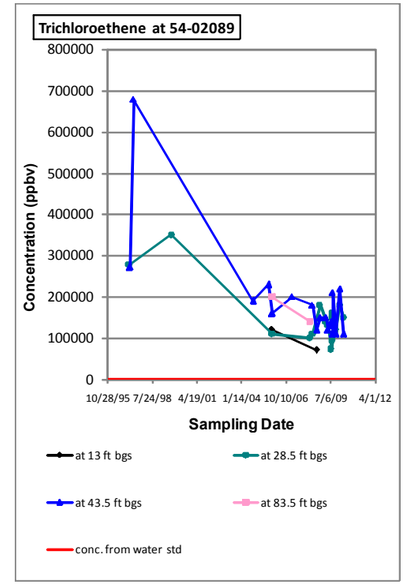
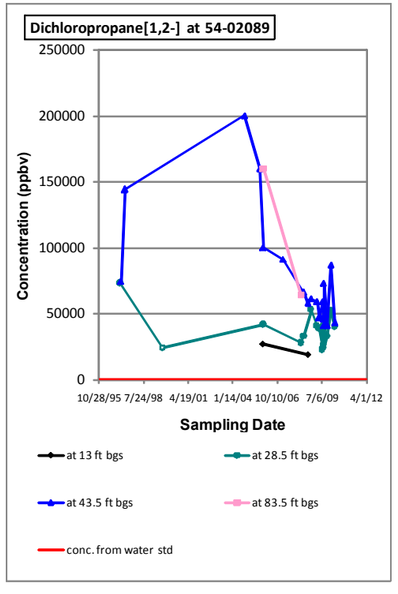


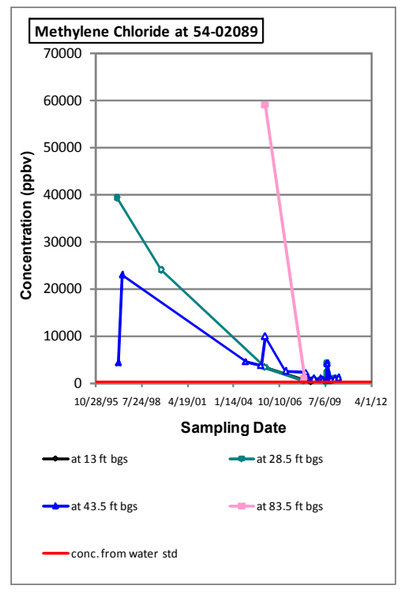
Figure B-3.2-4 Soil-vapor concentration time history plots for TCA; 1,2-dichloroethane; TCE, 1,2-dichloropropane; methylene chloride; and PCE at vapor-monitoring well 54-24239











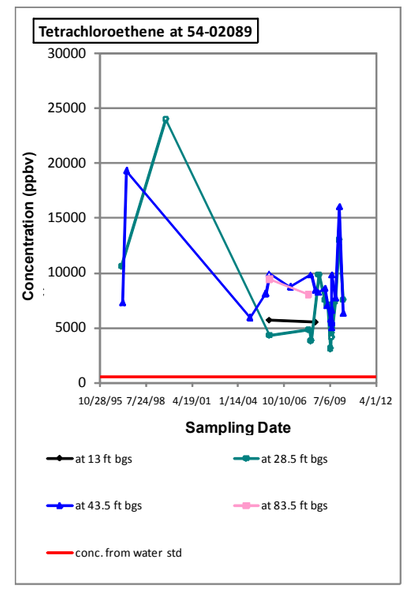
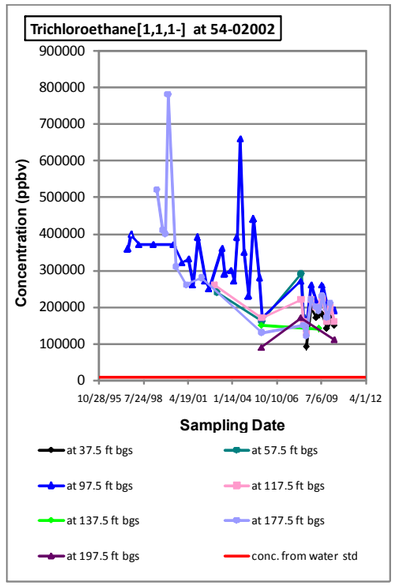
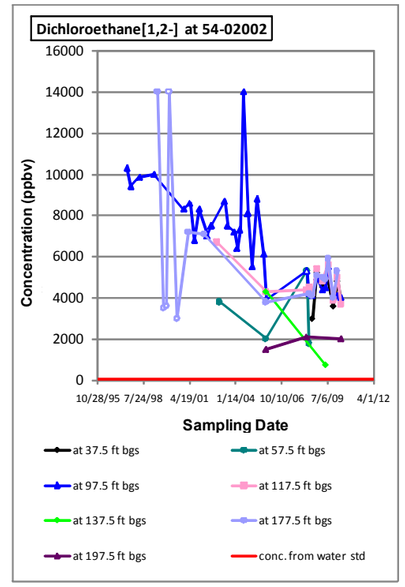
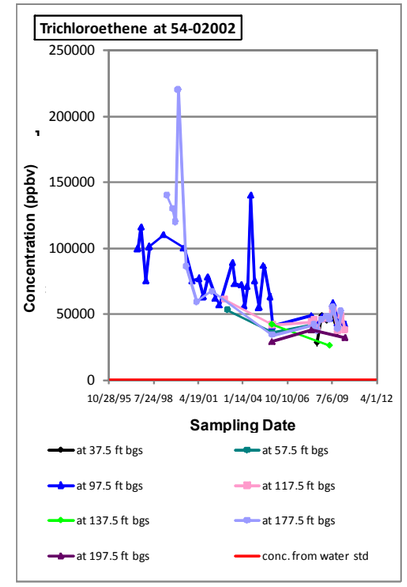
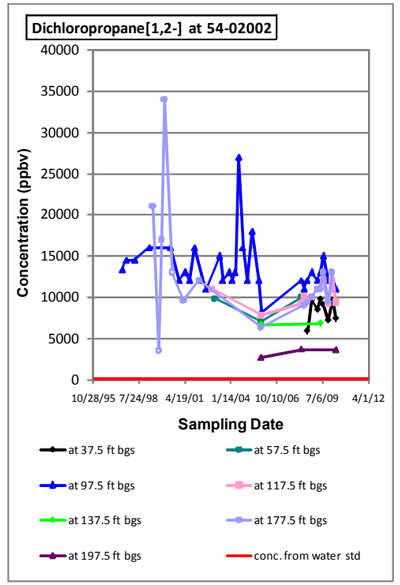


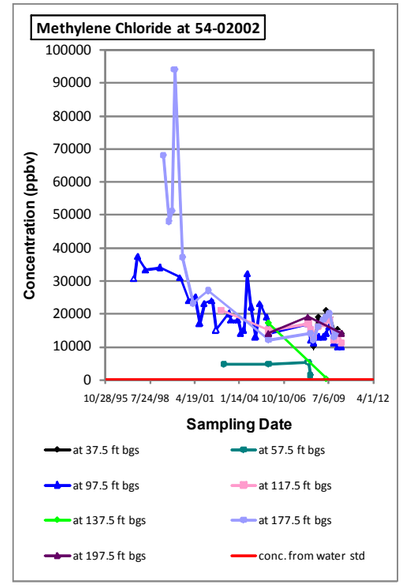
Figure B-3.2-5 Soil-vapor concentration time history plots for TCA; 1,2-dichloroethane; TCE; 1,2-dichloropropane; methylene chloride; and PCE at vapor-monitoring well 54-02089











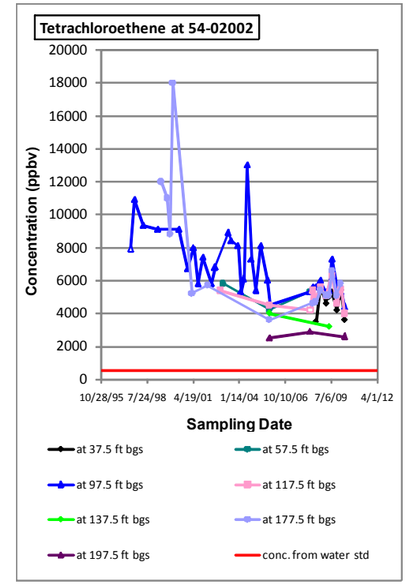
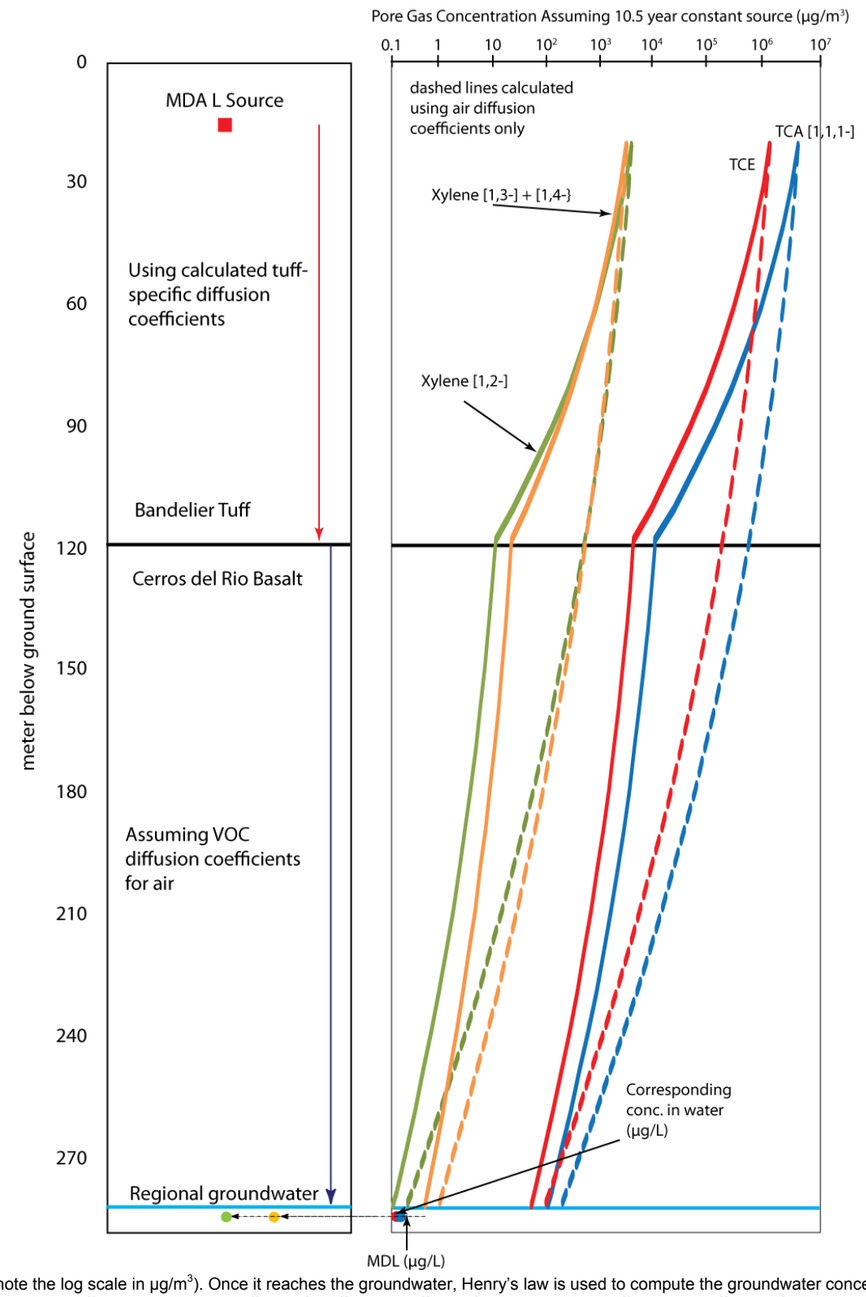


Figure B-3.2-6 Soil-vapor concentration time history plots for TCA; 1,2-dichloroethane; TCE; 1,2-dichloropropane; methylene chloride; and PCE at vapor-monitoring well 54-02002



Notes: Results for TCA, TCE, and 1,2-xylene are shown for illustration of transport behavior (note the log scale in µg/m^3). Once it reaches the groundwater, Henry's law is used to compute the groundwater concentration in µg/L (solid circles). Xylene plots far left of the graph because of a concentration several orders of magnitude below the plotted scale. The solid lines are based on the two-stage diffusion model using tuff-specific diffusion coefficient for the Bandelier Tuff and air coefficients for the basalt. The dashed line uses the air diffusion coefficient for all units.

Figure B-4.0-1 One-dimensional diffusion model used to compute vapor-phase transport of VOCs from MDA L to the regional groundwater

Table B-2.1-1
Henry's Law Constants, Groundwater SLs, and the Laboratory-Recommended Tier I and Tier II Vapor-Phase Screening Concentrations for MDA L

VOC	Henry's Law Constant[a] (dimensionless)	Groundwater SL (µg/L)	Source of Groundwater SL	Tier I Pore-Gas Concentrations Corresponding to Groundwater Standard (µg/m^3)	MDA L–Specific Tier II Calculated Pore-Gas Screening Concentrations (µg/m^3)
Acetone	0.0016	22,000	EPA regional SL	35,200	104,000,000
Benzene	0.228	5	EPA MCL	1140	34,900
Butanone[2-]	0.0023	7100	EPA regional SL	16,330	553,000
Carbon Tetrachloride	1.1	5	EPA MCL	5500	74,200
Chlorobenzene	0.13	100	EPA MCL	13,000	440,000
Chloroform	0.15	100	NMWQCC	15,000	508,000
Cyclohexane	6.1	13,000	EPA regional SL	79,300,000	496,000,000
Dichlorodifluoromethane	14	390	EPA regional SL	5,460,000	30,900,000
Dichloroethane[1,1-]	0.23	25	NMWQCC	5750	185,000
Dichloroethane[1,2-]	0.048	5	EPA MCL	240	8,120
Dichloroethene[1,1-]	1.1	5	NMWQCC	5500	58,800
Dichloroethene[trans-1,2-]	0.38	100	EPA MCL	38,000	789,000
Dichloropropane[1,2-]	0.12	5	EPA MCL	600	20,300
Dioxane[1,4-]	0.0002	61	EPA regional SL	12.2	413
Ethanol	na[b]	na	na	na	na
Ethylbenzene	0.323	700	EPA MCL	226,100	6,540,000
Ethyltoluene[4-]	na	na	na	na	na
Hexane	74	880	EPA regional SL	65,120,000	344,000,000
Methanol	0.00019	18,000	EPA regional SL	3420	116,000
Methylene Chloride	0.13	5	EPA MCL	650	22,000
Styrene	0.11	100	EPA MCL	11,000	372,000
Tetrachloroethene	0.72	5	EPA MCL	3600	70,500
Tetrahydrofuran	na	na	na	na	na
Toluene	0.272	750	NMWQCC	204,000	6,070,000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	22	59,000	EPA regional SL	1,298,000,000	7,540,000,000
Trichloroethane[1,1,1-]	0.705	60	NMWQCC	42,300	700,000
Trichloroethane[1,1,2-]	0.034	5	EPA MCL	170	5,760
Trichloroethene	0.4	5	EPA MCL	2000	48,100
Trichlorofluoromethane	4	1300	EPA regional SL	5,200,000	37,400,000
Trimethylbenzene[1,2,4-]	0.25	15	EPA regional SL	3750	127,000
Trimethylbenzene[1,3,5-]	0.36	370	EPA regional SL	133,200	3,900,000

Table B-2.1-1 (continued)

VOC	Henry's Law Constant[a] (dimensionless)	Groundwater SL (µg/L)	Source of Groundwater SL	Tier I Pore-Gas Concentrations Corresponding to Groundwater Standard (µg/m³)	MDA L–Specific Tier II Calculated Pore-Gas Screening Concentrations (µg/m³)
Xylene[1,2-]	0.213	1200	EPA regional SL	255,600	8,650,000
Xylene[1,3-]+Xylene[1,4-]	0.27	10,000[c]	EPA MCL	2,700,000	75,300,000

Notes: Tier I screening concentration is the calculated concentration in pore gas exceeding groundwater standard derived from the denominator of Equation B-2.1-3 for an SV of 1.0. Tier II screening concentration is the lower concentration of that calculated for the pore water or vapor-phase flow path based on Equations B-2.2-1 and B-2.2-10.

[a] From NMED (2009, 106420, Appendix B).

[b] na = Not available.

[c] SL for xylene[1,3-]+xylene[1,4-] is for xylene mixture.

Table B-2.1-2
Screening of VOCs Detected during Second Quarter FY2010 in Pore Gas at MDA L

VOCs	Maximum Pore-Gas Concentration (µg/m³)	Calculated Concentrations in Pore Gas Corresponding to Groundwater Standard (µg/m³)	Tier I SV (unitless)	Tier I Potential for Groundwater Impact[a]	Tier II Potential for Groundwater Impact
Acetone	260	35,200	0.0074	No	No
Benzene	4400	1140	3.9	Yes	No
Carbon Tetrachloride	19,000	5500	3.5	Yes	No
Chlorobenzene	1700	13,000	0.13	No	No
Chloroform	71,000	15,000	4.7	Yes	No
Cyclohexane	19,000	79,300,000	0.00024	No	No
Dichlorodifluoromethane	21,000	5,460,000	0.0038	No	No
Dichloroethane[1,1-]	94,000	5750	16	Yes	No
Dichloroethane[1,2-]	740,000	240	3100	Yes	Yes
Dichloroethene[1,1-]	130,000	5500	24	Yes	Yes
Dichloroethene[trans-1,2-]	1300	38,000	0.034	No	No
Dichloropropane[1,2-]	400,000	600	670	Yes	Yes
Dioxane[1,4-]	4300	12.2	350	Yes	Yes[b]
Ethanol	6300	na[c]	na	No	No
Hexane	3400	65,120,000	0.000052	No	No
Methylene Chloride	130,000	650	200	Yes	Yes
Tetrachloroethene	370,000	3600	100	Yes	Yes
Tetrahydrofuran	73,000	na	na	No	No
Toluene	17,000	204,000	0.083	No	No
Trichloro-1,2,2-trifluoroethane[1,1,2-]	2,200,000	1,298,000,000	0.0017	No	No
Trichloroethane[1,1,1-]	3,900,000	42,300	92	Yes	Yes
Trichloroethane[1,1,2-]	1000	170	5.9	Yes	No
Trichloroethene	1,200,000	2000	600	Yes	Yes
Trichlorofluoromethane	41,000	5,200,000	0.0079	No	No
Xylene[1,2-]	3200	255,600	0.013	No	No
Xylene[1,3-]+Xylene[1,4-]	2100	2,700,000	0.00078	No	No

Notes: Calculated concentrations in pore gas corresponding to groundwater SLs derived from denominator of Equation B-2.1-3. Tier I SV derived from Equation B-2.1-3. Shaded cells indicate VOCs that did not pass Tier I or Tier II screen.

[a] If the Tier I SV is less than 1, the concentration of the VOC in pore gas does not have the potential to exceed the groundwater SL.

[b] Results from pore-water migration.

[c] na = Not available.

Table B-2.2-1
Tier II Analysis of Chemicals Failing the Tier 1 Analysis

Parameters	Symbol	Unit	Benzene	Carbon Tetrachloride	Chloroform	Dichloroethane[1,1-]	Dichloroethane[1,2-]	Dichloroethene[1,1-]	Dichloropropane[1,2-]	Dioxane[1,4-]	Methylene Chloride	Tetrachloroethene	Trichloroethane[1,1,1-]	Trichloroethane[1,1,2-]	Trichloroethene
Source Properties															
SL/MCL	n/a[a]	µg/L	5	5	100	25	5	5	5	61	5	5	60	5	5
Contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vz}	µg/m^3	4400	25000	71000	94000	740000	130000	400000	4300	430000	510000	3900000	1000	1200000
Henry's law coefficient (dimensionless)	H	—[b]	0.228	1.1	0.15	0.23	0.048	1.1	0.12	0.0002	0.13	0.72	0.705	0.034	0.4
Equivalent contaminant concentration in the water phase in the vadose zone at the source	C^w_{vz}	µg/L	19	23	473	409	15417	118	3333	21500	3308	708	5532	29	3000
Distance from the vadose zone source to the water table	d_{vz}	m	260	260	260	260	260	260	260	260	260	260	260	260	260
Source length along the regional groundwater flow direction	L	m	30	30	30	30	30	30	30	30	30	30	30	30	30
Aquifer															
Hydraulic conductivity in the regional aquifer	k	m/d	3	3	3	3	3	3	3	3	3	3	3	3	3
Hydraulic gradient in the regional aquifer	I	m/m	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Considered aquifer thickness (e.g., screen length of a monitoring well)	d_a	m	3	3	3	3	3	3	3	3	3	3	3	3	3
Darcy velocity	v	m/d	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Pore-Water-Phase Migration															
Infiltration rate through the vadose zone	R	m/a	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Infiltration flux	q_{inf}	m^2/d	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04	8.22E-04
Regional aquifer flux (unit length perpendicular to the groundwater flow)	q_{aq}	m^2/d	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02	2.70E-02
Contaminant flux from the vadose-zone source to the water table under steady-state	q_{ssw}	m/d*µg/m^3	193	227	4733	4087	154167	1182	33333	215000	33077	7083	55319	294	30000
Aquifer mixing zone	d_m	m	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Dilution factor	F_{dw}	—	33.85	33.85	33.85	33.85	33.85	33.85	33.85	33.85	33.85	33.85	33.85	33.85	33.85
Contaminant concentration in the aquifer within the mixing zone	C^w_{aq}	µg/L	1	1	14	12	455	3	98	635	98	21	163	1	89
SL: acceptable contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vzMAX}	µg/m^3	38589	186175	507750	194638	8124	186175	20310	413	22003	121860	1431855	5755	67700
COPC based on pore-water migration? [yes/no]	n/a	Yes/no	No	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Gas-Phase Migration															
Diffusion coefficient of contaminants in air	D_a	m^2/d	0.7776	0.4925	0.6653	0.7258	0.7430	0.7430	0.6998	0.7517	0.8640	0.4346	0.5616	0.5789	0.5962
Diffusion coefficient of contaminants in the vadose zone	D_{ap}	m^2/d	0.0404	0.0256	0.0346	0.0377	0.0386	0.0386	0.0364	0.0391	0.0449	0.0226	0.0292	0.0301	0.0310
Diffusion coefficient of contaminants in water	D_w	m^2/d	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Diffusion coefficient of contaminants in the aquifer	D_{wp}	m^2/d	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05	2.01E-05
Porosity	n	—	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Volumetric moisture content in the vadose zone	θ	—	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Contaminant concentration in the vadose zone at the water table under steady-state	C^g_{wt}	µg/m^3	746	9606	7320	15160	29203	63042	35283	1	49262	135123	1221575	22	258597
Contaminant concentration in the aquifer at the water table under steady-state	C^w_{wt}	µg/m^3	3273	8733	48801	65912	608390	57311	294022	3723	378935	187670	1732730	652	646492

Table B-2.2-1 (continued)

Parameters	Symbol	Unit	Benzene	Carbon Tetrachloride	Chloroform	Dichloroethane[1,1-]	Dichloroethane[1,2-]	Dichloroethene[1,1-]	Dichloropropane[1,2-]	Dioxane[1,4-]	Methylene Chloride	Tetrachloroethene	Trichloroethane[1,1,1-]	Trichloroethane[1,1,2-]	Trichloroethene
Contaminant flux from the vadose-zone source to the water table under steady-state	q_{ssg}	m/d*µg/m^3	1	2	8	11	106	10	51	1	66	33	301	0	112
Aquifer mixing zone (only from diffusion; if dispersion is included, contaminant flux will increase)	d_m	m	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Dilution factor	F_{dg}	—	7.0	14.8	7.5	7.4	6.3	11.8	7.1	6.0	5.9	14.1	11.7	8.0	9.6
Contaminant concentration in the aquifer within the mixing zone	C^w_{aq}	µg/L	1	2	9	13	117	11	57	1	73	36	334	0	125
SL: acceptable contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vzMAX}	µg/m^3	34856	74222	754415	184878	31536	58811	35272	365368	29421	70458	700273	39763	48125
COPC based on air-phase migration? [yes/no]	n/a	Yes/no	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes

Note: Shaded cells indicate contaminants that did not pass the Tier II screen.

[a] n/a = Not applicable.

[b] — = Unitless.

Table B-3.1-1
MDA L Strata-Specific Properties Affecting Mass Estimates

Geologic Zone	Porosity[a]	Volumetric Water Content[b]	Air-Filled Porosity	Bulk Density[a] (g/cm^3)	Fraction Organic Carbon[c]
Soil	0.4	0.05	0.35	1.5	0.0005
Qbt 2	0.41	0.02	0.39	1.4	0.0005
Qbt 1vu	0.49	0.01	0.48	1.2	0.0005
Qbt 1vc	0.49	0.1	0.39	1.1	0.0005
Qbt 1g	0.46	0.08	0.38	1.2	0.0005
Qbtt	0.45	0.14	0.31	1.2	0.0005
Qct	0.45	0.14	0.31	1.2	0.0005
Qbof	0.44	0.11	0.33	1.2	0.0005
Qbog	0.67	0.2	0.47	0.8	0.0005
Tb4	0.001	0.0005	0.0005	2.7	0.0005

[a] Mean values from Springer (2005, 098534).
[b] Mean values from Hollis et al. (1997, 063131).
[c] Estimate.

Table B-3.1-2
TCA and TCE Masses Exceeding Ten Times the Tier I Vapor-Phase SLs, Distributions within the Different Strata and Phases

Region	Analyte	Mass (kg,%) within 10-Times Contour			
		Vapor	Aqueous	Sorbed	Total
Within Tshirege	TCA	342 (80%)	53 (12%)	33 (8%)	428
	TCE	143 (65%)	42 (19%)	35 (16%)	221
Below Tshirege	TCA	0.2(67%)	0.1 (33%)	0 (0%)	0.3
	TCE	11 (44%)	10 (42%)	3 (14%)	24
Total	**TCA**	**342 (80%)**	**53 (12%)**	**33 (8%)**	**428**
	TCE	**154 (63%)**	**52 (21%)**	**38 (16%)**	**245**

Notes: The Tshirege units include the soil, Qbt 2, and the subunits of Qbt 1 and Qtt. The units below the Tshirege include Qct, Qbof, Qbog, and Tb 4.

Table B-3.2-1
Observations of Soil-Vapor Concentration Trends in Time for TCA, 1,2-Dichloroethane; TCE; 1,2-Dichloropropane; Methylene Chloride; and PCE at Six Vapor-Monitoring Wells at MDA L

Location	TCA	1,2-Dichloroethane	TCE	1,2-Dichloropropane	Methylene chloride	PCE	Overall
54-02001 Near western shaft field	Concentrations decreased following SVE and appear to remain at new lower levels; uncertain current trend but appears to be an ongoing source area with concentrations in the 50,000- to 250,000-ppbv range	Concentrations decreased following SVE and appear to remain at new lower levels; uncertain current trend but appears to be an ongoing source area with concentrations in the 5000- to 20,000-ppbv range	SVE may have decreased concentrations but not for long term; uncertain current trend but appears to be an ongoing source area with concentrations in the 10,000- to 80,000-ppbv range	First-round of data are all ND but have elevated detection limits (DLs); SVE appears to have reduced overall concentrations but uncertain due to elevated DLs; uncertain current trend but appears to be an ongoing source area with concentrations in the 400- to 1000-ppbv range	Concentrations decreased following SVE and appear to be declining further; declining current trend implies that source is decreasing; concentrations are currently less than 10,000 ppbv	No obvious benefit from SVE; currently appears to be an ongoing source area with concentrations in the 5,000- to 24,000-ppbv range	SVE reduced concentrations for 5 of the 6 VOCs; appears to be an ongoing source area for TCA , dichloroethane[1,2-], TCE, dichloropropane[1,2-], and PCE; methylene chloride source seems to be declining
54-02022 Located approximately 150 ft west of western shafts	Concentrations decreased following SVE and appear steady at lower values in the 50,000- to 110,000-ppbv range	Concentrations may have decreased following SVE; appear steady at values in the 1000- to 3300-ppbv range	Concentrations decreased following SVE and appear steady at lower values in the 7500 to 18,000-ppbv range	Concentrations appear to have decreased following SVE; some uncertainty because pre-SVE concentrations were ND; appear steady at lower values in the 200- to 400-ppbv range	Concentrations decreased following SVE and appear to be declining further; concentrations are currently less than 2000 ppbv	Concentrations may have decreased for a short time following SVE; currently appear to be rising and are less than 3500 ppbv	SVE reduced concentrations for 5 of the 6 VOCs; current concentrations for TCA, dichloroethane[1,2-], TCE, and dichloropropane[1,2-] appear steady; methylene chloride concentrations seem to be declining; PCE concentrations seem to be increasing

Table B-3.2-1 (continued)

Location	TCA	1,2-Dichloroethane	TCE	1,2-Dichloropropane	Methylene chloride	PCE	Overall
54-02034 Located about 300 ft northwest of western shafts	No obvious effect of SVE; concentrations increasing with time; currently in the 50- to 10,000-ppbv range; obvious decline in concentration with depth	No obvious effect of SVE; uncertain time trend; concentrations currently in the ND to 60-ppbv range; obvious decline in concentration with depth	No obvious effect of SVE; concentrations increasing with time; currently in the ND to 1700-ppbv range; obvious decline in concentration with depth	SVE appears to have reduced overall concentrations but uncertain due to large number of ND; currently appears steady at ND to <20-ppbv range; obvious decline in concentration with depth	Concentrations may have been declining before the SVE test and decreased following SVE; currently appears steady at ND to <60-ppbv range; may be increasing concentration at 60-ft depth; obvious decline in concentration with depth	No obvious effect of SVE; concentrations increasing with time; currently in the ND to 130-ppbv range; obvious decline in concentration with depth	SVE test had little to no effect on concentrations at this location; diffusion outward from western shaft area is likely leading to increasing concentrations of TCA, dichloroethane[1,2-], TCE, and PCE
54-24239 Located just south of Imp C	Concentrations decreased with some lag time following SVE and appear to remain at new lower levels; uncertain current trend but may be an ongoing source area with concentrations in the 50,000- to 140,000-ppbv range	Concentrations may have decreased with some lag time following SVE and appear to remain at new lower levels; uncertain current trend but may be an ongoing source area with concentrations in the 600- to 2500-ppbv range	Concentrations decreased with some lag time following SVE and appear to remain at new lower levels; uncertain current trend but may be an ongoing source area with concentrations in the 15,000- to 40,000-ppbv range	Concentrations decreased with some lag time following SVE and appear to remain at new lower levels; uncertain current trend but may an ongoing source area with concentrations in the 800- to 2100-ppbv range	Concentrations decreased following SVE; current concentrations have dropped to ND	No obvious effect of SVE; uncertain current trend; may be an ongoing source region; current concentrations in the 19,000- to 45,000-ppbv range	Concentrations of 5 of 6 VOCs decreased with some lag time following SVE and appear to remain at new lower levels; highest concentrations of PCE indicate that this is a source area for PCE; unclear if it is an ongoing source region for others

Table B-3.2-1 (continued)

Location	TCA	1,2-Dichloroethane	TCE	1,2-Dichloropropane	Methylene chloride	PCE	Overall
54-02089 Located adjacent to the eastern shafts	Concentrations were declining before the SVE test and may have decreased following SVE; concentrations remain lower but may have a slight upward trend; appears to be an ongoing source area with concentrations in the 200,000- to 800,000-ppbv range; current source may be lower than previous	Concentrations are rising sharply following SVE; concentrations increased from 10,000 ppbv before the SVE test to >100,000 ppbv currently; only location where this behavior is observed	Concentrations were declining before the SVE test and may have decreased following SVE; concentrations remain lower but may have a slight upward trend; appears to be an ongoing source area with concentrations in the 100,000- to 210,000-ppbv range; current source may be lower than previous	Concentrations decreased following SVE and remain at lower levels; may be a slight upward trend; appears to be an ongoing source area with concentrations in the 20,000- to 80,000-ppbv range	Concentrations were declining before the SVE test and decreased following SVE; concentrations currently at ND	Concentrations were likely declining before the SVE test; no obvious effect of SVE; uncertain current trend; current concentrations in the 3000- to 16,000-ppbv range; current source may be lower than previous	Concentrations were declining before SVE test for TCA, TCE, methylene chloride, and PCE, implying that current source is lower than it had been; SVE likely reduced concentrations for 4 of 6 VOCs; dichloroethane[1,2-] concentrations rising sharply following SVE
54-02002 Located approximately 50 ft south of the eastern shafts	Concentrations were decreasing before SVE test and decreased further following SVE; appear steady currently at lower values in the 100,000- to 270,000-ppbv range	Concentrations were decreasing before SVE test and decreased further following SVE; appear steady currently at lower values in the 2000- to 6000-ppbv range	Concentrations were decreasing before SVE test and decreased further following SVE; appear steady currently at lower values in the 30,000- to 55,000-ppbv range	Concentrations reduced by SVE with some rebound afterwards; no apparent effect of SVE on concentrations at 197.5 ft bgs; appear steady or slightly increasing in the 4000- to 15,000-range	Concentrations were decreasing before SVE test and decreased further following SVE; appear steady currently at lower values in the 10,000- to 20,000-ppbv range	Concentrations were decreasing before SVE test and decreased further following SVE; appear steady currently at lower values in the 3000- to 7000-ppbv range	Concentrations were decreasing before SVE employed; currently concentrations are steady or increasing slightly and remain lower than pre-SVE values

Table B-4.0-1
One-Dimensional Diffusion Calculations for VOC Transport from MDA L VOC Plume to Groundwater

VOC	Detected in Groundwater Well	Henry's Law Constant[a]	Diffusion Coefficient in Air (m^2/s)[b]	Calculated. Diffusion Coefficient in Tuff (m^2/s)	Max. Concentration 3rd Quarter FY2009–2nd Quarter FY2010 ($\mu g/m^3$)	Estimated Pore-Gas Concentration at Tuff-Basalt Contact ($\mu g/m^3$)	Estimated Pore-Gas Concentration at Water Table ($\mu g/m^3$)	Corresponding Groundwater Concentration ($\mu g/L$)	MDL in Groundwater ($\mu g/L$)
Acetone	R-20, R-21, R-32, R-38, R-53, R-54	0.0016	1.10E-05	2.81E-06	260	5.5E+00	2.9E-01	1.8E-01	1.25
Benzene	R-38	0.228	9.00E-06	2.30E-06	4400	4.8E+01	1.5E+00	6.8E-03	0.3
Butanone [2-]	R-20, R-54	0.0023	1.04E-05	2.66E-06	120	2.1E+00	9.9E-02	4.3E-02	1.25
Carbon Tetrachloride		1.1	5.70E-06	1.46E-06	25,000	3.4E+01	2.4E-01	2.2E-04	0.25
Chlorobenzene		0.13	7.20E-06	1.84E-06	2200	9.6E+00	1.6E-01	1.2E-03	0.25
Chloroform		0.15	7.70E-06	1.97E-06	71,000	4.2E+02	8.6E+00	5.7E-02	0.25
Cyclohexane		6.1	8.00E-06	2.04E-06	19,000	1.3E+02	3.0E+00	5.0E-04	na[c]
Dichlorodifluoromethane		14	7.80E-06	1.99E-06	21,000	1.3E+02	2.8E+00	2.0E-04	0.5
Dichloroethane [1,1-]		0.23	8.40E-06	2.14E-06	94,000	7.8E+02	2.1E+01	9.1E-02	0.3
Dichloroethane [1,2-]		0.048	8.60E-06	2.20E-06	740,000	6.8E+03	1.9E+02	4.0E+00	0.25
Dichloroethene [1,1-]		1.1	8.60E-06	2.20E-06	130,000	1.2E+03	3.4E+01	3.1E-02	0.3
Dichloroethene [trans-1,2-]		0.38	8.80E-06	2.25E-06	1600	1.6E+01	4.9E-01	1.3E-03	0.3
Dichloropropane [1,2-]		0.12	8.10E-06	2.07E-06	400,000	2.9E+03	7.0E+01	5.80E-01	0.25
Dioxane [1,4-]	R-20, R-38	0.0002	8.70E-06	2.22E-06	4300	4.1E+01	1.2E+00	6.05E+00	1
Ethanol		na	1.28E-05	3.27E-06	96,000	3.1E+03	2.3E+02	—[d]	na
Ethylbenzene	R-20	0.323	6.80E-06	1.74E-06	380	1.3E+00	1.8E-02	5.48E-05	0.25
Ethyltoluene [4-]		na	0.00E+00	na	1200	—	—	—	na
Hexane		74	7.30E-06	1.86E-06	3400	1.6E+01	2.8E-01	3.75E-06	na
Methanol		0.00019	1.60E-05	4.08E-06	38,000	2.1E+03	2.3E+02	1.21E+03	na
Methylene Chloride		0.13	1.00E-05	2.55E-06	430,000	6.7E+03	2.8E+02	2.19E+00	2

Table B-4.0-1 (continued)

VOC	Detected in Groundwater Well	Henry's Law Constant[a]	Diffusion Coefficient in Air (m^2/s)[b]	Calculated. Diffusion Coefficient in Tuff (m^2/s)	Max. Concentration 3rd Quarter FY2009–2nd Quarter FY2010 ($\mu g/m^3$)	Estimated Pore-Gas Concentration at Tuff-Basalt Contact ($\mu g/m^3$)	Estimated Pore-Gas Concentration at Water Table ($\mu g/m^3$)	Corresponding Groundwater Concentration (µg/L)	MDL in Groundwater (µg/L)
Styrene	R-20	0.11	7.10E-06	1.81E-06	1000	4.1E+00	6.6E-02	5.98E-04	0.25
Tetrachloroethene		0.72	5.03E-06	1.28E-06	510,000	3.3E+02	1.4E+00	1.94E-03	0.25
Tetrahydrofuran		na	0.00E+00	na	73,000	—	—	—	na
Toluene	R-20, R-21, R-32, R-38, R-53	0.272	7.80E-06	1.99E-06	21,000	1.3E+02	2.8E+00	1.03E-02	0.25
Trichloro-1,2,2-trifluoroethane [1,1,2-]		22	3.80E-06	9.70E-07	2,200,000	1.9E+02	1.9E-01	8.69E-06	1
Trichloroethane [1,1,1-]		0.705	6.50E-06	1.66E-06	3,900,000	1.1E+04	1.2E+02	1.77E-01	0.3
Trichloroethane [1,1,2-]		0.034	6.70E-06	1.71E-06	1000	3.1E+00	4.1E-02	1.21E-03	0.25
Trichloroethene	R-20, R-53	0.4	6.90E-06	1.76E-06	1,200,000	4.3E+03	6.3E+01	1.57E-01	0.25
Trichlorofluoro-methane		4	6.50E-06	1.66E-06	41,000	1.1E+02	1.3E+00	3.28E-04	0.31
Trimethylbenzene [1,2,4-]	R-20	0.25	6.10E-06	1.56E-06	210	4.1E-01	3.9E-03	1.54E-05	0.25
Trimethylbenzene [1,3,5-]		0.36	6.00E-06	1.53E-06	300	5.4E-01	4.7E-03	1.32E-05	0.25
Xylene[1,2-]	R-20	0.213	6.90E-06	1.76E-06	4000	1.4E+01	2.1E-01	9.84E-04	0.25
Xylene[1,3-] + Xylene[1,4-]	R-20	0.27	8.50E-06	2.17E-06	3200	2.8E+01	7.7E-01	2.86E-03	0.25

[a] Dimensionless form: Concentration in air/concentration in water.

[b] Available at http://www.epa.gov/athens/learn2model/part-two/onsite/esthenry.html.

[c] na = Not available.

[d] — = Not estimated.

Appendix C

Soil-Vapor Transport at Material Disposal Area L: Numerical Modeling in Support of Decision Analysis

C-1.0 INTRODUCTION

This appendix presents an updated three-dimensional numerical model of a volatile organic compound (VOC) vapor plume in the subsurface at Material Disposal Area (MDA) L. A site-scale numerical model was developed over several years (1999–2005) to evaluate the nature and extent of the subsurface contaminant 1,1,1-trichloroethane (TCA) associated with waste disposed at the site. The model was then refined to include a 2006 soil-vapor extraction (SVE) pilot test. This study presents results of simulations following the SVE test in 2006 and compares current predicted TCA concentrations with those measured at MDA L in 2010. The model was also applied to evaluate future site behavior based on potential actions, such as asphalt removal and longer-term SVE starting with the 2010 TCA concentrations and extent of the plume.

The simulations presented in this appendix build on many years of work performed to use site data in numerical models to better understand the nature and extent of VOC contamination at MDA L (Neeper 2002, 098639; Neeper and Stauffer 2005, 098641; Stauffer et al. 2005, 090537; Stauffer et al. 2007, 104950; Stauffer et al. 2007, 097871; Vrugt et al. 2008, 104951). Specifically, calculations are presented using the numerical models developed to explore more scenarios related to the corrective measures evaluation (CME) and the possible role of SVE at MDA L (Stauffer et al. 2007, 097871; Vrugt et al. 2008, 104951). Previous analysis showed that SVE has the potential to effectively remove significant quantities of VOCs from the subsurface. Suggestions based on these results were made for a strategy to deal with sudden changes in the plume by suggesting both sampling frequency and locations that will allow rapid detection of such changes. Estimates of the radii of influence of the SVE pilot test wells (~120 ft) were given, and the suggestion was made that two deeper SVE wells be installed to address mass removal near the bottom of the plume.

C-2.0 MODEL DISCUSSION

C-2.1 Vadose Zone Transport Properties

This section describes the physical properties that are relevant for modeling the TCA vapor plume. Table C-2.1-1 lists physical properties relevant for TCA transport. The temperature correction for the dimensionless Henry's law coefficient (H ((mol_{TCA}/L_{air}) / (mol_{TCA} / L_{water}))) has been taken into account based on a solution of the Van't Hoff equation (Figure C-2.1-1), where the change in the Henry's law coefficient is a function of temperature (available at http://www.epa.gov/athens/learn2model/part-two/onsite/esthenry.html). The dimensionless coefficient used in the modeling corresponds to a temperature of 15°C, which is the average between the average surface temperature at MDA L (approximately 10°C) and the water table at a depth of 1000 ft (20°C). For all calculations of concentration just above the water table, the simulated vapor concentration times H = 0.57 = C_g/C_l (subscripts refer to gas and liquid) is used to calculate groundwater concentrations at 20°C. Supporting site data for porosities and permeability can be found in Tables II and III of Stauffer et al. (2007, 097871).

C-2.2 Concentration Units

All concentrations in the modeling presented are given in either $ppmv_g$ (parts per million by volume) for gas concentrations or $ppbm_l$ (parts per billion by mass) for water concentrations. The conversion from ppmv to $\mu g/m^3$ for TCA (really ppbm for gas if the density of air is taken as 1 kg/m^3, which is representative of the conditions on the Pajarito Plateau) is

$$1\ ppmv_g = 4600\ \mu g_{TCA}/m^3_{air} = 4600\ ppbm_g$$

If one assumes a water density of 1000 kg/m^3,

$H = (\mu gTCA/m^3_{air})/(\mu gTCA/m^3_{water})$ or

$H = (1/1000)(\mu gTCA/m^3_{air})/(\mu gTCA/L_{water})$ leading to

$H = (1/1000)\ ppbm_g/ppbm_l$

This relation does not generally hold and should not be taken as a rule; it is due only to the density of air on the Pajarito Plateau being approximately 1 kg/m^3, while the density of water is approximately 1000 kg/m^3. This exercise also highlights the need to choose the correct quantities to create the dimensionless Henry's law coefficient.

C-2.3 Conceptual Model

The conceptual model for the TCA plume is that two shaft fields at MDA L, one in the eastern portion and one to the west, generate vapors that diffuse away from the shafts to create a subsurface vapor plume. VOCs in liquid waste or in pore water volatilize to form soil vapor as determined by Henry's law partitioning. It is likely that the previous vapor concentrations were higher than current levels because uncontainerized wastes would evaporate and enter the subsurface more readily than containerized wastes. This effect would be more prevalent at the eastern shaft field because those shafts were used first and disposal operations (e.g., containerization) improved with time. Under natural conditions, the shape and growth of the plume follow a diffusion-driven pattern. Vapor-phase diffusion is a relatively rapid process that is faster than unsaturated liquid flow at MDA L and accounts for the observed migration to depth of VOCs in soil vapor within the Bandelier Tuff (Stauffer et al. 2005, 090537). Changes in atmospheric pressure can impact subsurface air pressures, which in turn can lead to enhanced dispersion of a subsurface vapor-phase plume; this phenomenon is diffusive and can be captured by employing a larger effective diffusion coefficient near the surface in porous units like the tuff (Auer et al. 1996, 069793). Diffusive growth is somewhat buffered by Henry's law partitioning; as the vapor plume migrates, it partitions into uncontaminated pore water, which acts as a sink for VOCs and, in turn, slows the diffusive process. Diffusion theoretically spreads contamination spherically along concentration gradients. However, topography plays an important role in vapor transport at MDA L. With low vapor concentrations along the top and sides of the mesas, the steepest concentration gradients are closer to the surface, which leads to preferential vapor transport toward the external mesa boundaries and yields releases to the atmosphere, as observed from the surface flux survey conducted at the site (Trujillo et al. 1998, 058242). Asphalt, which currently covers the site, decreases this mechanism somewhat because it blocks the vapors from exiting at the surface. Diffusive gradients also spread soil vapors downward toward the regional aquifer. Shallow vapors will tend to diffuse out of the mesa at the surface while deeper vapors may diffuse downward. Uniform diffusive behavior is thought to occur in the high porosity tuff.

It is uncertain whether vapor transport through the low-porosity, fractured Cerros del Rio basalt can be captured as uniform diffusive spreading or if transport will follow preferential pathways. Open,

interconnected air pathways probably occur between the top of the Cerros del Rio volcanic series and the regional aquifer beneath MDA L. However, any such open pathways would require a driving force to accentuate transport. Because the density of air with very low concentrations of VOCs is not sufficient to drive significant density driven-downward flow, the only other driving force for flow in preferential pathways would be advection of air. Subsurface air pressures measured in the basalt show that the pressures there more closely follow atmospheric pressure changes than do pressures in the tuff units (Neeper 2002, 098639). This has been attributed to a distant connection between the fractured basalt and the surface that may enhance dispersive vapor transport within the basalt. Such barometric pumping of air in the basalts may provide a driving force to cause increased spreading of vapors within the fractures of the basalt. Lithologic logs for well R-54, 1000 ft west of MDA L, indicate that 372 ft of Cerros del Rio volcanics overlie 80 ft of basaltic sediments in the vadose zone near MDA L. The Cerros del Rio sequence is a stratified stack of massive lava flows separated by interflow breccias, cinder and scoria beds, and volcanic sediments. This volcanic sequence is made up of approximately 50% lavas and 50% porous interflow deposits. Lava flows (generally <20 ft thick) are separated by interflow breccias and thick deposits of porous cinder and scoria. Borehole video logs indicate the lavas are variably fractured. Air pathways in these volcanic rocks include high- and low-angle fractures in the massive lava flows and open interconnected pores in the breccias, cinders, scoria, and sediments. The basaltic sediments beneath the Cerros del Rio rocks consist of porous sands and gravels.

During active SVE, advective air flow also controls vapor-phase migration. Vacuum applied during extraction pulls air containing vapors toward and out of the borehole. During the SVE test, vapors were extracted near the two higher-concentration areas near the shaft fields. This removal of higher concentration vapors can slow subsequent diffusion away from the source areas or even reverse gradients toward the extraction boreholes following SVE.

C-2.4 Model Formulation

The porous flow simulator, the Finite Element Heat and Mass (FEHM) transfer code, is used for all calculations presented in this appendix (Zyvoloski et al. 1997, 070147). Briefly, the simulations account for plume growth under various site conditions. Three periods of simulation lead to the model results presented in this appendix. The first two periods were conducted earlier and form the basis for the current study. In order to judge the quality of the model throughout the modeling process, spatially-dependent, TCA concentration data from the site and the predicted (i.e., modeled) concentrations are compared through linear regression.

1. Waste emplacement through 2006: This model accounts for diffusive plume growth from the shaft fields according to the timing of original waste emplacement (e.g., the eastern shafts were filled before the western shafts), and follows plume growth through time starting in 1975 and ending in 2006, before the start of the SVE pilot test (Stauffer et al. 2005, 090537). Higher concentrations near the shaft fields (up to 15,000 ppmv near the eastern shaft fields and 6000 ppmv near the western shaft field) are used initially to represent potential uncontainerized leaks, which match early monitoring data. These source concentrations are decreased over time (to 1000 and 2000 ppmv at the eastern and western sources, respectively) to match site data, and the upper boundary condition was modified at the appropriate time to account for the addition of asphalt pavement (Stauffer et al. 2005, 090537). Diffusion coefficients were calibrated during this modeling period. No advective transport of TCA from flow of pore water or subsurface air is included in the initial diffusion model, and therefore, the numerical solution did not require the input of rock permeability values. Henry's law partitioning is included to represent the interaction of the TCA in the vapor plume with pore water.

2. The 2006 SVE test: This model starts with the model input parameters and the TCA concentration distribution in 2006 developed in the first phase and then imposes the conditions of the 2006 SVE test (section 2.5.4 of the CME) to determine the subsurface effects of the test. The numerical grid was updated to add the two extraction boreholes used in the test. The model was calibrated to data gathered during the SVE test (i.e., applied vacuum, extraction rate, and TCA extraction concentration as functions of time) to generate permeability distributions. Whereas the diffusion model discussed above did not consider air movement and did not require permeability distributions, modeling of the SVE test requires these to properly model vapor migration. Two different permeability distributions were developed during this exercise, as discussed later, one using a manual calibration (HAND) and another using an optimization routine (AMALGAM). This modeling period also looked at hypothetical plume growth under differing scenarios, including significant increases in the source term and longer-term effects of SVE (Stauffer et al. 2007, 097871). The current study actually revisited the permeability calibration performed in this period because of an enhancement made to FEHM, as explained in item 3 below.

3. Current study: The current study starts with the model setup and parameters determined during the first two modeling periods and the plume distributions developed in the second period to predict forward to current and future conditions. Initially, diffusive plume growth following the 2006 SVE test is modeled to compare with current data. In addition, future plume growth is predicted based on scenarios that include 3 yr of SVE, asphalt removal, and uncertainty in the diffusive behavior of the Cerros del Rio basalt. These scenarios are discussed below.

As described by Stauffer et al. (2007, 097871), a novel wellbore mesh approach that embeds a two-dimensional (2-D) radial wellbore solution into a three-dimensional (3-D) mesh is used in the model to accurately capture the applied vacuum in the vapor extraction wells. This algorithm was improved during the last 3 yr to better represent the coupling term between the 2-D wellbore and the 3-D mesh. This difference in the FEHM formulation required recalibration of the estimates of permeability in the Bandelier Tuff to again match the SVE pilot test data. The recalibration is explained in more detail below.

The 3-D simulation domain is described in detail by Vrugt et al. (2008, 104951) and has not been modified for the work presented in this appendix. Boundary and initial conditions are discussed in detail by Stauffer et al. (2007, 104950) and Vrugt et al. (2008, 104951). These same boundary conditions were used for the test case discussed later, but additional boundary conditions were also explored. The data-model regression for the starting point of the current round of simulations is quite good for the time period of 1975–2006 (pre-SVE pilot test) with an r^2 correlation coefficient of greater than 0.89. The model overestimates the vapor concentration at depths greater than approximately 250 ft below ground surface (bgs), but only by a few parts per million. The boundary conditions at the bottom and sides of the model domain may be impacting this result. At borehole 54-02022, concentrations are slightly higher than the model predicts; however, because surrounding boreholes (54-02034 and 54-02001) show relatively good data-model correlation, no further refinement was made to try to better calibrate concentrations at this borehole. The goal of this calibration is not to match every point in space exactly but to have a model that captures a large percentage of the concentration data and the overall behavior of the vapor plume without spatial and temporal bias. This exercise gives confidence that the initial conditions for the 3-D SVE simulations are good representations of the actual plume beneath MDA L in 2006. Figure C-2.4-1 shows a horizontal slice of TCA concentrations in the vapor phase for the initial state (pre-SVE pilot test), and the two source areas located at the eastern and western shaft fields are evident in the figure.
Table C-2.4-1 contains all porosity, saturation, and diffusion coefficients used in the modeling. These parameters were fixed based on previous modeling and are not part of the following calibration exercise.

It is important to note that no-flow boundary condition on the sides of the mesh and at the bottom of the domain lead to reduced contaminant flux vertically (toward the regional water table) and laterally (toward the side model boundaries) as well as to higher concentrations at depth in the long-term simulations. Higher concentrations at the bottom of the model lead to lower concentration gradients, which are the driving force for mass flux. Therefore, a no-flow bottom boundary condition will not yield the highest predicted mass flux to the aquifer. The side boundary effects could be rectified by using a larger mesh that allowed the plume to expand laterally. Changing the side boundaries was not part of the scope of the current study. The appropriate bottom boundary is more difficult to determine. A single simulation is presented that employs a nonflowing, 2-m mixing zone as a bottom boundary condition rather than a no-flow boundary. However, a flowing groundwater table might allow VOC to leave the domain at an appropriate rate but was not simulated for this study. The models described in this report have evolved over more than a decade and were designed initially to examine plume growth and determine monitoring requirements. They evolved further to include extraction wells so that the effects of SVE could be determined. The model domain is sufficient to examine the behavior within the main body of the TCA plume. However, the domain may not be sufficient to fully examine plume growth toward the regional aquifer, and the effect of the bottom boundary condition is left as an uncertainty in this study.

The long-term water-phase infiltration rate to the regional aquifer at MDA L is thought to be on the order of 0.001 to 0.01 m/yr, and because this flux is not expected to impact the simulation results, unsaturated water flow is not included in the simulations presented. Also, the effects of naturally occurring air flow from barometric pressure or temperature changes at the surface and within the vadose zone are not explicitly included. Rather, these effects are diffusive processes that are included through calibration of the effective diffusion coefficients to vapor concentrations.

Most of the simulations discussed in sections C-3.0 and C-4.0 use a no-flow bottom boundary condition and the base-case diffusion coefficient for the Cerros del Rio basalt shown in Table C-2.4-1. The effects of a higher diffusion coefficient for the basalt are also explored.

C-3.0 MODEL CALIBRATION

C-3.1 Calibration Goals

The goals for calibration of the permeability fields, as described by Vrugt et al. (2008, 104951), are as follows:

> *"The goal of the calibration is not to find exact fits to all of the test data, but to find the set of parameters that will approximate the overall data trends. This is a vital point of the modeling study. Given the inherent uncertainty in the subsurface, we will never be able to exactly match all of the historical data. We do, however, strive to recreate as many aspects of the test as possible given constraints on the number of simulations, the number of adjustable parameters (horizontal and vertical permeability), the spatial variability of parameters, and uncertainty in the applicability of representing the rock units in the mesa as single continua with average fracture/matrix properties. The two most robust data sets that we have for each test are the concentration versus time in the extraction stream and the pressure at the top of the wellbore. The primary calibration target is the extraction concentration, while the pressure at the top of the hole is fixed to the average value for both the East and West tests. A final calibration target is to have the simulation maintain the approximate flow rate calculated from the data during the test period."*

These same goals drive the current recalibration of the SVE pilot test permeability fields used in the simulations of long-term plume behavior. The scope of the current modeling study was to build on existing work. Thus, no attempt was made to resimulate this system using automated calibration techniques that can yield insight into the interplay of the many nonlinear adjustable parameters found in this model. However, models using parameters based on reasonable average properties combined with expert knowledge of a particular site can lead to data-model correlations that lie well within the acceptable posterior distribution of potentially 1000s of parameter combinations that can be found using automated methods.

C-3.2 Recalibration Details

Original calibration of the 3-D model used to simulate the SVE pilot test was performed using the AMALGAM parallel optimization algorithm of Vrugt et al. (2008, 104951). Additionally, in 2007, a hand calibration (HAND), also known as trial-and-error or manual calibration, was completed that yielded results that were able to achieve many of the same calibration goals. To help understand uncertainty from the nonunique nature of solving this complex inverse problem, both calibration sets are carried forward in this study.

Targets for calibration are to match both (1) the pressure versus flow rate at the top of the eastern and western SVE pilot test boreholes during active extraction and (2) the concentration of TCA measured in the exhaust gas from each borehole (Stauffer et al. 2007, 097871; Vrugt et al. 2008, 104951). The values used in the calibration for flow rate and vacuum are detailed in Table C-3.2-1. As calibration parameters, the upper four geological units depicted in Figure C-3.2-1 are used. To simulate the effects of near-vertical fractures, separate values for the horizontal and vertical permeability were optimized for each rock type with the AMALGAM calibration method. The HAND calibration method uses a single value for permeability in the x, y, and z directions. The domain was split in half along a north-south line midway between the eastern and western extraction boreholes, and different permeability fields were found for each half of the domain. In this study, as described above, the two models (AMALGAM and HAND) needed to be recalibrated to adjust for the higher impedance in the updated wellbore algorithm recently added to FEHM. It was assumed that a constant multiplier could be used to adjust the permeability values previously found, and this approach was used to generate the data-model plots shown in Figure C-3.2-2. Both calibrated permeability fields yield reasonable fits to the TCA exhaust concentrations measured during the test while maintaining the correct flow rate for a given fixed wellhead pressure. In fact, the HAND fit is arguably just as good a fit as the AMALGAM fit for the western test, while for the eastern test, the HAND fit under predicts a bit more than the AMALGAM fit over predicts. Again, it should be noted that these calibrations are made to approximate the in situ processes and are not expected to perfectly match the full set of data points. Final values of permeability are shown in Tables C-3.2-2 and C-3.2-3. The multipliers for the recalibration for each case are 1.29 and 1.18 for the eastern and western permeability distributions, respectively, for the ALALGAM calibration and 1.46 for both the east and west permeability distributions for the HAND calibration. Permeability values for the asphalt, borehole, and casing were not adjusted in this recalibration and are the same as in the previous study (Vrugt et al. 2008, 104951). With the newly recalibrated permeability values, the next step is to determine if the model can be validated against the current 2010 vapor concentration data.

C-4.0 MODEL TESTING

To test the models, the post-2006 SVE simulations for both AMALGAM and HAND were next run to the year 2010. By comparing with TCA concentration data collected during 2009 and 2010 pore-gas monitoring, the model results can be checked to determine whether the model predictions honor the

spatial and temporal development of the TCA plume approximately 4 yr after the SVE test. The concentration data are based on statistical averaging of the most recent four sampling quarters, which span the period from the third quarter of fiscal year (FY) 2009 to second quarter FY2010 (LANL 2010, 109955). VOC data for 173 monitoring ports in 28 pore-gas monitoring boreholes are used to generate the data set, which is a combination of field screening and analytical data sets. If a given port has analytical data, those concentrations are used. A correlation was established between field-screening data and analytical data from sampling ports that have both measurements available. The correlation was applied to field-screening locations without analytical data to form a more spatially complete data set.

The 2000–2006 component of the original diffusion simulations found that fixed concentrations of 2000 ppmv and 1000 ppmv in the western and eastern source regions, respectively, provided a good match to field data during that time. These fixed concentrations were therefore used from the end of the 2006 SVE pilot test to simulate the plume rebound to the year 2010. Figure C-4.0-1 shows the data-model correlation for both the AMALGAM and HAND permeability sets. In both cases, the correlation is good, with an r^2 of 0.89 and a regression line close to the 1:1 data-model correlation. There are outlier points on both regression lines that neither model fits, but the fact that a majority of the 173 monitoring points in 28 separate monitoring wells within the plume closely align suggests that the model is able to reasonably predict future plume behavior. This model testing was truly blind; no parameters were adjusted to make the model fit the 2010 data set.

There is a set of measurements for which neither model matches the observed concentrations, including a few points on the western side of the site where the modeled concentrations are consistently high. To address this, the fixed concentration on the western side was lowered from 2000 ppmv to 1000 ppmv, and the models were rerun. These simulations yield a slightly better fit for both permeability sets; the net results are quite similar to the test case demonstrated in Figure C-4.0-1 (e.g., the regression lines and r^2 values). Because the two sets of simulations (using the differing source concentrations) are so similar, this demonstrates the uncertainty associated with contaminant concentration at the source. Both simulations (using the differing source concentrations) are carried forward into the long-term (100-yr) analysis section, with the second set denoted by a B in the figures.

Next, the data were analyzed to identify likely spurious points, which can be caused by sampling errors or leaky sampling ports. Data were removed from the 173-point concentration data set if large drops in concentration were seen over the span of 10 to 20 ft vertically in a single borehole. Also, data from wells 54-01015 and 54-01016 were removed on the recommendation of the field sampling team who noted that the ports were blocked. This deletion led to a total of 17 points being removed for the simulations. Figure C-4.0-2 shows the data-model regression for the AMALGAM SVE case with fixed concentrations of 1000 ppmv at both the eastern and western source regions. The fit has an r^2 of 0.93, and the few remaining outlier points are found to follow no specific trend. Table C-4.0-1 lists the measured and modeled concentrations for each point on this figure and can be used to match points to monitoring locations. Again, the goal of the modeling is not to match every observed concentration but to show that the models capture the bulk of the transport processes over the span of 35 yr, including the period of active SVE in 2006 without spatial and temporal bias.

Finally, to evaluate whether the shafts are still sources of contamination for the vadose zone, a simulation using the AMALGAM permeability sets was run for which no source of TCA is included following the SVE test (mid-2006 until 2010). The data-model correlation for this case does not cluster around the 1:1 line as well as the simulations with the continuous sources, the model significantly underpredicts concentrations, and the r^2 is reduced to 0.74. This poorer fit indicates that the shafts are likely a continuing source of TCA vapors.

C-5.0 DECISION ANALYSIS

This section discusses how the modeling results can be used to guide decisions about possible remediation alternatives and designs. Results are first presented to examine how running the available SVE system might affect the extent of the plume in the future. Next the plume is allowed to evolve to the year 2110, 100 years in the future, and concentrations of TCA in the unsaturated zone just above the regional water table are presented. Variations to the 100-yr simulations are explored including changes caused by removing the asphalt that covers the site in 2014, varying the vapor-phase diffusion coefficient in the basalt, and the impact of SVE performed in 2011–2013 on predicted long-term plume growth.

C-5.1 SVE Impact 2011 to 2013

This section presents results from simulations of SVE run in stages from 2011 through 2013 as a demonstration of a potential SVE remedy. The western SVE system is first run for 30 d at 85 standard cubic feet per minute (scfm), followed by a rest period of 30 d; then, the east SVE system is run for 30 d at 85 scfm followed by a rest of 30 d. This cycle is repeated for 3 yr. Figure C-5.1-1 shows how the total TCA mass (including both vapor and pore water contributions) drops from near 900 kg in 2010 to 400 kg in 2013 for both permeability cases. Also shown in this figure is the SVE mass removal rate for the HAND parameter set using 150 scfm in both extraction boreholes. The higher extraction rate of 150 scfm was chosen because it is close to the operational limit of the available extraction system. Nearly doubling the flow rate in the extraction boreholes during the 3-yr simulation removes only an additional 100 kg of mass from the plume. Figure C-5.1-2 shows how the system responds at a depth of 80 ft for the AMALGAM and HAND permeability sets. Figures C-5.1-3 and C-5.1-4 show the response on a cross-section through the source regions along the axis of the mesa. The location of the cross-section can be seen on Figure C-5.1-2. Both simulations respond nearly identically in terms of quantity and location of TCA removal, showing that the two permeability structures pull mass from similar regions of the model domain. The figures show higher TCA concentrations and at greater depth present near the eastern shafts from previous higher concentration releases assumed for the eastern shafts that have remained in the domain. The initial state in these figures looks very similar to those in Appendix B (Figures B-3.1-1 and B-3.1-3, which are interpolated plume maps based on recent monitoring data).

These results suggest that to remove more of the current TCA mass, additional SVE wells may be needed on both the eastern and western sides of the site, the current system will need to be run at a higher vacuum for a longer time, or deeper extraction ports might be beneficial. However, the current arrangement is capable of removing between 53%–63% of the current mass depending on the extraction rate. It was shown previously that a larger radius of influence can be achieved with longer extraction times, and refinement of these calculations might be warranted if SVE is chosen as a corrective measure (Vrugt et al. 2008, 104951). The predicted order of magnitude of the mass removal and the spatial and temporal effects of SVE on the plume are expected to be reasonable approximations of the general behavior of the plume under conditions similar to those used during calibration.

The assumptions for the simulations that consider the long-term effects of SVE on the plume are substantially different than the SVE operation proposed in Appendix I. The modeled scenario includes 3 yr of active SVE using two boreholes extending to 215 ft with 30-d alternating extraction periods followed by 30-d rebound periods at the two boreholes. The proposed SVE scheme for Alternatives 2A, 2B, 3A, and 3B recommends six extraction boreholes with extraction intervals extending to 200 ft and three additional boreholes with extraction intervals in the Cerro Toledo interval (250 to 300 ft bgs); extraction periods of 30 d with 30-d rebound periods are recommended until shutdown criteria are met. The additional extraction boreholes and extraction intervals proposed in Appendix I would presumably remediate larger portions of the plume than presented in these modeled results.

C-5.2 Long-Term Impact Near the Regional Water Table

Figure C-5.2-1 shows the time-dependent calculated concentration of TCA in vadose zone pore water at a node that is located below the eastern source area and just above the water table for a variety of simulation scenarios. These concentrations do not represent the concentrations in the regional aquifer; in these simulations, the concentrations in the regional aquifer are zero because the bottom boundary of the model is defined as a no-flow boundary (except in one case). This node has the highest predicted concentrations for all of the simulations caused by the assumed higher concentration source at the eastern shaft field early in the simulation, as discussed in section C-2.4. The effect of enhanced diffusion through the Cerros del Rio basalt is explored; simulations use the base case diffusion coefficient of 3×10^{-6} m^2/s, the free air diffusion coefficient of TCA (7.8×10^{-6} m^2/s), and 2 times the free air diffusion coefficient of TCA (1.56×10^{-5} m^2/s). The figure shows predicted vadose zone concentrations starting in 1975 for eight different cases:

- Two cases, using the HAND permeability set with the asphalt removed (red line) or the AMALGAM permeability set with the asphalt in place (orange line); no SVE from 2011 to 2013; base case diffusion coefficient for the Cerros del Rio basalt; 1000 ppmv fixed source at eastern and western shaft fields; no-flow bottom boundary;
- Two cases with the asphalt removed after 3 yr of SVE ,using the AMAGAM (blue line) or HAND (green line) permeability sets, base case diffusion coefficient for the Cerros del Rio basalt; 1000 ppmv fixed source at eastern and western shaft fields; no-flow bottom boundary;
- Two cases with the asphalt removed, using the AMAGAM permeability set (no SVE from 2011 to 2013); 1 times the free air diffusion coefficient (light blue line) or 2 times the free air diffusion coefficient (peach line) in the basalt to represent enhanced diffusion/dispersion because of uncertain transport through the basalt; 1000 ppmv fixed source at eastern and western shaft fields; no-flow bottom boundary; and,
- Two cases with the asphalt removed, using the AMAGAM permeability set (no SVE from 2011 to 2013); 2 times the free air diffusion coefficient in the basalt; 1000 ppmv and 2000 ppmv fixed sources at eastern and western shaft fields, respectively; no-flow (blue dotted line) or nonflowing, 2-m mixing zone (purple line) for the bottom boundary condition.

The following observations can be made:

- The first two cases indicate little difference in pore water concentrations at the base of the model with the removal of the asphalt. Near the surface, however, removal of the asphalt enhances TCA flux from the surface and reduces downward flux. This change does not manifest in the predicted concentrations at the base of the model for awhile. The deflection upward in the curve around 135 yr (i.e., the year 2110) for the case where the asphalt remains in place shows the effect, and if the simulation were run for longer, the change would become more apparent.
- The next two cases show that 3 yr of active SVE can significantly (~40% for the cases shown at ~135 yr (i.e., the year 2110) decrease the predicted concentration at the base of the model compared with the first two cases that don't include SVE. The slopes of the breakthrough curves are lower because the simulated SVE has extracted some of the residual higher-concentration plume, which was assumed earlier in the simulation (section C-2.4), remaining from the higher concentration at the eastern source.
- The next two cases illustrate that a higher assumed diffusion coefficient for the basalt significantly advances the predicted concentrations at the base of the model.

- The last two cases illustrate that the assumed bottom boundary condition affects the concentration predicted at the base of the model. The maximum predicted pore water concentration occurs for the case that uses the highest basalt diffusion coefficient and uses the non-flowing, 2-m mixing zone, which causes steeper simulated gradients in the model.

In all cases, the simulations predict that concentrations will continue to increase because diffusion from the continuous source leads to continued plume growth. This prediction is based on the assumption that the source remains constant. These long-term predictions for behavior of the plume near the water table are more uncertain than the shorter-term predictions in the high concentration portions of the plume near the shafts. Model uncertainties are from the unknown diffusive characteristics of the basalt and the effect of the bottom boundary condition on flux toward the water table.

C-6.0 CONCLUSIONS

The calculations presented in this appendix indicate that SVE can be an effective remedial alternative for vapor-phase VOCs in the vadose zone at MDA L. This conclusion is in agreement with the SVE pilot studies deployed at MDAs L and G (LANL 2006, 094152; LANL 2010, 109657).The simulated effects that SVE may have on mass extraction of the main portion of the TCA plume are expected to be reasonable approximations of the general behavior of the plume under conditions similar to those used during calibration, and the model can be used to inform SVE design. There are less data and more uncertainty related to predicted plume growth toward the regional aquifer, and although these predictions are uncertain, they provide general information about the effects that SVE may have on downward plume growth.

This appendix examines several scenarios involving transport of TCA vapors in the subsurface at MDA L. Two permeability parameter sets obtained using two different calibration techniques were carried through the analysis to show how uncertainty in the permeability affects the model results; and, as expected, the permeability uncertainty impacts the SVE simulations but does not affect the pre− and postextraction simulations. Because the primary transport mechanism in the tuff over long time periods is expected to be diffusive, the permeability structural differences are relevant only during the periods of simulated SVE (2006; and 2011 to 2013). Both permeability sets yield relatively good matches to both flow rate versus suction and to extraction concentrations for both the eastern and western SVE tests.

The model was tested by running a blind simulation in which the assumptions and parameters were not varied, and the simulations were continued through the year 2010. Results show that both permeability sets that were calibrated to model the 2006 SVE pilot test lead to postextraction contaminant distributions in the year 2010 that are relatively good fits to the measured TCA concentration data from 173 monitoring points in 28 separate wells. The model testing provides some confidence that the conceptual model and numerical implementation capture the bulk of the plume behavior under both diffusion-controlled (pre– and postextraction) and advection-controlled (extraction) conditions.

The two permeability sets were used to create model predictions with and without SVE in the years 2011 to 2013. The models predict that 53% to 63% of the current TCA mass can be extracted over a 3-yr period based on the assumed extraction rates and extraction boreholes. In addition, the simulations indicate SVE performed during the assumed period of 2011 to 2013 would have a positive effect on the long-term plume behavior and significantly reduce breakthrough concentrations at the water table over the next 10 to 100 yr. Much of this benefit is due to extraction of higher concentration regions of the plume that are due to former higher concentration releases. With these higher historical concentrations remediated, concentrations should not rebound to previous high values. The simulated order of magnitude of the mass removal and the spatial and temporal effects on the plume are expected to be a

reasonable approximation of the general behavior of the plume under conditions similar to those used during calibration. These models can be used to provide input on other remedial alternatives, potential SVE design criteria (e.g., different extraction intervals or timing), and information on monitoring design (e.g., frequency and placement).

If SVE is chosen as a remedial action for MDA L, these models can be employed to optimize the system design to meet remediation goals during the corrective measures implementation phase and during extraction based on field performance. For example, the model can be run to determine the effectiveness of the SVE design presented in Appendix I and to determine if a different extraction scheme may yield even better performance. Potential design parameters that can be optimized include, but are not limited to, the locations and spacing of extraction wells, stratigraphic zones to be targeted, extraction rate, extraction frequency, and duration for SVE.

Some model uncertainty was addressed by varying the fixed source strength in the western source area from 2000 to 1000 ppmv, a change that was found to give data-model correlations that were similar and within the range of previously-determined, likely fixed concentrations in this source region. It is important to note that the conceptual assumption that the source can be defined as a constant-concentration source is also uncertain. Concentrations in the source region will likely decrease with time as the source diminishes; this is supported by site data. However, both the site data and the model indicate that the shafts are still releasing TCA vapors to the subsurface.

The model results are less certain for predictions of plume migration toward the regional aquifer than for behavior near the surface. The predictions illustrate that the vapor plume will continue to diffuse downward with time and eventually may reach the regional aquifer depending on actions taken nearer the surface. Vapor transport mechanisms through the Cerros del Rio basalt were identified as key uncertainties that can affect plume growth near the base of the plume. Also, the assumed bottom boundary condition used in the model affects predicted flux toward the regional aquifer. Using a zero-concentration boundary enhances plume migration toward the aquifer even more than demonstrated in this appendix. Because there is uncertainty related to plume migration toward the regional aquifer, either some remediation of vadose zone vapors nearer the source are recommended (such as recommended under Alternatives 2 through 4), or further work to decrease these uncertainties is warranted.

C-7.0 REFERENCES

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

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

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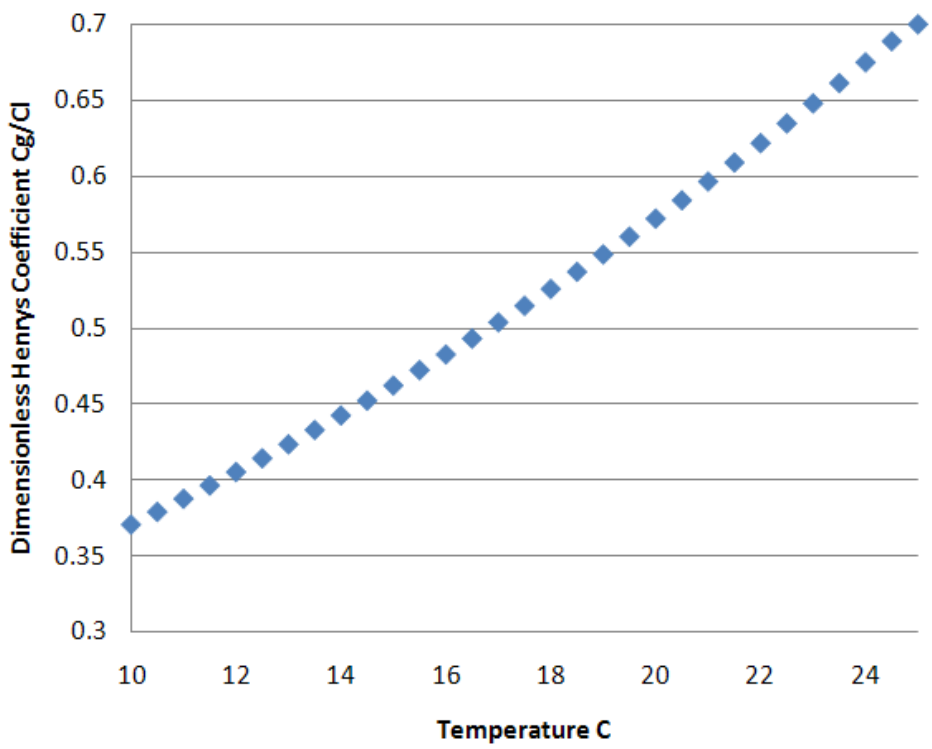
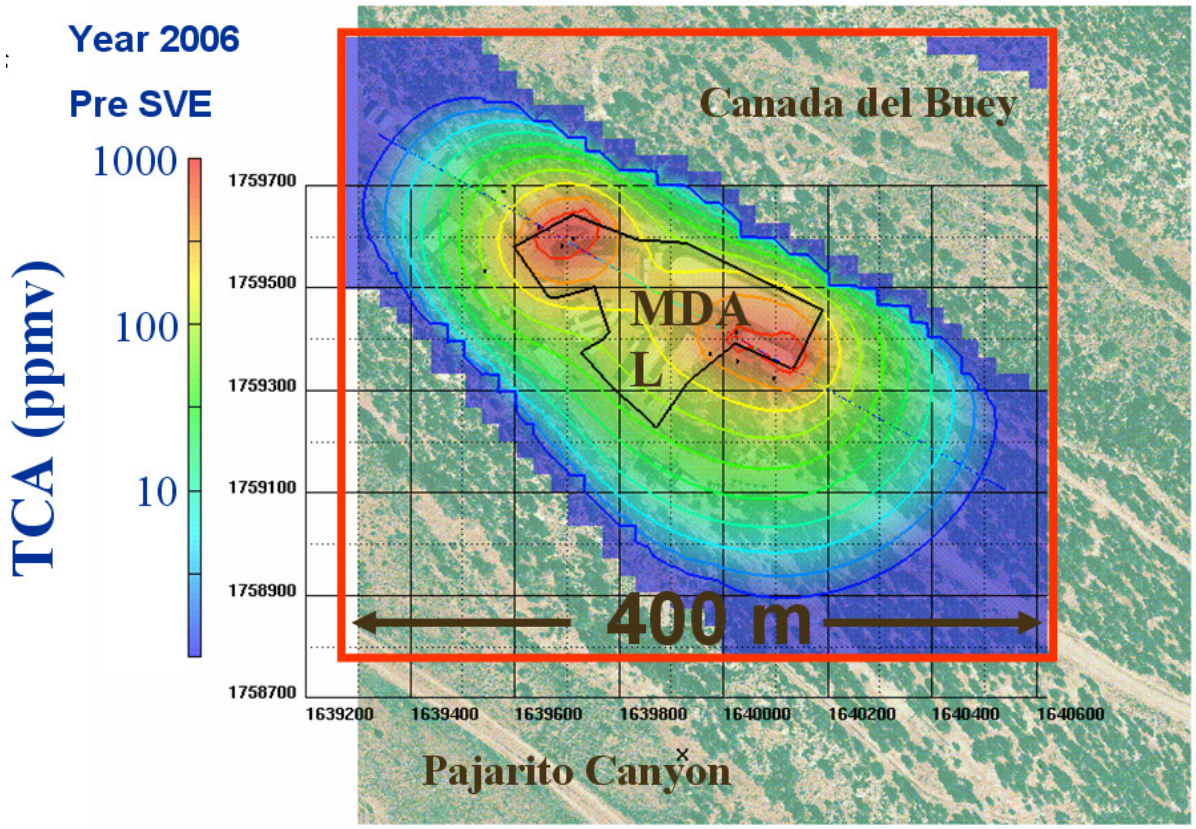
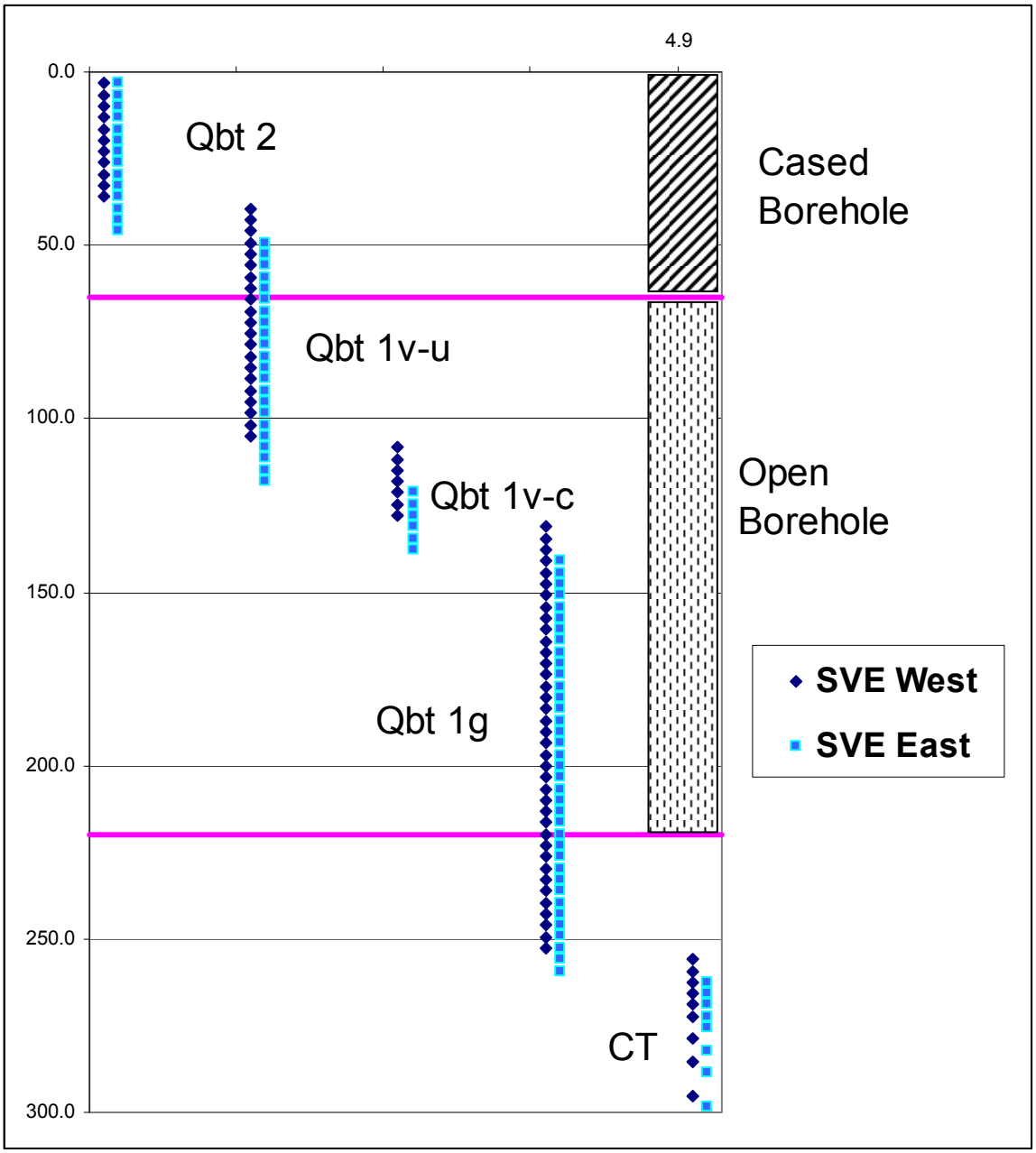


Figure C-2.1-1 Temperature dependence of the dimensionless Henry's law coefficient for TCA



Notes: The lateral extent of the numerical grid is shown by the red line. The aerial photograph shows the relationship of the site boundary to Pajarito Canyon and Cañada del Buey.

Figure C-2.4-1 Concentration contours of TCA on a plane 80 ft bgs in 2006 before the SVE pilot test



Note: Axis displays depth (ft bgs).

Figure C-3.2-1 Site stratigraphy for the eastern and western SVE boreholes in relation to the borehole construction

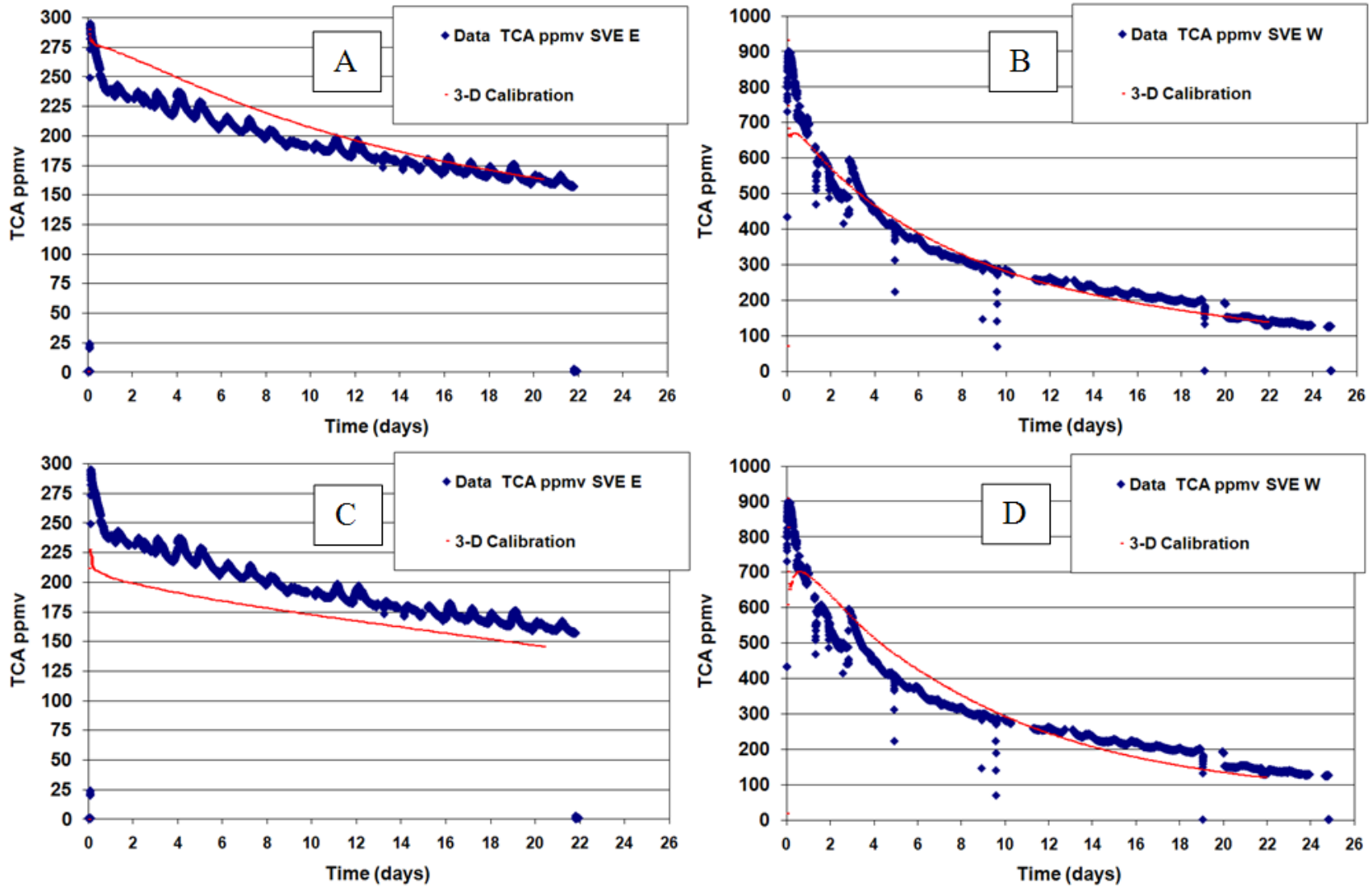
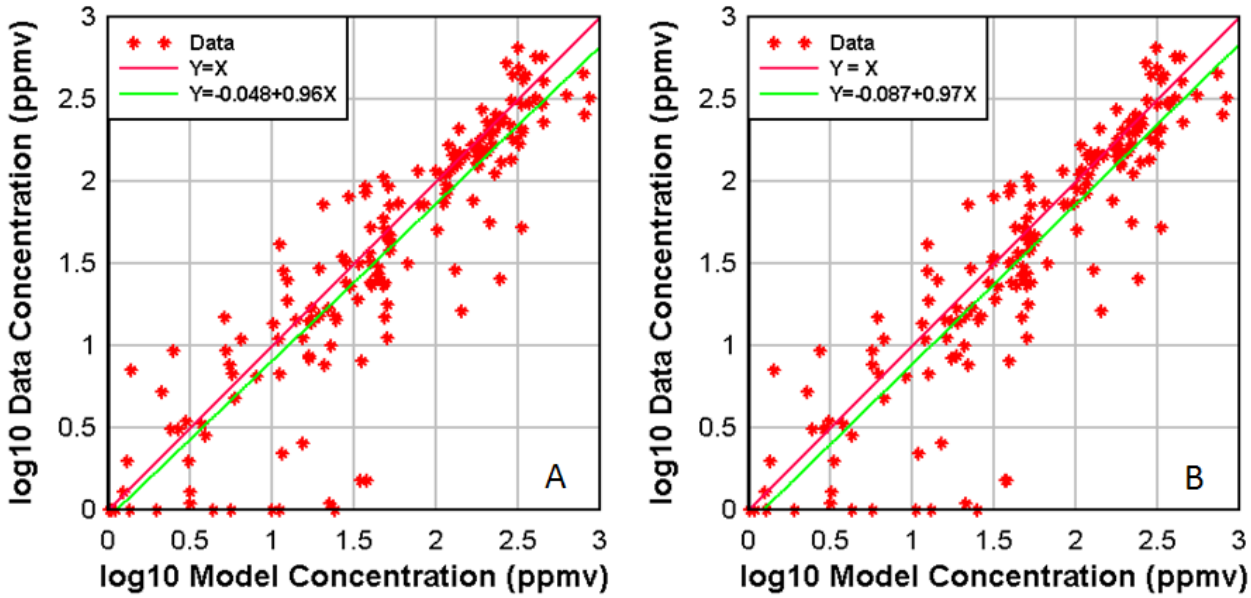
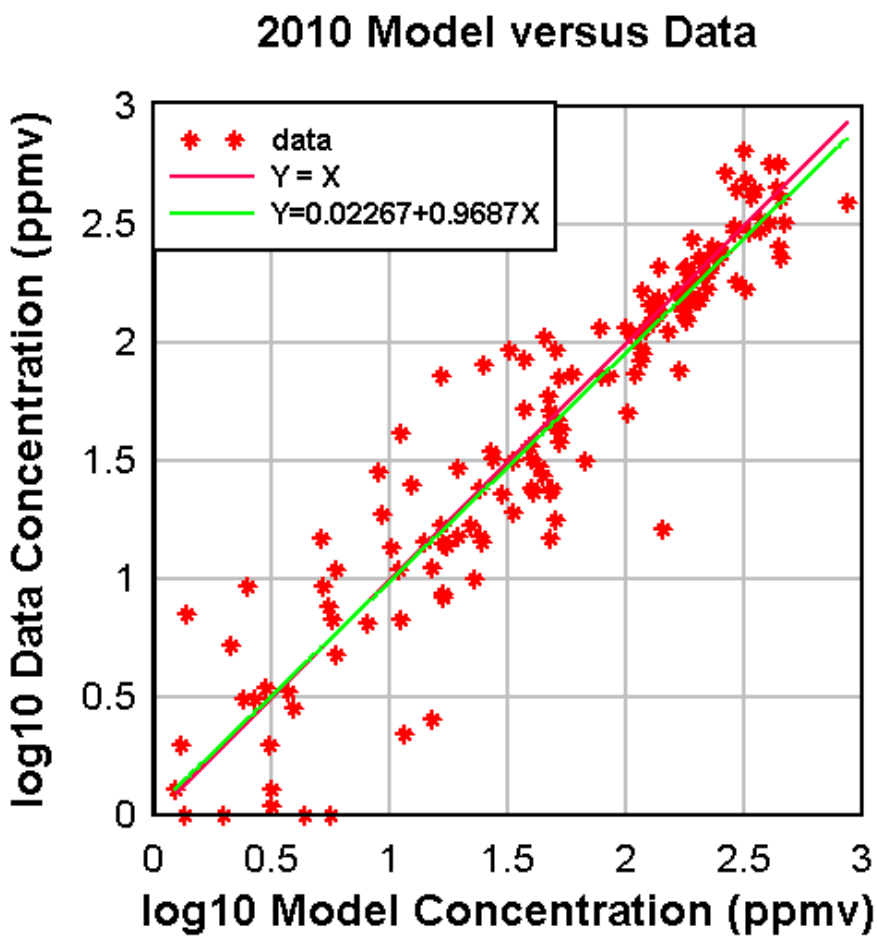


Figure C-3.2-2 Recalibrated concentration versus time TCA extraction concentration results for AMALGAM permeability distributions for the (A) eastern and (B) western SVE experiment and for the HAND permeability distributions for the (C) eastern and (D) western SVE experiment



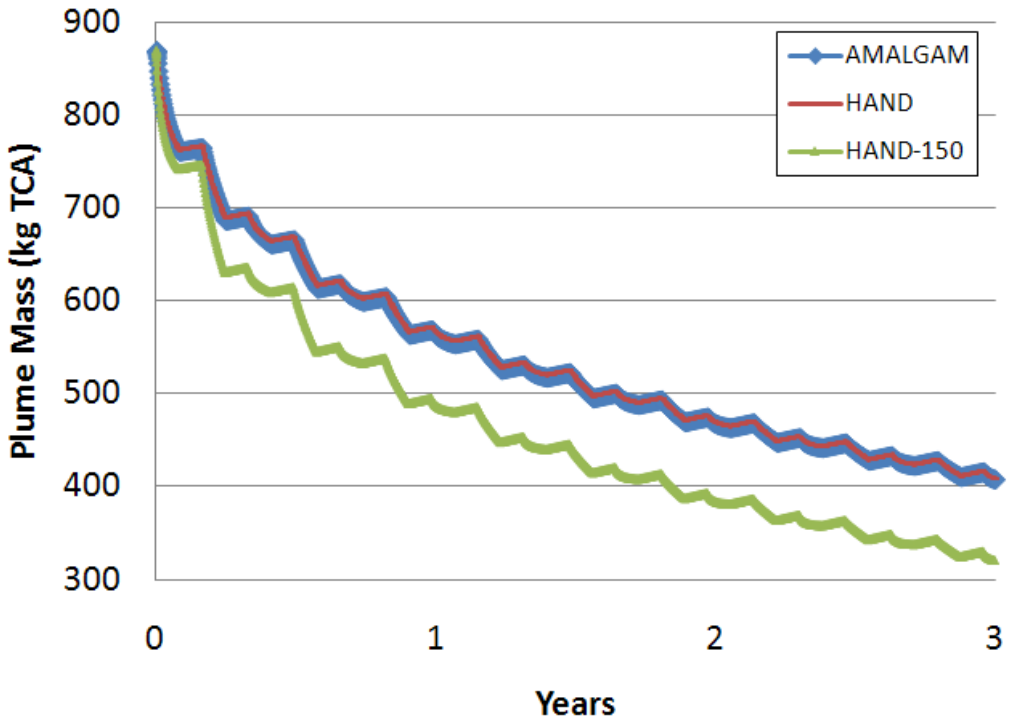
Note: Standard error about the line in both cases is approximately 0.35.

Figure C-4.0-1 Correlation of TCA concentration (log-scale) for modeled results versus measured data in 2010, with the western source at a fixed vapor concentration of 2000 ppmv and the eastern source at a fixed vapor concentration of 1000 ppmv for (A) AMALGAM (r^2 = 0.89) and (B) HAND (r^2 = 0.89)



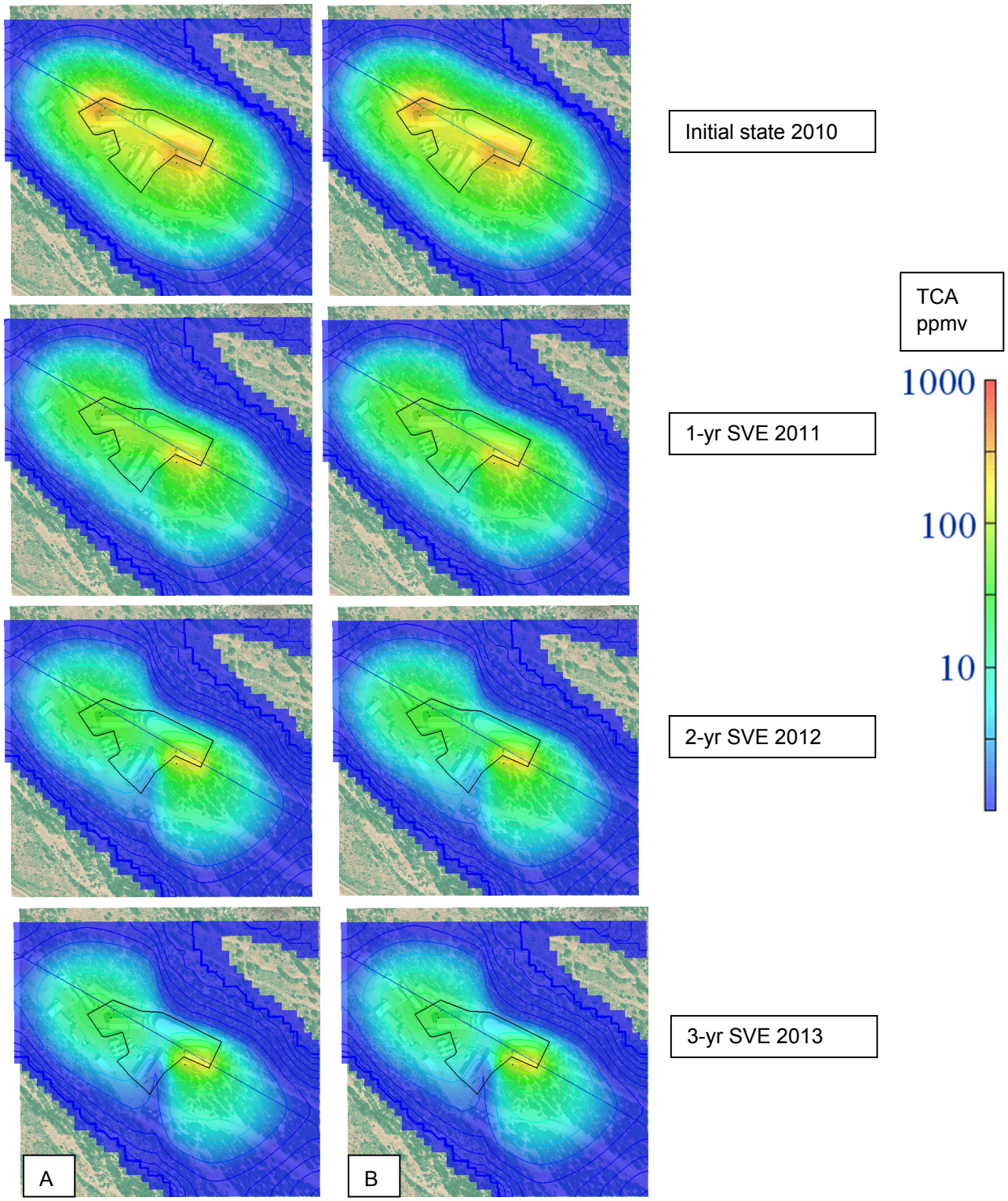
Notes: Data have been reduced to remove likely erroneous data (17 points removed). The green curve fit has an r^2 of 0.935 and a standard error about the line of 0.25.

Figure C-4.0-2 Correlation of TCA concentration (log-scale) for modeled results versus measured data in 2010, with both the western and eastern sources at fixed vapor concentrations of 1000 ppmv using AMALGAM simulation



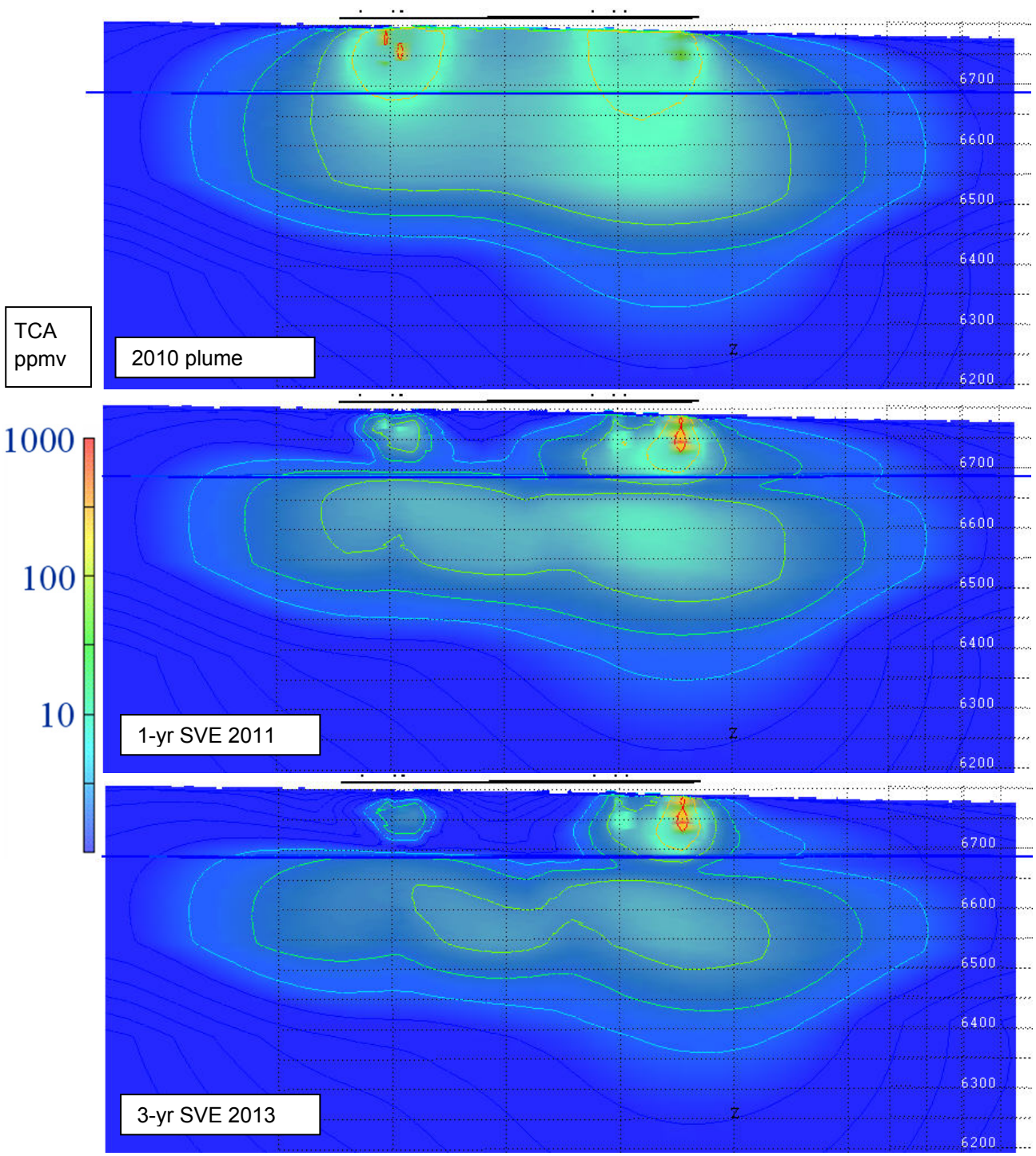
Notes: The TCA mass estimate presented in Appendix B is 428 kg within the region of the plume where vapor concentrations exceed 423,000 µg/m^3. However, when the data-based mass estimate incorporates concentrations exceeding 42,300 µg/m^3, the mass estimate increases to 821 kg—in good agreement with the model-predicted mass in 2010.

Figure C-5.1-1 SVE mass removal 2011–2013 for both AMALGAM and HAND calibrations at 85 scfm and for only the HAND calibration at 150 scfm.



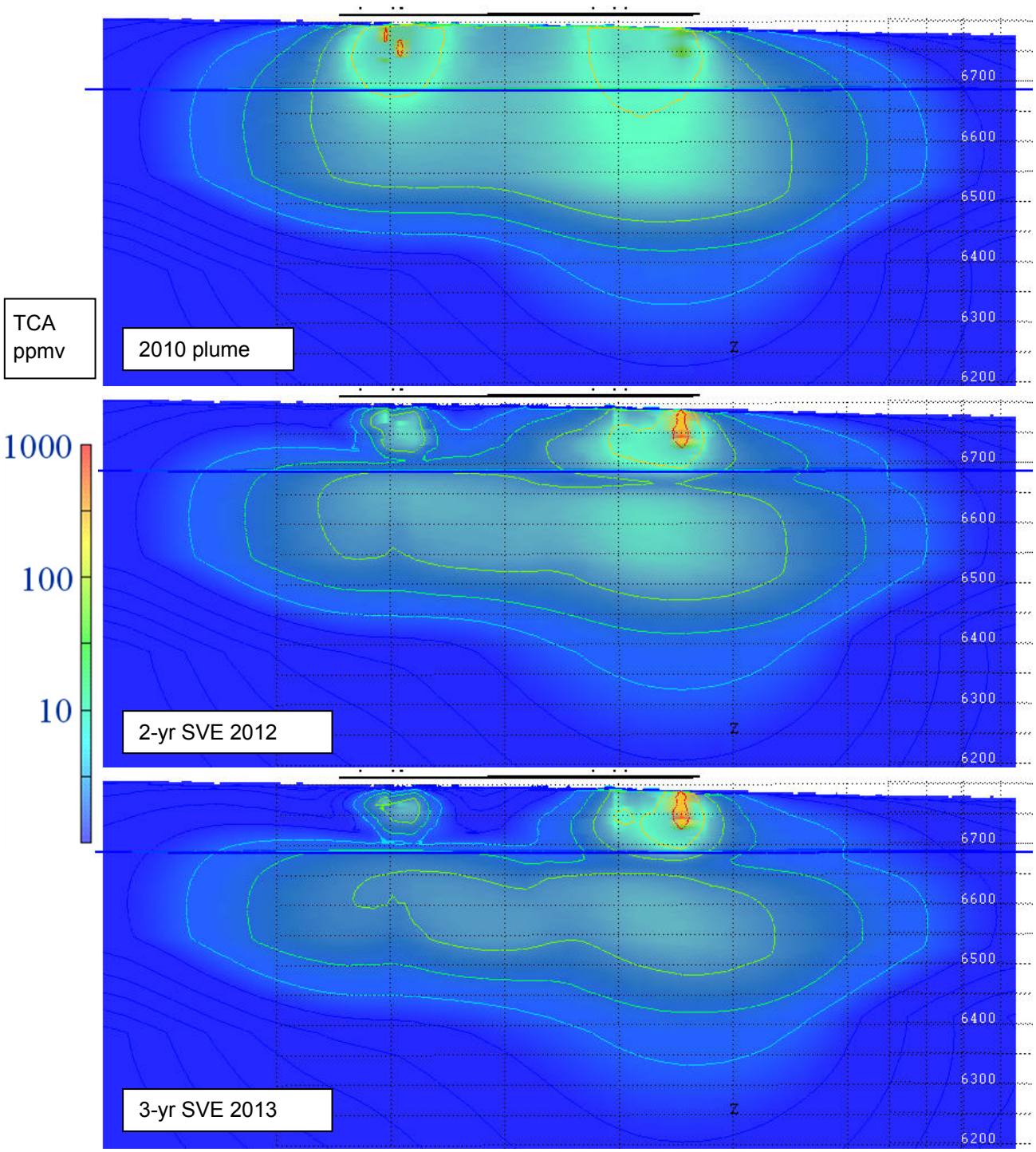
Note: The line through the source regions is a vertical cross-section that is shown next.

Figure C-5.1-2 TCA concentration (log-scale) on a plane at 80 ft deep for (A) AMALGAM and (B) HAND calibrations of permeability following active SVE with 85 scfm in both the eastern and western SVE pilot test locations



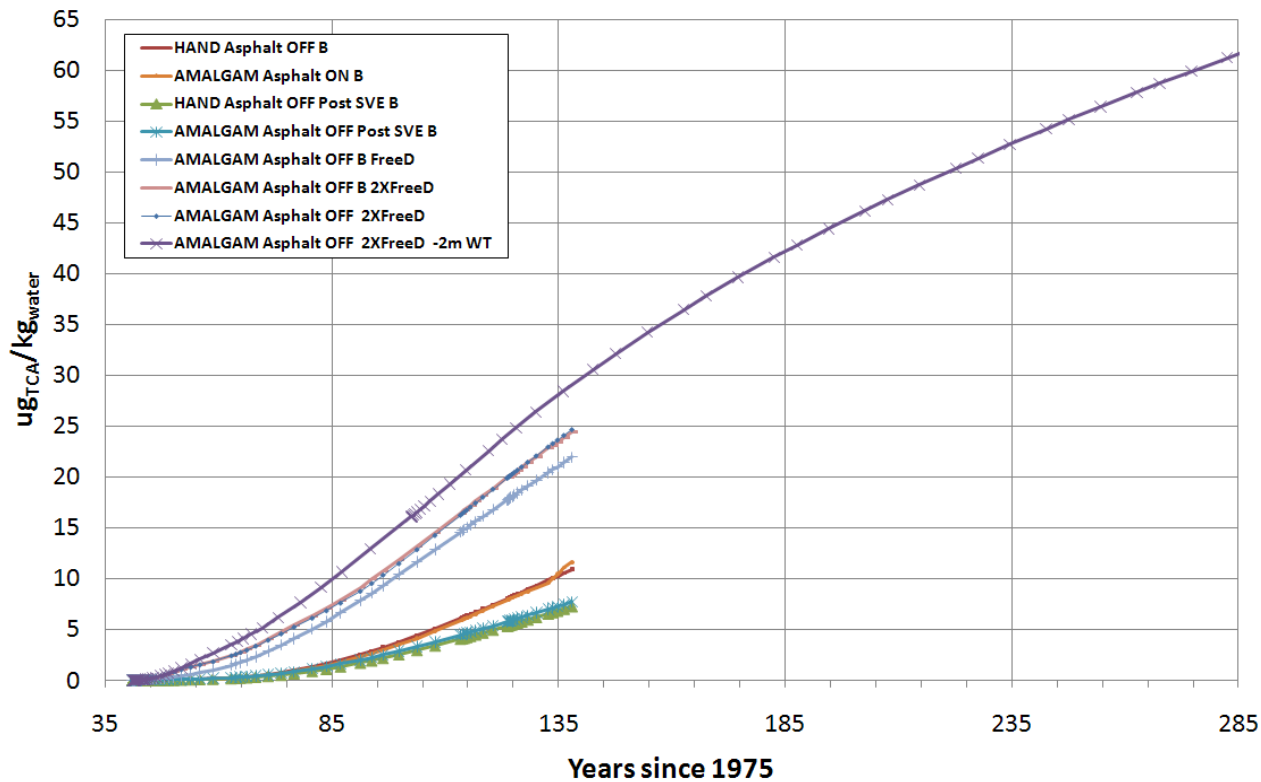
Notes: These results use the HAND calibration. The location of the cross-section can be seen in Figure C-5.1-2.

Figure C-5.1-3 TCA concentrations (log-scale) along a vertical cross-section along the mesa through the source regions showing the effects of 3 yr of SVE



Notes: These results use the AMALGAM calibration. The location of the cross-section can be seen in Figure C-5.1-2.

Figure C-5.1-4 TCA concentrations (log-scale) along a vertical cross-section along the mesa through the source regions showing the effects of 3 yr of SVE



Notes: Concentration is $\mu g_{TCA}/kg_{water}$ or $ppbm_l$. Cases marked with a B refer to the scenario where the western source was fixed to 1000 $ppmv_g$.

Figure C-5.2-1 TCA concentration predicted in pore water directly above the regional water table in the unsaturated zone and directly below the eastern source area

Table C-2.1-1
TCA Physiochemical Parameters

Parameter	Value
Molecular weight	133 g/mol
Liquid density	1325 kg/m^3 (at 293 K)
Vapor pressure	100 mmHg (at 293 K)
Water solubility (mg/L)	950 mg/L (at 293 K)
Tuff sorption coefficient K_d	< 0.08 mL/kg fully saturated
Henry's law constant (H_{TCA})	62 MPa/(liquid mole fraction) equal to 0.458 $(g/L)_{vapor}/(g/L)_{liquid}$ (at 288.5 K)
Diffusion coefficient in crushed Bandelier tuff assumed to be nearly equal to that of TCE $J = -\theta_a D \, gradC$ where J is flux, θ_a is volumetric air content, C is the vapor concentration, and D is the diffusion coefficient.	4.6e-6 to 9.3e-6 m^2/s at 2%–7% relative saturation 4.4e-7 to 1.4e-6 m^2/s at 29%–36% relative saturation

Note: Table modified from Stauffer et al. (2007, 097871).

Table C-2.4-1
Porosity, Saturation, and Effective Diffusion Coefficient Values Used in the Simulations for the Various Geologic Units and Features

Unit/Feature	Effective Porosity	In-Situ Saturation	D* (m^2/s)
Qbt 2	0.41[a]	0.06[b]	3×10^{-6}
Qbt 1vu	0.49[a]	0.15[b]	2×10^{-6}
Qbt 1vc	0.49[a]	0.15[b]	2×10^{-6}
Qbt 1g	0.46[a]	0.15[b]	2×10^{-6}
Cerro Toledo (Qct or CT)	0.45[a]	0.40[b]	5×10^{-7}
Otowi Member (Qbo)	0.44[a]	0.35[b]	5×10^{-7}
Cerros del Rio basalt (base case diffusion)	0.1[b]	0.02[c]	3×10^{-6}
Cerros del Rio basalt (2x free-air diffusion)	0.1[b]	0.02[c]	1.56×10^{-5}
Land surface	0.48[c]	0.02[c]	3×10^{-6}
Asphalt	0.5[c]	0.02[c]	1×10^{-14}
Shafts	0.5[c]	0.02[c]	3×10^{-6}
Wellbore	1.0	0.001	3×10^{-6}
Well Casing	0.5	0.001	1×10^{-14}

[a] Fixed to mean measured value from Springer (2005, 098534).

[b] Fixed to measured values presented in Birdsell et al. (2000, 069791).

[c] Assigned fixed value for the simulations.

Table C-3.2-1
Extraction Pressure and Flow Calibration Targets for the SVE Pilot Tests

Test Period	Average Pressure Drop across Orifice Plate (inches of water)	Pressure at the Top of the Wellhead[a] (kPa)	Wellhead Suction (inches of Hg)	Calculated Mass Flow Rate (kg/s)	Calculated Volumetric Flow Rate (standard ft^3/min[b])
SVE West 0–21.9 days	3.66	66.8	3.9	0.0487	85.61
SVE West 21.9–28.7 days	4.68	65.1	4.4	0.0543	95.45
SVE East	4.46	63.4	4.9	0.0523	91.97

[a] Assumes constant atmospheric pressure of 80 kPa at the wellhead.
[b] Standard cubic feet per minute assumes air at a density of 1.206 kg/m^3.

Table C-3.2-2
Calibrated Permeabilities in both the Horizontal and Vertical Directions for the Various Geologic Units Used for the SVE Pilot Test Simulations

Unit	SVE West Permeability (m^2)		SVE East Permeability (m^2)	
	x,y	z	x,y	z
Qbt 2	7.66E-13	5.41E-13	6.01E-13	9.63E-13
Qbt 1vu	7.07E-12	2.36E-12	9.83E-13	1.60E-13
Qbt 1vc	1.20E-13	6.74E-13	1.29E-11	1.97E-12
Qbt 1g	1.18E-13	6.05E-13	1.97E-13	4.87E-12
Qtt (TT)	5.90E-13	5.90E-13	6.44E-13	6.44E-13
Qct (CT)	5.90E-13	5.90E-13	6.44E-13	6.44E-13
Qbo	1.77E-13	1.77E-13	1.93E-13	1.93E-13

Note: Results are from AMALGAM calibration.

Table C-3.2-3
Calibrated Permeabilities for the Various Geologic Units Used for the SVE Pilot Test Simulations

Unit	SVE West Permeability (m^2)		SVE East Permeability (m^2)	
	x,y	z	x,y	z
Qbt 2	2.93E-12	2.93E-12	1.33E-12	1.33E-12
Qbt 1vu	5.85E-12	5.85E-12	1.47E-12	1.47E-12
Qbt 1vc	1.46E-12	1.46E-12	1.11E-11	1.11E-11
Qbt 1g	1.46E-13	1.46E-13	1.47E-13	1.47E-13
Qtt (TT)	7.32E-13	7.32E-13	7.37E-13	7.37E-13
Qct (CT)	7.32E-13	7.32E-13	7.37E-13	7.37E-13
Qbo	2.19E-13	2.19E-13	2.21E-13	2.21E-13

Note: Results from HAND calibration.

Table C-4.0-1
Modeled TCA Vapor Concentration (log-scale) versus
Current Average Vapor Concentrations (log-scale) for All Points Shown in Figure C-4.0-3

Monitoring Well	Depth (ft)	log10 (modeled C_{TCA})	log10 (data C_{TCA})
54-02001	20	2.13	2.12
54-02001	40	2.26	2.32
54-02001	80	2.24	2.13
54-02001	100	2.18	2.05
54-02001	120	2.14	2.19
54-02001	140	2.1	2.16
54-02001	200	2.02	2.04
54-02002	20	2.16	1.21
54-02002	40	2.33	2.3
54-02002	60	2.39	2.35
54-02002	100	2.37	2.41
54-02002	120	2.35	2.36
54-02002	140	2.34	2.23
54-02002	180	2.31	2.36
54-02002	200	2.3	2.18
54-02016	31	2.61	2.51
54-02016	82	2.51	2.23
54-02020	20	0.71	1.17
54-02020	40	1.09	1.4
54-02020	60	1.29	1.47
54-02020	80	1.43	1.54
54-02020	100	1.52	1.5
54-02020	120	1.59	1.56
54-02020	140	1.65	1.44
54-02020	160	1.69	1.38
54-02020	180	1.71	1.67
54-02020	200	1.73	1.63
54-02021	20	0.97	1.27
54-02021	60	1.38	1.38
54-02021	100	1.57	1.72
54-02021	120	1.63	1.48
54-02021	140	1.67	1.77
54-02021	160	1.69	1.66
54-02021	180	1.69	1.69
54-02021	200	1.68	1.71
54-02022	20	0.95	1.45
54-02022	40	1.22	1.86

Table C-4.0-1 (continued)

Monitoring Well	Depth (ft)	log10 (modeled C_{TCA})	log10 (data C_{TCA})
54-02022	60	1.4	1.91
54-02022	80	1.51	1.97
54-02022	120	1.66	2.02
54-02022	140	1.7	1.97
54-02022	160	1.72	1.85
54-02022	180	1.72	1.58
54-02022	200	1.7	1.64
54-02023	20	0.49	0.3
54-02023	40	0.72	0.97
54-02023	60	0.91	0.81
54-02023	80	1.05	0.83
54-02023	100	1.15	1.16
54-02023	120	1.23	0.94
54-02023	140	1.29	1.18
54-02023	159	1.34	1.23
54-02023	200	1.39	1.16
54-02024	20	0.76	0.83
54-02024	40	1.04	1.04
54-02024	60	1.24	1.14
54-02024	80	1.38	1.18
54-02024	100	1.48	1.36
54-02024	140	1.61	1.37
54-02024	160	1.65	1.44
54-02024	180	1.68	1.37
54-02024	200	1.7	1.25
54-02025	20	1.05	1.62
54-02025	100	1.77	1.87
54-02025	160	1.9	1.86
54-02025	190	1.93	1.86
54-02026	20	0.09	0.11
54-02026	100	0.38	0.49
54-02026	160	0.48	0.54
54-02026	200	0.5	0.11
54-02026	215	0.5	0.04
54-02027	20	0.33	0.72
54-02027	60	0.77	0.68
54-02027	100	1.01	1.13
54-02027	160	1.18	1.05
54-02027	200	1.23	1.15
54-02027	220	1.23	0.92

Table C-4.0-1 (continued)

Monitoring Well	Depth (ft)	log10 (modeled C_{TCA})	log10 (data C_{TCA})
54-02027	250	1.18	0.41
54-02028	20	0.12	0.3
54-02028	100	0.43	0.49
54-02028	160	0.57	0.52
54-02031	20	0.77	1.04
54-02031	60	1.22	1.23
54-02031	100	1.44	1.51
54-02031	160	1.6	1.51
54-02031	200	1.6	1.38
54-02031	260	1.52	1.28
54-02034	20	0.14	0.85
54-02034	60	0.4	0.97
54-02034	100	0.59	0.45
54-02034	160	0.74	0.88
54-02034	200	0.75	0
54-02034	260	0.64	0
54-02034	300	0.3	0
54-02089	13	2.66	2.36
54-02089	31	2.66	2.61
54-02089	46	2.65	2.76
54-02089	86	2.5	2.81
54-24238	44	2.55	2.65
54-24238	64	2.51	2.69
54-24238	84	2.47	2.65
54-24239	25	2.07	1.95
54-24239	50	2.09	2.07
54-24239	75	2.12	2.17
54-24239	100	2.14	2.13
54-24239	153	2.14	2.32
54-24240	28	2.67	2.51
54-24240	53	2.64	2.66
54-24240	78	2.57	2.52
54-24240	103	2.46	2.47
54-24240	128	2.33	2.34
54-24240	153	2.25	2.31
54-24241	73	2.28	2.44
54-24241	93	2.28	2.44
54-24241	113	2.27	2.26
54-24241	133	2.26	2.19
54-24241	153	2.25	2.22

Table C-4.0-1 (continued)

Monitoring Well	Depth (ft)	log10 (modeled C_{TCA})	log10 (data C_{TCA})
54-24241	173	2.23	2.2
54-24241	193	2.22	2.22
54-24242	25	2.04	1.87
54-24242	50	2.07	2.22
54-24242	75	2.1	2.16
54-24242	100	2.12	2.1
54-24242	111	2.13	2.14
54-24243	25	2.47	2.26
54-24243	50	2.57	2.48
54-24243	75	2.52	2.47
54-24243	100	2.46	2.49
54-24243	125	2.41	2.38
54-24399	579	0.13	0
54-27641	32	2.94	2.59
54-27641	82	2.65	2.41
54-27641	115	2.34	2.3
54-27641	182	2.12	2.17
54-27641	232	2.02	2.04
54-27641	271	1.83	1.5
54-27641	333	1.06	0.34
54-27642	30	2.61	2.76
54-27642	74	2.53	2.62
54-27642	117	2.42	2.72
54-27642	175	2.35	2.3
54-27642	235	2.31	2.18
54-27642	275	2.23	1.88
54-27642	338	1.68	1.17
54-27643	30	1.57	1.93
54-27643	74	1.89	2.06
54-27643	117	2	2.06
54-27643	167	2.06	2.04
54-27643	235	2.06	1.98
54-27643	275	2.01	1.7
54-27643	354	1.36	1
54-610786	25	2.06	1.92
54-610786	50	2.25	2.15
54-610786	75	2.27	2.17
54-610786	100	2.26	2.09
54-610786	119	2.25	2.11

Appendix D

Contaminants Detected in
Deep Wells in the Technical Area 54 Monitoring Network

D-1.0 INTRODUCTION

This appendix discusses contaminants detected during the monitoring of groundwater in wells assigned to the Technical Area 54 (TA-54) monitoring network for Material Disposal Areas (MDAs) G, H, and L. Groundwater monitoring at Los Alamos National Laboratory (LANL or the Laboratory) is currently conducted in accordance with the 2010 Interim Facility-Wide Groundwater Monitoring Plan (2010 IFGMP) (LANL 2010, 109830). Wells assigned to the TA-54 monitoring network include perched-intermediate and regional (hereafter, "deep") wells R-20, R-21, R-22, R-23, R-23i, R-32, R-37, R-38, R-39, R-40, R-40i, R-41, R-49, R-51, R-52, R-53, R-54, R-55, R-55i, R-56, and R-57 (Table 2.6-1; Figure 2.6-1). Although none of the TA-54 monitoring network wells are equally applicable to all three MDAs, it is recognized that all the wells contribute in an integrated fashion to monitoring for different potential sources of groundwater contaminants. Table D-1.0-1 summarizes information about screened intervals and sampling systems installed in these monitoring wells and the range of sampling dates for which water-quality data are available.

- Section D-2.0 outlines an approach for conducting reliability assessments of deep monitoring wells to determine their capability for producing reliable water-quality samples and to identify any potential effects of well installation, rehabilitation, or sampling protocol on data quality.
- Section D-3.0 summarizes the results of reliability assessments of the deep wells and addresses the capability of each screen to provide reliable data for contaminants relevant to MDAs G, H, and L.
- Section D-4.0 summarizes chemicals of potential concern (COPCs) detected in water-quality samples from these wells. COPC detections in groundwater are then compared with those known, or potentially expected, to be present in the vadose zone below MDAs G, H, and L, and potential sources of the COPCs detected in groundwater are discussed. For informational purposes, this section also provides data for activities of tritium and detections of radionuclides.
- Based on these data evaluations, section D-5.0 presents conclusions concerning the transport of COPCs from the vadose zone below MDAs G, H, and L to the deep groundwater downgradient of these MDAs.
- Attachment D-1 (on DVD), Analytical Suites and Results and Analytical Reports, contains the full set of analytical data for water-quality samples from all monitoring wells assigned to the TA-54 monitoring network.
- Attachment D-2, Geochemical Trend Plots for Technical Area 54 Monitoring Network Wells, compiles figures that depict geochemical trends for these wells and that support the reliability assessments in section D-3.0.

D-2.0 RELIABILITY ASSESSMENT PROTOCOL

The specific objective of a reliability assessment is to determine the current effectiveness of a deep well (including its sampling system) as it relates to the water-quality data objectives of the specific monitoring network to which it is assigned, which, in this case, is the TA-54 monitoring network specific to MDAs G, H, and L. Data examined for the assessment include field parameters monitored during purging before sample collection, field parameters associated with samples at the time of collection, major ion concentrations, trace metal concentrations, and detections of organic constituents. The assessments are based on site-specific geochemical criteria and generally focus on data obtained for the most recent sampling events. Each category of data is described below in greater detail.

Field parameters. Time-series data for field parameters monitored during purging before sample collection are examined for attaining stable values by the end of purging, and time-series trends are also compared for a sequence of events at the same location. Stabilization criteria are prescribed in Standard Operating Procedure (SOP) 5232, Groundwater Sampling, and are derived from the stabilization criteria recommended by the U.S. Environmental Protection Agency (EPA) (Yeskis and Zavala 2002, 204429) and from the Compliance Order on Consent (the Consent Order). The most sensitive indicator parameters are dissolved oxygen (DO) and turbidity (in nephelometric turbidity units [NTU]). Other parameters such as water temperature, specific conductance, pH, and oxidation-reduction potential (ORP) are also monitored but are considered less sensitive indicators of formation water. Final field-parameter values associated with the sample at the time of collection are compared with the range observed in background locations for perched-intermediate groundwater and regional groundwater.

Inorganic analytes. Analytical data for common inorganic ions and trace metals are examined for stability and for excursions from background concentrations, including the following:

- trends in concentrations of key indicators for the presence of residual drilling or construction products used in the screened interval, such as sodium (Na), chloride (Cl), sulfate (SO_4), and total organic carbon (TOC);
- trends in relative concentrations of major ions for identifying mixing of waters with different compositions; and
- comparison of concentrations for major ions and selected trace metals with concentration ranges for plateau-scale and site-specific background groundwater, as described below, to identify possible excursions from expected geochemical conditions.

Concentration trends may be depicted using time-series plots, standard trilinear diagrams, or modified Schoeller plots.

- Trilinear diagrams, also called Piper plots, show major ions as percentages of milliequivalents (meq) in two base triangles. The total cations and the total anions are set equal to 100%, and the data points in the two triangles are projected onto an adjacent grid. The main purpose of the Piper diagram is to show clustering of data points to indicate samples with similar compositions.
- Schoeller plots are semilogarithmic diagrams originally developed to represent major ion analyses in meq/L and to show different hydrochemical water types on the same diagram. This type of graphical representation has the advantage that, unlike the trilinear diagrams, actual sample concentrations are displayed and compared. The modified Schoeller plot used for the reliability assessment represents analyses as mg/L or µg/L to avoid the need to make assumptions about ion speciation, which may be particularly problematic for trace metals.

Organic analytes. Detections of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) are compiled for examination of temporal trends, evidence for the presence of residual organic drilling materials, and detections of area-specific COPCs.

Field documentation. As appropriate, field notes, groundwater sampling logs, and sample collection logs for each sampling event also may be examined for observations about unusual odors, colors, or other indications of impacted water samples.

Tritium. Tritium activities in groundwater are commonly used to evaluate the presence of a component of modern water or a contaminant plume in the screened interval. The presence or absence of tritium at a location may provide a useful tracer of flow and transport pathways because it travels conservatively in groundwater.

Plateau-scale background values for assessment. For naturally occurring analytes, statistical summaries of water-quality data for background groundwater locations establish an upper bound of concentrations against which data from the assessed wells are compared as a preliminary assessment step. Upper bounds of plateau-scale background values used in the reliability assessments are established by the upper tolerance limit (UTL) in the Groundwater Background Investigation Report, Revision 3 (hereafter, GBIR, R3) (LANL 2007, 095817). Some naturally occurring constituents do not have numerical background values that are based on UTLs in GBIR, R3, because the data do not meet the statistical criteria for UTL calculations. The GBIR is being updated to establish appropriate screening levels for these cases in accordance with EPA guidance.

Site-specific background values for assessment. Reliability may be assessed with greater specificity by comparing analytical concentrations with those in groundwater from other deep wells in sufficiently similar hydrogeologic settings and at which effects from downhole materials or local contaminants are known to be absent or negligible. The approach allows for the inclusion of wells not hydraulically upgradient of the well being assessed. This is similar to the interwell comparison approach described in sections 5.2.4 and 6.3.2 of the EPA guidance document, "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities" ("Unified Guidance") (EPA 2009, 110369).

The development and use of site-specific background values is illustrated in the "Reliability Assessment for Well R-47*i*" (LANL 2011, 201564). In that report, groundwater background values were derived from data for deep wells screened in the Puye Formation (Tpf) or the Cerro Toledo interval (Qct). This set of background values can be viewed as representative of deep groundwater in these lithologic units where they underlie the central Pajarito Plateau in an area bounded approximately by Mortandad and Water Canyons between NM 4 and NM 501. It is noted that this data set may not fully encompass the range of groundwater compositions in other local lithologic units in the vicinity of the TA-54 monitoring network wells, such as the Santa Fe Formation (Tsf) and the Cerros del Rio basalt (Tb4). Nonetheless, the 5th and 95th percentile concentrations calculated from the Tpf-Qct data set are included on the Schoeller plots in Attachment D-2 to facilitate quick visual identification of possible excursions from background geochemical conditions.

Under some conditions, some or all of the constituents measured in the sample collected at the end of development may also be appropriate to use as site-specific background values or to augment the background data set compiled for the interwell comparison. This is similar to the intrawell comparison approach described in sections 5.2.4 and 6.3.2 of EPA's Unified Guidance (EPA 2009, 110369).

In the future, the groundwater background values are expected to be based on analyte concentrations in an upgradient portion of the groundwater monitoring network specific to each MDA and in those downgradient or off-gradient monitoring wells that do not show contamination. However, implementation of this protocol is deferred until newly completed wells have reequilibrated to predrilling geochemistry. The reliability assessment in section D-3.0 summarizes the status of deep wells in the TA-54 monitoring network, including upgradient wells and downgradient, or off-gradient, wells that are candidates for defining background values for the TA-54 monitoring network wells.

D-3.0 GEOCHEMICAL PERFORMANCE OF MONITORING WELLS

Reliability of the geochemical performances of some of the TA-54 monitoring network wells were previously reported in the "Well Screen Analysis Report, Revision 2" (LANL 2007, 096330); "Technical Area 54 Well Evaluation and Network Recommendations, Revision 1" (LANL 2007, 098548, Appendix B); the 2010 IFGMP (LANL 2010, 109830); "Corrective Measures Evaluation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at Technical Area 54, Revision 2" (LANL 2010, 111362,

Appendix D); "Corrective Measures Evaluation Report for Material Disposal Area H, Solid Waste Management Unit 54-004, at Technical Area 54" (LANL 2010, 111506, Appendix E); and "Corrective Measures Evaluation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54, Revision 1" (LANL 2010, 110852, Appendix D). This section complements earlier evaluations by applying the approach described in section D-2.0 to the most recent water-quality samples. This section also extends the assessment protocol to newly completed wells such as R-53, R-54, R-55i, R-55, R-56, and R-57.

Key observations are summarized below, focusing on the capability of each well to provide reliable data for COPCs known to be present in the vadose zone beneath MDAs G, H, or L based on core samples and vapor monitoring. The vapor-phase organics detected at highest concentrations in the pore gas at MDA G are 1,1,1-trichloroethane (TCA); 1,1,2-trichloro-1,2,2-trifluoroethane; trichloroethene (TCE); 1,1-dichloroethene; 1,1-dichloroethane; and perchloroethene (PCE) (LANL 2010, 108496, Table 3.0-2). Similarly, the vapor-phase organics detected at highest concentrations in the vadose zone beneath MDA L are TCA, TCE, and PCE.

For convenience, most water-quality data used in these assessments are compiled into the following tables:

- Purge volumes and final field parameters (Table D-3.0-1)
- General inorganic constituents (Table D-3.0-2)
- Trace metals in filtered samples (Table D-3.0-3)
- Stable isotopes (Table D-3.0-4)

D-3.1 Well R-20

Well R-20 includes two intervals screened in the regional aquifer. This well is upgradient of MDA L (or potentially downgradient of MDA L if water-supply well PM-2 is pumping).

R-20 was equipped with a nonpurgeable Westbay sampling system until 2007 (Table D-1.0-1). Water-quality data from samples collected during this period may not be fully reliable indicators of predrilling groundwater chemistry. Residual effects of drilling and construction in these screens included the presence of inorganic and organic chemicals used downhole and persistent iron- or sulfate-reducing conditions. The well was redeveloped and converted to a purgeable sampling configuration in 2007. The assessments presented below apply to the current sampling configuration. However, COPC detection statistics for samples collected from this well using the Westbay sampling system are included in section D-4.0.

R-20 screen 1 (port P1A) is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA L based on the following observations for the four most recent sampling events.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R20-1 in Attachment D-2).
- Slightly reducing conditions are present as indicated, for example, by DO ≤2 mg/L, nitrate-nitrite as nitrogen (NO_3+NO_2-N), and perchlorate (ClO_4) <0.2 µg/L (Tables D-3.0-1 and D-3.0-2). Based on the results of an extended-purge event in January 2011, slightly reducing conditions are representative of this location and may be related to the location of this well near a zone of enhanced infiltration (discussed in section D-4.4). Nitrate-reducing conditions also manifest as

variability observed in $\delta^{15}N$ values measured for NO_3 (Table D-3.0-4), with some values extending above the range in natural background groundwater (4.7 ± 0.9 permil) because of isotopic fractionation by nitrate-reducing microbial processes.

- No evidence is observed of the presence of residual organic materials. For example, TOC is ≤1.1 mg/L (Table D-3.1-1), and acetone is not detected (Figure D-3.1-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and total dissolved solids (TDS) are stable and below UTLs for regional background groundwater (Table D-3.0-2; Figure D2-R20-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU (Table D-3.0-1). Aluminum (Al), a common indicator of formation solids, is not detected in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R20-3 in Attachment D-2). Similarly, iron (Fe) is either not detected or is detected at <100 µg/L in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R20-3 in Attachment D-2).
- No evidence is observed of water chemistry significantly out of equilibrium with formation mineralogy. Concentrations of major cations and trace metals are stable; all are below UTLs for regional background except for barium (Ba) (Table D-3.0-3; Figure D2-R20-3 in Attachment D-2). The average Ba concentration (86 µg/L) is above the UTL (57 µg/L) but only slightly above the 95th percentile concentration (81 µg/L) for regional background groundwater.
- This screen is assigned to the watch list in the 2011 Interim Facility-Wide Groundwater Monitoring Plan (hereafter, the 2011 IFGMP) (LANL 2011, 205231, Appendix F) because of issues concerning the sampling system and anomalous odors noted by the sampling team collecting the water samples.

R-20 screen 2 (port P2A) is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA L based on the following observations for the four most recent sampling events.

- Field parameters meet stability criteria the screen is purged in accordance with SOP-5232 (Figure D2-R20-4 in Attachment D-2).
- Oxic conditions may be present as indicated, for example, by an average DO concentration of 2.5 mg/L, detections of NO_3+NO_2-N at 0.2 mg/L, and detections of ClO_4 at 0.2 µg/L (Tables D-3.0-1 and D-3.0-2). Based on results of an extended-purge event in January 2011, these conditions are representative of this location.
- No evidence is observed of the presence of residual organic materials; NH_3-N <0.1 mg/L, total Kjeldahl nitrogen (TKN) <0.1 mg/L, and acetone is not detected (Figure D-3.0-1).
- Evidence is observed of the possible presence of local contaminants. The average TOC concentration (2.1 mg/L, Table D-3.0-2) for the four most recent sampling events exceeds the maximum detected concentration in regional background groundwater (1.37 mg/L); toluene, TCE, and xylene isomers are consistently detected below their respective practical quantitation limits (PQLs) (Figure D-3.1-1). Possible sources of these constituents are discussed in section D-4.4.
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2; Figure D2-R20-5 in Attachment D-2) are stable and below UTLs for regional background groundwater.

- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in unfiltered samples (Table D-3.0-3).
- No evidence is observed of water chemistry significantly out of equilibrium with formation mineralogy. Concentrations of major cations and trace metals are stable; average concentrations are below UTLs for regional background, except for Ba concentrations (Figure D2-R20-6 in Attachment D-2). The average Ba concentration (170 µg/L, Table D-3.0-3) is above the UTL (57 µg/L) as well as above the 95th percentile concentration (81 µg/L) for regional background groundwater. The reason for this condition in R-20 screen 2 is not fully understood, but the stability of the Ba concentrations suggests they are representative of groundwater in the formation next to the screened interval.
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of anomalous odors noted by the sampling team collecting the water samples. The watch list is used to identify deep monitoring wells for which the reliability of water-quality data for certain constituents has issues or has not yet been established.

D-3.2 Well R-21

Well R-21 contains a single screen in the regional aquifer, upgradient of MDA G and downgradient of MDA L. This well serves as a background location for establishing background values for naturally occurring chemical and radionuclides in regional groundwater beneath the Pajarito Plateau and the Laboratory in GBIR, R3 (LANL 2007, 095817) and the GBIR, Revision 4 (hereafter GBIR, R4) (LANL 2010, 110535). This well also served as a background location for establishing background values for groundwater in deep wells screened in Tpf or Qct.

R-21 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA L based on the following observations.

- Field parameters meet stability criteria when the well is purged in accordance with SOP-5232 (Figure D2-R21-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. TOC <1 mg/L (Table D-3.0-2), NH_3-N <0.1 mg/L, TKN <0.1 mg/L, and acetone is not detected.
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2; Figure D2-R21-2 in Attachment D-2) are stable and below UTLs for regional background groundwater.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R21-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination at this location.

D-3.3 Well R-22

Well R-22 is currently inactive for water-quality sampling. Well R-22 was originally constructed as a multiscreen well equipped with a nonpurgeable Westbay sampling system for five intervals screened in

the regional aquifer (Table D-1.0-1). R-22 was redeveloped from April to July 2009, focusing on screens 1 and 5. Before redevelopment, geochemical conditions in screen 1 were sulfate-reducing and indicated the apparent presence of residual inorganic and organic chemicals associated with materials used downhole during drilling or well construction. Evaluation of the samples collected at the end of an extended purge of screen 1 from June to July 2009, indicated water quality had mostly stabilized and oxidizing regional aquifer water was being drawn into the screen (LANL 2009, 106796). A decision for a final sampling configuration for R-22 is pending.

Samples collected using the Westbay sampling system at this well may not provide reliable water-quality data for predrilling groundwater chemistry. Nonetheless, COPC detection statistics for samples collected from R-22 during this period of time are included in section D-4.0.

D-3.4 Well R-23i

Well R-23i contains a piezometer (port P1A) and two screens (ports P2A and P3a) in perched-intermediate groundwater beneath Pajarito Canyon downgradient of MDA G.

The R-23i piezometer (port P1A) is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R23i-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1.1 mg/L, NH_3-N <0.1 mg/L, TKN ≤0.1 mg/L, and acetone is not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. However, this screen shows the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. In particular, specific conductance (Table D-3.0-1) and concentrations of Na, alkalinity, Cl, and TDS (Table D-3.0-2; Figure D2-R23i-2 in Attachment D-2) are above UTLs for perched-intermediate background groundwater. Sulfate concentrations are also above the 95th percentile of the Tpf-Qct data set. Possible sources of these constituents are discussed in the Pajarito Canyon Investigation Report, Revision 1 (LANL 2009, 106939) and in section D-4.4.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is consistently below 5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R23i-3 in Attachment D-2).

R-23i screen 1 (port P2A) is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R23i-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC ≤1.1 mg/L, NH_3-N <0.1 mg/L, TKN <0.1 mg/L, and acetone is not detected (Table D-3.0-2 and Attachment D-1).

- No evidence is observed of the presence of residual inorganic drilling or construction products. However, this screen shows the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. For example, although concentrations of Cl, SO_4, and TDS are below UTLs for perched-intermediate background groundwater, they are above corresponding 95th percentiles of the Tpf-Qct data set (Table D-3.0-2; Figure D2-R23i-4 in Attachment D-2). Possible sources of these constituents are discussed in the Pajarito Canyon Investigation Report, Revision 1 (LANL 2009, 106939) and in section D-4.4.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is consistently below 5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R23i-6 in Attachment D-2).

R-23i screen 2 (port P3A) is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R23i-7 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC ≤1.1 mg/L, NH_3-N <0.1 mg/L, TKN <0.1 mg/L, and acetone is not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. However, this screen shows the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. For example, although concentrations of Cl, SO_4, and TDS are below UTLs for perched-intermediate background groundwater, they are above corresponding 95th percentiles of the Tpf-Qct data set (Table D-3.0-2; Figure D2-R23i-8). Possible sources of these constituents are discussed in the Pajarito Canyon Investigation Report, Revision 1 (LANL 2009, 106939) and in section D-4.4.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is consistently below 5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R23i-9 in Attachment D-2).

D-3.5 Well R-23

Well R-23 contains a single screen in the regional aquifer beneath Pajarito Canyon downgradient of MDA G.

R-23 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the well is purged in accordance with SOP-5232 (Figure D2-R23-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >5 mg/L, NO_3+NO_2-N at 0.3 mg/L, and ClO_4 at 0.3 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Although TOC exceeds 1.1 mg/L in some samples (Table D-3.0-2), NH_3-N <0.1 mg/L, TKN <0.1 mg/L, and acetone is not detected (Attachment D-1). Diethylphthalate is frequently detected, generally below its PQL

(Attachment D-1); the origin of this SVOC is not known, but it is not a COPC known to be present in the vadose zone beneath MDA G.

- No evidence is observed of the presence of residual inorganic drilling or construction products. However, this screen may show the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. For example, although concentrations of Cl and SO_4 are below UTLs for regional background groundwater, they are above corresponding 95th percentiles of the Tpf-Qct data set (Table D-3.0-2; Figure D2-R23-2 in Attachment D-2). NO_3+NO_2-N concentrations are above the UTL for regional groundwater as well as the corresponding 95th percentile of the Tpf-Qct data set. Possible sources of these constituents are discussed in the Pajarito Canyon Investigation Report, Revision 1 (LANL 2009, 106939) and in section D-4.4.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is consistently <5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3 and Figure D2-R23-3 in Attachment D-2).

D-3.6 Well R-32

Well R-32 contains a single screen in the regional aquifer, upgradient of MDA G and downgradient of MDA L.

Before 2007, well R-32 was equipped with a nonpurgeable Westbay sampling system (Table D-1.0-1). Some water-quality data from samples collected during this period may not be fully reliable indicators of predrilling groundwater chemistry. In particular, residual effects of drilling and construction in the deeper screen (port MP3A) included the presence of inorganic and organic chemicals used downhole and persistent iron- or sulfate-reducing conditions. R-32 was redeveloped and converted to a single-screen sampling configuration in 2007. The assessment presented below applies to the current sampling configuration. However, COPC detection statistics for samples collected from R-32 using the Westbay sampling system are included in section D-4.0.

R-32 is capable of providing reliable water-quality data for COPCs detected in the vadose zones beneath MDAs G and L based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R32-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic drilling materials. TOC <1 mg/L (Table D-3.0-2), and NH_3-N, TKN, and acetone generally are not detected in recent samples (Figure D-3.6-1; Attachment D-1). Bis(2-ethylhexyl)phthalate and toluene were detected in samples collected before 2010 but have not been detected in recent samples (Figure D-3.6-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. However, this screen may show the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. For example, although concentrations of Cl, NO_3+NO_2-N, and SO_4 are below UTLs for regional background groundwater, they are above corresponding 95th percentiles of the Tpf-Qct data set (Table D-3.0-2; Figure D2-R32-2 in Attachment D-2). Possible sources of these constituents are discussed in the Pajarito Canyon Investigation Report, Revision 1 (LANL 2009, 106939) and in section D-4.4.

- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3 and Figure D2-R32-3 in Attachment D-2).

D-3.7 Well R-37

Well R-37 is a dual-screen well with screens in perched-intermediate groundwater and the regional aquifer, downgradient of MDA H.

R-37 screen 1 (port P1A) is capable of providing reliable water-quality data for tritium and organic COPCs detected in the vadose zone beneath MDA H based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R37-1 in Attachment D-2).
- Slightly reducing conditions may be present as indicated, for example, by consistent detections of DO ≤2 mg/L, but oxic conditions are indicated by NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2). The stability of these concentrations suggests they are reliable indicators of predrilling groundwater chemistry at this location (Figures D2-R37-1 and D2-R37-2 in Attachment D-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1.1 mg/L, NH_3-N <0.1 mg/L, total TKN ≤0.1 mg/L, and acetone is not detected (Table D-3.0-2 and Attachment D-1). Consistent detection of 1,4-dioxane (Attachment D-1) indicates the presence of local contamination of unknown origin; possible sources of this SVOC are discussed in section D-4.4.
- No evidence is observed of the presence of residual inorganic drilling or construction products. However, this screen shows the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. In particular, specific conductance (Table D-3.0-1) and concentrations of Cl and SO_4 (Table D-3.0-2; Figure D2-R37-2 in Attachment D-2) are above UTLs for perched-intermediate background groundwater. Alkalinity, Na, and TDS concentrations are also above the corresponding 95th percentiles of the Tpf-Qct data set. Possible sources of these constituents are discussed in section D-4.4.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is consistently below 5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R37-3 in Attachment D-2).
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of minor drilling-related issues and evidence that groundwater in the screened interval may not have fully reequilibrated with the adjacent formation.

R-37 screen 2 (port P2A) is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA H based on the following observations.

- Field parameters meet stability criteria when the well is purged in accordance with SOP-5232 (Figure D2-R37-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).

- No evidence is observed of the presence of residual organic materials. TOC <1 mg/L (Table D-3.0-2), NH_3-N <0.1 mg/L, TKN <0.1 mg/L, and acetone is not detected (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2; Figure D2-R21-2 in Attachment D-2) are stable and below UTLs for regional background groundwater and only slightly above corresponding 95th percentiles of the Tpf-Qct data set.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU (Table D-3.0-1). Al and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R37-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.8 Well R-38

Well R-38 contains a single screen in the regional aquifer upgradient of MDA G and downgradient of MDA L.

R-38 is capable of providing reliable water-quality data for COPCs detected in the vadose zones beneath MDAs G and L based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R38-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials from drilling or construction activities. Generally, TOC <1.1 mg/L and NH_3-N, TKN, and acetone are nondetects (Table D-3.0-2, Figure D-3.8-1). Bis(2-ethylhexyl)phthalate, benzene, chloromethane, and toluene were detected in 2009 but generally have not been detected in the most recent samples (Figure D-3.8-1 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2; Figure D2-R38-2 in Attachment D-2) are stable and below UTLs for regional background groundwater for regional background groundwater, and only slightly above corresponding 95th percentiles of the Tpf-Qct data set.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R38-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination at this location.

D-3.9 Well R-39

Well R-39 contains a single screen in the regional aquifer, downgradient of MDA G.

R-39 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R39-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials from drilling or construction activities. Generally, TOC <1 mg/L and NH_3-N, TKN, and acetone are nondetects (Table D-3.0-2, Attachment D-1). Chloromethane and toluene were detected in samples collected in 2009 and 2010 but not in the most recent samples (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2; Figure D2-R39-2 in Attachment D-2) are stable, below UTLs for regional background groundwater, and only slightly above corresponding 95th percentiles of the Tpf-Qct data set.
- The possible presence of minor quantities of formation solids in water-quality samples is indicated by the detection of Al and Fe concentrations in unfiltered samples. However, decreasing concentration trends indicate this condition will resolve in the near future. In addition, turbidity is <5 NTU (Table D-3.0-1), and concentrations of these two trace metals are nondetect in filtered samples (Table D-3.0-3; Figure D2-R39-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination at this location.

D-3.10 Well R-40i

Well R-40i is a piezometer screened in the perched-intermediate zone, downgradient of MDA H and upgradient of MDA L.

R-40i is not capable at present of providing reliable water-quality data for organic COPCs detected in the vadose zones beneath MDAs H and L based on the observations listed below.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R40i-1 in Attachment D-2). However, the water is sudsy and has an odor.
- Reducing conditions are present as indicated, for example, by consistent observations of DO <2 mg/L, nondetects for NO_3+NO_2-N and ClO_4 , Fe >1000 µg/L in filtered samples, and Mn >300 µg/L (Tables D-3.0-1, D-3.0-2, and D-3.0-3; Figures D2-R40i-2 and D2-R40i-3 in Attachment D-2).
- Organic drilling products were used in this interval and residual organic materials are present as indicated by TOC >10 mg/L (Table D-3.0-2), detections of NH_3-N and TKN, and the sudsy condition of the water samples. Chloromethane and toluene were detected in samples collected in 2009 but not in the most recent samples (Attachment D-1).
- Residual inorganic drilling or construction products are present as indicated, for example, by concentrations of Na (average 22 mg/L, Table D-3.0-2) above the UTL of 12.2 mg/L for perched-intermediate background groundwater (Figure D2-R40i-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Concentrations of Al are nondetect in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R40i-3 in Attachment D-2).

- This well screen is capable of providing reliable data for tritium. Continued sampling of this well is proposed in the 2011 IFGMP for a limited set of analyses that include tritium (LANL 2011, 205231).
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of conditions noted above.
- No compelling evidence is observed of the presence of local contamination at this screened interval although this possibility cannot be ruled out at this time. However, the absence of consistent detections of tritium activity using a sensitive low-level analytical method supports the absence of contamination.

D-3.11 Well R-40

Well R-40 is a dual-screen well with screens in perched-intermediate and regional groundwaters. Well R-20 screen 1 samples perched-intermediate groundwater that is considered to be downgradient of MDA H and upgradient of MDA L. R-20 screen 2 samples regional groundwater upgradient (or "sidegradient") of MDA H (or downgradient if PM-2 is pumping) and upgradient of MDA L.

R-40 screen 1 is not capable of providing reliable water-quality data for COPCs detected in the vadose zones beneath MDAs H and L based on the following observations.

- The screen is located in a tight formation and cannot provide water for a 3–casing volume (CV) purge because the water level drops to the elevation of the pump intake after purging of 1 CV. The screened interval takes 2 wk to recover from purging of 1 CV. Not all field parameters have stabilized at the time samples are collected (Figure D2-R40-1 in Attachment D-2). Typically the screen has been purged dry, and samples are collected the following day.
- Sampling of this well screen is proposed to be discontinued in the 2011 IFGMP (LANL 2011, 205231). Monitoring is limited to water-level measurements for the reasons given above (LANL 2011, 205231, Appendix F).

R-40 screen 2 is capable of providing reliable water-quality data for COPCs detected in the vadose zones beneath MDAs H and L based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R40-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L (Table D-3.0-2) and NH_3-N, TKN, and acetone are not detected (Attachment D-1). Toluene was detected in samples collected in 2009 and early 2010 but not in the most recent samples (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable, below UTLs for regional background groundwater, and below corresponding 95th percentiles of the Tpf-Qct data set (Figure D2-R40-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are

generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R40-6 in Attachment D-2).

- This well screen is capable of providing representative data for all COPCs
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.12 Well R-41

Well R-41 is a dual-screen well with screens in perched-intermediate and regional groundwaters, downgradient of MDA G. The upper screen (port P1A) has been dry since installation.

R-41 screen 2 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R41-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L (Table D-3.0-2) and NH_3-N, TKN, and acetone are not detected (Attachment D-1). Chloromethane and toluene were detected in 2009 but have not been detected in the most recent samples (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable and below UTLs for regional background groundwater although slightly above corresponding 95th percentiles of the Tpf-Qct data set (Figure D2-R41-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R41-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.13 Well R-49

Well R-49 is a dual-screen well with both screens in the regional aquifer, downgradient of MDA G.

R-49 screen 1 is capable of providing reliable water-quality data for tritium and organic COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters for the samples collected in 2011 meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R49-1 in Attachment D-2). The first two characterization samples (collected in 2010) did not provide stable field data for specific conductivity and turbidity, but this condition has been resolved in recent samples.
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L (Table D-3.0-2) and NH_3-N, TKN, and acetone are not detected (Attachment D-1).

Chloromethane and toluene were detected in the first characterization sample collected in June 2009 but have not been detected in subsequent samples (Attachment D-1).

- No evidence is observed of the presence of residual inorganic drilling or construction products in recent samples. Geochemical conditions improved significantly following an extended purge of this screen on June 10–11, 2010. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable and below UTLs for regional background groundwater although slightly above corresponding 95th percentiles of the Tpf-Qct data set (Figure D2-R49-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R49-3 in Attachment D-2).
- No compelling evidence is observed of the presence of local contamination in this screened interval. The geochemical performance of this screen will continue to be reassessed as additional data become available.

R-49 screen 2 is capable of providing reliable water-quality data for tritium and COPCs detected in the vadose zone beneath MDA G based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R-49-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L (Table D-3.0-2) and NH_3-N, TKN, and acetone are not detected (Attachment D-1). Chloromethane and toluene were detected in samples collected in March 2010 but not in any other samples (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable and below UTLs for regional background groundwater although slightly above corresponding 95th percentiles of the Tpf-Qct data set (Figure D2-R49-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R49-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.14 Well R-51

Well R-51 is a dual-screen well with both screens in the regional aquifer, upgradient of MDA H.

R-51 screen 1 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA H based on the following observations for the four most recent sampling events.

- Field parameters in recent samples meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R51-1 in Attachment D-2).

- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2) in recent samples.
- No evidence is observed of the presence of residual organic materials. TOC <1 mg/L (Table D-3.0-2), TKN, and acetone are not detected, and NH_3-N is not detected above 0.07 mg/L.
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS in the most recent samples (Table D-3.0-2) are stable and below UTLs for regional background groundwater (Figure D2-R51-2 in Attachment D-2). Na and SO_4 concentrations were elevated in the sample collected in October 2010 but otherwise have been stable and within the range of regional background values.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is <2 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R51-3 in Attachment D-2).

R-51 screen 2 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA H although it may not yet be capable of providing reliable water-quality data for some inorganic COPCs. Based on the following observations for the four most recent sampling events, water quality in the screened interval may not have completely equilibrated with the adjacent formation, particularly for sampling events before 2011:

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R51-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN is not detected. Acetone was detected only in samples collected in July 2010 and not in the preceding or three subsequent events.
- Some evidence is observed of the presence of a small component of residual inorganic drilling or construction products. Although concentrations of Na and SO_4 (Table D-3.0-2) are below UTLs for regional background groundwater (Figure D2-R51-5 in Attachment D-2), they exceed the range expected for site-specific background and decreased steadily for the last three sampling events.
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is generally stable and <5 NTU. Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Figure D2-R51-6 in Attachment D-2).
- Groundwater in this screen interval is expected to reequilibrate fully with native groundwater by the end of 2011.

D-3.15 Well R-52

Well R-52 is a dual-screen well with both screens in the regional aquifer, downgradient of MDA H.

R-52 screen 1 is capable of providing reliable water-quality data for tritium and COPCs detected in the vadose zone beneath MDA H based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R-52-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. In the most recent samples, TOC <1 mg/L (Table D-3.0-2) and NH_3-N, TKN, and acetone are not detected (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable and below UTLs for regional background groundwater although slightly above corresponding 95th percentiles of the Tpf-Qct data set (Figure D2-R-52-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-52-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

R-52 screen 2 is capable of providing reliable water-quality data for tritium and COPCs detected in the vadose zone beneath MDA H based on the following observations.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R-52-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. In the most recent samples, TOC <1 mg/L (Table D-3.0-2) and NH_3-N, TKN, and acetone are not detected (Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable and below UTLs for regional background groundwater although slightly above corresponding 95th percentiles of the Tpf-Qct data set (Figure D2-R-52-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-52-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of anomalous odors noted by the sampling team collecting the water samples.

D-3.16 Well R-53

Well R-53 is a dual-screen well with both screens in the regional aquifer, downgradient of MDA L.

R-53 screen 1 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA L based on the following observations for the four most recent sampling events.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R53-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L (Table D-3.0-2) and NH_3-N and TKN are not detected. Acetone was detected only in samples collected in July 2010 and not in the three subsequent events.
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS (Table D-3.0-2) are stable and below UTLs for regional background groundwater (Figure D2-R53-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <1 NTU (Table D-3.0-1). Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R53-3 in Attachment D-2).

R-53 screen 2 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA L based on the following observations for the four most recent sampling events.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R53-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. Generally, TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN is not detected. Acetone was detected only in samples collected in July 2010 and not in the preceding or three subsequent events.
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable and below UTLs for regional background groundwater (Figure D2-R53-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is generally stable and <1 NTU. Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Figure D2-R53-6 in Attachment D-2).

D-3.17 Well R-54

Well R-54 is a dual-screen well with both screens in the regional aquifer, upgradient of MDA L (or downgradient of MDA L if PM-2 is pumping).

R-54 screen 1 is capable of providing reliable data for tritium but may not yet be fully capable of providing reliable water-quality data for organic COPCs detected in the vadose zone beneath MDA L. Based on the following observations for the most recent sampling events, water quality in the screened interval may not have completely reequilibrated with the adjacent formation, particularly for sampling events before 2011:

- Some field parameters have not stabilized after 3 CVs have been purged (Figure D2-R54-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of NO_3+NO_2-N between 0.2 and 0.3 mg/L, and ClO_4 at 0.2 µg/L (Table D-3.0-2). However, DO concentrations below 2 mg/L (Table D-3.0-1) and $\delta^{15}N$ values heavier than background (Table D-3.0-4) indicate the presence of microbial activity associated with degradation of residual organics (see next bullet). These observations are typical for the first year of water-quality data following well completion.
- Residual organic materials may be present in the screened interval. Acetone is not detected, and NH_3-N and TKN are nondetect or detected <0.1 mg/L. However, TOC concentrations are variable and range from 0.6 mg/L to 7 mg/L for the four most recent sampling events (Table D-3.0-2).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are below UTLs for regional background groundwater but are more variable than is typical for a fully equilibrated screened interval (Table D-3.0-2; Figure D2-R54-2 in Attachment D-2).
- Formation solids may be present in water-quality samples. Although turbidity is <2 NTU at the time samples are collected, Fe and Mn concentrations are elevated in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R54-3 in Attachment D-2).
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of issues noted above.

R-54 screen 2 is capable of providing reliable water-quality data for COPCs detected in the vadose zone beneath MDA L based on the following observations for the four most recent sampling events.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R54-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN and acetone are not detected.
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable and below UTLs for regional background groundwater Table D-3.0-2; Figure D2-R54-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is generally stable and <1 NTU. Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R54-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.18 Well R-55i

Well R-55i is a single-screen well in perched-intermediate groundwater, downgradient of MDA G.

R-55i is expected to be capable of providing reliable data for tritium and organic COPCs detected in the vadose zone beneath MDA G. However, this conclusion is preliminary because this is a relatively new well; presently, data are only available for two water-quality samples and a longer data record is needed.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R54-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N ≥0.2 mg/L, and ClO_4 ≥0.2 µg/L (Table D-3.0-2).
- Residual organic materials may be present in the screened interval. TOC >2 mg/L, acetone and toluene are detected, and TKN >0.1 mg/Lin the first sample (Table D-3.0-2 and Attachment D-1).
- The presence of residual inorganic drilling or construction products cannot be determined with certainty at this time. This screen shows the presence of local contaminants that affect the applicability of some of the geochemical evaluation criteria. In particular, specific conductance (Table D-3.0-1) and concentrations of alkalinity, Cl, NO_3+NO2-N, and TDS (Table D-3.0-2; Figure D2-R55i-2 in Attachment D-2) are above UTLs for perched-intermediate background groundwater. SO_4 concentrations are also above the corresponding 95th percentile of the Tpf-Qct data set. Possible sources of these constituents are discussed in section D-4.4 (Table D-3.0-2; Figure D2-R55i-2 in Attachment D-2).
- Formation solids may be present in water-quality samples. Although turbidity is <2 NTU at the time samples are collected, Fe and Mn concentrations are elevated in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R55i-3 in Attachment D-2).
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of its status as a new well.

D-3.19 Well R-55

Well R-55 is a dual-screen well with both screens in the regional aquifer, downgradient of MDA G.

R-55 screen 1 is capable of providing reliable data for tritium and organic COPCs detected in the vadose zone beneath MDA G.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R55-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Table D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN and acetone are not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable and below UTLs for regional background groundwater Table D-3.0-2; Figure D2-R55-2 in Attachment D-2).

- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU. Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R55-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

R-55 screen 2 is capable of providing reliable data for tritium and organic COPCs detected in the vadose zone beneath MDA G.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R55-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Table D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN and acetone are not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable and below UTLs for regional background groundwater Table D-3.0-2; Figure D2-R55-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU. Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R55-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.20 Well R-56

Well R-56 is a dual-screen well with both screens in the regional aquifer, upgradient of MDA G and downgradient of MDA L.

R-56 screen 1 is capable of providing reliable data for tritium and organic COPCs detected in the vadose zones beneath MDAs G and L.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R56-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Table D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN and acetone are not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable and below UTLs for regional background groundwater Table D-3.0-2; Figure D2-R56-2 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU. Al and Fe concentrations are generally

nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R56-3 in Attachment D-2).

- No evidence is observed of the presence of local contamination in this screened interval.

R-56 screen 2 is capable of providing reliable data for tritium and organic COPCs detected in the vadose zones beneath MDAs G and L.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R56-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. TOC <1 mg/L and NH_3-N, TKN, and acetone are not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable (Table D-3.0-2) and below UTLs for regional background groundwater (Figure D2-R56-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is generally stable and <1 NTU (Table D-3.0-1). Al is not detected and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R56-6 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is generally stable and <1 NTU. Al is not detected and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-2; Figure D2-R56-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.

D-3.21 Well R-57

Well R-57 is a dual-screen well with both screens in the regional aquifer, downgradient of MDA G.

R-57 screen 1 is expected to be capable of providing reliable data for tritium and organic COPCs detected in the vadose zone beneath MDA G. However, this conclusion is preliminary because this is a relatively new well; presently, data are available for only two water-quality samples and a longer data record is needed.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R57-1 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by consistent detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Table D-3.0-2).
- No evidence is observed of the presence of residual organic materials; TOC <1 mg/L, NH_3-N is nondetect or detected <0.1 mg/L, and TKN and acetone are not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable and below UTLs for regional background groundwater Table D-3.0-2; Figure D2-R57-2 in Attachment D-2).

- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is stable and <5 NTU. Al and Fe concentrations are generally nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R57-3 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of its status as a new well.

R-57 screen 2 is expected to be capable of providing reliable data for tritium and organic COPCs detected in the vadose zone beneath MDA G. However, this conclusion is preliminary because this is a relatively new well; presently, data are available for only two water-quality samples and a longer data record is needed.

- Field parameters meet stability criteria when the screen is purged in accordance with SOP-5232 (Figure D2-R57-4 in Attachment D-2).
- Oxic conditions are present as indicated, for example, by detections of DO >2 mg/L, NO_3+NO_2-N >0.2 mg/L, and ClO_4 >0.2 µg/L (Tables D-3.0-1 and D-3.0-2).
- No evidence is observed of the presence of residual organic materials. TOC <1 mg/L and NH_3-N, TKN, and acetone are not detected (Table D-3.0-2 and Attachment D-1).
- No evidence is observed of the presence of residual inorganic drilling or construction products. Concentrations of Na, Cl, SO_4, and TDS are stable (Table D-3.0-2) and below UTLs for regional background groundwater (Figure D2-R57-5 in Attachment D-2).
- No evidence is observed of the presence of a significant quantity of formation solids in water-quality samples. Turbidity is generally stable and <1 NTU (Table D-3.0-1). Al is not detected and Fe concentrations are nondetect or negligibly low in filtered and unfiltered samples (Table D-3.0-3; Figure D2-R57-6 in Attachment D-2).
- No evidence is observed of the presence of local contamination in this screened interval.
- This screen is assigned to the watch list in the 2011 IFGMP (LANL 2011, 205231, Appendix F) because of its status as a new well.

D-4.0 COPC DETECTIONS IN MONITORING WELLS

D-4.1 Screening Protocol

Sampling of the network wells for TA-54 began in 2001 and 2003 following the completion of R-22 and R-23, respectively. Since then, over 300 sampling events have taken place in the 21 wells. Water-quality data collected during these sampling events are screened against one-half of the groundwater cleanup level and against the Laboratory's groundwater background values (Attachment D-1). Selection of the screening values is described in section 5.1.2 of the corrective measures evaluation (CME) report and follows the approach prescribed for the development of groundwater cleanup levels in Section VIII of the Consent Order.

The outcome of the screening protocol is presented in frequency of detection tables that summarize detections of organic compounds as well as inorganic constituents detected above groundwater background concentrations (Attachment D-1 on DVD). The detection status for an analytical result is established using the combined set of laboratory-assigned validation qualifiers and reason codes

assigned during data validation. For detected constituents, the screening tables include summary information such as the total number of samples collected for each analyte at the location where it was detected; the numbers of detections; the mean and maximum detected values; the number of detections exceeding groundwater background values (for naturally occurring inorganic constituents); the number of detections exceeding the lowest applicable regulatory or risk-based screening levels; and the number of detections exceeding one-half the lowest applicable screening levels. Analytical data for field duplicates are included in the statistics presented in the frequency of detection tables.

D-4.2 Organic COPC Detections

Table D-4.2-1 presents a statistical summary of high-explosive and organic COPCs detected in deep monitoring wells specific to MDAs G, H, and L and scheduled for water-quality sampling under the 2010 IFGMP. This table includes monitoring wells specific to MDAs G, H, and L but for which sampling was discontinued in the 2010 IFGMP because of conversion to a different sampling configuration or abandonment following removal of the Westbay sampling system (port designations “MP”). As shown in Table D.4.2-1, 71 organic constituents have been detected, including 22 SVOCs, 26 VOCs, 6 high explosive compounds, 5 dioxins/furans, 2 polychlorinated biphenyl (PCB) compounds, and 10 pesticides.

The majority of these cases are sporadic detections at low concentrations at or below the PQL of the analytical method. Of the 71 organic constituents, only 21 have been detected more than once in the same screened interval, and it is important to note this statistic includes analytes detected in field duplicates such that two detections of a given analyte may occur in a single sampling event.
Table D-4.2-2 summarizes the occurrences of the 21 organic constituents detected more than once at the same location for more than one sampling event. Table D-4.2-3 shows detected and nondetected organic analytes with PQLs greater than applicable regulatory standards.

Among the detected organic compounds, 11 have been detected at concentrations that exceed one-half the lowest applicable groundwater cleanup level (standard) determined following the approach in the Consent Order, Section VIII: benzene (R-38); benzo(a)pyrene (R-22); benzo(b)fluoranthene (R-22 and R-55); bis(2-ethylhexyl)phthalate (R-22, R-32, R-37, R-38, R-40, and R-54); 1-4-dioxane (R-20, R-37, and R-38); indeno(1,2,3-cd)pyrene (R-55); methylene chloride (R-23 and R-49); 4-methylphenol (R-22); pentachlorophenol (R-22); phenol (R-22); and TCE (R-20).

Among the detected organic compounds, nine have been detected at concentrations that exceed the lowest applicable groundwater cleanup level (standard): benzene (R-38); benzo(a)pyrene (R-22); benzo(b)fluoranthene (R-22 and R-55); bis(2-ethylhexyl)phthalate (R-23, R-32, R-38, and R-54); 1,4-dioxane (R-20); indeno(1,2,3-cd)pyrene (R-55); 4-methylphenol (R-22); pentachlorophenol (R-22); and phenol (R-22) (Table D.4.2-1)

Review of the data provided in Table D.4.2-1 show the following.

Benzene

At well R-38, benzene was detected at 6.34 µg/L, which is above the EPA MCL of 5 µg/L, in the first sample collected in February 2009. Benzene was detected below the MCL later in 2009 and has not been detected since in this well.

Benzo(a)pyrene

At well R-22 screen 5 (port MP5A), benzo(a)pyrene was detected at 0.23 µg/L, which is slightly above the EPA MCL of 0.20 µg/L and below the PQL of 1 µg/L. This sample was collected in December 2001 from samples collected between March 2001 and February 2009.

Benzo(b)fluoranthene

The detections of benzo(b)fluoranthene above the EPA tap standard of 0.29 µg/L were from samples collected at wells R-22 and R-55.

- At well R-22 screen 5 (port MP5A), it was detected at 0.4 µg/L, which is above the standard but below the PQL of 1 µg/L. The sample was collected and analyzed in December 2001 from samples collected between March 2001 and February 2009.
- At well R-55 screen 2 (port P2A), it was detected at 0.42 µg/L, which is above the standard but below the PQL of 1 µg/L. The sample was collected in the first sampling event during September 2010, but benzo(b)fluoranthene was not detected in the two subsequent sampling events.

Bis(2-ethylhexyl)phthalate

The detections of bis(2-ethylhexyl)phthalate above the EPA MCL standard of 6 µg/L were from samples collected at wells R-23, R-32, R-38, and R-54.

- At well R-23, it was detected at 7.6 µg/L, which is above the standard but below the PQL of 10 µg/L, in December 2003. This was the only time between December 2003 and April 2011 that bis(2-ethylhexyl)phthalate was detected at this well.
- At well R-32, it was detected at 6 µg/L, which is equivalent to the standard but below the PQL of 10 µg/L in June 2008. It has not been detected at this well in samples collected between June 2009 and May 2011.
- At well R-38, it was detected 3 times (out of 12 analyses) above the standard between February 2009 and May 2009. The maximum concentration was 35.6 µg/L, and the average concentration was 8.3 µg/L.
- At well R-54 screen 1(port P1A), it was detected at 11.2 µg/L, which is above the standard. This sample was the first sample collected from this well screen in February 2010. It has not been detected at this screen in samples collected between June 2010 and May 2011.

Dioxane(1,4-)

At well R-20 screen 2 (port P2A), 1,4-dioxane was detected at 61.4 µg/L, which is above the EPA tap water standard of 6.7 µg/L. This analyte has been detected only once above the standard using EPA Method 8260. This method has been discontinued for this analyte in favor of EPA Method 8270. Dioxane(1,4-) has not been detected using EPA Method 8270 from 2009 to 2011.

At well R-37 screen 1 (port P1A), 1,4-dioxane has been detected above one-half the EPA tap water standard of 6.7 µg/L, but it has not exceeded the standard.

Indeno(1,2,3-cd)pyrene

At well R-55 screen 2 (port P2A), indeno(1,2,3-cd)pyrene was detected at 0.466 µg/L, which is above the EPA tap standard of 0.29 µg/L but below the PQL of 1 µg/L. This sample was collected in September 2010. Indeno(1,2,3-cd)pyrene has not been detected in samples collected at this well screen between February and April 2011.

Methylphenol(4-)

At well R-22 screen 4 (port MP4A), 4-methylphenol was detected at 210 µg/L, which is above the EPA tap standard of 180 µg/L and the PQL of 10 µg/L. It was detected above the standard in one out of seven samples collected from this location and analyzed for 4-methylphenol.

Pentachlorophenol

At well R-22 screen 5 (port MP5A), pentachlorophenol was detected at 6.19 µg/L, which is above the EPA MCL of 1 µg/L but below the PQL of 10 µg/L. It was detected above the standard in one out of eight samples collected from this well screen and analyzed for pentachlorophenol.

Phenol

At well R-22 screen 4 (port MP4A), phenol was detected at 32 µg/L which is above the New Mexico groundwater standard of 5 µg/L. It was detected above the standard in one out of seven samples collected from this screen and analyzed for phenol.

At well R-22 screen 5 (port MP5A), phenol was detected at 19 µg/L which is above the New Mexico groundwater standard of 5 µg/L. It was detected above the standard in one out of eight samples collected from this screen and analyzed for phenol.

D-4.3 Inorganic COPC Detections above Screening Levels

Table D-4.3-1 presents a statistical summary of inorganic constituents detected above one-half standard or full standard in deep monitoring wells specific to MDAs G, H and L and scheduled for water-quality sampling under the 2010 IFGMP. Table D-4.3-1 also presents a statistical summary of inorganic constituents detected above one-half standard or the standard for monitoring wells specific to MDAs G, H or L but for which sampling was discontinued in the 2010 IFGMP because of conversion to a different sampling configuration or abandonment following removal of the Westbay sampling system (port designations “MP”). As shown in this table, 11 inorganic constituents have been detected above one-half standard, including fluoride, nitrate-nitrite, TDS, and 8 metals in filtered samples. The majority of these cases are associated with the first year or two following well completion or redevelopment, or with a screened interval impacted by residual effects of drilling or redevelopment. Table D-4.3-2 summarizes the occurrences of the 11 inorganic constituents detected above one-half standard more than once at the same location for more than one sampling event.

Among inorganic COPCs, eight constituents have been detected above the lowest applicable groundwater standard (Table D-4.3-1). They include two general inorganics (nitrate-nitrite and total dissolved solids) and six metals (aluminum, antimony, arsenic, iron, lead, and manganese).

Review of the data provided in Table D-4.3-1 show the following:

Nitrate-Nitrite

The only detection of nitrate-nitrite above the EPA MCL of 10 mg/L was 748 mg/L at R-20 screen 1 (port P1A). This is most likely the result from a sample that was improperly preserved with nitric acid instead of the required sulfuric acid. The remaining nitrate-nitrite detections from the TA-54 monitoring network range from 0.01 mg/L to 3.88 mg/L.

Total Dissolved Solids

At well R-23, the concentration of total dissolved solids (2900 mg/L) exceeds the New Mexico groundwater standard of 1000 mg/L appears to be an analytical reporting error because such a high concentration is inconsistent with concentrations reported for individual dissolved constituents, none of which are out of line with the overall stable geochemical trends at this well.

Aluminum

At well R-32, the reanalysis of aluminum in the one sample detected at 6850 µg/L, which is above the New Mexico groundwater standard of 5000 µg/L, resulted in a nondetect value. Therefore, the 6850 µg/L result is suspect.

Antimony

At well R-40 screen 1 (port P1A), the two antimony results detected above the EPA MCL were collected in October 2010. No results were detected above the MCL before or after this sampling event.

Arsenic

At well R-20 screen 3 (port MP3A), the one detection of arsenic at 10.6 µg/L, which is above the EPA MCL of 10 µg/L. This well screen has now been plugged and abandoned because of residual effects of drilling products.

Iron

The detections of iron above the NM groundwater standard of 1000 µg/L were from samples collected at wells R-20, R-22, R-32, R-40, and R-54.

- For wells R-20 (port MP3A) and R-32 (port MP3A), the screens have been plugged and abandoned because of residual effects of drilling products.
- Eighteen of the remaining detections were at well R-22, which is off-line and a decision for its final sampling configuration is pending.
- At well R-32, the one result detected (3850 µg/L) above the standard is suspect because the unfiltered sample taken at the same time was nondetect.
- At well R-40i, the five detections above the standard may be attributed to reducing conditions at this screen (see section D-4.4).
- At well R-54 screen 1 (port P1A), iron was detected above the standard in three of the six samples. The average detected concentration at this screen was 1548 µg/L.

Lead

The one detection of lead above the New Mexico groundwater standard of 15 µg/L (19.7 µg/L) was from a sample collected at R-22 screen 3 (port MP3A). R-22 is currently off-line and a decision for its final sampling configuration is pending.

Manganese

The detections of manganese above the New Mexico groundwater standard of 200 µg/L were from samples collected at wells R-20, R-22, R-23, R-32, R-40, R-54, and R-55i.

- At well R-20 screen 2 (port MP2A), five detections were above the standard before well rehabilitation. Results were below New Mexico groundwater standard after well rehabilitation.
- At well R-20 screen 3 (port MP3A) and R-32 screen 3 (MP3A), the screens have been plugged and abandoned because of residual effects of drilling products.
- Twenty-one of the remaining detections were at well R-22, which is currently off-line and a decision for its final sampling configuration is pending.
- Of the 25 samples analyzed for manganese at R-23, one result was detected above the standard. This was only detected in the first sampling event at this well.
- At well R-40 screen 1 (port P1A), only one result (400 µg/L) out of seven was detected above the standard in December 2009.
- At well R-40i, manganese was consistently detected above the standard. The average concentration at this location is 301 µg/L.
- At well R-54 screen 1 (port P1A), manganese was detected above the standard in three of the six samples at this screen.
- At well R-55i, manganese was consistently detected above the standard. The average concentration at this location is 528 µg/L.

For informational purposes, Table 4.3-3 presents detections of radionuclides, including tritium, in the TA-54 groundwater monitoring wells.

D-4.4 COPC Sources

Sources of the COPCs detected in deep groundwater wells have not been determined with certainty. Four candidate sources are discussed here.

COPCs from MDA L

Among the three vapor-phase organics detected at highest concentrations in the vadose zone beneath MDA L (TCA, TCE, and PCE), only TCE has been detected in any of the monitoring wells near MDA L. Two primary lines of evidence indicate that MDA L is not the likely source of the TCE or other organics detected in the seven regional wells nearest to MDA L. First, TCA, the VOC detected at the highest concentration in the vapor phase below MDA L, including at the deepest port located within the basalt (Figure B-3.1-9 of Appendix B of the MDA L CME report), has not been detected in any of the six regional wells that are downgradient of MDA L. Secondly, other organic analytes detected in the vapor phase beneath MDA L are at relatively low levels in the vadose zone monitoring wells compared with those observed for the three main vadose-zone VOCs.

Indications are that the largely sporadic detections of VOCs in regional groundwater beneath MDA L (as summarized in section D-4.2 and presented for selected constituents detected in well R-20 in Figure D-3.1-1) are not likely to be associated with the vapor-phase contamination beneath and sourced from MDA L. However, there is uncertainty related to transport of VOCs present in the vadose zone beneath MDA L through the Cerros del Rio basalt toward groundwater, as described in the conceptual site model (section 4 of this report) and in Appendix C of the MDA L CME report. The pathway is considered to be potentially complete, and remediation of the vapor plume is recommended in section 9 of the MDA L CME to break the potential pathway.

COPCs from MDA G

The vapor-phase VOCs detected at highest concentrations in the pore gas at MDA G are TCA; 1,1,2-trichloro-1,2,2-trifluoroethane; TCE, 1,1-dichloroethene; 1,1-dichloroethane; and PCE (LANL 2010, 108496, Table 3.0-2). Of these six VOCs, only TCE has been detected in the monitoring wells downgradient of MDA G (Tables D-4.2-1 and 4.2-2). Two primary lines of evidence indicate MDA G is not the likely source of the TCE or other organics detected in the deep groundwater wells downgradient of MDA G. First, none of the VOCs detected at the highest concentrations in the vapor phase below MDA G have been detected in the six regional wells closest to MDA G; the location at which TCE was detected once (R-23i) is considerably downgradient of MDA G and is along a potential line of infiltration beneath Pajarito Canyon. Secondly, the VOCs detected with the greatest frequency in the wells closest to MDA G—chloromethane and toluene—are either not detected in the vapor plume beneath MDA G or else are detected only at relatively low levels. Therefore, indications are that the largely sporadic detections of VOCs in regional groundwater immediately downgradient of MDA G (as summarized in Tables D-4.2-1 and D-4.2-2) are not associated with the vapor-phase contamination beneath and sourced from MDA G. However, there is uncertainty related to transport of VOCs present in the vadose zone beneath MDA G through the Cerros del Rio basalt toward groundwater, as described in the conceptual site model (section 4 of the MDA G CME report). The pathway is considered to be potentially complete, and remediation of the vapor plume is recommended in section 9 of the MDA G CME to break the potential pathway.

COPCs from MDA H

Toluene and 1,4-dioxane have been detected in wells downgradient of MDA H (Tables D-4.2-1 and D-4.2-2). Although it is conceivable that these constituents are present because of vapor-phase transport beneath MDA H, this source is not likely given the extremely low VOC concentrations in the vapor-phase beneath MDA H (Table B-2.3-1 of the MDA H CME report) and because 1,4-dioxane is a semivolatile compound.

COPCs from TA-18 or Other Potential Release Sites in the Pajarito Canyon Watershed

R-20 is located beneath Pajarito Canyon downgradient of TA-18 and near a zone of enhanced infiltration (LANL 2009, 106939, section 7.2.1 and Appendix H). Former septic systems at TA-18 are a potential source of VOCs in the canyon. Elevated nitrate concentrations to 65 ft at well R-20 suggest the presence of a driving force for the transport of soluble contaminants in alluvial groundwater into the underlying bedrock at the confluence of Threemile Canyon with Pajarito Canyon. In addition, borehole samples and alluvial groundwater samples have indicated the presence of inorganic, organic, and radionuclide COPCs in the subsurface beneath the canyon bottom (LANL 2009, 106939). Subsurface samples to depths of 180 ft below ground surface (bgs) will be collected near two former sanitary lagoons [Consolidated Unit 18-001(a)] and an inactive septic system [Solid Waste Management Unit 18-003(e)] in TA-18 as part

of the lower Pajarito Canyon Aggregate Area investigation (LANL 2010, 111328). These units are located approximately 2500 ft up- and downcanyon of R-20, respectively, and will provide information regarding VOCs and other constituents that were potentially released to Pajarito Canyon.

TCE, xylene[1,3], and xylene[1,4] are detected in regional aquifer water collected from the lower screen of R-20. The concentrations and the concentration histories for these constituents both appear to be strongly correlated (Figure D-3.1-1). However, their distributions in the vapor plume at MDA L are dissimilar. For example, based on data collected from the third quarter of fiscal year 2009 through the second quarter of 2010, xylene[1,3] and xylene[1,4] were detected at low levels in only 7 ports in 4 vapor monitoring wells, with 6 of these ports located east of the MDA L fence line; TCE and TCA are detected in all 25 boreholes and 89 ports sampled, with maximum concentrations occurring within the MDA L fence line and close to the disposal units (LANL 2010, 109955). Xylene[1,3] and xylene[1,4] concentrations are less than 1% of TCE concentrations in collocated samples. It seems unlikely that the few low-concentration xylene detections in the vapor plume at MDA L would manifest as detectable concentrations at R-20 that are correlated to the TCE concentrations, especially given they are not collocated. In addition, it seems unlikely that TCA would be absent at R-20 if the other constituents are from MDA L, given that the TCA and TCE are well correlated in the deep portion of the vapor plume (Figure B-3.1-10 of the MDA L CME report). This analysis suggests a source other than MDA L for the TCE and xylenes detected at R-20. However, a caveat of this analysis is that it is based on current-day vapor distributions. If the distributions of TCA, TCE, and the xylene constituents within the vapor plume beneath MDA L were significantly different in the past, this conclusion may not be correct.

R-23 and R-23i are located within Pajarito Canyon downgradient of TA-18. Borehole samples and alluvial groundwater samples have indicated the presence of inorganic, organic, and radionuclide COPCs in the subsurface beneath the canyon bottom (LANL 2009, 106939). Water levels at well R-23i appear to be impacted by surface water flow and alluvial water levels in Pajarito Canyon, especially at alluvial well PCO-3. Infiltration near R-23i and R-23 may be focused through the Cerros del Rio basalt, which is located close to the surface in this part of the canyon (LANL 2009, 106939). Therefore, it is possible the water chemistry at wells R-23i and R-23 may be impacted by surface water and alluvial groundwater in Pajarito Canyon.

Lateral flow along perching horizons may transport contaminants from nearby wet canyon sources such that they are detected in wells near MDA H. For example, elevated concentrations of 1,4-dioxane, chloride, perchlorate, and tritium are present at intermediate well MCOI-6 in Mortandad Canyon (LANL 2006, 094161); these constituents could potentially be transported southward toward R-37 (Figures E-2.1-3 and E-2.1-4). Similarly, chloride, 1,4-dioxane, and tritium are observed at elevated concentrations in upcanyon sources in Pajarito Canyon (e.g., at shallow wells 03-B-10 and 03-B-13). These contaminants may be transported toward R-37 by means of infiltration in the canyon floor of Pajarito Canyon and by lateral flow along perching horizons in the vadose zone. Even if not present in the source, concentrations of many major ions as well as trace metals are likely to be altered from natural conditions as a result of water-rock interactions along the flow path if contaminants are present in the groundwater. This mechanism could account for slightly elevated concentrations of chloride, magnesium, iron, manganese, and molybdenum detected in perched-intermediate groundwater.

Contaminants from Residual Materials or Products Used Downhole

A large proportion of the VOC and SVOC detections occur during the initial year of sampling or in the first year following screen rehabilitation and sampling-system conversion activities. In these cases, the analyte typically shows a maximum concentration in the first one or two sampling rounds and decreases steadily thereafter because of its gradual removal from the screen interval via advective flow, purging, and

biodegradation. Organic VOC detections frequently occur along with elevated concentrations of total organic carbon, acetone, or other common indicators of residual organic products. Organic analytes that may be present in residual downhole products primarily as a result of their introduction into the product during the manufacturing process include acetone, toluene, benzene, and the plasticizers bis(2-ethylhexyl)phthalate and diethylphthalate.

Elevated iron and manganese concentrations at R-40i are thought to be related to reducing conditions caused by the presence of residual organic drilling products remaining at this well screen (section D-3.10). Temporarily elevated concentrations of constituents are also commonly observed during the first few sampling events following well completion or installation of a sampling system from suspended particulates or colloidal material from the formation or from residual mixing of groundwater from higher saturated zones. With time, these constituents gradually approach predrilling concentrations as the interval is flushed by ambient groundwater flow. However, this natural return to equilibrium conditions is quite prolonged at some screens, such as R-40 screen 1, because of the extremely low permeability of the screened interval (section D-3.11 and Appendix E) and may account for the continued presence of zinc in groundwater at R-40 screen 1. Drilling products or materials used downhole also cannot be ruled out as sources of trace metals because of their presence in lubricants and greases, and 1,4-dioxane may be present in products that contain diethylene glycol.

Sporadic Low-Level Detections

Some of the sporadic low-level detections may be the result of field or laboratory contamination or analytical errors. For example, acetone, 2-butanone, chloromethane, and toluene are among the VOCs detected with the greatest frequency in equipment blanks, field blanks, and field trip blanks collected during groundwater sampling events.

Analytical error may also be the case for the single detection of 1,4-dioxane reported for R-20 screen 2 (61 µg/L for a sample collected on September 18, 2008) obtained as part of the VOC analytical suite using EPA Method 8260. This analytical method is prone to false detections of 1,4-dioxane, which is now analyzed as part of the SVOC analytical suite using the more sensitive EPA Method 8270. Dioxane[1,4-] has not been detected in R-20 screen 2 samples analyzed using the more sensitive method. Laboratory contamination is the also likely cause for the improbably high nitrate-nitrite concentration reported for R-20 screen 1 (748 mg/L as nitrogen for a sample collected on August 3, 2010; Table D-4.3-1).

Analytical error may also be the case for the single detections of benzo(a)pyrene, benzo(b)fluoranthene, 4-methylphenol, and phenol reported for screened intervals at well R-22.

Groundwater characterization and monitoring is ongoing at TA-54 in accordance with annual revisions to the IFGMP. Monitoring frequency and analyte suites are specified in annual updates to the IFGMP.

D-5.0 CONCLUSIONS

The analysis of existing groundwater monitoring data presented in this appendix suggests a low probability that constituents detected in perched-intermediate and regional groundwater at TA-54 are because of contaminant transport from the three TA-54 MDAs.

At MDA L, the analysis of existing groundwater monitoring data considered in light of the vapor transport model presented in Appendix B of the MDA L CME suggests a low probability that the VOCs detected in the regional aquifer in the vicinity of MDA L are from vapor-phase transport from the MDA L VOC vapor plume under the assumption that the current soil-vapor-phase contaminant concentrations are

representative of the source contaminant concentrations in the past. The analysis indicates that if the VOCs detected in the groundwater are associated with MDA L, then detectable concentrations of TCA, TCE, and numerous other compounds found in the MDA L plume should also be present.

The analysis of existing groundwater monitoring data presented in this appendix suggests a low probability that the organic COPCs detected in the perched-intermediate zone or in the regional aquifer downgradient of MDA G are from vapor-phase transport from the MDA G VOC vapor plume. Detections at wells immediately downgradient of MDA G are sporadic, and none of the detected compounds has been consistently detected beyond the first 2 yr following well completion or installation of a sampling system. The analysis also indicates that if the VOCs detected in the groundwater are associated with MDA G, then detectable concentrations of TCA and several other VOCs found in the MDA G plume should also be present.

Based on the preceding analysis, no compelling evidence indicates contaminants sourced at MDA H are present at any MDA H groundwater monitoring wells. Although 1,4-dioxane may be a local contaminant in the perched-intermediate groundwater at R-37, sources other than MDA H are more likely. A longer period of record for MDA H monitoring wells as well as for other wells in the TA-54 groundwater monitoring network will help in an integrated fashion to distinguish potential sources of contaminants.

Although groundwater data do indicate that VOCs have reached groundwater beneath TA-54, there is uncertainty related to transport of VOCs present in the vadose zone beneath MDAs L and G through the Cerros del Rio basalt toward groundwater, as described in the conceptual site models (section 4 of the MDAs L and G CME reports). The pathway is considered to be potentially complete based on this uncertainty, and remediation of the vapor plume is recommended in those CMEs to break the potential pathway. Remediation is not recommended for MDA H because of the very low VOC concentrations and inventory present at that site.

D-6.0 REFERENCES

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

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

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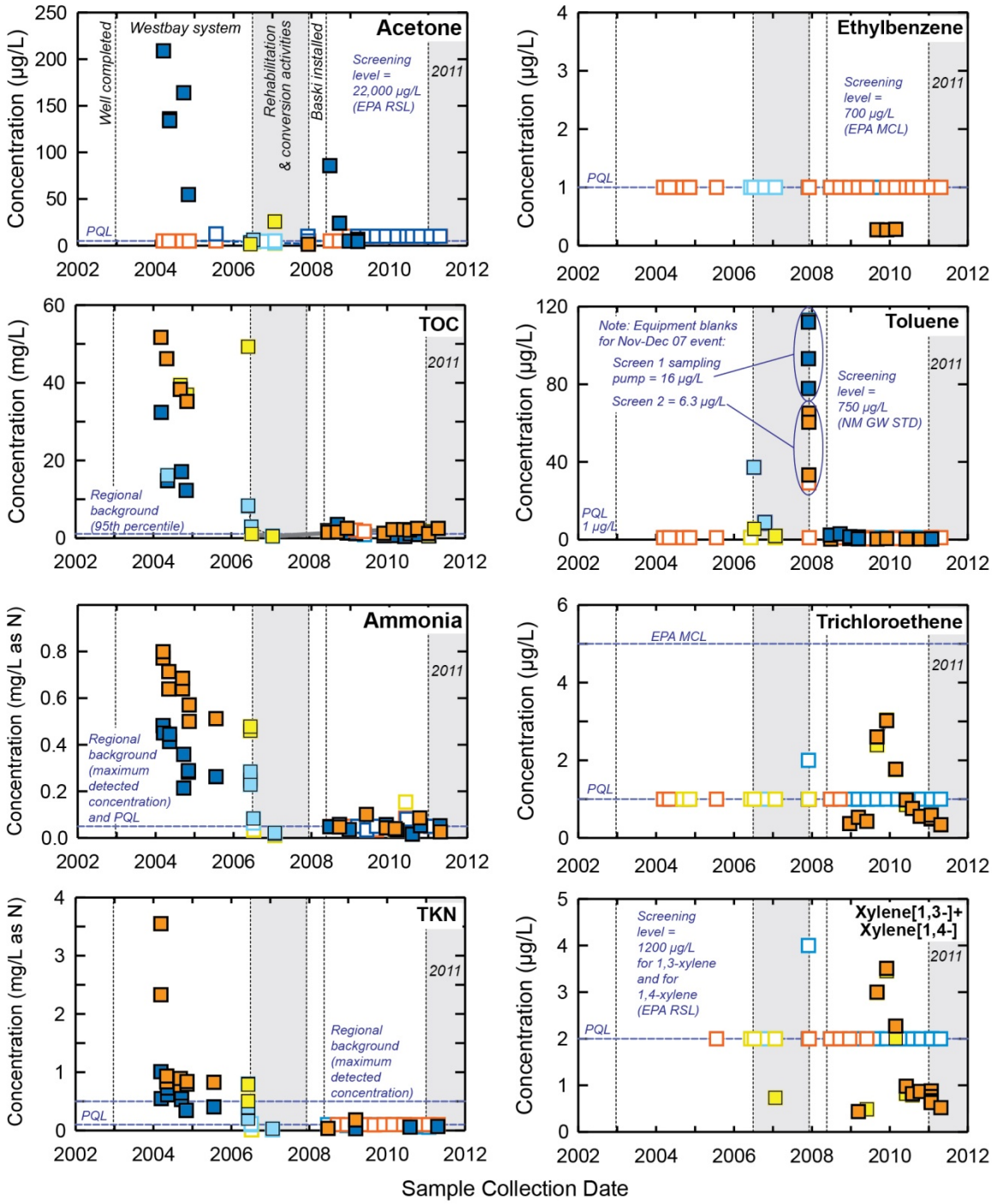
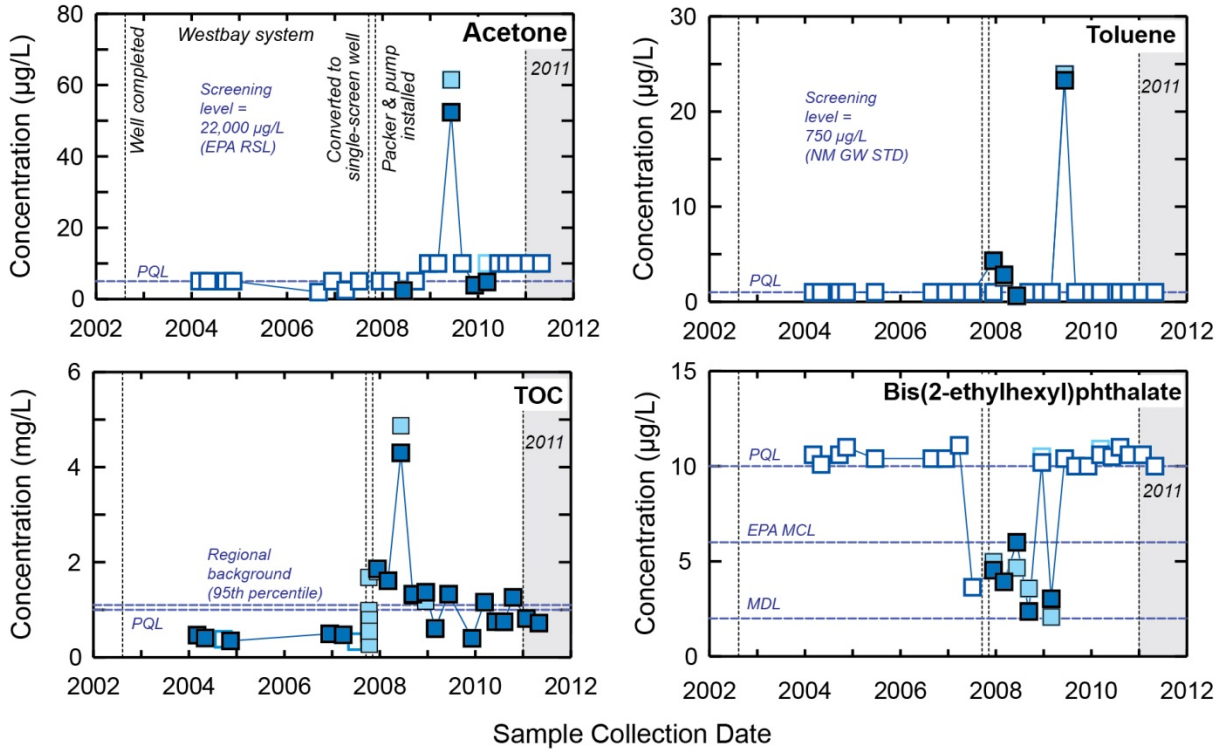


	Screen 1	Screen 2
Primary sample	Detect Nondetect	Detect Nondetect
Field duplicate or redevelopment sample	Detect Nondetect	Detect Nondetect
Data source: LANL water-quality database		

Notes:
1) Practical Quantitation Limits (PQL) and screening levels from 2010 Interim Plan (LANL 2010, 109830, section C-4.1).
2) EPA MCL = EPA maximum contaminant level; EPA RSL = EPA regional screening level (for tapwater); NM GW STD = New Mexico Groundwater Human Health Standard
3) Regional background = upper limit for background regional groundwater (LANL 2007, 095817, Table 4.2-3).

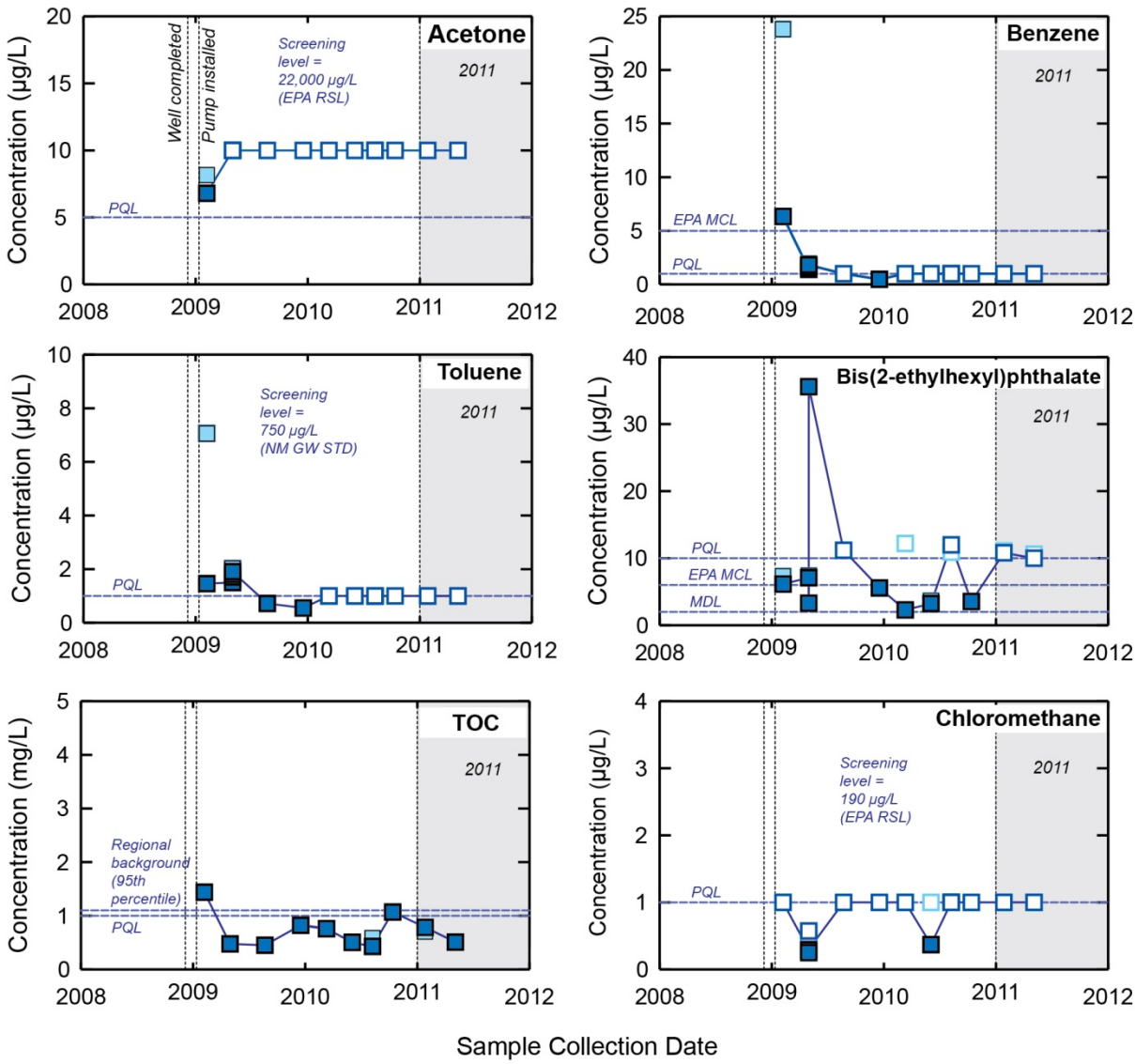
Figure D-3.1-1 Concentration trends for selected organic chemicals and indicators of residual organic drilling products in R-20 screens 1 and 2



	Screen 1
Primary sample	Detect Nondetect
Field duplicate or redevelopment sample	Detect Nondetect
Data source: LANL water-quality database	

Notes:
1) Practical Quantitation Limits (PQL) and screening levels from 2010 Interim Plan (LANL 2010, 109830, section C-4.1).
2) EPA MCL = EPA maximum contaminant level; EPA RSL = EPA regional screening level (for tapwater); NM GW STD = New Mexico Groundwater Human Health Standard
3) Regional background = upper limit for background regional groundwater (LANL 2007, 095817, Table 4.2-3).

Figure D-3.6-1 Concentration trends for selected organic chemicals and indicators of residual organic drilling products in R-32



Primary sample: Detect / Nondetect Field duplicate: Detect / Nondetect Data source: LANL water-quality database	Notes: 1) Practical Quantitation Limits (PQL) and screening levels from 2010 Interim Plan (LANL 2010, 109830, section C-4.1). 2) EPA MCL = EPA maximum contaminant level; EPA RSL = EPA regional screening level (for tapwater); NM GW STD = New Mexico Groundwater Human Health Standard 3) Regional background = upper limit for background regional groundwater (LANL 2007, 095817, Table 4.2-3).

Figure D-3.8-1 Concentration trends for selected organic analytes and indicators of residual organic drilling products in R-38

Table D-1.0-1
Perched-Intermediate and Regional Wells in the TA-54 Monitoring Well Network

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-20	Screen 1 Port P1A	905	6	11-Mar-04	6-Jun-06	Westbay	• Multiple-screened regional well was completed on 15-Sept-02. Westbay multiport sampling system was installed on 18-Jan-03. • Westbay system was removed 28-Jun-06; screens 1, 2, and 3 isolated by temporary packers. • Packers were removed on 12-Nov-07 for redevelopment, abandonment of screen 3, and testing activities. Single packer was installed between screens 1 and 2 on 05-Dec-07. • Screen 3 was plugged and abandoned on 18-Nov-07 because of unfavorable geochemical conditions resulting from residual drilling, construction, and development products. • Baski dual-pump sampling system and Baski k-packer were installed on 22-May-08 (LANL 2008, 103100). • Potential cross-flow occurred between screened intervals in 2009 because of underinflated packer; water-quality samples not affected (LANL 2010, 108783). • Extended purge of screen 1 was conducted from 26-Jan-11 to 27-Jan-11; extended purge of screen 2 was conducted 21-Jan-11. The pump in screen 1 malfunctioned during the extended purge event and is scheduled for replacement in 2011.
			4	6-Jul-06	30-Nov-07	Temporary packers	
			13	21-Jun-08	20-Apr-11	Baski system	
	Screen 2 Port P2A	1147	6	10-Mar-04	7-Jun-06	Westbay system	
			3	8-Jul-06	4-Dec-07	Temporary packers	
			13	23-Jun-08	25-Apr-11	Baski system	
	Screen 3 Port MP3A	1330	6	9-Mar-04	8-Jun-06	Westbay system	
			4	7-Jul-06	19-Jan-07	Temporary packers	
R-21	Single	889	25	31-Mar-04	19-Apr-11	Single completion well	• Single-screen regional well was completed on 26-Nov-02. Dedicated submersible pump installed on 14-Feb-03.

Table D-1.0-1 (continued)

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-22	Screen 1 Port MP1A	907	19	13-Mar-01	26-Feb-09	Westbay	• Well R-22 was completed on 19-Oct-00. Portland cement was used in the annular space above screens 1 and 2, between screens 2 and 3, and between screens 3 and 4. • Screens 1 and 2 did not produce sufficient water for pump development before the sampling system was installed. • Westbay multiport sampling system was installed on 8-Dec-00 (Ball et al. 2002, 071471). • Westbay system was removed between 19-Apr-09 and 3-May-09 for redevelopment focused on screens 1 and 5. • Several specific-capacity tests and purging, and sampling events were conducted between 13-May-09 and 2-Jul-09 in configurations that included a single packer and double packers as well as open-hole (no packers). Analytical samples were collected from screen 1 during the extended purging activity conducted from 23-Jun-09 to 2-Jul-09 using a pneumatic Bennett pump and inflatable packer. Analytical samples were collected from screen 5 during the extended hydraulic testing and purging activity conducted from 17-May-09 to 27-May-09 using a 10-hp pump and single inflatable packer above the pump. • The sample collected from screen 1 at the end of redevelopment on 02-Jul-09 is included in the statistical summaries of analyte detections (section D-3.0). Data for earlier samples and other screens are discussed in the text but are not included in the statistical summaries. • Four temporary inflatable packers were installed on 28-May-09 and 30-May-09 to isolate the five screens from one another. • Well R-22 was removed from sampling under the 2010 IFGMP until a decision has been made concerning its final post-conversion configuration.
			15 (4)[b]	24-Jun-09	2-Jul-09	Bennett pump	
	Screen 2 Port MP2A	963	19	12-Mar-01	26-Feb-09	Westbay	
	Screen 3 Port MP3A	1274	19	8-Mar-01	27-Feb-09	Westbay	
	Screen 4 Port MP4A	1378	19	7-Mar-01	26-Feb-09	Westbay	
	Screen 5 Port MP5A	1448	20	6-Mar-01	26-Feb-09	Westbay	
			29 (8)[b]	18-May-09	26-May-09	10-hp pump, single inflatable packer	

Table D-1.0-1 (continued)

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-23i	Piezometer Port P1A	400	14	6-Sep-07	28-Apr-11	Portable pump	• Well was completed on 10-Nov-05. • Sampling system was installed in well on 15-Dec-06. • A piezometer was installed in well annulus. Development methods were limited to bailing, or bailing and swabbing. Geochemistry appears to be affected by seasonal water-level changes (LANL 2010, 109830, Table F-4.0-1). R-23i was sampled using portable Bennett pump. • Some samples from screen 2 in 2009 potentially affected by cross-flow (LANL 2010, 109830, Table F-4.0-1). Sampling system was removed for repairs in Dec-09. • Well was redeveloped in Jan-10 before reinstallation of the Baski sampling system on 2-Mar-10 (Koch and Schmeer 2010, 201566).
	Screen 1 Port P2A	470	19	3-Oct-06	3-May-11	Baski dual-pump	
	Screen 2 Port P3A	524	17	11-Oct-06	18-Apr-11	Baski dual-pump	
R-23	Single	816	25	17-Dec-03	18-Apr-11	Dedicated pump	• Well R-23 was completed on 02-Oct-02. • Dedicated submersible pump was installed on 14-Feb-03.
R-32	Screen 1 Port MP1A	871	9	1-Mar-04	7-Jul-07	Westbay system	• Multiple-screen regional well was completed on 12-Aug-02. Westbay multiport sampling system was installed on 17-Nov-02. Screen 2 never used for water-quality sampling. • Westbay system was removed 18-Sept-07 for well rehabilitation and conversion to single completion well at screen 1 (LANL 2007, 100572). • Screens 2 and 3 were plugged and abandoned on 20-Sept-07 because of unfavorable geochemical conditions resulting from residual drilling, construction and development products (LANL 2007, 100572). • Baski k-packer and dedicated submersible pump were installed on 07-Nov-07 (LANL 2007, 100572).
	Screen 3 Port MP3A	976	10	3-Mar-04	6-Jul-07	Westbay system	
	Single	867.5	15	14-Dec-07	2-May-11	Single completion well	
R-37	Screen 1 Port P1A	929	10	13-Jul-09	3-May-11	Baski dual-pump	• Well R-37 was completed 06-Jun-09. • Baski dual-pump system was installed 19-Dec-09.
	Screen 2 Port P2A	1026	9	22-Jun-09	26-Apr-11	Baski dual-pump	
R-38	Single	821.2	10	6-Feb-09	6-May-11	Single completion well	• Single-screen regional was well completed on 07-Dec-08. Dedicated submersible pump installed 12-Jan-09. • First characterization sample was collected 06-Feb-09. Characterization sampling completed.

Table D-1.0-1 (continued)

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-39	Single	859	11	19-Feb-09	21-Apr-11	Dedicated pump	• Fluid-assisted air-rotary drilling was performed in an open borehole using AQF-2 foaming agent from surface to 717 ft bgs; no foam was added from 717 ft bgs to TD. • Drilling was completed on 12-Nov-08. Regional water table at 824 ft bgs (13-Nov-08). • Well R-39 was completed by 01-Dec-08. • Well development and aquifer testing were completed on 22-Dec-08. • Dedicated submersible pump installed on 19-Feb-09.
R-40i	Single	649.7	7	28-Jan-09	20-Oct-11	Single completion well	• 3-in. polyvinyl chloride piezometer completed in the annulus of well R-40. • Dedicated pump installed. • The screen was redeveloped 21-Jan-11 because of the persistent presence of drilling products manifested by sudsy water and odor. An extended purge event was conducted 12-Jul-11, but results were not available in time to be included in this report.
R-40	Screen 1 Port P1A	751.6	8	21-Apr-09	5-May-11	Baski system	• Dual-screen well R-40 was completed 05-Jan-09. Inflatable packer was installed 07-Jan-09; replaced with TAM International detachable packer 20-Jan-09. • Mixing occurred between perched-intermediate groundwater and the regional aquifer during the 60 d that it took to install the annular backfill material once the borehole total depth was reached. Geochemical evaluations indicate that water-quality impacts of mixing were largely mitigated by subsequent development and testing activities and by purging protocols (LANL 2010, 108498). • Aquifer test was conducted on 21-Apr-09 (screen 1), and 05-Jan-09, and 28-Apr-09 (screen 2). • Dual-pump Baski sampling system was installed Jun-09 (LANL 2010, 108498). • Screen 1 has limited purge capability because of tight formation in which it is completed; water level draws down to bottom of screen during purging and requires weeks to recover. Subsequently only a prioritized suite of water-quality samples are collected.
	Screen 2 Port P2A	849.3	9	15-Jan-09	26-Apr-11	Baski system	

Table D-1.0-1 (continued)

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-41	Screen 1 (no port designation)	~935	0	n/a	n/a	n/a	• Dual-rotary fluid-assisted drilling was performed using AQF-2 foaming agent from surface to 775 ft bgs; no foam was added from 775 ft bgs to TD. • Drilling was completed on 21-Feb-09. • Well R-41 was completed on 19-Mar-09. Regional water table was encountered at 960 ft bgs (22-Mar-09). • Only the lower screen interval produced water and was able to be developed. • Dedicated submersible pump was installed in screen 2 on 06-Jul-09, with a Baski inflatable packer installed between screens 1 and 2. • Screen 1 has been dry since installation.
	Screen 2 Port P2A	965	9	2-Apr-09	21-Apr-11	Dedicated pump	
R-49	Screen 1 Port P1A	845	9	23-Jun-09	2-May-11	Baski dual-APV	• Dual-rotary fluid-assisted drilling was performed using AQF-2 foaming agent from surface to 577 ft bgs; no foam was added from 577 ft bgs to TD. • Drilling was completed on 30-Apr-09. • Well R-49 was completed on 1-Jun-09. Regional water table at 832 ft bgs (composite depth, 9-Jun-09). • Well development and aquifer testing were completed on 23-Jun-09. • Baski dual-APV sampling system was installed on 20-Aug-09.
	Screen 2 Port P2A	906	9	18-Jun-09	29-Apr-11	Baski dual-APV	
R-51	Screen 1 Port P1A	915	6	8-Mar-10	9-May-11	Baski dual-APV	• Fluid-assisted air-rotary and dual-rotary drilling was performed using AQF-2 foaming agent from surface to 776 ft bgs; no foam was added from 776 ft bgs to TD. • Drilling was completed on 14-Jan-10. • Well completed on 08-Feb-10. Regional water table at 891 ft bgs (composite depth, 17-Feb-10). • Well development was completed on 08-Mar-10 (upper screen) and 22-Feb-10 (lower screen). Baski dual-APV sampling system was installed on 07-May-10.
	Screen 2 Port P2A	1031	6	22-Feb-10	9-May-11	Baski dual-APV	

Table D-1.0-1 (continued)

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-52	Screen 1 Port P1A	1035	5	2-May-10	4-May-11	Baski dual-APV	• Fluid-assisted air-rotary and dual-rotary drilling was performed using AQF-2 foaming agent from surface to 915 ft bgs; no foam was added from 915 ft bgs to TD. • Drilling was completed on 06-Feb-10. Regional water table at 1021 ft bgs (composite depth, 7-Feb-10). • Well R-52 was completed on 05-Apr-10. • Baski dual-APV sampling system was installed by 19-Jul-10.
	Screen 2 Port P2A	1107	5	23-Apr-10	4-May-11	Baski dual-APV	
R-53	Screen 1 Port P1A	849.2	1	19-Apr-10	19-Apr-10	Temporary packers	• Dual-screen regional well was completed on 29-Mar-2010. • Baski dual-APV* sampling system and pump were installed 07-Jul-10 (LANL 2010, 110516). • First characterization sample was collected April 2010. Characterization sampling was completed.
	Screen 1 Port P1A	849.2	4	26-Jul-10	6-May-11	Baski system	
	Screen 2 Port P2A	959.7	1	14-Apr-10	14-Apr-10	Temporary packers	
	Screen 2 Port P2A	959.7	4	26-Jul-10	6-May-11	Baski system	
R-54	Screen 1 Port P1A	830	1	15-Feb-10	15-Feb-10	Temporary packers	• Dual-screen regional well was completed on 29-Jan-10. • Baski dual-APV sampling system and pump were installed on 17-May-10 (LANL 2010, 109828). • First characterization sample was collected Feb-10. Characterization sampling was completed.
	Screen 1 Port P1A	830	5	18-Jun-10	4-May-11	Baski system	
	Screen 2 Port P2A	915	1	21-Feb-10	21-Feb-10	Temporary packers	
	Screen 2 Port P2A	915	5	18-Jun-10	5-May-11	Baski system	
R-55i	Single	510	2	23-Mar-11	10-May-11	Dedicated pump	• Dual-rotary fluid-assisted drilling was performed using AQF-2 foaming agent from surface to 400 ft bgs (LANL 2011, 203665). • No additives other than potable water were used below 400 ft bgs to the total borehole depth of 565 ft bgs. • Drilling was completed on 08-Jan-11. Depth to water before well completion was 498.4 ft. • Well R-55i was completed on 18-Jan-11, with a 20-ft screened interval in the Cerros del Rio volcanic series. • A dedicated sampling system was installed on 15-Mar-11.

Table D-1.0-1 (continued)

Well	Screen and Port Designation	Depth (ft bgs)	Total No. of Sampling Events[a]	Earliest Sampling Event	Most Recent Sampling Event	Sampling System	Chronology of Events Relevant to Groundwater Sampling
R-55	Screen 1 Port P1A	860	1	9-Sep-10	9-Sep-10	Portable pump	• Dual-rotary fluid-assisted drilling was performed using AQF-2 foaming agent from surface to 682 ft bgs; no foam was added from 682 ft bgs to TD. • Drilling was completed on 29-Jun-10. Regional water table at 843.5 ft bgs (composite depth, 30-Jun-10). • Well R-55 was completed on 25-Aug-10. • Baski system was scheduled to be installed in late 2010.
	Screen 1 Port P1A	860	2	7-Feb-11	28-Apr-11	Baski system	
	Screen 2 Port P2A	994.4	1	14-Sep-10	14-Sep-10	Portable pump	
	Screen 2 Port P2A	994.4	2	1-Feb-11	28-Apr-11	Baski system	
R-56	Screen 1 Port P1A	945	1	19-Aug-10	19-Aug-10	Temporary packers	• Dual-screen regional well was completed on 19-Jul-10 (LANL 2010, 111512). • Baski dual-APV sampling system and pump was installed 20-Jan-11. • First characterization sample was collected Aug-10 (temporary packer in place). Cross-flow between screened intervals occurred during installation of the Baski sampling system. Additional characterization sampling is in progress.
	Screen 1 Port P1A	945	2	3-Feb-11	10-May-11	Baski system	
	Screen 2 Port P2A	1046.6	1	13-Aug-10	13-Aug-10	Temporary packers	
	Screen 2 Port P2A	1046.6	2	7-Feb-11	10-May-11	Baski system	
R-57	Screen 1 Port P1A	910	2	1-Jul-10	9-May-11	Baski dual-APV	• Dual-rotary fluid-assisted drilling was performed using AQF-2 foaming agent from surface to 786 ft bgs (LANL 2010, 111310). No additives other than potable water were used below 786 ft bgs to the total borehole depth of 1081.6 ft bgs. • Drilling was completed on 24-Apr-10. Depth to water before well completion was 896.7 ft (composite depth). • Well R-57 was completed as a dual-screen regional-aquifer well on 8-Jun-10 with the upper 20-ft screened interval in the dacitic lava flows at the bottom of the Cerros del Rio volcanic series and the lower 20-ft screened interval within the Puye Formation. • A dual-valve Baski sampling system was installed on 16-Dec-10 (Koch and Schmeer, 2011, 201566).
	Screen 2 Port P2A	972	2	25-Jun-10	9-May-11	Baski dual-APV	

Sources: Well completion reports for R-20 (LANL 2003, 079600); R-21 (Kleinfelder 2003, 090047); R-22 (Ball et al. 2002, 071471); R-23 (LANL 2003, 079601); R-23i (Kleinfelder 2006, 092495); R-32 (LANL 2003, 079602); R-37 (LANL 2009, 107116); R-38 (LANL 2009, 105298); R-39 (LANL 2009, 105620); R-40 (LANL 2009, 106432); R-41 (LANL 2009, 106453); R-49 (LANL 2009, 107450); R-51 (LANL 2010, 109949); R-52 (LANL 2010, 110533); R-53 (LANL 2010, 110516); R-54 (LANL 2010, 109828). Fact sheets for R-55 (LANL 2010, 110717); R-56 (LANL 2010, 110482), and R-57 (LANL 2010, 109836). Well rehabilitation and conversion reports for R-20 (LANL 2008, 100473) and R-32 (LANL 2007, 100572). Well redevelopment report for R-22 (LANL 2009, 106796). Assessment of cross flow in monitoring wells with inflatable packers (LANL 2010, 108783).

Notes: APV = access port valve; hp = horsepower; N = number; TD = total depth; n/a = not applicable.

[a] Sampling events for analyses by off-site laboratories.

[b] The first number indicates the number of discrete sampling events for perchlorate; the number in parentheses indicates the number of discrete sampling events for VOCs.

Table D-3.0-1
Final Field Parameters for Recent Sampling Events

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-20	P1A	905	3-Aug-10	197	3.0	1.8	-19	8.2	137	20	0.8	82
R-20	P1A	905	20-Oct-10	271	4.1	2.4	92	8.2	152	18	0.5	79
R-20	P1A	905	27-Jan-11	576	7.9	1.2	331	8.2	145	14	1.6	72
R-20	P1A	905	20-Apr-11	75	1.0	1.2	-102	8.6	145	18	1.8	78
R-20	P1A	905	27-Jul-11	205	2.7	2.3	-32	8.5	142	19	0.8	86
R-20	P2A	1147	30-Jul-10	124	3.0	2.0	-70	7.8	137	20	1.1	84
R-20	P2A	1147	11-Oct-10	187	4.6	1.8	89	7.8	138	20	0.3	83
R-20	P2A	1147	21-Jan-11	513	12.5	3.0	231	7.9	128	20	0.4	78
R-20	P2A	1147	25-Apr-11	125	3.0	2.4	-75	7.9	142	20	0.7	83
R-20	P2A	1147	25-Jul-11	126	3.1	2.5	-77	8.0	144	20	0.4	86
R-21	Single	889	11-Aug-10	660	3.2	5.7	195	7.7	132	23	0.6	74
R-21	Single	889	11-Oct-10	702	3.4	5.3	89	7.9	126	21	0.2	75
R-21	Single	889	27-Jan-11	695	3.4	5.3	74	7.9	124	21	0.2	68
R-21	Single	889	19-Apr-11	619	3.0	6.3	149	8.0	127	21	0.2	73
R-21	Single	889	21-Jul-11	618	3.0	6.2	85	8.0	128	21	0.3	78
R-23	Single	816	12-Aug-10	240	5.0	5.2	363	7.3	173	20	1.9	88
R-23	Single	816	22-Oct-10	280	5.8	7.8	280	7.8	169	21	0.5	90
R-23	Single	816	24-Jan-11	340	7.5	5.6	207	7.7	166	19	0.5	89
R-23	Single	816	18-Apr-11	202	4.4	6.9	103	8.1	172	22	0.7	91
R-23	Single	816	22-Jul-11	174	3.8	6.9	119	8.1	174	22	1.3	—[b]
R-23i	P1A	400	9-Aug-10	9	3.0	5.7	267	7.4	289	20	2.3	121
R-23i	P1A	400	21-Oct-10	24	7.7	7.0	418	7.3	296	15	4.6	129
R-23i	P1A	400	14-Jan-11	22	7.1	5.4	250	7.6	277	14	2.9	130
R-23i	P1A	400	28-Apr-11	13	4.2	6.8	172	7.6	275	15	3.1	127
R-23i	P1A	400	28-Jul-11	19	6.0	6.6	203	7.7	295	18	1.3	—

Table D-3.0-1 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-23i	P2A	470	4-Aug-10	117	3.0	5.3	54	7.8	214	17	0.4	103
R-23i	P2A	470	18-Oct-10	132	3.4	4.7	57	7.8	207	16	1.5	105
R-23i	P2A	470	18-Jan-11	156	3.9	5.1	350	8.0	206	15	0.3	104
R-23i	P2A	470	3-May-11	115	3.0	6.0	260	8.1	190	16	0.4	102
R-23i	P2A	470	26-Jul-11	115	3.0	5.7	214	8.2	196	17	1.3	—
R-23i	P3A	524	4-Aug-10	125	2.9	5.4	10	8.0	211	20	1.0	99
R-23i	P3A	524	18-Oct-10	170	4.0	5.3	-19	8.0	203	18	0.9	100
R-23i	P3A	524	24-Jan-11	155	3.6	5.4	128	8.0	203	17	1.4	97
R-23i	P3A	524	18-Apr-11	129	3.0	6.1	80	8.2	189	17	1.2	103
R-23i	P3A	524	29-Jul-11	147	3.5	7.0	180	8.2	198	18	1.4	—
R-32	Single	868	6-Aug-10	305	3.4	4.0	108	6.9	175	21	0.7	91
R-32	Single	868	14-Oct-10	326	3.7	4.1	136	6.8	171	19	0.9	93
R-32	Single	868	25-Jan-11	325	3.7	4.4	392	6.9	168	18	0.8	92
R-32	Single	868	2-May-11	279	3.2	4.2	82	7.0	172	18	0.5	90
R-32	Single	868	27-Jul-11	300	3.4	4.5	189	7.0	170	20	0.6	95
R-37	P1A	929	5-Aug-10	155	2.9	3.9	—	10.6	232	18	1.7	130
R-37	P1A	929	12-Oct-10	170	3.2	1.7	-14	7.8	235	19	0.6	133
R-37	P1A	929	21-Jan-11	293	5.6	1.5	49	8.4	233	17	0.8	131
R-37	P1A	929	3-May-11	147	2.8	1.8	70	8.0	237	18	0.5	129
R-37	P1A	929	19-Jul-11	164	3.1	1.8	153	8.1	239	18	0.3	—
R-37	P2A	1026	10-Aug-10	360	6.5	6.7	363	7.6	131	22	8.1	78
R-37	P2A	1026	14-Oct-10	266	4.8	6.6	182	7.8	137	22	1.3	79
R-37	P2A	1026	25-Jan-11	—	—	8.3	392	7.9	135	22	0.8	79
R-37	P2A	1026	26-Apr-11	163	3.0	7.5	65	8.1	130	21	1.3	77
R-37	P2A	1026	13-Jul-11	252	4.7	8.0	96	8.0	118	22	0.6	—
R-38	Single	821	6-Aug-10	300	7.0	4.7	117	7.2	145	20	0.8	80

Table D-3.0-1 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-38	Single	821	11-Oct-10	162	3.8	6.6	311	7.3	141	18	1.4	81
R-38	Single	821	27-Jan-11	129	3.0	6.0	59	7.4	132	18	0.9	73
R-38	Single	821	6-May-11	163	3.8	7.0	46	7.3	142	19	0.6	79
R-38	Single	821	26-Jul-11	129	3.0	7.0	114	7.4	135	19	0.9	82
R-39	Single	859	12-Aug-10	190	3.9	3.8	166	7.8	144	24	2.3	80
R-39	Single	859	8-Oct-10	210	4.3	5.2	430	7.8	143	20	2.4	81
R-39	Single	859	26-Jan-11	227	4.7	5.1	73	8.1	134	22	3.6	79
R-39	Single	859	21-Apr-11	147	3.0	6.3	134	8.1	140	23	2.2	77
R-39	Single	859	28-Jul-11	163	3.4	6.7	155	8.1	139	23	2.4	—
R-40i	Single	650	4-Dec-09	39	3.0	1.4	-158	7.2	257	15	1.3	NC
R-40i	Single	650	3-Mar-10	26	2.0	1.4	-120	7.1	256	16	1.3	NC
R-40i	Single	650	17-Jun-10	39	3.0	1.5	-127	7.2	282	19	0.1	176
R-40i	Single	650	28-Jul-10	46	3.5	1.3	-147	7.0	253	17	1.2	161
R-40i	Single	650	20-Oct-10	50	3.8	1.3	-85	6.9	266	17	1.5	166
R-40i	Single	650	21-Jan-11	39	3.0	0.7	-138	7.4	255	16	0.3	167
R-40i	Single	650	29-Apr-11	50	3.9	6.3	-156	7.5	255	17	0.3	161
R-40i	Single	650	12-Jul-11	78	6.0	0.2	-117	7.5	242	17	1.0	154
R-40	P1A	752	4-Jun-10	40	1.3	3.3	99	7.5	208	18	4.6	—
R-40	P1A	752	28-Jul-10	40	1.4	2.0	67	7.8	212	18	1.4	141
R-40	P1A	752	20-Oct-10	40	1.4	3.5	422	8.4	210	16	4.8	121
R-40	P1A	752	21-Jan-11	30	1.0	3.1	150	8.5	216	12	0.9	131
R-40	P1A	752	5-May-11	33	1.1	0.8	82	8.6	208	17	0.8	—
R-40	P1A	752	11-Jul-11	40	1.3	5.7	265	8.9	195	16	1.5	—
R-40	P2A	849	27-Jul-10	165	4.0	7.7	59	7.7	123	21	3.4	77
R-40	P2A	849	19-Oct-10	170	4.1	7.8	123	7.8	131	21	1.8	75
R-40	P2A	849	19-Jan-11	127	3.0	7.7	374	7.7	123	20	1.0	73

Table D-3.0-1 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-40	P2A	849	26-Apr-11	138	3.0	7.9	49	7.9	116	20	0.7	72
R-40	P2A	849	8-Jul-11	128	3.1	8.2	102	8.2	119	21	0.7	76
R-41	P2A	965	9-Aug-10	182	5.0	4.3	23	8.0	159	24	1.0	91
R-41	P2A	965	8-Oct-10	150	4.1	4.1	386	7.9	173	21	1.0	92
R-41	P2A	965	12-Jan-11	170	4.7	4.6	64	8.1	164	23	0.8	91
R-41	P2A	965	21-Apr-11	123	3.4	5.6	28	8.0	165	23	0.5	88
R-41	P2A	965	15-Jul-11	111	3.1	6.0	104	8.1	164	23	0.4	—
R-49	P1A	845	29-Jul-10	322	4.1	3.7	-44	7.8	145	23	42.2	91
R-49	P1A	845	7-Oct-10	280	3.5	3.7	253	7.9	167	23	4.4	93
R-49	P1A	845	19-Jan-11	350	4.4	3.7	34	8.0	169	21	2.8	91
R-49	P1A	845	2-May-11	251	3.2	4.5	19	8.1	162	22	1.1	89
R-49	P1A	845	8-Jul-11	245	3.1	4.6	23	8.0	160	23	1.7	—
R-49	P2A	906	29-Jul-10	230	4.0	5.7	-20	7.8	125	23	1.0	78
R-49	P2A	906	7-Oct-10	220	3.8	5.9	504	7.8	141	22	0.3	78
R-49	P2A	906	26-Jan-11	188	3.2	5.1	87	7.9	162	21	1.0	78
R-49	P2A	906	29-Apr-11	183	3.1	6.4	30	8.0	143	23	0.1	77
R-49	P2A	906	25-Jul-11	175	3.0	6.5	221	8.0	146	23	0.2	—
R-51	P1A	915	26-Jul-10	275	4.4	6.5	289	8.0	118	21	1.2	76
R-51	P1A	915	19-Oct-10	296	4.8	5.7	318	8.1	146	21	1.3	82
R-51	P1A	915	11-Jan-11	188	3.0	6.9	71	8.6	131	20	1.4	57
R-51	P1A	915	9-May-11	195	3.1	8.0	107	8.2	125	21	1.7	74
R-51	P1A	915	28-Jul-11	353	5.6	7.4	178	8.2	103	21	2.4	—
R-51	P2A	1031	26-Jul-10	211	2.3	6.0	424	7.9	135	21	2.5	82
R-51	P2A	1031	19-Oct-10	216	5.8	6.3	222	8.0	147	22	1.0	82
R-51	P2A	1031	11-Jan-11	273	3.0	4.9	96	8.4	140	21	1.7	77
R-51	P2A	1031	9-May-11	276	3.0	6.1	100	8.2	128	22	1.0	78

Table D-3.0-1 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-51	P2A	1031	28-Jul-11	341	3.7	6.0	141	8.1	114	22	0.7	—
R-52	P1A	1035	5-Aug-10	275	4.2	5.6	377	7.8	145	23	1.3	84
R-52	P1A	1035	12-Oct-10	247	3.8	5.1	—	7.9	164	22	0.9	83
R-52	P1A	1035	13-Jan-11	196	3.0	5.9	78	8.3	145	22	1.3	82
R-52	P1A	1035	4-May-11	237	3.6	6.6	154	8.5	128	22	0.9	78
R-52	P1A	1035	18-Jul-11	262	4.1	8.7	141	8.1	140	22	0.7	—
R-52	P2A	1107	5-Aug-10	210	4.9	6.1	396	7.5	131	23	1.8	74
R-52	P2A	1107	12-Oct-10	237	5.5	7.0	353	7.7	129	21	0.7	75
R-52	P2A	1107	13-Jan-11	130	3.0	6.4	91	7.6	121	21	0.6	75
R-52	P2A	1107	4-May-11	251	5.8	6.6	169	7.9	123	22	0.3	73
R-52	P2A	1107	18-Jul-11	165	3.8	7.7	98	7.9	113	22	0.2	—
R-53	P1A	849	26-Jul-10	240	3.1	3.7	79	7.5	103	22	0.9	78
R-53	P1A	849	12-Oct-10	301	3.9	4.4	149	7.8	130	21	1.3	76
R-53	P1A	849	14-Jan-11	231	3.0	6.3	214	7.8	125	21	1.2	75
R-53	P1A	849	6-May-11	232	3.0	5.7	145	7.9	129	22	0.7	75
R-53	P1A	849	14-Jul-11	232	3.0	5.8	118	8.0	127	22	0.4	77
R-53	P2A	960	26-Jul-10	390	4.2	5.5	142	7.7	100	22	0.8	75
R-53	P2A	960	12-Oct-10	359	3.8	5.5	145	8.1	126	21	0.5	74
R-53	P2A	960	13-Jan-11	281	3.0	6.7	195	8.1	122	20	1.1	74
R-53	P2A	960	6-May-11	281	3.0	6.1	111	8.1	126	22	0.3	73
R-53	P2A	960	14-Jul-11	285	3.0	6.4	122	8.1	126	22	0.1	75
R-54	P1A	830	27-Jul-10	210	3.8	2.4	104	6.8	198	23	2.8	105
R-54	P1A	830	13-Oct-10	240	4.3	0.3	-77	7.6	221	21	2.0	125
R-54	P1A	830	14-Jan-11	166	3.0	1.4	-75	7.0	185	21	1.5	111
R-54	P1A	830	4-May-11	664	12.0	2.7	-63	7.3	133	22	0.4	87
R-54	P1A	830	12-Jul-11	210	3.8	1.5	-59	7.0	176	22	0.4	103

Table D-3.0-1 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-54	P2A	915	27-Jul-10	225	3.7	5.2	150	8.1	132	22	1.3	77
R-54	P2A	915	13-Oct-10	246	4.0	4.9	112	8.1	123	20	0.8	78
R-54	P2A	915	12-Jan-11	184	3.0	5.7	108	8.2	124	21	0.6	77
R-54	P2A	915	5-May-11	186	3.0	6.5	181	8.2	130	22	0.5	74
R-54	P2A	915	12-Jul-11	189	3.1	6.8	56	8.3	125	22	0.5	72
R-55i	Single	510	23-Mar-11	230	5.2	5.7	-53	7.9	305	18	1.8	122
R-55i	Single	510	10-May-11	134	3.0	4.5	-98	7.5	322	18	1.6	124
R-55i	Single	510	18-Jul-11	135	3.0	3.8	-81	7.4	317	19	1.4	—
R-55	P1A	860	9-Sep-10	—	—	7.1	204	8.0	187	23	0.7	—
R-55	P1A	860	7-Feb-11	337	3.0	5.2	190	8.0	174	22	0.5	99
R-55	P1A	860	28-Apr-11	338	3.0	6.5	46	8.1	177	23	0.3	94
R-55	P1A	860	15-Jul-11	337	3.0	6.3	265	8.1	168	23	0.3	—
R-55	P2A	994	14-Sep-10	—	—	5.3	101	7.9	175	23	0.7	—
R-55	P2A	994	1-Feb-11	338	4.7	2.2	287	8.5	172	22	0.3	82
R-55	P2A	994	28-Apr-11	223	3.1	4.9	73	8.5	172	23	0.3	89
R-55	P2A	994	14-Jul-11	218	3.0	6.5	97	8.1	181	23	0.3	—
R-56	P1A	945	19-Aug-10	8065	90 (est[c])	8.0	377	7.6	127	21	0.4	—
R-56	P1A	945	3-Feb-11	312	3.6	3.1	169	7.7	145	19	0.7	80
R-56	P1A	945	10-May-11	300	3.5	5.2	104	7.9	151	21	0.4	83
R-56	P1A	945	20-Jul-11	259	3.0	5.7	136	8.0	153	22	0.3	87
R-56	P2A	1047	13-Aug-10	20300	300 (est)	8.4	346	7.6	127	18	0.2	—
R-56	P2A	1047	7-Feb-11	249	3.6	3.9	192	7.8	141	21	1.1	86
R-56	P2A	1047	10-May-11	232	3.4	4.2	97	8.2	144	21	0.9	82
R-56	P2A	1047	20-Jul-11	224	3.3	4.9	118	8.2	135	22	0.5	84
R-57	P1A	910	1-Jul-10	—	—	5.4	33	8.1	135	22	0.9	—
R-57	P1A	910	9-May-11	228	3.2	4.6	30	7.9	147	23	0.5	82

Table D-3.0-1 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purge Volume (gal.)	Purged CV	DO (mg/L)	ORP (mV)	Field pH	Specific Conductance (µS/cm)	Temperature °C	Turbidity (NTU)	Alkalinity[a] (mg/L as $CaCO_3$)
R-57	P1A	910	13-Jul-11	215	3.0	4.7	-69	7.9	134	23	0.3	—
R-57	P2A	972	25-Jun-10	—	—	2.8	192	7.8	137	22	1.8	—
R-57	P2A	972	9-May-11	170	3.3	5.9	58	7.5	145	23	0.6	82
R-57	P2A	972	13-Jul-11	160	3.1	5.7	61	7.5	121	23	0.7	—

Source: Attachment D-1 (for water-quality data); field notes (for purge volumes and casing volumes).

[a] Alkalinity measured at on-site analytical laboratory.

[b] — = Not available.

[c] est = Estimated.

Table D-3.0-2
General Inorganic Constituents in Filtered Samples and TOC

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3+NO_2-N (mg/L)	ClO_4 (µg/L)	SiO_2 (mg/L)	TDS (mg/L)	TOC (mg/L)	Alkalinity[b] (mg/L as $CaCO_3$)	Lab pH[b]
R-20	P1A	905	3-Aug-10	3.0	16	2.7	12	2.3	2.4	2.3	0.26	748[c]	0.19	72	145	1.1	63	8.4
R-20	P1A	905	20-Oct-10	4.1	14	2.5	11	2.1	2.4	2.5	0.25	< 0.26	0.17	67	127	0.9	63	8.3
R-20	P1A	905	27-Jan-11	7.9	14	2.7	12	2.3	3.1	2.5	0.24	0.12	0.19	69	122	0.6	63	8.3
R-20	P1A	905	20-Apr-11	1.0	14	2.7	13	2.4	2.7	2.5	0.22	< 0.05	0.07	71	134	0.6	67	8.4
R-20	P2A	1147	30-Jul-10	3.0	12	2.4	13	2.5	1.9	1.9	0.26	0.19	0.17	72	145	2.0	64	8.0
R-20	P2A	1147	11-Oct-10	4.6	11	2.3	13	2.5	1.7	1.8	0.22	0.24	0.21	70	147	2.5	59	8.1
R-20	P2A	1147	21-Jan-11	12.5	11	2.4	11	2.4	1.9	< 1.8	0.21	0.22	0.23	79	142	1.2	55	8.0
R-20	P2A	1147	25-Apr-11	3.0	12	2.5	14	2.9	1.9	1.9	0.29	0.23	0.19	77	137	2.5	64	7.8
R-21	Single	889	11-Aug-10	3.2	10	1.7	12	3.1	2.0	1.8	0.20	0.34	0.30	71	133	0.6	59	8.1
R-21	Single	889	11-Oct-10	3.4	10	1.7	12	3.1	2.1	1.8	0.24	0.37	0.28	77	128	< 0.4	61	8.0
R-21	Single	889	27-Jan-11	3.4	10	1.6	11	2.8	2.0	1.8	0.23	0.31	0.30	69	125	0.5	58	7.9
R-21	Single	889	19-Apr-11	3.0	10	1.8	12	3.1	2.0	1.8	0.22	0.20	0.28	73	127	0.5	57	8.0
R-23	Single	816	12-Aug-10	5.0	11	1.8	16	4.0	5.2	3.5	0.36	1.18	0.49	60	150	0.5	68	8.0
R-23	Single	816	22-Oct-10	5.8	11	1.8	17	4.1	5.3	3.6	0.36	1.37	0.44	65	141	< 1	66	8.1
R-23	Single	816	24-Jan-11	7.5	11	2.0	17	4.0	5.3	3.5	0.33	1.10	0.48	65	153	2.6	69	8.0
R-23	Single	816	18-Apr-11	4.4	11	1.9	17	4.1	5.2	3.6	0.29	1.13	0.45	60	150	1.7	67	8.0
R-23i	P1A	400	9-Aug-10	3.0	14	3.7	26	9.4	12.0	19.4	0.20	0.46	0.29	51	199	0.7	91	7.8
R-23i	P1A	400	21-Oct-10	7.7	14	3.8	27	9.6	12.7	19.4	0.19	0.56	0.28	52	195	0.7	94	8.0
R-23i	P1A	400	14-Jan-11	7.1	15	3.9	27	9.6	13.2	17.8	0.22	0.56	0.32	51	177	0.7	100	7.8
R-23i	P1A	400	28-Apr-11	4.2	14	3.7	27	9.4	4.8	3.7	0.27	0.40	0.32	51	190	0.5	98	7.4
R-23i	P2A	470	4-Aug-10	3.0	12	2.6	21	5.9	7.7	7.8	0.21	0.82	0.26	44	169	0.8	79	8.2
R-23i	P2A	470	18-Oct-10	3.4	11	2.6	20	5.6	7.7	7.9	0.19	0.88	0.25	40	147	0.7	84	8.2
R-23i	P2A	470	18-Jan-11	3.9	11	2.6	21	5.7	7.9	8.2	0.21	0.77	0.26	43	128	0.7	80	8.2

Table D-3.0-2 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3+NO_2-N (mg/L)	ClO_4 (µg/L)	SiO_2 (mg/L)	TDS (mg/L)	TOC (mg/L)	Alkalinity[b] (mg/L as $CaCO_3$)	Lab pH[b]
R-23i	P2A	470	3-May-11	3.0	12	2.4	21	5.8	7.8	7.8	0.23	0.64	0.24	41	143	1.1	77	8.1
R-23i	P3A	524	4-Aug-10	2.9	11	2.6	21	5.9	7.4	8.3	0.22	0.91	0.29	46	163	1.0	77	8.2
R-23i	P3A	524	18-Oct-10	4.0	10	2.6	20	5.6	7.5	8.3	0.19	0.93	0.25	41	143	0.7	86	8.3
R-23i	P3A	524	24-Jan-11	3.6	11	2.7	21	5.8	7.7	8.3	0.19	0.80	0.28	47	154	0.7	77	8.2
R-23i	P3A	524	18-Apr-11	3.0	11	2.7	22	6.0	7.5	8.1	0.20	0.79	0.26	41	146	0.7	77	8.0
R-32	Single	868	6-Aug-10	3.4	11	1.8	16	4.9	5.1	3.0	0.29	0.96	0.37	64	157	0.7	69	7.5
R-32	Single	868	14-Oct-10	3.7	10	1.8	16	4.7	5.3	2.9	0.26	1.02	0.37	65	148	1.3	68	7.4
R-32	Single	868	25-Jan-11	3.7	11	1.8	16	5.0	5.2	2.9	0.27	0.90	0.39	< 40	149	0.8	71	7.3
R-32	Single	868	2-May-11	3.2	11	1.8	17	5.0	5.6	3.1	0.33	0.66	0.36	67	143	0.7	69	7.6
R-37	P1A	929	5-Aug-10	2.9	16	1.9	25	5.7	9.3	4.6	0.47	0.49	0.55	57	182	0.9	98	8.1
R-37	P1A	929	12-Oct-10	3.2	15	1.7	24	5.5	9.8	4.6	0.52	0.52	0.52	52	187	1.1	95	8.1
R-37	P1A	929	21-Jan-11	5.6	15	1.9	25	5.7	9.8	4.8	0.57	0.47	0.52	60	186	0.9	101	8.1
R-37	P1A	929	3-May-11	2.8	16	1.7	26	5.8	9.5	4.6	0.51	0.38	0.45	56	177	0.9	97	8.1
R-37	P2A	1026	10-Aug-10	6.5	11	1.7	11	2.8	2.9	2.4	0.30	0.56	0.37	63	141	0.3	62	8.0
R-37	P2A	1026	14-Oct-10	4.8	11	1.8	12	2.9	2.8	2.3	0.26	0.62	0.38	69	134	0.8	57	8.1
R-37	P2A	1026	25-Jan-11	NC	12	1.7	12	2.8	2.9	2.2	0.26	0.49	0.35	< 69	139	< 1	61	8.0
R-37	P2A	1026	26-Apr-11	3.0	12	1.9	13	3.1	2.9	2.4	0.32	0.57	0.32	71	133	0.5	60	8.0
R-38	Single	821	6-Aug-10	7.0	11	1.5	12	3.5	2.9	2.5	0.29	0.58	0.39	64	152	0.4	61	7.6
R-38	Single	821	11-Oct-10	3.8	10	1.5	12	3.5	3.1	2.4	0.27	0.61	0.38	62	127	1.1	59	7.7
R-38	Single	821	27-Jan-11	3.0	11	1.6	12	3.5	2.9	2.4	0.27	0.55	0.38	68	131	0.8	62	7.5
R-38	Single	821	6-May-11	3.8	11	1.5	13	3.8	3.2	2.6	0.32	0.53	0.37	68	131	0.5	61	7.7
R-39	Single	859	12-Aug-10	3.9	12	1.5	13	3.6	3.5	2.2	0.29	0.66	0.38	66	139	0.5	61	8.1
R-39	Single	859	8-Oct-10	4.3	12	1.5	13	3.5	3.5	2.2	0.27	0.55	0.33	63	138	0.5	63	8.1
R-39	Single	859	26-Jan-11	4.7	11	1.4	12	3.4	3.0	2.2	0.27	0.59	0.37	68	135	< 1	61	8.0

Table D-3.0-2 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3+NO_2-N (mg/L)	ClO_4 (µg/L)	SiO_2 (mg/L)	TDS (mg/L)	TOC (mg/L)	Alkalinity[b] (mg/L as $CaCO_3$)	Lab pH[b]
R-39	Single	859	21-Apr-11	3.0	10	1.4	13	3.6	2.9	2.1	0.28	0.65	0.34	69	134	0.4	60	7.7
R-40i	Single	650	4-Dec-09	3.0	23	1.7	19	8.1	2.2	2.6	0.34	< 0.25	< 0.2	51	184	12.5	113	7.5
R-40i	Single	650	3-Mar-10	2.0	24	2.0	20	8.6	1.2	2.4	0.29	<0.25	< 0.2	52	189	14.5	120	7.6
R-40i	Single	650	28-Jul-10	3.5	21	1.9	19	8.3	1.3	2.5	0.24	< 0.25	< 0.2	54	91	11.9	118	7.6
R-40i	Single	650	20-Oct-10	3.8	21	1.9	19	8.3	1.2	2.4	0.22	< 0.09	< 0.2	49	164	13.5	60	7.7
R-40	P1A	752	4-Jun-10	1.3	14	1.8	22	6.4	4.8	2.2	0.37	0.09	0.08	59	162	3.0	94	8.2
R-40	P1A	752	28-Jul-10	1.4	12	1.7	22	6.8	5.5	2.2	0.28	0.11	< 0.2	55	174	0.9	102	8.2
R-40	P1A	752	20-Oct-10	1.4	13	1.9	19	6.2	4.1	2.1	0.32	0.20	0.09	55	153	3.2	94	8.4
R-40	P1A	752	21-Jan-11	1.0	14	2.0	20	7.2	4.7	2.2	0.33	< 0.25	< 0.2	55	166	1.4	105	8.5
R-40	P2A	849	27-Jul-10	4.0	11	1.5	12	3.1	2.7	2.0	0.25	0.37	0.27	72	144	0.5	60	8.0
R-40	P2A	849	19-Oct-10	4.1	11	1.6	11	3.0	2.2	1.8	0.20	< 0.49	0.29	68	136	0.3	59	7.9
R-40	P2A	849	19-Jan-11	3.0	11	1.5	11	2.9	2.1	1.9	0.22	0.36	0.29	75	133	0.5	56	7.9
R-40	P2A	849	26-Apr-11	3.0	10	1.6	11	2.9	2.2	2.0	0.26	0.36	0.26	71	133	0.5	56	7.9
R-41	P2A	965	9-Aug-10	5.0	13	1.9	15	4.0	4.6	3.1	0.34	0.66	0.37	63	144	0.5	65	8.0
R-41	P2A	965	8-Oct-10	4.1	13	1.9	15	4.0	4.6	3.1	0.30	0.56	0.42	61	167	0.4	66	8.0
R-41	P2A	965	12-Jan-11	4.7	14	2.0	15	3.9	4.5	3.0	0.31	0.58	0.40	65	132	< 1	70	8.1
R-41	P2A	965	21-Apr-11	3.4	13	2.0	16	4.2	4.6	3.0	0.34	0.69	0.38	65	147	0.4	68	7.9
R-49	P1A	845	29-Jul-10	4.1	18	1.6	12	3.6	4.5	2.7	0.24	0.64	0.32	70	155	0.9	69	8.0
R-49	P1A	845	7-Oct-10	3.5	15	1.6	12	3.5	4.6	2.8	0.29	0.46	0.30	65	146	1.3	66	8.1
R-49	P1A	845	19-Jan-11	4.4	17	1.9	13	3.8	4.4	2.8	0.26	0.56	0.31	71	145	1.2	70	8.1
R-49	P1A	845	2-May-11	3.2	15	1.9	13	3.7	4.6	2.9	0.33	0.41	0.29	69	144	0.7	65	8.0
R-49	P2A	906	29-Jul-10	4.0	11	1.5	13	3.5	3.4	2.4	0.23	0.70	0.33	71	144	0.6	58	7.9
R-49	P2A	906	7-Oct-10	3.8	9	1.4	12	3.4	3.5	2.4	0.29	0.60	0.37	68	145	0.7	56	8.0
R-49	P2A	906	26-Jan-11	3.2	10	1.5	13	3.4	3.5	2.3	0.27	0.64	0.36	69	138	< 1	60	8.0

Table D-3.0-2 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3+NO_2-N (mg/L)	ClO_4 (µg/L)	SiO_2 (mg/L)	TDS (mg/L)	TOC (mg/L)	Alkalinity[b] (mg/L as $CaCO_3$)	Lab pH[b]
R-49	P2A	906	29-Apr-11	3.1	11	1.6	13	3.7	3.8	2.5	0.31	0.57	0.35	67	130	< 1	60	8.0
R-51	P1A	915	26-Jul-10	4.4	11	1.5	12	2.8	3.0	2.0	0.26	0.34	0.28	66	131	0.4	70	8.3
R-51	P1A	915	19-Oct-10	4.8	14	1.6	11	2.8	7.2	1.9	0.15	0.34	0.29	65	139	0.5	61	8.2
R-51	P1A	915	11-Jan-11	3.0	11	1.5	12	2.7	3.2	2.0	0.26	0.25	0.28	70	127	< 1	60	8.3
R-51	P1A	915	9-May-11	3.1	11	1.3	12	2.7	3.1	2.1	0.28	0.33	0.26	72	120	0.4	58	8.2
R-51	P2A	1031	26-Jul-10	2.3	17	1.8	11	3.1	7.0	2.1	0.20	0.28	0.28	74	139	0.6	64	8.2
R-51	P2A	1031	19-Oct-10	5.8	15	1.7	11	2.8	7.0	1.9	0.15	0.36	0.30	65	142	0.6	120	8.2
R-51	P2A	1031	11-Jan-11	3.0	15	1.7	11	2.8	5.5	1.9	0.21	0.21	0.29	69	132	0.4	61	8.3
R-51	P2A	1031	9-May-11	3.0	13	1.6	11	2.8	3.3	2.0	0.22	0.27	0.26	73	126	0.5	59	8.2
R-52	P1A	1035	5-Aug-10	4.2	13	1.9	13	3.1	3.8	2.5	0.25	0.70	0.44	68	146	0.8	64	8.0
R-52	P1A	1035	12-Oct-10	3.8	13	1.9	15	3.1	4.5	2.5	0.25	0.62	0.40	62	134	1.5	66	8.5
R-52	P1A	1035	13-Jan-11	3.0	14	1.9	13	2.9	3.5	2.3	0.28	0.41	0.36	69	136	0.6	68	8.5
R-52	P1A	1035	4-May-11	3.6	14	1.8	14	3.1	3.9	2.6	0.25	0.58	0.38	67	147	0.5	66	8.4
R-52	P2A	1107	5-Aug-10	4.9	11	1.8	11	2.9	3.0	2.2	0.19	0.43	0.34	72	135	0.5	56	8.0
R-52	P2A	1107	12-Oct-10	5.5	10	1.7	11	2.9	3.0	2.1	0.20	0.45	0.33	68	128	0.6	54	8.0
R-52	P2A	1107	13-Jan-11	3.0	11	1.8	11	2.9	3.0	2.1	0.21	0.31	0.32	72	134	< 1	58	7.9
R-52	P2A	1107	4-May-11	5.8	11	1.7	11	3.0	3.0	2.2	0.19	0.39	0.31	72	150	0.4	57	7.9
R-53	P1A	849	26-Jul-10	3.1	11	1.6	11	3.2	2.0	1.8	0.27	0.27	0.21	72	137	0.8	62	7.9
R-53	P1A	849	12-Oct-10	3.9	11	1.6	10	3.0	1.9	1.8	0.23	0.38	0.28	66	129	0.7	55	7.9
R-53	P1A	849	14-Jan-11	3.0	12	1.8	10	3.0	1.9	1.8	0.25	0.34	0.28	70	123	0.4	59	8.0
R-53	P1A	849	6-May-11	3.0	11	1.5	11	3.1	2.1	1.9	0.28	0.47	0.29	70	144	0.4	57	8.0
R-53	P2A	960	26-Jul-10	4.2	11	1.6	11	3.2	1.9	1.8	0.26	0.35	0.29	75	130	< 1	58	8.1
R-53	P2A	960	12-Oct-10	3.8	10	1.7	11	3.2	1.9	1.7	0.21	0.35	0.30	68	124	0.7	55	8.1
R-53	P2A	960	13-Jan-11	3.0	10	1.8	11	3.2	2.0	1.7	0.22	0.25	0.30	74	124	< 1	57	8.0

Table D-3.0-2 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3+NO_2-N (mg/L)	ClO_4 (µg/L)	SiO_2 (mg/L)	TDS (mg/L)	TOC (mg/L)	Alkalinity[b] (mg/L as $CaCO_3$)	Lab pH[b]
R-53	P2A	960	6-May-11	3.0	10	1.9	11	3.3	2.0	1.9	0.26	0.44	0.28	74	141	0.4	57	8.0
R-54	P1A	830	27-Jul-10	3.8	19	1.8	12	4.5	1.8	2.0	0.25	0.22	0.17	70	160	7.0	83	7.3
R-54	P1A	830	13-Oct-10	4.3	19	2.0	14	5.3	1.8	1.9	0.22	0.28	0.18	71	165	2.3	55	7.2
R-54	P1A	830	14-Jan-11	3.0	18	2.1	12	5.3	1.8	1.9	0.27	0.26	0.21	70	156	1.0	87	7.2
R-54	P1A	830	4-May-11	12.0	14	1.4	10	4.1	1.9	1.9	0.20	0.33	0.25	66	141	0.6	67	7.7
R-54	P2A	915	27-Jul-10	3.7	11	1.9	12	3.0	2.1	1.9	0.25	0.39	0.28	71	132	0.7	60	8.3
R-54	P2A	915	13-Oct-10	4.0	11	2.0	13	3.1	1.9	1.8	0.20	0.46	0.28	73	135	1.0	57	8.2
R-54	P2A	915	12-Jan-11	3.0	11	2.0	12	3.1	2.0	1.9	0.22	0.29	0.29	75	134	0.4	59	8.3
R-54	P2A	915	5-May-11	3.0	11	1.7	12	3.2	2.1	2.0	0.26	0.33	0.26	73	146	0.4	60	8.1
R-55	P1A	860	9-Sep-10	—[d]	11	1.6	17	4.1	5.0	3.7	0.36	0.76	0.46	74	163	1.1	119	8.0
R-55	P1A	860	7-Feb-11	3.0	12	1.8	17	4.3	5.0	3.8	0.36	0.68	0.46	70	159	0.9	76	8.2
R-55	P1A	860	28-Apr-11	3.0	11	1.7	18	4.2	12.4	16.4	0.20	0.63	0.46	68	157	0.5	73	8.0
R-55	P2A	994	14-Sep-10	—	12	1.8	17	4.2	4.3	3.6	0.34	0.70	0.44	70	154	1.0	69	8.3
R-55	P2A	994	1-Feb-11	4.7	13	1.9	18	4.4	4.8	3.6	0.37	0.56	0.43	67	151	0.9	77	8.5
R-55	P2A	994	28-Apr-11	3.1	11	1.8	18	4.4	4.4	3.7	0.32	0.50	0.42	66	148	0.5	75	8.2
R-55i	Single	510	23-Mar-11	5.2	13	2.3	35	9.0	21.1	16.6	0.22	3.88	0.99	44	218	2.6	90	7.8
R-55i	Single	510	10-May-11	3.0	13	2.4	36	9.1	20.3	17.2	0.28	3.83	0.88	46	218	2.4	92	7.8
R-56	P1A	945	19-Aug-10	90	11	1.7	13	4.0	2.7	2.2	0.28	0.70	0.35	65	141	1.4	63	8.0
R-56	P1A	945	3-Feb-11	3.6	10	1.8	13	4.2	3.0	2.4	0.33	0.57	0.30	65	144	0.9	66	7.8
R-56	P1A	945	10-May-11	3.5	10	1.6	14	4.2	3.2	2.4	0.36	0.93	0.28	67	127	0.3	65	7.9
R-56	P2A	1047	13-Aug-10	300	11	1.7	12	3.5	2.8	2.2	0.31	0.66	0.33	64	132	0.4	60	8.0
R-56	P2A	1047	7-Feb-11	3.6	11	1.9	12	3.6	3.0	2.3	0.33	0.51	0.30	66	148	0.9	66	8.0
R-56	P2A	1047	10-May-11	3.4	12	1.9	13	3.6	3.4	2.1	0.32	0.68	0.28	68	136	< 1	62	8.0
R-57	P1A	910	1-Jul-10	—	11	1.4	13	3.3	3.2	2.5	0.30	0.61	0.34	65	137	0.5	61	8.1

Table D-3.0-2 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	SO_4 (mg/L)	Cl (mg/L)	F (mg/L)	NO_3+NO_2-N (mg/L)	ClO_4 (µg/L)	SiO_2 (mg/L)	TDS (mg/L)	TOC (mg/L)	Alkalinity[b] (mg/L as $CaCO_3$)	Lab pH[b]
R-57	P1A	910	9-May-11	3.2	11	1.6	13	3.6	2.8	2.3	0.34	0.50	0.27	68	120	0.7	64	7.6
R-57	P2A	972	25-Jun-10	—	13	1.6	13	3.5	3.6	2.4	0.30	0.75	0.33	70	157	0.4	63	7.9
R-57	P2A	972	9-May-11	3.3	11	1.4	13	3.4	2.7	2.3	0.31	0.45	0.28	69	127	0.5	64	7.8

Source: Attachment D-1.

[a] Purged CVs from Table D-3.0-1.

[b] Alkalinity and pH measured at offsite analytical laboratory.

[c] — = Suspect data; see discussion of this result in Table D-4.3-1.

[d] — = Not available.

Table D-3.0-3
Trace Metals

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Filtered (µg/L)											Unfiltered (µg/L)	
					Al	Ba	Cr	Fe	Mn	Mo	Ni	Sr	U	V	Zn	Al	Fe
R-20	P1A	905	3-Aug-10	3.0	< 200	93	< 10	< 100	25	1.3	1.3	155	0.70	4.4	8	< 200	34
R-20	P1A	905	20-Oct-10	4.1	< 200	85	< 10	< 100	21	< 1.4	1.1	142	0.65	4.1	4	< 200	< 100
R-20	P1A	905	27-Jan-11	7.9	< 200	81	< 10	< 100	11	< 1.4	5.6	148	1.09	7.8	8	< 200	45
R-20	P1A	905	20-Apr-11	1.0	< 200	84	< 10	< 100	21	1.2	0.8	157	0.39	< 3.0	< 10	< 75	42
R-20	P2A	1147	30-Jul-10	3.0	< 200	173	3.3	30	66	1.5	2.7	210	0.40	3.5	< 10	< 200	50
R-20	P2A	1147	11-Oct-10	4.6	< 200	166	3.7	< 100	64	1.5	2.8	200	0.55	3.7	< 10	< 200	31
R-20	P2A	1147	21-Jan-11	12.5	70	155	2.2	< 100	39	1.5	2.0	176	0.64	5.2	< 10	82	< 100
R-20	P2A	1147	25-Apr-11	3.0	< 200	185	< 10	< 100	75	1.5	2.1	210	0.39	5.1	4	< 200	39
R-21	Single	889	11-Aug-10	3.2	< 200	14	6.5	< 100	5	1.5	0.5	47	0.37	4.7	< 10	< 200	< 100
R-21	Single	889	11-Oct-10	3.4	< 200	15	3.9	< 100	6	1.4	< 2	48	< 0.37	5.4	4	< 200	< 39
R-21	Single	889	27-Jan-11	3.4	< 200	14	< 10	37	4	< 1.5	< 2	44	0.36	5.2	< 10	< 200	< 100
R-21	Single	889	19-Apr-11	3.0	< 200	14	3.6	35	5	1.2	0.8	46	0.31	5.1	< 10	< 200	< 100
R-23	Single	816	12-Aug-10	5.0	< 200	20	3.9	< 100	< 10	1.9	< 2	80	0.51	6.1	< 10	< 200	< 100
R-23	Single	816	22-Oct-10	5.8	< 200	22	3.8	< 100	< 10	2.1	8.8	84	0.47	6.8	8	< 200	< 100
R-23	Single	816	24-Jan-11	7.5	< 200	21	3.9	< 100	< 10	1.8	1.6	80	0.49	6.1	< 10	< 200	66
R-23	Single	816	18-Apr-11	4.4	< 200	20	< 10	< 100	< 10	1.5	0.7	77	0.41	6.2	22	< 200	< 100
R-23i	P1A	400	9-Aug-10	3.0	< 200	51	4.3	< 100	< 10	0.9	0.8	155	0.78	2.8	< 10	< 200	74
R-23i	P1A	400	21-Oct-10	7.7	< 200	54	< 10	< 100	< 10	1.1	0.6	168	0.68	2.7	6	94	137
R-23i	P1A	400	14-Jan-11	7.1	< 200	55	< 10	< 100	< 10	1.2	1.1	169	0.97	3.3	5	< 136	55
R-23i	P1A	400	28-Apr-11	4.2	< 200	53	< 10	< 100	< 10	1.2	0.7	158	0.78	3.0	< 10	165	163
R-23i	P2A	470	4-Aug-10	3.0	< 200	11	< 10	< 100	< 10	1.7	0.7	101	0.74	4.2	< 10	< 200	< 100
R-23i	P2A	470	18-Oct-10	3.4	< 200	10	3.2	< 100	< 10	1.9	0.8	92	0.75	4.3	4	< 200	< 32
R-23i	P2A	470	18-Jan-11	3.9	< 200	9	< 10	< 100	< 10	1.7	0.9	93	0.78	4.3	9	< 200	< 100
R-23i	P2A	470	3-May-11	3.0	< 200	9	< 10	< 100	2	1.6	0.6	91	0.71	4.5	5	87	< 100

Table D-3.0-3 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Filtered (µg/L)											Unfiltered (µg/L)	
					Al	Ba	Cr	Fe	Mn	Mo	Ni	Sr	U	V	Zn	Al	Fe
R-23i	P3A	524	4-Aug-10	2.9	< 200	8	3.4	< 100	< 10	1.4	1.2	96	0.57	4.3	< 10	< 200	< 100
R-23i	P3A	524	18-Oct-10	4.0	< 200	8	4.4	< 100	< 10	1.6	1.2	90	0.68	4.7	< 10	< 200	< 50
R-23i	P3A	524	24-Jan-11	3.6	< 200	8	3.6	< 100	< 10	1.5	2.3	96	0.59	5.1	< 10	187	147
R-23i	P3A	524	18-Apr-11	3.0	< 200	8	< 10	< 100	< 10	1.3	1.1	91	0.55	4.7	7	< 200	< 100
R-32	Single	868	6-Aug-10	3.4	< 200	40	< 10	< 100	< 10	2.2	1.3	77	0.65	3.2	42	< 200	< 100
R-32	Single	868	14-Oct-10	3.7	< 200	41	< 10	< 100	< 10	2.2	1.1	78	0.65	2.6	44	< 200	< 100
R-32	Single	868	25-Jan-11	3.7	< 200	42	< 10	< 100	< 10	2.5	1.2	78	0.65	3.1	41	< 200	< 100
R-32	Single	868	2-May-11	3.2	< 200	41	< 10	< 100	< 10	2.1	1.4	77	0.55	3.4	37	< 200	< 100
R-37	P1A	929	5-Aug-10	2.9	< 200	10	< 10	33	7	3.7	1.1	109	1.55	5.0	< 10	< 200	76
R-37	P1A	929	12-Oct-10	3.2	< 200	9	3.0	38	4	3.6	1.1	100	1.61	4.7	< 10	< 200	32
R-37	P1A	929	21-Jan-11	5.6	< 200	9	< 10	< 100	< 10	4.1	1.5	103	1.32	4.7	9	< 200	52
R-37	P1A	929	3-May-11	2.8	90	8	< 10	< 100	< 2	3.3	1.3	100	1.41	4.8	6	89	< 100
R-37	P2A	1026	10-Aug-10	6.5	< 200	28	4.4	< 100	< 10	1.6	0.9	51	0.48	5.2	< 10	267	272
R-37	P2A	1026	14-Oct-10	4.8	< 200	30	3.5	< 100	< 10	1.6	0.8	55	0.50	5.8	< 10	111	163
R-37	P2A	1026	25-Jan-11	NC	< 200	29	3.1	< 100	< 10	1.8	0.7	53	0.46	< 5.0	< 10	< 200	30
R-37	P2A	1026	26-Apr-11	3.0	< 200	30	2.8	< 100	< 10	1.5	0.8	53	0.40	6.2	6	< 200	89
R-38	Single	821	6-Aug-10	7.0	< 200	29	< 10	< 100	< 10	1.6	3.7	50	0.40	4.0	5	< 200	< 100
R-38	Single	821	11-Oct-10	3.8	< 200	29	5.2	< 100	2	1.7	5.6	49	0.45	3.7	9	< 200	< 100
R-38	Single	821	27-Jan-11	3.0	< 200	30	< 10	< 100	2	< 1. 8	3.0	52	0.40	4.9	8	< 200	< 100
R-38	Single	821	6-May-11	3.8	< 200	29	< 10	< 100	2	1.7	3.5	51	0.44	4.7	6	< 200	< 100
R-39	Single	859	12-Aug-10	3.9	< 200	16	4.3	< 100	< 10	2.7	0.6	56	0.47	6.0	< 10	< 200	43
R-39	Single	859	8-Oct-10	4.3	< 200	15	3.8	< 100	< 10	2.4	0.6	54	0.48	5.6	< 10	189	199
R-39	Single	859	26-Jan-11	4.7	< 200	15	2.7	< 100	< 10	1.8	1.4	56	0.39	4.8	< 10	129	133
R-39	Single	859	21-Apr-11	3.0	< 200	15	5.3	< 100	< 10	1.3	1.1	56	0.30	5.9	< 10	106	70
R-40i	Single	650	4-Dec-09	3.0	< 200	28	<10	1410	372	20	0.9	100	< 0.48	< 5	< 10	< 200	1470

Table D-3.0-3 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Filtered (µg/L)											Unfiltered (µg/L)	
					Al	Ba	Cr	Fe	Mn	Mo	Ni	Sr	U	V	Zn	Al	Fe
R-40i	Single	650	3-Mar-10	2.0	< 200	30	< 6.4	1420	398	22	1.0	106	0.27	< 5	< 10	< 200	1420
R-40i	Single	650	28-Jul-10	3.5	< 200	28	< 10	1210	366	16.9	0.7	99	0.35	< 5	3	< 200	1210
R-40i	Single	650	20-Oct-10	3.8	< 200	27	3.6	1190	340	18.3	0.9	96	0.37	< 5	< 10	< 200	1190
R-40	P1A	752	4-Jun-10	1.3	< 200	29	< 10	41	48	9.3	14.8	990	1.00	4.7	13	< 200	170
R-40	P1A	752	28-Jul-10	1.4	< 200	28	< 10	< 100	10	6.4	1.3	103	1.08	2.7	6	< 200	40
R-40	P1A	752	20-Oct-10	1.4	< 200	27	4.1	< 75	4	6.7	2.4	96	1.06	3.8	5	< 200	< 95
R-40	P1A	752	21-Jan-11	1.0	< 200	29	< 10	30	24	9.0	1.7	114	1.10	2.3	8	< 200	< 100
R-40	P2A	849	27-Jul-10	4.0	< 200	25	< 10	< 100	4	2.3	0.8	54	0.32	4.7	12	< 200	126
R-40	P2A	849	19-Oct-10	4.1	< 200	23	< 10	< 35	< 10	1.8	< 2	49	0.30	5.3	7	< 200	< 125
R-40	P2A	849	19-Jan-11	3.0	< 200	25	2.3	< 100	< 10	1.4	0.9	53	0.33	5.8	5	< 200	56
R-40	P2A	849	26-Apr-11	3.0	< 200	24	< 10	< 100	< 10	1.3	0.6	50	0.29	4.8	< 10	< 200	32
R-41	P2A	965	9-Aug-10	5.0	< 200	29	4.5	< 100	6	4.3	2.9	78	0.73	6.1	4	< 200	< 100
R-41	P2A	965	8-Oct-10	4.1	537	28	3.4	< 100	3	3.3	1.8	75	0.68	5.9	< 10	< 200	< 100
R-41	P2A	965	12-Jan-11	4.7	< 200	28	2.3	< 100	< 10	3.5	1.6	78	0.56	6.2	< 10	< 200	< 100
R-41	P2A	965	21-Apr-11	3.4	< 200	27	4.1	30	< 10	2.9	2.1	75	0.39	6.8	< 10	< 200	< 100
R-49	P1A	845	29-Jul-10	4.1	< 200	22	2.7	< 100	11	2.1	1.0	70	0.89	3.7	< 10	467	238
R-49	P1A	845	7-Oct-10	3.5	< 200	20	2.8	< 100	6	2.4	1.7	58	1.26	3.9	< 10	141	52
R-49	P1A	845	19-Jan-11	4.4	< 200	21	2.2	< 100	5	2.1	1.2	62	1.07	4.1	4	76	151
R-49	P1A	845	2-May-11	3.2	< 200	20	< 10	< 100	5	2.1	0.9	58	0.88	4.8	< 10	69	35
R-49	P2A	906	29-Jul-10	4.0	< 200	21	3.4	< 100	< 10	1.4	0.6	59	0.30	4.0	< 10	< 200	< 100
R-49	P2A	906	7-Oct-10	3.8	< 200	21	3.3	< 100	< 10	1.5	1.1	55	0.35	4.5	4	< 200	< 100
R-49	P2A	906	26-Jan-11	3.2	< 200	21	2.1	< 100	< 10	1.7	0.7	59	0.36	4.1	< 10	< 200	< 100
R-49	P2A	906	29-Apr-11	3.1	< 200	21	2.2	< 100	< 10	1.5	0.8	56	0.34	4.8	< 10	< 200	39
R-51	P1A	915	26-Jul-10	4.4	< 200	25	5.2	< 100	< 10	1.3	1.8	90	0.33	5.6	20	< 200	53
R-51	P1A	915	19-Oct-10	4.8	< 200	20	< 10	< 100	< 10	1.4	< 2	53	0.33	5.0	6	< 200	68

Table D-3.0-3 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Filtered (µg/L)											Unfiltered (µg/L)	
					Al	Ba	Cr	Fe	Mn	Mo	Ni	Sr	U	V	Zn	Al	Fe
R-51	P1A	915	11-Jan-11	3.0	< 200	29	2.4	< 100	< 10	1.3	0.6	93	0.34	6.0	20	< 200	50
R-51	P1A	915	9-May-11	3.1	< 200	28	< 10	< 100	< 10	1.2	0.7	77	0.23	5.5	4	< 200	44
R-51	P2A	1031	26-Jul-10	2.3	< 200	20	3.8	32	2	1.4	0.9	58	0.39	6.2	7	< 200	93
R-51	P2A	1031	19-Oct-10	5.8	< 200	19	< 10	< 40	< 10	1.3	< 2	53	0.33	5.5	9	< 200	75
R-51	P2A	1031	11-Jan-11	3.0	< 200	20	2.2	30	< 10	1.2	< 2	54	0.37	5.8	4	< 200	56
R-51	P2A	1031	9-May-11	3.0	< 200	22	4.2	30	< 10	1.3	0.7	52	0.30	5.4	< 10	78	60
R-52	P1A	1035	5-Aug-10	4.2	< 200	28	3.2	< 100	< 10	1.5	0.6	57	0.45	5.6	41	83	64
R-52	P1A	1035	12-Oct-10	3.8	< 200	30	4.5	< 100	3	1.8	0.8	67	0.72	5.5	11	< 200	33
R-52	P1A	1035	13-Jan-11	3.0	< 200	30	< 10	< 100	< 10	2.2	1.4	67	0.75	6.6	18	< 200	40
R-52	P1A	1035	4-May-11	3.6	< 200	30	2.1	< 100	< 10	1.7	< 2	65	0.47	6.2	13	< 200	< 100
R-52	P2A	1107	5-Aug-10	4.9	< 200	28	3.5	< 100	2	1.2	0.5	50	0.36	5.8	9	< 200	< 100
R-52	P2A	1107	12-Oct-10	5.5	< 200	29	4.5	< 100	< 10	1.1	1.2	48	0.39	5.8	< 10	< 200	< 100
R-52	P2A	1107	13-Jan-11	3.0	< 200	30	< 10	< 100	< 10	< 1.5	1.2	50	0.45	6.2	< 10	< 200	< 100
R-52	P2A	1107	4-May-11	5.8	< 200	30	< 10	< 100	< 10	1.2	0.5	48	0.29	6.0	< 10	< 200	< 100
R-53	P1A	849	26-Jul-10	3.1	< 200	30	< 3.8	< 100	37	2.3	1.0	45	0.49	4.4	221	< 200	< 100
R-53	P1A	849	12-Oct-10	3.9	< 200	24	3.8	< 100	3	1.5	0.7	42	0.49	4.2	76	< 200	< 100
R-53	P1A	849	14-Jan-11	3.0	< 200	24	2.1	< 100	< 10	1.4	0.8	44	0.51	4.5	65	< 563	< 100
R-53	P1A	849	6-May-11	3.0	< 200	23	< 10	< 100	< 10	1.3	1.5	44	0.51	5.5	15	< 200	< 100
R-53	P2A	960	26-Jul-10	4.2	< 200	29	< 3.0	< 100	< 10	1.3	< 2	45	0.43	4.9	11	< 200	< 100
R-53	P2A	960	12-Oct-10	3.8	< 200	28	5.2	< 100	< 10	1.0	0.8	45	0.41	4.9	5	< 200	< 100
R-53	P2A	960	13-Jan-11	3.0	< 200	30	2.9	< 100	< 10	< 1.6	0.6	47	0.52	5.3	4	< 200	< 100
R-53	P2A	960	6-May-11	3.0	< 200	29	2.0	< 100	< 10	1.1	0.7	46	0.40	5.7	< 10	< 200	< 100
R-54	P1A	830	27-Jul-10	3.8	< 200	12	< 10	1940	216	4.0	3.1	57	0.37	1.0	25	127	2050
R-54	P1A	830	13-Oct-10	4.3	< 200	14	< 10	3850	280	3.9	3.6	66	0.53	< 5	23	< 200	4600
R-54	P1A	830	14-Jan-11	3.0	< 200	14	< 10	2650	252	3.2	2.4	64	0.58	1.4	12	< 200	2670

Table D-3.0-3 (continued)

Location	Port Name	Depth (ft bgs)	Date	Purged CV[a]	Filtered (µg/L)											Unfiltered (µg/L)	
					Al	Ba	Cr	Fe	Mn	Mo	Ni	Sr	U	V	Zn	Al	Fe
R-54	P1A	830	4-May-11	12.0	< 200	13	< 10	614	136	2.1	1.3	46	0.51	2.5	4	< 200	668
R-54	P2A	915	27-Jul-10	3.7	< 200	10	3.1	< 100	3	1.1	0.8	52	0.40	5.3	< 10	< 200	45
R-54	P2A	915	13-Oct-10	4.0	< 200	10	4.2	< 100	< 10	1.2	1.0	57	0.50	5.1	< 10	95	36
R-54	P2A	915	12-Jan-11	3.0	< 200	10	< 10	< 100	< 10	1.2	0.7	57	0.43	5.0	< 10	< 71	39
R-54	P2A	915	5-May-11	3.0	< 200	10	< 10	< 100	< 10	1.1	0.7	52	0.43	5.1	< 10	< 200	< 100
R-55i	Single	510	23-Mar-11	5.2	< 200	38	3.8	82	435	7.8	3.9	166	1.12	2.9	< 10	< 200	168
R-55i	Single	510	10-May-11	3.0	< 200	51	< 10	431	621	9.5	3.9	166	1.23	2.5	8	< 200	675
R-55	P1A	860	9-Sep-10	—[b]	< 200	36	< 10	< 100	9	1.2	2.9	73	0.62	5.7	4	< 200	< 100
R-55	P1A	860	7-Feb-11	3.0	< 200	35	2.8	36	16	1.2	1.0	73	0.64	4.9	< 10	< 200	64
R-55	P1A	860	28-Apr-11	3.0	< 200	35	< 10	< 100	5	1.1	0.9	73	0.65	5.2	< 10	< 200	< 100
R-55	P2A	994	14-Sep-10	—	< 200	31	6.5	< 100	14	1.8	< 2	73	0.61	5.5	5	< 200	41
R-55	P2A	994	1-Feb-11	4.7	< 200	29	2.0	35	2	1.4	< 2	81	0.60	4.3	< 10	< 200	58
R-55	P2A	994	28-Apr-11	3.1	< 200	32	< 10	< 100	< 10	1.3	0.9	87	0.68	< 5	< 10	< 200	< 100
R-56	P1A	945	19-Aug-10	~90	< 200	31	< 10	< 100	18	1.9	0.6	55	0.66	3.9	14	< 200	55
R-56	P1A	945	3-Feb-11	3.6	< 200	32	< 10	< 75	4	2.0	< 1.9	58	0.65	3.5	106	< 200	< 87
R-56	P1A	945	10-May-11	3.5	< 200	33	2.1	< 100	5	2.0	0.8	58	0.67	< 4.2	< 14	< 200	< 100
R-56	P2A	1047	13-Aug-10	~300	< 200	30	4.8	< 100	16	2.2	0.5	54	0.61	3.7	< 10	< 200	46
R-56	P2A	1047	7-Feb-11	3.6	< 200	29	< 10	69	< 10	2.7	0.9	54	0.66	3.9	14	< 200	103
R-56	P2A	1047	10-May-11	3.4	< 200	23	< 10	48	2	3.1	0.6	56	0.53	< 4.0	< 4	< 200	65
R-57	P1A	910	1-Jul-10	—	201	17	4.6	54	14	1.8	0.7	58	0.35	5.1	< 10	201	< 100
R-57	P1A	910	9-May-11	3.2	< 200	17	< 10	< 100	79	2.3	1.6	61	0.37	4.3	29	< 200	< 100
R-57	P2A	972	25-Jun-10	—	< 200	20	3.9	36	9	1.9	< 2	62	0.45	< 5	< 10	< 200	89
R-57	P2A	972	9-May-11	3.3	< 200	20	< 10	< 100	17	1.4	0.8	59	0.31	3.9	4	< 200	55

Source: Attachment D-1.

[a] Purged CVs from Table D-3.0-1.

[b] — = Not available.

Table D-3.0-4
Stable Isotopes

Well Port	Field QC Type	Date	$\delta^{15}N\text{-}NO_3$ (permil)	$\delta^{18}O$ (permil)	$\delta^{2}H$ (permil)
R-20 P1A, 904.6 ft	—[a]	6/21/08 3:50 PM	6.6	-11.1	-81.6
R-20 P1A, 904.6 ft	—	9/18/08 12:00 PM	—	-11.3	-80.8
R-20 P1A, 904.6 ft	—	3/10/09 10:13 AM	—	-11.3	-80.9
R-20 P1A, 904.6 ft	—	3/10/09 3:02 PM	6.3	-11.3	-81.4
R-20 P1A, 904.6 ft	—	3/10/09 9:13 PM	6.6	-11.2	-81.3
R-20 P1A, 904.6 ft	—	6/2/09 2:15 PM	5.5	-11.5	-81.4
R-20 P1A, 904.6 ft	—	9/2/09 5:30 PM	5.5	-11.2	-79.7
R-20 P1A, 904.6 ft	—	12/1/09 3:31 PM	3.7	-11.4	-82.0
R-20 P1A, 904.6 ft	—	3/13/10 1:43 PM	7.1	-11.3	-80.2
R-20 P1A, 904.6 ft	—	6/15/10 1:30 PM	6.9	-11.1	-78.4
R-20 P1A, 904.6 ft	—	10/20/10 2:05 PM	4.7	-11.3	-77.5
R-20 P1A, 904.6 ft	—	4/20/11 2:11 PM	—	-11.4	-81.0
R-20 P2A, 1147.1 ft	—	6/23/08 11:55 AM	—	-11.2	-81.0
R-20 P2A, 1147.1 ft	—	9/18/08 12:00 PM	6.3	-11.3	-79.8
R-20 P2A, 1147.1 ft	—	3/9/09 2:20 PM	6.5	-11.1	-78.5
R-20 P2A, 1147.1 ft	—	5/29/09 12:35 PM	6.6	-11.2	-80.2
R-20 P2A, 1147.1 ft	—	9/3/09 12:44 PM	—	-11.2	-81.1
R-20 P2A, 1147.1 ft	—	2/24/10 3:09 PM	16.3	-11.0	-79.8
R-20 P2A, 1147.1 ft	—	6/1/10 12:25 PM	—	-11.3	-78.1
R-20 P2A, 1147.1 ft	—	10/11/10 3:30 PM	4.7	-11.3	-79.5
R-20 P2A, 1147.1 ft	—	4/25/11 1:20 PM	—	-11.3	-79.4
R-21 Single, 888.8 ft	—	7/7/06 2:32 PM	5.2	-9.1	-80.4
R-21 Single, 888.8 ft	—	8/20/07 3:41 PM	3.5	-11.4	—
R-21 Single, 888.8 ft	—	8/14/08 12:00 PM	—	-11.1	-81.0
R-21 Single, 888.8 ft	—	8/14/08 2:55 PM	4.7	—	—
R-21 Single, 888.8 ft	—	8/18/09 1:40 PM	5.5	-11.1	-80.4
R-21 Single, 888.8 ft	—	12/4/09 2:35 PM	4.6	-10.7	-81.6
R-21 Single, 888.8 ft	—	3/12/10 3:15 PM	4.5	-11.2	-77.8
R-21 Single, 888.8 ft	—	6/11/10 12:45 PM	4.5	-11.0	-80.6
R-21 Single, 888.8 ft	—	10/11/10 12:45 PM	4.4	-11.2	-77.0
R-22 MP1A, 907.1 ft	—	3/13/01 9:20 AM	3.3	-11.0	-78.0
R-22 MP1A, 907.1 ft	—	6/19/01 2:45 PM	1.6	-10.8	-76.0
R-22 MP1A, 907.1 ft	—	11/30/01 10:15 AM	1.4	-11.0	-77.0

Table D-3.0-4 (continued)

Well Port	Field QC Type	Date	$\delta^{15}N\text{-}NO_3$ (permil)	$\delta^{18}O$ (permil)	$\delta^{2}H$ (permil)
R-22 MP1A, 907.1 ft	—	2/27/02 9:55 AM	—	-10.8	-79.0
R-22 MP1A, 907.1 ft	—	8/22/06 12:29 PM	—	-10.9	-77.5
R-22 MP2A, 962.8 ft	—	3/12/01 9:00 AM	2.6	-11.3	-78.0
R-22 MP2A, 962.8 ft	—	6/20/01 2:05 PM	0.6	-11.1	-75.0
R-22 MP2A, 962.8 ft	—	12/3/01 12:50 PM	2.7	-11.2	-77.0
R-22 MP2A, 962.8 ft	—	2/28/02 9:50 AM	5.6	-11.0	-77.0
R-22 MP2A, 962.8 ft	—	8/28/06 11:59 AM	—	-11.1	-78.5
R-22 MP2A, 962.8 ft	—	9/18/07 10:07 AM	—	-10.9	—
R-22 MP2A, 962.8 ft	—	9/16/08 9:43 AM	6.6	-11.2	-79.0
R-22 MP2A, 962.8 ft	—	2/26/09 1:30 PM	6.9	-11.0	-79.6
R-22 MP3A, 1273.5 ft	—	3/8/01 1:45 PM	-3.5	-11.2	-76.0
R-22 MP3A, 1273.5 ft	—	6/21/01 12:30 PM	0.7	-11.0	-73.0
R-22 MP3A, 1273.5 ft	—	12/4/01 12:15 PM	1.2	-10.9	-73.0
R-22 MP3A, 1273.5 ft	—	3/4/02 9:45 AM	6.4	-10.7	-78.0
R-22 MP3A, 1273.5 ft	—	8/23/06 1:35 PM	—	-10.9	-77.4
R-22 MP3A, 1273.5 ft	—	9/17/08 11:05 AM	—	-10.9	-78.3
R-22 MP3A, 1273.5 ft	—	9/17/08 11:42 AM	5.4	—	—
R-22 MP3A, 1273.5 ft	—	2/27/09 12:46 PM	6.5	-10.8	-77.1
R-22 MP4A, 1378 ft	—	3/7/01 10:15 AM	—	-11.0	-76.0
R-22 MP4A, 1378 ft	—	6/25/01 3:15 PM	2.1	-10.8	-78.0
R-22 MP4A, 1378 ft	—	12/5/01 1:40 PM	5.5	-10.5	-72.0
R-22 MP4A, 1378 ft	—	3/5/02 9:57 AM	3.7	-10.5	-74.0
R-22 MP4A, 1378 ft	FD[b]	3/5/02 9:57 AM	4.8	-10.4	-74.0
R-22 MP4A, 1378 ft	—	8/22/06 11:30 AM	—	-10.6	-76.2
R-22 MP5A, 1448.2 ft	—	3/6/01 9:45 AM	—	-11.2	-76.0
R-22 MP5A, 1448.2 ft	—	6/26/01 11:45 AM	2.5	-11.2	-80.0
R-22 MP5A, 1448.2 ft	—	12/7/01 5:00 PM	4.2	-10.7	-74.0
R-22 MP5A, 1448.2 ft	FD	12/7/01 5:00 PM	3.8	-11.0	-75.0
R-22 MP5A, 1448.2 ft	—	3/7/02 9:15 AM	—	-11.3	-77.0
R-22 MP5A, 1448.2 ft	—	8/21/06 2:59 PM	—	-10.8	-78.9
R-23 Single, 816 ft	—	8/15/06 11:40 AM	—	-10.7	-80.1
R-23 Single, 816 ft	FD	8/15/06 11:40 AM	—	-10.9	-79.9
R-23 Single, 816 ft	—	9/6/07 10:01 AM	5.8	-10.8	—
R-23 Single, 816 ft	FD	9/6/07 10:01 AM	5.7	-10.9	—
R-23 Single, 816 ft	—	9/8/08 9:35 AM	6.2	-10.5	-78.1
R-23 Single, 816 ft	—	2/25/09 2:34 PM	—	-10.6	-78.3
R-23 Single, 816 ft	—	6/4/09 3:15 PM	6.6	-10.7	-78.5
R-23 Single, 816 ft	—	9/3/09 3:45 PM	6.5	-10.5	-79.6
R-23 Single, 816 ft	—	12/9/09 11:18 AM	7.2	-10.5	-79.4

Table D-3.0-4 (continued)

Well Port	Field QC Type	Date	$\delta^{15}N\text{-}NO_3$ (permil)	$\delta^{18}O$ (permil)	$\delta^{2}H$ (permil)
R-23 Single, 816 ft	—	3/5/10 8:47 AM	6.9	-10.8	-78.1
R-23 Single, 816 ft	—	6/9/10 9:44 AM	6.8	-11.1	-80.2
R-23 Single, 816 ft	—	8/12/10 9:11 AM	—	-10.9	-78.5
R-23 Single, 816 ft	—	8/12/10 12:00 PM	5.1	—	—
R-23i P1A, 400.3 ft	—	6/16/08 1:55 PM	—	-10.6	-81.2
R-23i P1A, 400.3 ft	—	9/16/08 3:50 PM	7.1	-10.9	-79.7
R-23i P1A, 400.3 ft	—	3/3/09 1:25 PM	7.3	-10.8	-80.3
R-23i P1A, 400.3 ft	—	6/9/09 1:48 PM	5.8	-10.9	-79.5
R-23i P1A, 400.3 ft	—	9/10/09 11:25 AM	8.0	-10.6	-79.1
R-23i P1A, 400.3 ft	—	3/10/10 10:26 AM	5.5	-10.8	-79.8
R-23i P1A, 400.3 ft	—	6/15/10 11:15 AM	6.0	-10.7	-80.6
R-23i P1A, 400.3 ft	—	8/9/10 1:45 PM	5.4	-10.9	-77.6
R-23i P2A, 470.2 ft	—	12/19/07 10:35 AM	6.5	-10.6	-78.8
R-23i P2A, 470.2 ft	—	9/16/08 12:00 PM	6.4	-10.6	-78.3
R-23i P2A, 470.2 ft	—	9/8/09 4:00 PM	6.8	-10.8	-78.9
R-23i P2A, 470.2 ft	—	12/2/09 11:50 AM	7.5	-10.9	-79.7
R-23i P2A, 470.2 ft	—	3/9/10 12:15 PM	5.5	-10.8	-79.7
R-23i P2A, 470.2 ft	—	6/17/10 11:28 AM	7.1	-10.4	-76.7
R-23i P2A, 470.2 ft	—	8/4/10 11:45 AM	5.3	—	—
R-23i P2A, 470.2 ft	—	8/4/10 12:00 PM	—	-10.7	-75.1
R-23i P3A, 524 ft	—	9/15/08 12:20 PM	—	-10.8	-78.4
R-23i P3A, 524 ft	—	9/9/09 2:00 PM	6.2	-10.7	-77.8
R-23i P3A, 524 ft	—	12/1/09 1:14 PM	5.7	-10.9	-78.3
R-23i P3A, 524 ft	—	3/8/10 3:05 PM	6.2	-11.0	-78.7
R-23i P3A, 524 ft	—	6/16/10 11:52 AM	7.0	-10.5	-79.4
R-23i P3A, 524 ft	—	8/4/10 2:15 PM	5.9	-10.5	-78.2
R-32 MP1A, 870.9 ft	—	8/29/06 1:10 PM	—	-10.9	-79.0
R-32 MP3A, 976 ft	—	8/30/06 12:14 PM	—	-11.5	-80.1
R-32 Single, 867.5 ft	—	12/14/07 1:07 PM	6.0	-10.8	-78.0
R-32 Single, 867.5 ft	FD	12/14/07 1:07 PM	6.6	-10.6	-77.8
R-32 Single, 867.5 ft	—	9/8/08 1:40 PM	7.0	-10.6	-78.3
R-32 Single, 867.5 ft	FD	9/8/08 1:40 PM	6.8	-10.6	-78.6
R-32 Single, 867.5 ft	—	2/26/09 12:57 PM	—	-10.8	-79.1
R-32 Single, 867.5 ft	FD	2/26/09 12:57 PM	—	-10.8	-79.5
R-32 Single, 867.5 ft	—	6/8/09 2:40 PM	6.7	-11.0	-78.8
R-32 Single, 867.5 ft	—	8/31/09 2:00 PM	7.1	-11.0	-78.6
R-32 Single, 867.5 ft	—	12/7/09 1:55 PM	6.7	-10.7	-79.3
R-32 Single, 867.5 ft	—	3/9/10 12:27 PM	6.1	-10.9	—
R-32 Single, 867.5 ft	—	6/7/10 12:50 PM	6.5	—	-76.3

Table D-3.0-4 (continued)

Well Port	Field QC Type	Date	$\delta^{15}N\text{-}NO_3$ (permil)	$\delta^{18}O$ (permil)	$\delta^{2}H$ (permil)
R-32 Single, 867.5 ft	—	10/14/10 12:00 PM	5.3	-10.8	-79.0
R-37 P1A, 929.3 ft	—	7/13/09 5:00 AM	6.0	-11.1	-78.6
R-37 P1A, 929.3 ft	—	8/20/09 7:40 PM	7.5	-11.0	-80.7
R-37 P1A, 929.3 ft	—	11/18/09 5:40 PM	5.8	-10.9	-81.3
R-37 P1A, 929.3 ft	—	12/18/09 2:58 PM	6.4	-11.3	-79.5
R-37 P1A, 929.3 ft	—	3/2/10 1:37 PM	6.0	-11.3	-81.3
R-37 P1A, 929.3 ft	—	6/16/10 2:35 PM	7.0	-11.0	-82.1
R-37 P1A, 929.3 ft	—	10/12/10 2:45 PM	5.3	-11.2	-81.2
R-37 P2A, 1026 ft	—	6/22/09 5:25 AM	5.2	-10.9	-78.0
R-37 P2A, 1026 ft	—	11/18/09 10:52 AM	5.2	-10.7	-79.4
R-37 P2A, 1026 ft	—	12/18/09 9:22 AM	5.9	-11.3	-79.7
R-37 P2A, 1026 ft	—	3/3/10 9:06 AM	6.0	-10.9	-79.3
R-37 P2A, 1026 ft	—	6/8/10 9:40 AM	5.8	—	-78.5
R-37 P2A, 1026 ft	—	10/14/10 11:10 AM	4.1	-10.9	-77.6
R-37 P2A, 1026 ft	FD	10/14/10 11:10 AM	4.1	-10.8	-76.5
R-38 Single, 821.2 ft	—	2/6/09 12:45 PM	5.0	-11.0	-79.8
R-38 Single, 821.2 ft	—	5/1/09 11:40 AM	6.2	-11.1	-80.3
R-38 Single, 821.2 ft	—	8/21/09 11:10 AM	6.0	-11.0	-78.9
R-38 Single, 821.2 ft	—	12/17/09 12:57 PM	4.4	—	-78.0
R-38 Single, 821.2 ft	—	3/12/10 1:55 PM	4.6	-11.1	-77.5
R-38 Single, 821.2 ft	—	6/2/10 1:25 PM	5.2	-11.0	-76.9
R-38 Single, 821.2 ft	—	10/11/10 11:25 AM	4.6	-11.2	-78.8
R-39 Single, 859 ft	—	2/19/09 2:13 PM	—	-10.9	-80.0
R-39 Single, 859 ft	—	3/12/09 2:10 PM	5.8	-10.9	-79.2
R-39 Single, 859 ft	—	6/9/09 1:25 PM	5.4	-11.0	-80.6
R-39 Single, 859 ft	—	9/2/09 11:51 AM	5.2	-11.2	-77.9
R-39 Single, 859 ft	—	12/9/09 1:30 PM	5.7	-10.8	-81.5
R-39 Single, 859 ft	—	2/26/10 10:25 AM	5.5	-11.2	-80.1
R-39 Single, 859 ft	—	6/2/10 10:42 AM	5.9	-10.9	-78.0
R-39 Single, 859 ft	—	10/8/10 12:33 PM	4.5	-11.1	-79.3
R-40 P1A, 751.6 ft	—	4/21/09 8:18 AM	—	-10.7	-78.4
R-40 P1A, 751.6 ft	—	12/4/09 9:42 AM	—	-10.5	-78.9
R-40 P1A, 751.6 ft	—	2/23/10 12:00 PM	11.3	—	—
R-40 P1A, 751.6 ft	—	10/20/10 9:05 AM	8.2	-10.8	-76.6
R-40 P2A, 849.3 ft	—	9/3/09 3:02 PM	5.8	-11.1	-79.8
R-40 P2A, 849.3 ft	—	6/3/10 2:06 PM	5.2	-11.1	-79.4
R-40 P2A, 849.3 ft	—	10/19/10 12:52 PM	4.3	-10.9	-79.4
R-40 R-40i, 649.7 ft	—	6/10/09 11:33 AM	—	-10.9	-79.0
R-40 R-40i, 649.7 ft	—	8/31/09 1:10 PM	—	-10.9	-79.3

Table D-3.0-4 (continued)

Well Port	Field QC Type	Date	$\delta^{15}N\text{-}NO_3$ (permil)	$\delta^{18}O$ (permil)	$\delta^{2}H$ (permil)
R-40 R-40i, 649.7 ft	—	12/4/09 12:05 PM	—	-10.5	-80.3
R-40 R-40i, 649.7 ft	—	3/3/10 11:13 AM	—	-10.8	-79.2
R-40 R-40i, 649.7 ft	—	10/20/10 11:23 AM	—	-10.8	-78.3
R-41 P2A, 965.3 ft	—	4/2/09 7:00 AM	6.6	-10.6	-79.2
R-41 P2A, 965.3 ft	—	9/1/09 3:15 PM	5.6	-11.0	-79.2
R-41 P2A, 965.3 ft	—	12/15/09 10:10 AM	5.4	-11.5	-80.0
R-41 P2A, 965.3 ft	—	2/26/10 12:48 PM	6.3	-11.1	-80.4
R-41 P2A, 965.3 ft	—	6/9/10 10:06 AM	5.7	-11.1	-78.9
R-41 P2A, 965.3 ft	—	10/8/10 9:48 AM	5.5	-10.9	-75.6
R-41 P2A, 965.3 ft	FD	10/8/10 9:48 AM	5.4	-11.0	-76.3
R-49 P1A, 845 ft	—	6/23/09 5:45 AM	13.1	-11.1	-79.8
R-49 P1A, 845 ft	—	9/1/09 4:35 PM	3.9	-11.1	-79.5
R-49 P1A, 845 ft	—	12/7/09 1:55 PM	6.9	-10.8	-81.0
R-49 P1A, 845 ft	—	3/3/10 2:18 PM	5.0	-10.9	-79.6
R-49 P1A, 845 ft	—	6/14/10 1:56 PM	5.7	-11.1	-80.3
R-49 P1A, 845 ft	—	10/7/10 2:35 PM	5.3	-11.0	-77.6
R-49 P2A, 905.6 ft	—	6/18/09 5:50 AM	3.6	-11.2	-80.6
R-49 P2A, 905.6 ft	—	9/1/09 2:08 PM	5.8	-11.0	-80.4
R-49 P2A, 905.6 ft	—	12/9/09 11:23 AM	5.7	-10.9	-81.1
R-49 P2A, 905.6 ft	—	3/5/10 11:40 AM	5.7	-11.2	-79.8
R-49 P2A, 905.6 ft	—	6/9/10 3:13 PM	6.3	-11.0	-81.0
R-49 P2A, 905.6 ft	—	10/7/10 11:00 AM	5.6	-11.2	-77.4
R-51 P1A, 914.96 ft	—	3/8/10 6:14 AM	5.2	-10.9	-79.1
R-51 P1A, 914.96 ft	—	6/18/10 12:10 PM	5.6	-11.0	-78.3
R-51 P1A, 914.96 ft	—	7/26/10 1:40 PM	4.4	-11.2	-78.5
R-51 P1A, 914.96 ft	—	10/19/10 10:50 AM	3.6	-11.3	-80.1
R-51 P2A, 1030.96 ft	—	2/22/10 6:12 AM	5.7	-11.1	-80.0
R-51 P2A, 1030.96 ft	—	6/18/10 10:00 AM	4.6	—	—
R-51 P2A, 1030.96 ft	—	6/18/10 12:00 PM	—	-11.3	-79.1
R-51 P2A, 1030.96 ft	—	7/26/10 11:21 AM	2.8	-11.3	-81.6
R-51 P2A, 1030.96 ft	—	10/19/10 12:55 PM	1.2	-11.4	-79.5
R-52 P1A, 1035.2 ft	—	5/2/10 6:48 AM	5.8	-10.7	-77.0
R-52 P1A, 1035.2 ft	—	8/5/10 12:23 PM	—	-11.0	-78.1
R-52 P1A, 1035.2 ft	—	8/5/10 12:43 PM	5.1	—	—
R-52 P1A, 1035.2 ft	—	10/12/10 1:31 PM	4.5	-10.9	-78.8
R-52 P1A, 1035.2 ft	—	1/13/11 2:59 PM	3.5	-10.8	-77.3
R-52 P2A, 1107 ft	—	4/23/10 6:07 AM	5.5	—	—
R-52 P2A, 1107 ft	—	4/23/10 12:00 PM	—	-10.5	-79.4
R-52 P2A, 1107 ft	—	8/5/10 10:40 AM	4.6	-11.0	-77.5

Table D-3.0-4 (continued)

Well Port	Field QC Type	Date	$\delta^{15}N\text{-}NO_3$ (permil)	$\delta^{18}O$ (permil)	$\delta^{2}H$ (permil)
R-52 P2A, 1107 ft	—	10/12/10 11:34 AM	4.0	-10.8	-76.7
R-52 P2A, 1107 ft	—	1/13/11 12:26 PM	4.9	-10.8	-77.2
R-53 P1A, 849.2 ft	—	4/19/10 6:36 AM	4.6	-11.3	-82.6
R-53 P1A, 849.2 ft	—	7/26/10 1:50 PM	4.7	-11.5	-80.3
R-53 P1A, 849.2 ft	—	10/12/10 1:46 PM	3.4	-11.3	-77.9
R-53 P1A, 849.2 ft	—	1/14/11 11:05 AM	3.4	-11.1	-80.1
R-53 P2A, 959.7 ft	—	4/14/10 6:10 AM	—	-11.4	-80.5
R-53 P2A, 959.7 ft	—	4/14/10 12:00 PM	5.0	—	—
R-53 P2A, 959.7 ft	—	7/26/10 12:19 PM	4.2	-11.1	-79.8
R-53 P2A, 959.7 ft	—	10/12/10 11:55 AM	3.8	-10.9	-76.6
R-53 P2A, 959.7 ft	—	1/13/11 3:14 PM	4.3	-11.0	-78.0
R-54 P1A, 830 ft	—	2/15/10 6:06 AM	—	-11.0	-78.4
R-54 P1A, 830 ft	—	6/18/10 11:40 AM	3.9	-11.1	-79.8
R-54 P1A, 830 ft	—	7/27/10 12:21 PM	12.0	-11.2	-80.7
R-54 P1A, 830 ft	—	10/13/10 12:17 PM	6.4	-11.3	-79.3
R-54 P2A, 915 ft	—	2/21/10 6:03 AM	5.5	-11.3	-78.3
R-54 P2A, 915 ft	—	6/18/10 9:44 AM	4.8	-11.3	-78.7
R-54 P2A, 915 ft	—	7/27/10 10:43 AM	4.5	-11.3	-81.9
R-54 P2A, 915 ft	—	10/13/10 10:25 AM	3.2	-11.3	-78.4
R-55 P1A, 860 ft	—	9/9/10 6:08 AM	5.9	-9.2	-72.3
R-55 P1A, 860 ft	—	2/7/11 2:02 PM	4.9	-10.6	-77.3
R-55 P2A, 994.4 ft	—	9/14/10 6:02 AM	4.5	-10.6	-76.5
R-55 P2A, 994.4 ft	—	2/1/11 12:35 PM	6.0	-10.7	-77.0
R-56 P1A, 945 ft	—	8/19/10 6:10 AM	4.3	-11.2	-77.1
R-56 P2A, 1046.6 ft	—	8/13/10 6:15 AM	3.9	-11.1	-77.8
R-56 P2A, 1046.6 ft	—	2/7/11 12:42 PM	4.4	-11.1	-79.4
R-57 P1A, 910 ft	—	7/1/10 6:00 AM	4.2	-10.9	-77.7
R-57 P2A, 971.5 ft	—	6/25/10 6:10 AM	5.8	-11.0	-77.1

Source: Attachment D-1.

[a] — = Not applicable.

[b] FD = Field duplicate.

Table D-4.2-1
Statistical Summary of High-Explosive and Organic Compounds Detected in Groundwater Samples from TA-54 Groundwater Monitoring Network Wells for the Period Extending from Well Development to May 2011

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Dioxin Furan Detections															
Heptachlorodibenzodioxin[1,2,3,4,6,7,8-]	R-23i	P3A	524	n/a[d]	3	1	0.000000745	0.000000745	0.00005	—[e]	—	—	—	—	—
	R-32	Single	867.5	n/a	4	1	0.000000706	0.000000706	0.00005	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	7	1	0.000000869	0.000000869	0.00005	—	—	—	—	—	—
	R-38	Single	821.2	n/a	6	1	0.00000147	0.00000147	0.00005	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	6	1	0.00000054	0.00000054	0.00005	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	6	1	0.000000919	0.000000919	0.00005	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	1	0.000000712	0.000000712	0.00005	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	1	0.000000996	0.000000996	0.00005	—	—	—	—	—	—
Heptachlorodibenzodioxins (Total)	R-23i	P3A	524	n/a	3	1	0.0000021	0.0000021	0.00005	—	—	—	—	—	—
	R-32	Single	867.5	n/a	4	1	0.00000186	0.00000186	0.00005	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	7	1	0.00000239	0.00000239	0.00005	—	—	—	—	—	—
	R-37	P2A	1026	n/a	6	2	0.000001375	0.00000147	0.00005	—	—	—	—	—	—
	R-38	Single	821.2	n/a	6	1	0.00000315	0.00000315	0.00005	—	—	—	—	—	—
	R-39	Single	859	n/a	8	1	0.00000258	0.00000258	0.00005	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	6	1	0.00000054	0.00000054	0.00005	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	6	1	0.00000235	0.00000235	0.00005	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	1	0.00000172	0.00000172	0.00005	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	1	0.00000101	0.00000101	0.00005	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	1	0.000000996	0.000000996	0.00005	—	—	—	—	—	—
Heptachlorodibenzofuran[1,2,3,4,6,7,8-]	R-23	Single	816	n/a	4	1	0.0000151	0.0000151	0.00005	—	—	—	—	—	—
	R-38	Single	821.2	n/a	6	1	0.00000292	0.00000292	0.00005	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	6	1	0.000000395	0.000000395	0.00005	—	—	—	—	—	—
Heptachlorodibenzofurans (Total)	R-23	Single	816	n/a	4	1	0.0000151	0.0000151	0.00005	—	—	—	—	—	—
	R-38	Single	821.2	n/a	6	1	0.00000292	0.00000292	0.00005	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	6	1	0.000000395	0.000000395	0.00005	—	—	—	—	—	—
Hexachlorodibenzofuran[1,2,3,4,7,8-]	R-23	Single	816	n/a	4	1	0.0000029	0.0000029	0.00005	—	—	—	—	—	—
Hexachlorodibenzofurans (Total)	R-23	Single	816	n/a	4	1	0.00000963	0.00000963	0.00005	—	—	—	—	—	—
Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-]	R-20	P1A	904.6	n/a	4	1	0.00000296	0.00000296	0.00005	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	7	1	0.00000445	0.00000445	0.00005	—	—	—	—	—	—
	R-37	P2A	1026	n/a	6	1	0.00000242	0.00000242	0.00005	—	—	—	—	—	—
	R-39	Single	859	n/a	8	1	0.00000137	0.00000137	0.00005	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	4	1	0.00000245	0.00000245	0.00005	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	6	2	0.000003165	0.00000342	0.00005	—	—	—	—	—	—

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Octachlorodibenzofuran[1,2,3,4,6,7,8,9-] (continued)	R-23	Single	816	n/a	4	1	0.0000237	0.0000237	0.00005	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	5	1	0.00000088	0.00000088	0.00005	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	7	1	0.00000257	0.00000257	0.00005	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	1	0.000000618	0.000000618	0.00005	—	—	—	—	—	—
High Explosive Detections															
Amino-2,6-dinitrotoluene[4-]	R-22	MP1A	907.1	n/a	5	1	0.42	0.42	0.33	73	EPA Tap	0	36.5	0	R-22 is off-line and will undergo rehabilitation.
Amino-4,6-dinitrotoluene[2-]	R-22	MP1A	907.1	n/a	5	1	0.51	0.51	0.33	73	EPA Tap	0	36.5	0	R-22 is off-line and will undergo rehabilitation.
HMX	R-20	MP2A	1147.1	n/a	4	1	0.88	0.88	0.33	1800	EPA Tap	0	900	0	Before well rehabilitation.
Nitrobenzene	R-20	P2A	1147.1	n/a	8	1	0.154	0.154	0.33	1.2	EPA Tap	0	0.6	0	Detected once below the PQL.
	R-22	MP4A	1378	n/a	5	1	0.0196	0.0196	0.33	1.2	EPA Tap	0	0.6	0	R-22 is off-line and will undergo rehabilitation.
	R-54	P1A	830	n/a	6	1	0.124	0.124	0.33	1.2	EPA Tap	0	0.6	0	Detected once below the PQL.
RDX	R-22	MP5A	1448.2	n/a	5	1	0.34	0.34	0.33	6.1	EPA Tap	0	3.05	0	R-22 is off-line and will undergo rehabilitation.
	R-40	P2A	849.3	n/a	6	1	0.198	0.198	0.33	6.1	EPA Tap	0	3.05	0	Detected once below the PQL.
Trinitrobenzene[1,3,5-]	R-22	MP2A	962.8	n/a	16	1	0.12	0.12	0.33	1100	EPA Tap	0	550	0	R-22 is off-line and will undergo rehabilitation.
PCB Detections															
Aroclor-1242	R-23i	P1A	400.3	n/a	6	1	0.061	0.061	0.5	0.5	EPA MCL	0	0.25	0	Detected once below the PQL.
Aroclor-1254	R-20	MP3A	1330	n/a	5	1	0.11	0.11	0.5	0.5	EPA MCL	0	0.25	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-23i	P1A	400.3	n/a	6	1	0.09	0.09	0.5	0.5	EPA MCL	0	0.25	0	Detected once below the PQL.
Pesticide Detections															
BHC[beta-]	R-53	P2A	959.7	n/a	5	1	0.0108	0.0108	0.02	0.37	EPA Tap	0	0.185	0	Detected once below the PQL.
	R-55i	Single	510	n/a	2	1	0.0338	0.0338	0.02	0.37	EPA Tap	0	0.185	0	—
BHC[gamma-]	R-22	MP3A	1273.5	n/a	11	1	0.01	0.01	0.02	0.2	EPA MCL	0	0.1	0	R-22 is off-line and will undergo rehabilitation.
Chlordane[gamma-]	R-40	P1A	751.6	n/a	3	1	0.011	0.011	0.02	—	—	—	—	—	Detected once below the PQL.
DDD[4,4'-]	R-22	MP3A	1273.5	n/a	11	1	0.00918	0.00918	0.04	2.8	EPA Tap	0	1.4	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD[f]	10	1	0.00609	0.00609	0.04	2.8	EPA Tap	0	1.4	0	Detected once below the PQL.
DDE[4,4'-]	R-20	MP2A	1147.1	FD	2	1	0.00789	0.00789	0.04	2	EPA Tap	0	1	0	Before well rehabilitation.
	R-22	MP3A	1273.5	n/a	11	1	0.0199	0.0199	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-32	MP1A	870.9	n/a	9	1	0.00578	0.00578	0.04	2	EPA Tap	0	1	0	Detected once below the PQL.
	R-37	P2A	1026	n/a	6	1	0.0904	0.0904	0.04	2	EPA Tap	0	1	0	—
DDT[4,4'-]	R-22	MP1A	907.1	n/a	6	1	0.01	0.01	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	15	1	0.008	0.008	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	10	2	0.0094	0.01	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	0.01	0.01	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	1	0.02	0.02	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	0.0082	0.0082	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	1	0.02	0.02	0.04	2	EPA Tap	0	1	0	R-22 is off-line and will undergo rehabilitation.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
DDT[4,4'-] (continued)	R-32	MP1A	870.9	n/a	9	1	0.0148	0.0148	0.04	2	EPA Tap	0	1	0	Detected once below the PQL.
	R-37	P2A	1026	n/a	6	1	0.0523	0.0523	0.04	2	EPA Tap	0	1	0	—
Endosulfan Sulfate	R-20	MP2A	1147.1	n/a	5	1	0.0175	0.0175	0.04	—	—	—	—	—	Before well rehabilitation.
	R-23	Single	816	n/a	18	2	0.0104	0.0105	0.04	—	—	—	—	—	—
	R-38	Single	821.2	n/a	7	1	0.0365	0.0365	0.04	—	—	—	—	—	Detected once below the PQL.
Endrin Aldehyde	R-23	Single	816	n/a	17	1	0.0334	0.0334	0.04	—	—	—	—	—	Detected once below the PQL.
	R-23i	P3A	524	n/a	7	1	0.00722	0.00722	0.04	—	—	—	—	—	Detected once below the PQL.
Endrin Ketone	R-23	Single	816	n/a	18	2	0.009	0.00998	0.04	—	—	—	—	—	—
Heptachlor	R-20	P2A	1147.1	n/a	5	1	0.0135	0.0135	0.02	0.4	EPA MCL	0	0.2	0	Detected once below the PQL.
	R-40	P1A	751.6	n/a	3	1	0.0196	0.0196	0.02	0.4	EPA MCL	0	0.2	0	Detected once below the PQL.
Semivolatile Detections															
Acenaphthene	R-22	MP5A	1448.2	n/a	8	1	0.41	0.41	1	2200	EPA Tap	0	1100	0	R-22 is off-line and will undergo rehabilitation.
Acenaphthylene	R-22	MP5A	1448.2	n/a	8	1	0.4	0.4	1	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
Anthracene	R-22	MP5A	1448.2	n/a	8	1	0.36	0.36	1	11000	EPA Tap	0	5500	0	R-22 is off-line and will undergo rehabilitation.
Benzo(a)pyrene	R-22	MP5A	1448.2	n/a	8	1	0.23	0.23	1	0.2	EPA MCL	1	0.1	1	Detected once below the PQL in December 2001 from samples collected between March 2001 to February 2009.
Benzo(b)fluoranthene	R-22	MP5A	1448.2	n/a	8	1	0.4	0.4	1	0.29	EPA Tap	1	0.145	1	Detected once below the PQL in December 2001 from samples collected between March 2001 to February 2009.
	R-55	P2A	994.4	n/a	3	1	0.42	0.42	1	0.29	EPA Tap	1	0.145	1	Detected once below the PQL in first sampling event, September 2010, not detected in 2 subsequent sampling events.
Benzo(k)fluoranthene	R-22	MP5A	1448.2	n/a	8	1	0.37	0.37	1	2.9	EPA Tap	0	1.45	0	R-22 is off-line and will undergo rehabilitation.
	R-55	P2A	994.4	n/a	3	1	0.466	0.466	1	2.9	EPA Tap	0	1.45	0	Detected once below the PQL.
Benzoic Acid	R-20	MP1A	904.6	n/a	4	1	18.2	18.2	20	150000	EPA Tap	0	75000	0	Before well rehabilitation.
	R-20	P2A	1147.1	FD	5	1	15.7	15.7	20	150000	EPA Tap	0	75000	0	Detected once below the PQL.
	R-20	P2A	1147.1	n/a	15	1	15.7	15.7	20	150000	EPA Tap	0	75000	0	Detected once below the PQL.
	R-21	Single	888.8	n/a	19	1	12.5	12.5	20	150000	EPA Tap	0	75000	0	Detected once below the PQL.
	R-22	MP1A	907.1	n/a	8	3	10.47	15.9	20	150000	EPA Tap	0	75000	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	1	9.7	9.7	20	150000	EPA Tap	0	75000	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	1	11	11	20	150000	EPA Tap	0	75000	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	24	1	24.2	24.2	20	150000	EPA Tap	0	75000	0	—
	R-39	Single	859	n/a	11	1	20	20	20	150000	EPA Tap	0	75000	0	—
	R-54	P1A	830	n/a	6	1	14.1	14.1	20	150000	EPA Tap	0	75000	0	Detected once below the PQL.
Bis(2-ethylhexyl)phthalate	R-20	MP1A	904.6	n/a	5	1	1.5	1.5	10	6	EPA MCL	0	3	0	Before well rehabilitation.
	R-20	MP2A	1147.1	FD	2	1	1.9	1.9	10	6	EPA MCL	0	3	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	1	2.7	2.7	10	6	EPA MCL	0	3	0	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Bis(2-ethylhexyl)phthalate (continued)	R-22	MP1A	907.1	n/a	8	1	4.6	4.6	10	6	EPA MCL	0	3	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	15	3	2.38	3.9	10	6	EPA MCL	0	3	2	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	0.74	0.74	10	6	EPA MCL	0	3	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	8	1	1	1	10	6	EPA MCL	0	3	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	14	1	1.3	1.3	10	6	EPA MCL	0	3	0	Detected once below the PQL.
	R-23	Single	816	n/a	25	2	5.425	7.6	10	6	EPA MCL	1	3	2	Detected 3 times below the PQL between December 2003 and April 2011.
	R-32	MP3A	976	n/a	9	2	4	4.3	10	6	EPA MCL	0	3	2	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	8	5	3.842	4.97	10	6	EPA MCL	0	3	4	—
	R-32	Single	867.5	n/a	15	5	3.972	6	10	6	EPA MCL	1	3	4	Detected 5 times (and in the 5 field duplicates) below the PQL from December 2007 to February 2009. Not detected from June 2009 to May 2011.
	R-37	P1A	929.3	n/a	10	2	3.495	4.66	10	6	EPA MCL	0	3	1	—
	R-38	Single	821.2	FD	7	3	6.12	7.38	10	6	EPA MCL	2	3	3	See parent sample information.
	R-38	Single	821.2	n/a	12	8	8.3425	35.6	10	6	EPA MCL	3	3	7	Detected 3 times above the EPA MCL between February 2009 and May 2009.
	R-40	P1A	751.6	n/a	7	1	3.11	3.11	10	6	EPA MCL	0	3	1	Detected once below the PQL.
	R-40	R-40i	649.7	n/a	6	1	4.85	4.85	10	6	EPA MCL	0	3	1	Detected once below the PQL.
	R-54	P1A	830	n/a	6	1	11.2	11.2	10	6	EPA MCL	1	3	1	Detected once in first sample collected in February 2010. Not detected from June 2010 to may 2011.
Butylbenzylphthalate	R-22	MP5A	1448.2	n/a	8	1	9.8	9.8	10	350	EPA Tap	0	175	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	1	1.6	1.6	10	350	EPA Tap	0	175	0	Detected once below the PQL.
Chloronaphthalene[2-]	R-22	MP5A	1448.2	n/a	8	1	0.46	0.46	1	2900	EPA Tap	0	1450	0	R-22 is off-line and will undergo rehabilitation.
Chrysene	R-23	Single	816	n/a	25	1	0.295	0.295	1	29	EPA Tap	0	14.5	0	Detected once below the PQL.
Diethylphthalate	R-20	MP2A	1147.1	n/a	5	2	1.75	2	10	29000	EPA Tap	0	14500	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	1	1	1	10	29000	EPA Tap	0	14500	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	16	2	19.6	28.5	10	29000	EPA Tap	0	14500	0	—
	R-21	Single	888.8	n/a	19	1	7.38	7.38	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-22	MP5A	1448.2	n/a	8	1	1.29	1.29	10	29000	EPA Tap	0	14500	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	3	9.69	14.5	10	29000	EPA Tap	0	14500	0	—
	R-23i	P3A	524	n/a	9	2	8.185	11.7	10	29000	EPA Tap	0	14500	0	—
	R-32	Single	867.5	n/a	15	1	96.3	96.3	10	29000	EPA Tap	0	14500	0	—
	R-38	Single	821.2	n/a	12	1	13.3	13.3	10	29000	EPA Tap	0	14500	0	—
	R-39	Single	859	n/a	11	1	12.1	12.1	10	29000	EPA Tap	0	14500	0	—
	R-40	P1A	751.6	n/a	7	1	5.8	5.8	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Diethylphthalate (continued)	R-40	P2A	849.3	n/a	9	1	16.6	16.6	10	29000	EPA Tap	0	14500	0	—
	R-40	R-40i	649.7	n/a	6	1	3.04	3.04	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-41	P2A	965.3	n/a	10	1	3.07	3.07	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-51	P1A	914.96	FD	2	1	22	22	10	29000	EPA Tap	0	14500	0	—
	R-51	P2A	1031	n/a	6	1	9.47	9.47	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-53	P1A	849.2	n/a	5	1	11.7	11.7	10	29000	EPA Tap	0	14500	0	—
	R-54	P1A	830	n/a	6	3	30.9	55.4	10	29000	EPA Tap	0	14500	0	—
	R-55	P1A	860	FD	1	1	2.23	2.23	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-55	P1A	860	n/a	3	1	7.25	7.25	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-56	P1A	945	FD	1	1	3.68	3.68	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
	R-56	P1A	945	n/a	3	1	17.6	17.6	10	29000	EPA Tap	0	14500	0	—
	R-57	P2A	971.5	n/a	2	1	8.14	8.14	10	29000	EPA Tap	0	14500	0	Detected once below the PQL.
Dioxane[1,4-]	R-23i	P1A	400.3	n/a	9	1	1.15	1.15	10	6.7	EPA Tap	0	3.35	0	Detected once below the PQL.
	R-37	P1A	929.3	FD	4	3	3.67	4.75	10	6.7	EPA Tap	0	3.35	2	—
	R-37	P1A	929.3	n/a	10	6	4.1	5.02	10	6.7	EPA Tap	0	3.35	5	—
	R-37	P2A	1026	FD	4	1	2.19	2.19	10	6.7	EPA Tap	0	3.35	0	Detected once below the PQL.
	R-37	P2A	1026	n/a	9	1	2.29	2.29	10	6.7	EPA Tap	0	3.35	0	Detected once below the PQL.
	R-38	Single	821.2	n/a	12	1	4.83	4.83	10	6.7	EPA Tap	0	3.35	1	Detected once below the PQL.
Fluoranthene	R-22	MP5A	1448.2	n/a	8	1	0.37	0.37	1	1500	EPA Tap	0	750	0	R-22 is off-line and will undergo rehabilitation.
Fluorene	R-22	MP5A	1448.2	n/a	8	1	0.41	0.41	1	1500	EPA Tap	0	750	0	R-22 is off-line and will undergo rehabilitation.
Indeno(1,2,3-cd)pyrene	R-55	P2A	994.4	n/a	3	1	0.466	0.466	1	0.29	EPA Tap	1	0.145	1	Detected once below the PQL in first sample collected in September 2010. Not detected from February to April 2011.
Methylnaphthalene[2-]	R-22	MP5A	1448.2	n/a	8	1	0.41	0.41	1	150	EPA Tap	0	75	0	R-22 is off-line and will undergo rehabilitation.
Methylphenol[4-]	R-22	MP1A	907.1	n/a	7	1	44	44	10	180	EPA Tap	0	90	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	1	210	210	10	180	EPA Tap	1	90	1	Detected once above the PQL.
	R-22	MP5A	1448.2	n/a	6	1	60	60	10	180	EPA Tap	0	90	0	R-22 is off-line and will undergo rehabilitation.
	R-54	P1A	830	FD	2	1	3.85	3.85	10	180	EPA Tap	0	90	0	Detected once below the PQL.
	R-54	P1A	830	n/a	6	1	3.32	3.32	10	180	EPA Tap	0	90	0	Detected once below the PQL.
Naphthalene	R-20	MP1A	904.6	n/a	5	1	0.24	0.24	1	30	NM GW STD	0	15	0	Before well rehabilitation.
	R-20	MP2A	1147.1	FD	2	2	0.35	0.41	1	30	NM GW STD	0	15	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	4	0.4375	0.56	1	30	NM GW STD	0	15	0	Before well rehabilitation.
Pentachlorophenol	R-22	MP5A	1448.2	n/a	8	1	6.19	6.19	10	1	EPA MCL	1	0.5	1	Detected once below the PQL.
Phenanthrene	R-22	MP3A	1273.5	n/a	15	1	0.14	0.14	1	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	8	1	0.4	0.4	1	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Phenol	R-22	MP4A	1378	n/a	7	1	32	32	10	5	NM GW STD	1	2.5	1	Detected once above the PQL.
	R-22	MP5A	1448.2	n/a	8	1	19	19	10	5	NM GW STD	1	2.5	1	Detected once above the PQL.
	R-23	Single	816	n/a	25	1	1.99	1.99	10	5	NM GW STD	0	2.5	0	Detected once below the PQL.
	R-22	MP5A	1448.2	n/a	8	1	0.49	0.49	10	1100	EPA Tap	0	550	0	R-22 is off-line and will undergo rehabilitation.
Volatile Detections															
Acetone	R-20	MP1A	904.6	FD	1	1	134	134	5	22000	EPA Tap	0	11000	0	Before well rehabilitation.
	R-20	MP1A	904.6	n/a	5	4	140.95	209	5	22000	EPA Tap	0	11000	0	Before well rehabilitation.
	R-20	P1A	904.6	n/a	21	5	25.126	85.7	5	22000	EPA Tap	0	11000	0	—
	R-20	P2A	1147.1	FD	7	1	1.42	1.42	5	22000	EPA Tap	0	11000	0	Detected once below the PQL.
	R-21	Single	888.8	n/a	21	1	2.8	2.8	5	22000	EPA Tap	0	11000	0	Detected once below the PQL.
	R-22	MP1A	907.1	n/a	12	2	7.2	13	5	22000	EPA Tap	0	11000	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	17	1	2.5	2.5	5	22000	EPA Tap	0	11000	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	5.8	5.8	5	22000	EPA Tap	0	11000	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	8	4	15.5	32	5	22000	EPA Tap	0	11000	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	22	3	11.7	16	5	22000	EPA Tap	0	11000	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	14	4	3.6925	6.9	5	22000	EPA Tap	0	11000	0	—
	R-23	Single	816	n/a	24	4	15.5325	50.8	5	22000	EPA Tap	0	11000	0	—
	R-23i	P3A	524	n/a	16	1	1.33	1.33	5	22000	EPA Tap	0	11000	0	Detected once below the PQL.
	R-32	MP3A	976	n/a	9	1	2.48	2.48	5	22000	EPA Tap	0	11000	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	9	2	32.13	61.5	5	22000	EPA Tap	0	11000	0	—
	R-32	Single	867.5	n/a	15	4	15.86	52.4	5	22000	EPA Tap	0	11000	0	—
	R-37	P1A	929.3	FD	4	1	21.5	21.5	5	22000	EPA Tap	0	11000	0	—
	R-37	P1A	929.3	n/a	10	1	20.9	20.9	5	22000	EPA Tap	0	11000	0	—
	R-38	Single	821.2	FD	9	1	8.16	8.16	5	22000	EPA Tap	0	11000	0	—
	R-38	Single	821.2	n/a	15	1	6.8	6.8	5	22000	EPA Tap	0	11000	0	—
	R-52	P1A	1035.2	FD	2	1	6.54	6.54	5	22000	EPA Tap	0	11000	0	—
	R-52	P1A	1035.2	n/a	5	2	5.25	5.73	5	22000	EPA Tap	0	11000	0	—
	R-53	P1A	849.2	FD	2	1	40.3	40.3	5	22000	EPA Tap	0	11000	0	—
	R-53	P1A	849.2	n/a	5	1	39.4	39.4	5	22000	EPA Tap	0	11000	0	—
	R-54	P1A	830	n/a	6	1	8.62	8.62	5	22000	EPA Tap	0	11000	0	—
	R-55i	Single	510	FD	1	1	56.3	56.3	5	22000	EPA Tap	0	11000	0	—
	R-55i	Single	510	n/a	2	2	29.45	48.8	5	22000	EPA Tap	0	11000	0	—
Acetonitrile	R-23	Single	816	n/a	13	1	9.06	9.06	5	130	EPA Tap	0	65	0	—
	R-23i	P2A	470.2	FD	2	1	6.78	6.78	5	130	EPA Tap	0	65	0	—
	R-40	P1A	751.6	n/a	4	1	7.46	7.46	5	130	EPA Tap	0	65	0	—

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Benzene	R-38	Single	821.2	FD	9	3	9.09	23.8	1	5	EPA MCL	1	2.5	1	See parent sample information.
	R-38	Single	821.2	n/a	15	6	2.238	6.34	1	5	EPA MCL	1	2.5	1	Detected once in first sample collected in February 2009 above the MCL. Detected below the MCL in 2009. Not detected since 2009.
Butanol[1-]	R-20	P1A	904.6	n/a	8	1	16	16	50	3700	EPA Tap	0	1850	0	Detected once below the PQL.
	R-40	P1A	751.6	n/a	8	1	25	25	50	3700	EPA Tap	0	1850	0	Detected once below the PQL.
	R-40	R-40i	649.7	n/a	6	1	16	16	50	3700	EPA Tap	0	1850	0	Detected once below the PQL.
Butanone[2-]	R-20	P1A	904.6	FD	5	1	1.62	1.62	5	7100	EPA Tap	0	3550	0	Detected once below the PQL.
	R-20	P1A	904.6	n/a	21	3	1.98	2.9	5	7100	EPA Tap	0	3550	0	—
	R-22	MP4A	1378	n/a	8	1	6.9	6.9	5	7100	EPA Tap	0	3550	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	23	2	8.5	8.9	5	7100	EPA Tap	0	3550	0	R-22 is off-line and will undergo rehabilitation.
	R-40	P1A	751.6	n/a	8	1	1.87	1.87	5	7100	EPA Tap	0	3550	0	Detected once below the PQL.
	R-54	P1A	830	n/a	6	1	3.15	3.15	5	7100	EPA Tap	0	3550	0	Detected once below the PQL.
	R-55i	Single	510	n/a	2	1	2.6	2.6	5	7100	EPA Tap	0	3550	0	Detected once below the PQL.
Carbon Disulfide	R-22	MP5A	1448.2	n/a	22	1	1.98	1.98	5	1000	EPA Tap	0	500	0	R-22 is off-line and will undergo rehabilitation.
	R-38	Single	821.2	n/a	15	1	2.16	2.16	5	1000	EPA Tap	0	500	0	Detected once below the PQL.
Chloroform	R-22	MP3A	1273.5	n/a	18	1	0.94	0.94	1	80	EPA MCL	0	40	0	R-22 is off-line and will undergo rehabilitation.
Chloromethane	R-20	P1A	904.6	n/a	21	1	0.458	0.458	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-22	MP1A	907.1	FD	2	1	0.461	0.461	1	190	EPA Tap	0	95	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP1A	907.1	n/a	11	1	0.304	0.304	1	190	EPA Tap	0	95	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	23	1	0.363	0.363	1	190	EPA Tap	0	95	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	1	0.364	0.364	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-23i	P1A	400.3	FD	4	1	0.346	0.346	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-23i	P1A	400.3	n/a	14	1	0.715	0.715	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-23i	P2A	470.2	FD	5	1	0.353	0.353	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-23i	P2A	470.2	n/a	19	1	0.307	0.307	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-37	P2A	1026	n/a	9	1	0.338	0.338	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-38	Single	821.2	n/a	15	3	0.3	0.37	1	190	EPA Tap	0	95	0	—
	R-39	Single	859	FD	6	2	0.363	0.368	1	190	EPA Tap	0	95	0	—
	R-39	Single	859	n/a	11	2	0.394	0.46	1	190	EPA Tap	0	95	0	—
	R-40	R-40i	649.7	FD	2	1	0.353	0.353	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-40	R-40i	649.7	n/a	7	1	0.352	0.352	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-41	P2A	965.3	FD	5	1	0.342	0.342	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-49	P1A	845	n/a	9	1	0.463	0.463	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-52	P1A	1035.2	FD	2	1	0.33	0.33	1	190	EPA Tap	0	95	0	Detected once below the PQL.
	R-54	P1A	830	n/a	6	1	0.94	0.94	1	190	EPA Tap	0	95	0	Detected once below the PQL.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Dichlorobenzene[1,4-]	R-22	MP2A	962.8	n/a	19	1	0.23	0.23	1	75	EPA MCL	0	37.5	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	18	1	0.21	0.21	1	75	EPA MCL	0	37.5	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	8	1	0.16	0.16	1	75	EPA MCL	0	37.5	0	R-22 is off-line and will undergo rehabilitation.
Dichloroethene[cis-1,2-]	R-20	P2A	1147.1	n/a	20	1	0.31	0.31	1	70	EPA MCL	0	35	0	Detected once below the PQL.
Diethyl Ether	R-22	MP2A	962.8	n/a	8	1	0.338	0.338	1	7300	EPA Tap	0	3650	0	R-22 is off-line and will undergo rehabilitation.
Dioxane[1,4-]	R-20	P2A	1147.1	n/a	1	1	61.4	61.4	n/a	6.7	EPA Tap	1	3.35	1	Detected once above the EPA tap screening level using EPA Method 8260. This method has been discontinued for this analyte in favor of EPA Method 8270. Not detected using EPA Method 8270 from 2009 to 2011.
Ethylbenzene	R-20	P2A	1147.1	FD	7	1	0.265	0.265	1	700	EPA MCL	0	350	0	Detected once below the PQL.
	R-20	P2A	1147.1	n/a	20	3	0.274	0.28	1	700	EPA MCL	0	350	0	—
Isopropylbenzene	R-20	MP3A	1330	n/a	5	1	0.31	0.31	1	680	EPA Tap	0	340	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P2A	1147.1	FD	7	1	0.252	0.252	1	680	EPA Tap	0	340	0	Detected once below the PQL.
	R-22	MP1A	907.1	n/a	12	6	0.737	1	1	680	EPA Tap	0	340	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	23	1	0.16	0.16	1	680	EPA Tap	0	340	0	R-22 is off-line and will undergo rehabilitation.
	R-32	Single	867.5	n/a	15	2	0.28	0.288	1	680	EPA Tap	0	340	0	—
Methyl Methacrylate	R-20	P1A	904.6	n/a	21	1	1.08	1.08	5	1400	EPA Tap	0	700	0	Detected once below the PQL.
Methyl-2-pentanone[4-]	R-20	P1A	904.6	FD	5	1	2.93	2.93	5	2000	EPA Tap	0	1000	0	Detected once below the PQL.
	R-20	P1A	904.6	n/a	21	3	3.76	5.95	5	2000	EPA Tap	0	1000	0	—
	R-54	P1A	830	n/a	6	1	5.73	5.73	5	2000	EPA Tap	0	1000	0	—
Methylene Chloride	R-22	MP1A	907.1	n/a	12	1	2.2	2.2	10	5	EPA MCL	0	2.5	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	1	0.62	0.62	10	5	EPA MCL	0	2.5	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	18	1	2.38	2.38	10	5	EPA MCL	0	2.5	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	1	4.27	4.27	10	5	EPA MCL	0	2.5	1	Detected once below the PQL.
	R-49	P2A	905.6	n/a	9	1	4.09	4.09	10	5	EPA MCL	0	2.5	1	Detected once below the PQL.
Naphthalene	R-22	MP1A	907.1	n/a	10	1	0.33	0.33	1	30	NM GW STD	0	15	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	21	1	0.656	0.656	1	30	NM GW STD	0	15	0	Detected once below the PQL.
	R-40	P1A	751.6	n/a	8	1	0.746	0.746	1	30	NM GW STD	0	15	0	Detected once below the PQL.
Styrene	R-20	P1A	904.6	n/a	21	1	0.501	0.501	1	100	EPA MCL	0	50	0	Detected once below the PQL.
Toluene	R-20	P1A	904.6	FD	5	2	56.673	113	1	750	NM GW STD	0	375	0	—
	R-20	P1A	904.6	n/a	21	11	26.62	112	1	750	NM GW STD	0	375	0	—
	R-20	P2A	1147.1	FD	7	5	6.1324	29.2	1	750	NM GW STD	0	375	0	—
	R-20	P2A	1147.1	n/a	20	10	16.1793	65.1	1	750	NM GW STD	0	375	0	—
	R-21	Single	888.8	n/a	22	1	0.5	0.5	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-22	MP1A	907.1	n/a	12	2	1.038	1.78	1	750	NM GW STD	0	375	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	8	1	0.2	0.2	1	750	NM GW STD	0	375	0	R-22 is off-line and will undergo rehabilitation.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Toluene (continued)	R-22	MP5A	1448.2	FD	4	2	0.5335	0.79	1	750	NM GW STD	0	375	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	23	13	1.098	6.86	1	750	NM GW STD	0	375	0	R-22 is off-line and will undergo rehabilitation.
	R-23i	P1A	400.3	n/a	14	1	0.564	0.564	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-23i	P2A	470.2	FD	5	1	16	16	1	750	NM GW STD	0	375	0	—
	R-23i	P2A	470.2	n/a	19	1	14.7	14.7	1	750	NM GW STD	0	375	0	—
	R-23i	P3A	524	n/a	16	1	3.52	3.52	1	750	NM GW STD	0	375	0	—
	R-32	Single	867.5	FD	9	3	9.02	23.9	1	750	NM GW STD	0	375	0	—
	R-32	Single	867.5	n/a	15	4	7.7705	23.3	1	750	NM GW STD	0	375	0	—
	R-37	P1A	929.3	n/a	10	1	1.33	1.33	1	750	NM GW STD	0	375	0	—
	R-37	P2A	1026	n/a	9	1	0.42	0.42	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-38	Single	821.2	FD	9	3	3.57	7.06	1	750	NM GW STD	0	375	0	—
	R-38	Single	821.2	n/a	15	7	1.38	1.9	1	750	NM GW STD	0	375	0	—
	R-39	Single	859	FD	6	2	1.2175	2.1	1	750	NM GW STD	0	375	0	—
	R-39	Single	859	n/a	11	1	2.37	2.37	1	750	NM GW STD	0	375	0	—
	R-40	P1A	751.6	n/a	8	3	0.64	0.84	1	750	NM GW STD	0	375	0	—
	R-40	P2A	849.3	FD	4	1	0.27	0.27	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-40	P2A	849.3	n/a	9	2	0.279	0.29	1	750	NM GW STD	0	375	0	—
	R-40	R-40i	649.7	FD	2	2	12.2455	24.2	1	750	NM GW STD	0	375	0	—
	R-40	R-40i	649.7	n/a	7	4	7.349	23.9	1	750	NM GW STD	0	375	0	—
	R-41	P2A	965.3	n/a	10	1	7.5	7.5	1	750	NM GW STD	0	375	0	—
	R-49	P1A	845	n/a	9	1	0.298	0.298	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-49	P2A	905.6	FD	2	1	0.309	0.309	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-49	P2A	905.6	n/a	9	1	0.462	0.462	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-53	P1A	849.2	FD	2	1	0.73	0.73	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-54	P1A	830	n/a	6	1	0.27	0.27	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-55	P1A	860	n/a	3	1	0.27	0.27	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-55i	Single	510	FD	1	1	0.63	0.63	1	750	NM GW STD	0	375	0	Detected once below the PQL.
	R-55i	Single	510	n/a	2	2	1.175	1.72	1	750	NM GW STD	0	375	0	—
	R-56	P1A	945	n/a	3	1	0.81	0.81	1	750	NM GW STD	0	375	0	Detected once below the PQL.
Trichlorobenzene[1,2,3-]	R-23	Single	816	n/a	21	1	0.592	0.592	1	29	EPA Tap	0	14.5	0	Detected once below the PQL.
	R-40	P1A	751.6	n/a	8	1	0.62	0.62	1	29	EPA Tap	0	14.5	0	Detected once below the PQL.
Trichlorobenzene[1,2,4-]	R-40	P1A	751.6	n/a	8	1	0.503	0.503	1	70	EPA MCL	0	35	0	Detected once below the PQL.

Table D-4.2-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Average Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	PQL[a] (µg/L)	Standard[b] (µg/L)	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	Comment
Trichloroethene	R-20	P2A	1147.1	FD	7	6	1.54	3.04	1	5	EPA MCL	0	2.5	1	—
	R-20	P2A	1147.1	n/a	20	14	0.96	3.02	1	5	EPA MCL	0	2.5	2	—
	R-23i	P2A	470.2	FD	5	1	0.297	0.297	1	5	EPA MCL	0	2.5	0	Detected once below the PQL.
	R-23i	P2A	470.2	n/a	19	1	0.285	0.285	1	5	EPA MCL	0	2.5	0	Detected once below the PQL.
	R-40	P1A	751.6	n/a	8	2	0.635	0.81	1	5	EPA MCL	0	2.5	0	—
	R-53	P2A	959.7	n/a	5	1	0.43	0.43	1	5	EPA MCL	0	2.5	0	Detected once below the PQL.
Trimethylbenzene[1,2,4-]	R-20	MP2A	1147.1	FD	2	2	0.345	0.44	1	15	EPA Tap	0	7.5	0	—
	R-23	Single	816	n/a	25	1	0.27	0.27	1	15	EPA Tap	0	7.5	0	Detected once below the PQL.
Xylene[1,2-]	R-20	P2A	1147.1	FD	7	2	0.3795	0.419	1	1200	EPA Tap	0	600	0	—
	R-20	P2A	1147.1	n/a	20	2	0.3715	0.403	1	1200	EPA Tap	0	600	0	—
Xylene[1,3-]+Xylene[1,4-]	R-20	P2A	1147.1	FD	7	6	1.76	3.45	2	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	20	12	1.279	3.51	2	—	—	—	—	—	—
	R-23	Single	816	n/a	21	1	0.28	0.28	2	—	—	—	—	—	Detected once below the PQL.
	R-23i	P3A	524	n/a	16	1	0.289	0.289	2	—	—	—	—	—	Detected once below the PQL.

Source: Attachment D-1.

[a] PQL = Practical quantitation limit (LANL 2010, 109830, section C-4.1).

[b] Standard = Lowest applicable regulatory standard or other type of screening level.

[c] Standard Source = Reference for lowest-applicable water-quality screening level, as prescribed by the Consent Order and implemented as documented in Appendix B of the 2010 IFGMP (LANL 2010, 109830):

- EPA MCL = EPA maximum contaminant level (40 Code of Federal Regulations Part 141).
- EPA TAP SCRN LVL = EPA regional screening level for tapwater June 2011 (EPA 2011, 204336). Available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm).
- NM GW STD = New Mexico Groundwater Human Health Standards (New Mexico Administrative Code 20.6.2).

[d] n/a = Not applicable.

[e] — = None.

[f] FD = Field duplicate.

Table D-4.2-2
Number of Sampling Events for Organic COPCs Detected at Least Twice in the Same Screened Interval

Suite	Analyte	Field QC Type	Single or Dual Screen Wells															Westbay Wells						
			R-20 P1A	R-20 P2A	R-23	R-23i P3A	R-32	R-37 P1A	R-37 P2A	R-38	R-39	R-40 P1A	R-40 P2A	R-40 R-40i	R-52 P1A	R-54 P1A	R-55i	R-20 MP1A	R-20 MP2A	R-22 MP1A	R-22 MP3A	R-22 MP4A	R-22 MP5A	R-32 MP3A
Dioxin/Furan	Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-]	—[a]	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—
Pesticides	DDT[4,4'-]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
	Endosulfan Sulfate	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Endrin Ketone	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SVOA[b]	Benzoic Acid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—
	Bis(2-ethylhexyl)phthalate	FD[c]	—	—	—	—	5	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	2	—	5	2	—	8	—	—	—	—	—	—	—	—	—	—	3	—	—	2
	Diethylphthalate	—	2	—	3	2	—	—	—	—	—	—	—	—	—	3	—	—	2	—	—	—	—	—
	Dioxane[1,4-]	FD	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Naphthalene	FD	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—
VOA[d]	Acetone	FD	—	—	4	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	5	—	4	—	4	—	—	—	—	—	—	—	2	—	2	4	—	2	—	4	3	—
	Benzene	FD	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Butanone[2-]	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
	Chloromethane	FD	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—
	Ethylbenzene	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Isopropylbenzene	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—
	Methyl-2-pentanone[4-]	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Toluene	FD	2	5	—	—	3	—	—	3	2	—	—	2	—	—	—	—	—	—	—	—	2	—
		—	11	10	—	—	4	—	—	7	—	3	2	4	—	—	2	—	—	2	—	—	13	—
	Trichloroethene	FD	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	14	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
	Trimethylbenzene[1,2,4-]	FD	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
	Xylene[1,2-]	FD	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Xylene[1,3-]+Xylene[1,4-]	FD	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		—	—	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Source: Table D-4.2-1 and raw data tables in Attachment D-1.
[a] — = Not applicable.
[b] SVOA = Semivolatiles.
[c] FD = Field duplicate.
[d] VOA = Volatiles.

Table D-4.2-3
Detected and Nondetected Organic Analytes with PQLs Greater than Applicable Regulatory Standards

Suite	Analyte	Units	Standard[a]	Standard Source[b]	PQL[c]
Detected Analytes with PQLs Greater Than Standards					
SVOA[d]	Benzo(a)pyrene	µg/L	0.2	EPA MCL	1
SVOA	Benzo(b)fluoranthene	µg/L	0.29	EPA TAP SCRN LVL	1
SVOA	Bis(2-ethylhexyl)phthalate	µg/L	6	EPA MCL	10
SVOA	Dioxane[1,4-]	µg/L	6.7	EPA TAP SCRN LVL	10
SVOA	Indeno(1,2,3-cd)pyrene	µg/L	0.29	EPA TAP SCRN LVL	1
SVOA	Pentachlorophenol	µg/L	1	EPA MCL	10
SVOA	Phenol	µg/L	5	NM GW STD	10
VOA[e]	Dioxane[1,4-]	µg/L	6.7	EPA TAP SCRN LVL	10
Nondetected Analytes with PQLs Greater Than Standards					
SVOA	Atrazine	µg/L	3	EPA MCL	10
SVOA	Azobenzene	µg/L	1.3	EPA TAP SCRN LVL	10
SVOA	Benzidine	µg/L	0.00094	EPA TAP SCRN LVL	50
SVOA	Benzo(a)anthracene	µg/L	0.29	EPA TAP SCRN LVL	1
SVOA	Benzo(a)pyrene	µg/L	0.2	EPA MCL	1
SVOA	Benzo(b)fluoranthene	µg/L	0.29	EPA TAP SCRN LVL	1
SVOA	Bis(2-chloroethyl)ether	µg/L	0.12	EPA TAP SCRN LVL	10
SVOA	Bis(2-ethylhexyl)phthalate	µg/L	6	EPA MCL	10
SVOA	Chloroaniline[4-]	µg/L	3.4	EPA TAP SCRN LVL	10
SVOA	Dibenz(a,h)anthracene	µg/L	0.029	EPA TAP SCRN LVL	1
SVOA	Dichlorobenzidine[3,3'-]	µg/L	1.5	EPA TAP SCRN LVL	10
SVOA	Dinitro-2-methylphenol[4,6-]	µg/L	2.9	EPA TAP SCRN LVL	10
SVOA	Dinitrotoluene[2,4-]	µg/L	2.2	EPA TAP SCRN LVL	10
SVOA	Dioxane[1,4-]	µg/L	6.7	EPA TAP SCRN LVL	10
SVOA	Hexachlorobenzene	µg/L	1	EPA MCL	10
SVOA	Hexachlorobutadiene	µg/L	8.6	EPA TAP SCRN LVL	10
SVOA	Indeno(1,2,3-cd)pyrene	µg/L	0.29	EPA TAP SCRN LVL	1
SVOA	Nitrobenzene	µg/L	1.2	EPA TAP SCRN LVL	10
SVOA	Nitrosodiethylamine[N-]	µg/L	0.0014	EPA TAP SCRN LVL	10
SVOA	Nitrosodimethylamine[N-]	µg/L	0.0042	EPA TAP SCRN LVL	10
SVOA	Nitroso-di-n-butylamine[N-]	µg/L	0.024	EPA TAP SCRN LVL	10
SVOA	Nitroso-di-n-propylamine[N-]	µg/L	0.096	EPA TAP SCRN LVL	10
SVOA	Nitrosopyrrolidine[N-]	µg/L	0.32	EPA TAP SCRN LVL	10
SVOA	Oxybis(1-chloropropane)[2,2'-]	µg/L	3.2	EPA TAP SCRN LVL	10
SVOA	Pentachlorophenol	µg/L	1	EPA MCL	10
SVOA	Phenol	µg/L	5	NM GW STD	10
VOA	Acrolein	µg/L	0.042	EPA TAP SCRN LVL	5

Table D-4.2-3 (continued)

Suite	Analyte	Units	Standard[a]	Standard Source[b]	PQL[c]
VOA	Acrylonitrile	µg/L	0.45	EPA TAP SCRN LVL	5
VOA	Chloro-1,3-butadiene[2-]	µg/L	0.16	EPA TAP SCRN LVL	1
VOA	Dibromo-3-Chloropropane[1,2-]	µg/L	0.2	EPA MCL	1
VOA	Dibromoethane[1,2-]	µg/L	0.05	EPA MCL	1
VOA	Dioxane[1,4-]	µg/L	6.7	EPA TAP SCRN LVL	10
VOA	Hexachlorobutadiene	µg/L	8.6	EPA TAP SCRN LVL	10
VOA	Methacrylonitrile	µg/L	1	EPA TAP SCRN LVL	5
VOA	Trichloropropane[1,2,3-]	µg/L	0.0072	EPA TAP SCRN LVL	1

Source: Attachment D-1.

[a] Standard = Lowest applicable regulatory standard or other type of screening level.

[b] Standard Source = Reference for lowest-applicable water-quality screening level, as prescribed by the Consent Order and implemented as documented in Appendix B of the 2010 IFGMP (LANL 2010, 109830).

[c] PQL = Practical quantitation limit (LANL 2010, 109830, section C-4.1).

- EPA MCL = EPA maximum contaminant level (40 Code of Federal Regulations Part 141).
- EPA TAP SCRN LVL = EPA regional screening level for tapwater June 2011 (EPA 2011, 204336). Available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm).
- NM GW STD = New Mexico Groundwater Human Health Standards (New Mexico Administrative Code 20.6.2).

[d] SVOA = Semivolatiles.

[e] VOA = Volatiles.

Table D-4.3-1
Statistical Summary of Inorganic Constituents Detected above One-Half Standard or Standard in Groundwater Samples from TA-54 Groundwater Monitoring Network Wells for the Period Extending from Well Development to May 2011

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
General Inorganic Filtered																			
Alkalinity-CO3	R-20	MP1A	904.6	n/a[d]	5	4	mg/L	3.64	6.12	1	—[e]	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	1	mg/L	3.2	3.2	1	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	P1A	904.6	n/a	13	12	mg/L	5.4958	11.9	1	—	—	—	—	—	—	—	—	—
	R-22	MP2A	962.8	n/a	12	1	mg/L	0.73	0.73	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD[f]	1	1	mg/L	2.27	2.27	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	8	8	mg/L	4.1875	8.48	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	mg/L	0.785	0.785	1	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	1	mg/L	1.03	1.03	1	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	4	mg/L	0.9023	1.06	1	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	1	mg/L	1.17	1.17	1	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	19	4	mg/L	1.3455	2.01	1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	8	4	mg/L	2.4075	4.14	1	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	1	mg/L	2.09	2.09	1	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	3	mg/L	8.32	17.7	1	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	1	mg/L	2.13	2.13	1	—	—	—	—	—	—	—	—	—
Alkalinity-CO3+HCO3	R-20	MP1A	904.6	n/a	5	5	mg/L	106.2	134	1	—	—	—	—	—	156.6	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	4	mg/L	232.25	275	1	—	—	—	—	—	156.6	Regional	3	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	93.1	120	1	—	—	—	—	—	156.6	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	65.685	73.8	1	—	—	—	—	—	156.6	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	65.1	66.2	1	—	—	—	—	—	156.6	Regional	0	—
	R-20	P2A	1147.1	n/a	16	16	mg/L	65.05	72.5	1	—	—	—	—	—	156.6	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	56.333	58.4	1	—	—	—	—	—	156.6	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	57.76	85.8	1	—	—	—	—	—	156.6	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	271	342	1	—	—	—	—	—	156.6	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	65.543	84.69	1	—	—	—	—	—	156.6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	108	108	1	—	—	—	—	—	156.6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	12	12	mg/L	116.77	250	1	—	—	—	—	—	156.6	Regional	1	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Alkalinity-CO3+HCO3 (continued)	R-22	MP4A	1378	FD	1	1	mg/L	271	271	1	—	—	—	—	—	156.6	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	mg/L	274	304	1	—	—	—	—	—	156.6	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	214	214	1	—	—	—	—	—	156.6	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	164.6	179	1	—	—	—	—	—	156.6	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	66.008	68.7	1	—	—	—	—	—	156.6	Regional	0	—
	R-23	Single	816	n/a	24	24	mg/L	67.6	85.8	1	—	—	—	—	—	156.6	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	90.9	90.9	1	—	—	—	—	—	52	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	94.686	156	1	—	—	—	—	—	52	Intermediate	14	—
	R-23i	P2A	470.2	FD	2	2	mg/L	81.5	82.1	1	—	—	—	—	—	52	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	82.447	95	1	—	—	—	—	—	52	Intermediate	19	—
	R-23i	P3A	524	FD	2	2	mg/L	77.25	81.7	1	—	—	—	—	—	52	Intermediate	2	—
	R-23i	P3A	524	n/a	19	19	mg/L	75.132	85.9	1	—	—	—	—	—	52	Intermediate	19	—
	R-32	MP1A	870.9	n/a	8	8	mg/L	72.525	79.4	1	—	—	—	—	—	156.6	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	58.567	61.7	1	—	—	—	—	—	156.6	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	5	5	mg/L	70.96	72.5	1	—	—	—	—	—	156.6	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	69.613	72.5	1	—	—	—	—	—	156.6	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	103	103	1	—	—	—	—	—	52	Intermediate	1	—
	R-37	P1A	929.3	n/a	11	11	mg/L	96.309	102	1	—	—	—	—	—	52	Intermediate	11	—
	R-37	P2A	1026	FD	1	1	mg/L	60.4	60.4	1	—	—	—	—	—	156.6	Regional	0	—
	R-37	P2A	1026	n/a	10	10	mg/L	66.87	85.8	1	—	—	—	—	—	156.6	Regional	0	—
	R-38	Single	821.2	FD	4	4	mg/L	61.05	62.3	1	—	—	—	—	—	156.6	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	60.45	62.4	1	—	—	—	—	—	156.6	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	57.4	57.4	1	—	—	—	—	—	156.6	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	59.427	63	1	—	—	—	—	—	156.6	Regional	0	—
	R-40	P1A	751.6	n/a	8	8	mg/L	97.738	105	1	—	—	—	—	—	52	Intermediate	8	—
	R-40	P2A	849.3	FD	2	2	mg/L	60.5	65.5	1	—	—	—	—	—	156.6	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	58.689	75.6	1	—	—	—	—	—	156.6	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	102.89	120	1	—	—	—	—	—	52	Intermediate	7	—
	R-41	P2A	965.3	FD	2	2	mg/L	67.2	69.3	1	—	—	—	—	—	156.6	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	69.79	80.3	1	—	—	—	—	—	156.6	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	70.278	86.9	1	—	—	—	—	—	156.6	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	57.778	59.6	1	—	—	—	—	—	156.6	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	59.95	70	1	—	—	—	—	—	156.6	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Alkalinity-CO3+HCO3 (continued)	R-51	P2A	1031	n/a	6	6	mg/L	71.433	120	1	—	—	—	—	—	156.6	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	64.46	68.4	1	—	—	—	—	—	156.6	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	56.44	57.9	1	—	—	—	—	—	156.6	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	57.4	61.7	1	—	—	—	—	—	156.6	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	56.95	57	1	—	—	—	—	—	156.6	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	56.34	57.5	1	—	—	—	—	—	156.6	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	70.217	87.2	1	—	—	—	—	—	156.6	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	57.667	60.1	1	—	—	—	—	—	156.6	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	89.167	119	1	—	—	—	—	—	156.6	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	73.3	76.7	1	—	—	—	—	—	156.6	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	90.7	91.9	1	—	—	—	—	—	52	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	64.6	66	1	—	—	—	—	—	156.6	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	62.2	65.5	1	—	—	—	—	—	156.6	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	62.8	64.2	1	—	—	—	—	—	156.6	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	63.35	63.7	1	—	—	—	—	—	156.6	Regional	0	—
Alkalinity-HCO3	R-20	MP1A	904.6	n/a	4	4	mg/L	103.63	131	1	—	—	—	—	—	132.3	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	3	3	mg/L	216.33	269	1	—	—	—	—	—	132.3	Regional	2	Before well rehabilitation.
	R-20	MP3A	1330	n/a	4	4	mg/L	97.125	120	1	—	—	—	—	—	132.3	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	n/a	4	4	mg/L	63.175	85.3	1	—	—	—	—	—	132.3	Regional	0	—
	R-23	Single	816	n/a	3	3	mg/L	73.667	85.5	1	—	—	—	—	—	132.3	Regional	0	—
	R-32	MP1A	870.9	n/a	3	3	mg/L	68.233	70.5	1	—	—	—	—	—	132.3	Regional	0	—
	R-32	MP3A	976	n/a	4	4	mg/L	58.375	61.6	1	—	—	—	—	—	132.3	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
Ammonia	R-22	MP1A	907.1	n/a	4	3	mg/L	0.9067	1.06	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	4	1	mg/L	1.01	1.01	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	0.72	0.72	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	4	4	mg/L	1.1375	1.8	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	0.68	0.68	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	4	4	mg/L	0.725	1.1	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Ammonia as Nitrogen	R-20	MP1A	904.6	n/a	5	5	mg/L	0.36	0.482	0.05	—	—	—	—	—	0.05	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	0.6412	0.799	0.05	—	—	—	—	—	0.05	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	0.3576	0.502	0.05	—	—	—	—	—	0.05	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	8	mg/L	0.044	0.058	0.05	—	—	—	—	—	0.05	Regional	4	—
	R-20	P2A	1147.1	FD	3	1	mg/L	0.034	0.034	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-20	P2A	1147.1	n/a	13	6	mg/L	0.0572	0.101	0.05	—	—	—	—	—	0.05	Regional	2	—
	R-21	Single	888.8	n/a	22	2	mg/L	0.1765	0.331	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	0.432	0.531	0.05	—	—	—	—	—	0.05	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	7	1	mg/L	0.021	0.021	0.05	—	—	—	—	—	0.05	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	0.1723	0.275	0.05	—	—	—	—	—	0.05	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	3	2	mg/L	0.15	0.227	0.05	—	—	—	—	—	0.05	Regional	2	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	mg/L	0.017	0.017	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-23	Single	816	n/a	24	1	mg/L	0.05	0.05	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-23i	P1A	400.3	n/a	14	1	mg/L	0.016	0.016	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-23i	P2A	470.2	n/a	18	1	mg/L	0.029	0.029	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-23i	P3A	524	FD	2	1	mg/L	0.041	0.041	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-23i	P3A	524	n/a	16	1	mg/L	0.032	0.032	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-32	MP1A	870.9	n/a	7	1	mg/L	0.08	0.08	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-32	MP3A	976	n/a	9	8	mg/L	0.183	0.401	0.05	—	—	—	—	—	0.05	Regional	7	Screen plugged and abandoned because of residual effects of drilling products.
	R-37	P1A	929.3	n/a	10	4	mg/L	0.0329	0.048	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-38	Single	821.2	FD	4	1	mg/L	0.0746	0.0746	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-38	Single	821.2	n/a	10	1	mg/L	0.0197	0.0197	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-39	Single	859	n/a	11	2	mg/L	0.019	0.022	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-40	P1A	751.6	n/a	7	1	mg/L	0.018	0.018	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-40	P2A	849.3	FD	2	1	mg/L	0.0169	0.0169	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-40	P2A	849.3	n/a	9	1	mg/L	0.046	0.046	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-40	R-40i	649.7	n/a	7	6	mg/L	0.178	0.277	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-41	P2A	965.3	n/a	10	1	mg/L	0.075	0.075	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-49	P1A	845	n/a	9	3	mg/L	0.0533	0.0976	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-49	P2A	905.6	n/a	9	1	mg/L	0.063	0.063	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-51	P1A	914.96	n/a	6	2	mg/L	0.0326	0.0331	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-51	P2A	1031	n/a	6	3	mg/L	0.0366	0.0629	0.05	—	—	—	—	—	0.05	Regional	1	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Ammonia as Nitrogen (continued)	R-52	P1A	1035.2	n/a	5	3	mg/L	0.173	0.45	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-52	P2A	1107	n/a	5	2	mg/L	0.054	0.083	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-53	P1A	849.2	n/a	5	2	mg/L	0.046	0.0729	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-53	P2A	959.7	FD	2	1	mg/L	0.0314	0.0314	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-53	P2A	959.7	n/a	5	3	mg/L	0.0489	0.064	0.05	—	—	—	—	—	0.05	Regional	2	—
	R-54	P1A	830	n/a	6	2	mg/L	0.0405	0.046	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-54	P2A	915	n/a	6	2	mg/L	0.0415	0.067	0.05	—	—	—	—	—	0.05	Regional	1	—
	R-55	P2A	994.4	n/a	3	1	mg/L	0.04	0.04	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-55i	Single	510	n/a	2	1	mg/L	0.0438	0.0438	0.05	—	—	—	—	—	1.5	Intermediate	0	—
	R-56	P2A	1046.6	n/a	3	1	mg/L	0.0261	0.0261	0.05	—	—	—	—	—	0.05	Regional	0	—
	R-57	P1A	910	n/a	2	1	mg/L	0.042	0.042	0.05	—	—	—	—	—	0.05	Regional	0	—
Bromide	R-20	P1A	904.6	n/a	13	1	mg/L	0.102	0.102	0.2	—	—	—	—	—	0.1	Regional	1	—
	R-22	MP3A	1273.5	n/a	13	3	mg/L	0.101	0.166	0.2	—	—	—	—	—	0.1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	2	mg/L	0.101	0.114	0.2	—	—	—	—	—	0.1	Regional	1	—
	R-23	Single	816	n/a	25	5	mg/L	0.1906	0.529	0.2	—	—	—	—	—	0.1	Regional	3	—
	R-23i	P1A	400.3	n/a	14	9	mg/L	0.1283	0.151	0.2	—	—	—	—	—	0.03	Intermediate	9	—
	R-23i	P2A	470.2	n/a	19	5	mg/L	0.0958	0.123	0.2	—	—	—	—	—	0.03	Intermediate	5	—
	R-23i	P3A	524	FD	2	1	mg/L	0.12	0.12	0.2	—	—	—	—	—	0.03	Intermediate	1	—
	R-23i	P3A	524	n/a	16	4	mg/L	0.1078	0.129	0.2	—	—	—	—	—	0.03	Intermediate	4	—
	R-32	MP1A	870.9	n/a	9	1	mg/L	0.201	0.201	0.2	—	—	—	—	—	0.1	Regional	1	—
	R-32	Single	867.5	FD	5	1	mg/L	0.089	0.089	0.2	—	—	—	—	—	0.1	Regional	0	—
	R-32	Single	867.5	n/a	15	4	mg/L	0.0901	0.125	0.2	—	—	—	—	—	0.1	Regional	1	—
	R-37	P1A	929.3	FD	1	1	mg/L	0.0783	0.0783	0.2	—	—	—	—	—	0.03	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	1	mg/L	0.0871	0.0871	0.2	—	—	—	—	—	0.03	Intermediate	1	—
	R-38	Single	821.2	FD	4	1	mg/L	0.105	0.105	0.2	—	—	—	—	—	0.1	Regional	1	—
	R-38	Single	821.2	n/a	10	1	mg/L	0.104	0.104	0.2	—	—	—	—	—	0.1	Regional	1	—
	R-39	Single	859	n/a	11	1	mg/L	0.0981	0.0981	0.2	—	—	—	—	—	0.1	Regional	0	—
	R-40	P1A	751.6	n/a	8	1	mg/L	0.0818	0.0818	0.2	—	—	—	—	—	0.03	Intermediate	1	—
	R-40	R-40i	649.7	n/a	7	1	mg/L	0.078	0.078	0.2	—	—	—	—	—	0.03	Intermediate	1	—
	R-49	P1A	845	n/a	9	1	mg/L	0.0797	0.0797	0.2	—	—	—	—	—	0.1	Regional	0	—
	R-55	P2A	994.4	n/a	3	1	mg/L	0.0855	0.0855	0.2	—	—	—	—	—	0.1	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	0.2445	0.245	0.2	—	—	—	—	—	0.03	Intermediate	2	—
	R-57	P1A	910	n/a	2	1	mg/L	0.0852	0.0852	0.2	—	—	—	—	—	0.1	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Calcium	R-20	MP1A	904.6	n/a	5	5	mg/L	3.792	4.05	0.2	—	—	—	—	—	24.88	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	39.48	43.2	0.2	—	—	—	—	—	24.88	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	14.14	21.4	0.2	—	—	—	—	—	24.88	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	11.431	13.2	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	13.567	14.3	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	13.2	14.9	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	11.667	11.9	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	11.532	12.1	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	59.76	71.7	0.2	—	—	—	—	—	24.88	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	14.35	58.8	0.2	—	—	—	—	—	24.88	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	17.5	17.5	0.2	—	—	—	—	—	24.88	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	19.177	35	0.2	—	—	—	—	—	24.88	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	44.9	44.9	0.2	—	—	—	—	—	24.88	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	mg/L	48.2	61	0.2	—	—	—	—	—	24.88	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	37.5	37.5	0.2	—	—	—	—	—	24.88	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	35.76	37.6	0.2	—	—	—	—	—	24.88	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	16.525	17.4	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-23	Single	816	n/a	25	25	mg/L	16.804	17.9	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	21	21	0.2	—	—	—	—	—	17.31	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	27.936	39.9	0.2	—	—	—	—	—	17.31	Intermediate	14	—
	R-23i	P2A	470.2	FD	2	2	mg/L	20.95	21.7	0.2	—	—	—	—	—	17.31	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	20.732	22.9	0.2	—	—	—	—	—	17.31	Intermediate	19	—
	R-23i	P3A	524	FD	2	2	mg/L	20.3	20.6	0.2	—	—	—	—	—	17.31	Intermediate	2	—
	R-23i	P3A	524	n/a	17	17	mg/L	20.706	21.6	0.2	—	—	—	—	—	17.31	Intermediate	17	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	16.344	16.7	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	11.156	11.9	0.2	—	—	—	—	—	24.88	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	16.067	16.8	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	16.133	17	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	24.5	24.5	0.2	—	—	—	—	—	17.31	Intermediate	1	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Calcium (continued)	R-37	P1A	929.3	n/a	10	10	mg/L	24.55	26.2	0.2	—	—	—	—	—	17.31	Intermediate	10	—
	R-37	P2A	1026	FD	1	1	mg/L	12.1	12.1	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	13.922	20.4	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-38	Single	821.2	FD	4	4	mg/L	12.35	13.1	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	12.48	13.3	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	12.2	12.2	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	12.473	13.3	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	mg/L	20.957	23.9	0.2	—	—	—	—	—	17.31	Intermediate	7	—
	R-40	P2A	849.3	FD	2	2	mg/L	11.25	11.8	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	11.289	12.5	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	18.157	20.1	0.2	—	—	—	—	—	17.31	Intermediate	5	—
	R-41	P2A	965.3	FD	2	2	mg/L	14.45	14.7	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	14.14	15.2	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	12.311	13.4	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	12.156	13	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	11.75	12.6	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	10.8	11.5	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	13.06	14.4	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	11.1	11.5	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	10.62	11.2	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	10.85	11	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	10.8	11.3	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	10.862	13.6	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	11.667	12.5	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	17.333	17.6	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	17.7	18	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	35.45	35.6	0.2	—	—	—	—	—	17.31	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	13.067	13.6	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	12.2	12.7	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	13.05	13.6	0.2	—	—	—	—	—	24.88	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	12.8	12.9	0.2	—	—	—	—	—	24.88	Regional	0	—
Chloride	R-20	MP1A	904.6	n/a	5	5	mg/L	3.922	6.25	0.2	250	NM GW	0	125	0	3.57	Regional	3	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	6.704	7.53	0.2	250	NM GW	0	125	0	3.57	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	1.614	1.94	0.2	250	NM GW	0	125	0	3.57	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	2.4238	3.45	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	1.8933	1.93	0.2	250	NM GW	0	125	0	3.57	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Chloride (continued)	R-20	P2A	1147.1	n/a	13	12	mg/L	1.985	2.3	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	1.8567	1.96	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	1.83	1.98	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	4.894	10.2	0.2	250	NM GW	0	125	0	3.57	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	2.6381	3.1	0.2	250	NM GW	0	125	0	3.57	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	4.39	4.39	0.2	250	NM GW	0	125	0	3.57	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	4.2592	4.81	0.2	250	NM GW	0	125	0	3.57	Regional	12	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	7.51	7.51	0.2	250	NM GW	0	125	0	3.57	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	6	mg/L	7.835	8.3	0.2	250	NM GW	0	125	0	3.57	Regional	6	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	2.69	2.69	0.2	250	NM GW	0	125	0	3.57	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	6	6	mg/L	2.9333	4.2	0.2	250	NM GW	0	125	0	3.57	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	3.4967	3.82	0.2	250	NM GW	0	125	0	3.57	Regional	8	—
	R-23	Single	816	n/a	25	25	mg/L	3.6172	4	0.2	250	NM GW	0	125	0	3.57	Regional	15	—
	R-23i	P1A	400.3	FD	1	1	mg/L	6.97	6.97	0.2	250	NM GW	0	125	0	7.78	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	24.121	36.7	0.2	250	NM GW	0	125	0	7.78	Intermediate	12	—
	R-23i	P2A	470.2	FD	2	2	mg/L	7.315	8.19	0.2	250	NM GW	0	125	0	7.78	Intermediate	1	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	7.6658	8.5	0.2	250	NM GW	0	125	0	7.78	Intermediate	8	—
	R-23i	P3A	524	FD	2	2	mg/L	8.25	8.3	0.2	250	NM GW	0	125	0	7.78	Intermediate	2	—
	R-23i	P3A	524	n/a	16	16	mg/L	8.4594	9.13	0.2	250	NM GW	0	125	0	7.78	Intermediate	16	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	2.9356	3.11	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	2.0356	2.3	0.2	250	NM GW	0	125	0	3.57	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	5	5	mg/L	2.976	3.11	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	2.93	3.12	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	4.75	4.75	0.2	250	NM GW	0	125	0	7.78	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	mg/L	4.437	4.75	0.2	250	NM GW	0	125	0	7.78	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	mg/L	2.23	2.23	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	3.2944	8.49	0.2	250	NM GW	0	125	0	3.57	Regional	2	—
	R-38	Single	821.2	FD	4	4	mg/L	2.4925	2.61	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	2.487	2.8	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	2.2	2.2	0.2	250	NM GW	0	125	0	3.57	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Chloride (continued)	R-39	Single	859	n/a	11	11	mg/L	2.1818	2.3	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-40	P1A	751.6	n/a	8	8	mg/L	2.1775	2.26	0.2	250	NM GW	0	125	0	7.78	Intermediate	0	—
	R-40	P2A	849.3	FD	2	2	mg/L	1.915	2	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	1.9578	2.54	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	2.6943	3.7	0.2	250	NM GW	0	125	0	7.78	Intermediate	0	—
	R-41	P2A	965.3	FD	2	2	mg/L	3.005	3.05	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	3.153	3.75	0.2	250	NM GW	0	125	0	3.57	Regional	2	—
	R-49	P1A	845	n/a	9	9	mg/L	2.7133	2.89	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	2.5811	4.73	0.2	250	NM GW	0	125	0	3.57	Regional	1	—
	R-51	P1A	914.96	n/a	6	6	mg/L	2.09	2.62	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	2.1367	2.8	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	2.486	2.58	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	2.166	2.25	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	1.822	1.94	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	1.8	1.86	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	1.792	1.87	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	1.9333	2.04	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	1.8667	1.98	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	7.9733	16.4	0.2	250	NM GW	0	125	0	3.57	Regional	3	—
	R-55	P2A	994.4	n/a	3	3	mg/L	3.62	3.69	0.2	250	NM GW	0	125	0	3.57	Regional	2	—
	R-55i	Single	510	n/a	2	2	mg/L	16.9	17.2	0.2	250	NM GW	0	125	0	7.78	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	2.3367	2.44	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	2.1767	2.27	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	2.415	2.5	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	2.3	2.35	0.2	250	NM GW	0	125	0	3.57	Regional	0	—
Cyanide (Total)	R-22	MP1A	907.1	n/a	1	1	mg/L	0.0047	0.0047	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	3	1	mg/L	0.0026	0.0026	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-32	MP1A	870.9	n/a	3	1	mg/L	0.0624	0.0624	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	—
Dissolved Organic Carbon	R-20	MP1A	904.6	FD	1	1	mg/L	5.7	5.7	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP1A	904.6	n/a	4	4	mg/L	5.625	7.2	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	FD	2	2	mg/L	7.65	8.5	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	4	mg/L	8.1	9	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	FD	1	1	mg/L	5.5	5.5	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Dissolved Organic Carbon (continued)	R-20	MP3A	1330	n/a	3	3	mg/L	4.6333	5.2	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	FD	2	2	mg/L	0.5	0.6	n/a	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	3	3	mg/L	0.7333	1.1	n/a	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	1	1	mg/L	8.1	8.1	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	1	1	mg/L	6.3	6.3	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	1	1	mg/L	8.4	8.4	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	1	1	mg/L	5.5	5.5	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	1	1	mg/L	0.9	0.9	n/a	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	3	3	mg/L	1.0333	1.1	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	3	3	mg/L	0.5967	0.7	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	4	4	mg/L	0.975	1.2	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Fluoride	R-20	MP1A	904.6	n/a	5	5	mg/L	0.4346	0.534	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	0.6468	0.829	0.1	1.6	NM GW	0	0.8	1	0.57	Regional	3	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	1.0656	1.31	0.1	1.6	NM GW	0	0.8	5	0.57	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	0.3065	0.469	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	0.2477	0.263	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	0.3011	0.512	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	0.2597	0.305	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	0.2859	0.473	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-22	MP1A	907.1	n/a	5	4	mg/L	0.4445	0.62	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	15	mg/L	0.3378	0.46	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	0.481	0.481	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	0.5233	0.67	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	0.61	0.61	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	6	mg/L	0.6512	0.8	0.1	1.6	NM GW	0	0.8	1	0.57	Regional	5	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Fluoride (continued)	R-22	MP5A	1448.2	FD	1	1	mg/L	0.4	0.4	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	6	6	mg/L	0.3597	0.41	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	0.3638	0.51	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-23	Single	816	n/a	25	25	mg/L	0.3692	0.514	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	0.252	0.252	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	0.2357	0.43	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	5	—
	R-23i	P2A	470.2	FD	2	2	mg/L	0.219	0.245	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	1	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	0.2241	0.327	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	7	—
	R-23i	P3A	524	FD	2	2	mg/L	0.218	0.244	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	1	—
	R-23i	P3A	524	n/a	16	16	mg/L	0.2379	0.391	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	8	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	0.3153	0.383	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	0.6586	0.974	0.1	1.6	NM GW	0	0.8	2	0.57	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	5	5	mg/L	0.3534	0.472	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	0.3157	0.458	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	0.56	0.56	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	mg/L	0.5765	0.735	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	10	—
	R-37	P2A	1026	FD	1	1	mg/L	0.254	0.254	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	0.352	0.606	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	2	—
	R-38	Single	821.2	FD	4	4	mg/L	0.295	0.319	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	0.3391	0.507	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	0.237	0.237	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	0.3043	0.465	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-40	P1A	751.6	n/a	8	7	mg/L	0.385	0.534	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	7	—
	R-40	P2A	849.3	FD	2	2	mg/L	0.3545	0.457	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	0.2832	0.465	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	0.4174	1.12	0.1	1.6	NM GW	0	0.8	1	0.23	Intermediate	6	—
	R-41	P2A	965.3	FD	2	2	mg/L	0.3045	0.305	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	0.3486	0.497	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	0.2956	0.485	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	0.2912	0.469	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	0.2333	0.276	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	0.1985	0.217	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	0.263	0.286	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	0.1982	0.213	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Fluoride (continued)	R-53	P1A	849.2	n/a	5	5	mg/L	0.2574	0.278	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	0.2435	0.259	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	0.2322	0.26	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	0.2328	0.271	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	0.23	0.26	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	0.307	0.362	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	0.3437	0.373	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	0.249	0.279	0.1	1.6	NM GW	0	0.8	0	0.23	Intermediate	1	—
	R-56	P1A	945	n/a	3	3	mg/L	0.3233	0.357	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	0.3223	0.333	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	0.319	0.335	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	0.3065	0.311	0.1	1.6	NM GW	0	0.8	0	0.57	Regional	0	—
Hardness	R-20	MP1A	904.6	n/a	1	1	mg/L	11.6	11.6	2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	1	1	mg/L	122	122	2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	1	1	mg/L	38.6	38.6	2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	37.469	43	2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	mg/L	44.533	46.9	2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	43.886	49.2	2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	mg/L	41.267	42.8	2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	21	21	mg/L	41.019	42.5	2	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	1	1	mg/L	267	267	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	12	12	mg/L	47.8	50.1	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	65.9	65.9	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	9	9	mg/L	69.278	74.3	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	1	1	mg/L	119	119	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	1	1	mg/L	114	114	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	58.175	60.8	2	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	21	21	mg/L	58.333	61.3	2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	mg/L	76.4	76.4	2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	110.47	156	2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	mg/L	76.7	79.2	2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	75.374	83.3	2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Hardness (continued)	R-23i	P3A	524	FD	2	2	mg/L	74.65	75.7	2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	17	17	mg/L	75.465	79.2	2	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	5	5	mg/L	61.66	62.4	2	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	5	5	mg/L	40.06	41.5	2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	59.55	63.5	2	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	mg/L	57.82	63.4	2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	mg/L	84.2	84.2	2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	mg/L	84.18	89.4	2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	42.3	42.3	2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	mg/L	48.322	70.1	2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	mg/L	45.55	48.4	2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	mg/L	45.96	48.8	2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	mg/L	44.8	44.8	2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	mg/L	45.473	48.6	2	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	7	7	mg/L	79.171	87.6	2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	mg/L	40.15	42	2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	mg/L	40.611	46.7	2	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	76.843	85.6	2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	mg/L	52.4	53.1	2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	mg/L	51.24	54.8	2	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	mg/L	45.489	48.9	2	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	8	mg/L	44.288	47.4	2	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	mg/L	40.617	42.7	2	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	mg/L	38.833	41.4	2	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	45.04	48.5	2	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	mg/L	39.54	41.1	2	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	mg/L	39.2	41.2	2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	mg/L	39.9	40.6	2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	mg/L	39.8	41.7	2	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	mg/L	44.367	55.7	2	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	mg/L	41.817	43.8	2	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	mg/L	60.5	61.3	2	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	mg/L	62	63.3	2	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	mg/L	126	126	2	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	mg/L	49.7	51.5	2	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	45.167	46.3	2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Hardness (continued)	R-57	P1A	910	n/a	2	2	mg/L	47	48.9	2	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	mg/L	46.15	46.3	2	—	—	—	—	—	—	—	—	—
Magnesium	R-20	MP1A	904.6	n/a	5	5	mg/L	0.5186	0.625	0.3	—	—	—	—	—	4.15	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	3.904	4.31	0.3	—	—	—	—	—	4.15	Regional	1	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	3.83	5.72	0.3	—	—	—	—	—	4.15	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	2.1715	2.42	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	2.5967	2.73	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	2.6521	2.9	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	2.9533	3.16	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	2.9876	3.14	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	16.24	21.3	0.3	—	—	—	—	—	4.15	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	5.29	15.9	0.3	—	—	—	—	—	4.15	Regional	16	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	4.69	4.69	0.3	—	—	—	—	—	4.15	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	5.5808	11	0.3	—	—	—	—	—	4.15	Regional	13	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	12	12	0.3	—	—	—	—	—	4.15	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	mg/L	12.598	15	0.3	—	—	—	—	—	4.15	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	6.67	6.67	0.3	—	—	—	—	—	4.15	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	6.388	7.26	0.3	—	—	—	—	—	4.15	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	4.1092	4.36	0.3	—	—	—	—	—	4.15	Regional	2	—
	R-23	Single	816	n/a	25	25	mg/L	4.1308	4.42	0.3	—	—	—	—	—	4.15	Regional	13	—
	R-23i	P1A	400.3	FD	1	1	mg/L	5.83	5.83	0.3	—	—	—	—	—	6.12	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	9.8643	13.7	0.3	—	—	—	—	—	6.12	Intermediate	13	—
	R-23i	P2A	470.2	FD	2	2	mg/L	5.895	6.05	0.3	—	—	—	—	—	6.12	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	5.7411	6.37	0.3	—	—	—	—	—	6.12	Intermediate	1	—
	R-23i	P3A	524	FD	2	2	mg/L	5.805	5.86	0.3	—	—	—	—	—	6.12	Intermediate	0	—
	R-23i	P3A	524	n/a	17	17	mg/L	5.7724	6.12	0.3	—	—	—	—	—	6.12	Intermediate	1	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	4.9522	5.05	0.3	—	—	—	—	—	4.15	Regional	9	—
	R-32	MP3A	976	n/a	9	9	mg/L	3.23	3.6	0.3	—	—	—	—	—	4.15	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	4.7167	5.24	0.3	—	—	—	—	—	4.15	Regional	6	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Magnesium (continued)	R-32	Single	867.5	n/a	15	15	mg/L	4.7787	5.09	0.3	—	—	—	—	—	4.15	Regional	15	—
	R-37	P1A	929.3	FD	1	1	mg/L	5.61	5.61	0.3	—	—	—	—	—	6.12	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	mg/L	5.555	5.87	0.3	—	—	—	—	—	6.12	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	mg/L	2.93	2.93	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	3.2889	4.67	0.3	—	—	—	—	—	4.15	Regional	2	—
	R-38	Single	821.2	FD	4	4	mg/L	3.585	3.82	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	3.597	3.81	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	3.46	3.46	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	3.4736	3.74	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	mg/L	6.5143	7.19	0.3	—	—	—	—	—	6.12	Intermediate	6	—
	R-40	P2A	849.3	FD	2	2	mg/L	2.91	3.02	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	3.0167	3.76	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	7.6586	8.59	0.3	—	—	—	—	—	6.12	Intermediate	7	—
	R-41	P2A	965.3	FD	2	2	mg/L	3.95	3.98	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	3.864	4.09	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	3.5967	3.77	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	3.3811	3.59	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	2.7333	2.86	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	2.8867	3.15	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	3.012	3.11	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	2.862	2.97	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	3.068	3.19	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	3.135	3.21	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	3.12	3.26	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	4.185	5.3	0.3	—	—	—	—	—	4.15	Regional	3	—
	R-54	P2A	915	n/a	6	6	mg/L	3.075	3.16	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	4.17	4.26	0.3	—	—	—	—	—	4.15	Regional	2	—
	R-55	P2A	994.4	n/a	3	3	mg/L	4.3333	4.44	0.3	—	—	—	—	—	4.15	Regional	3	—
	R-55i	Single	510	n/a	2	2	mg/L	9.125	9.17	0.3	—	—	—	—	—	6.12	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	4.1367	4.24	0.3	—	—	—	—	—	4.15	Regional	2	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	3.5767	3.64	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	3.49	3.62	0.3	—	—	—	—	—	4.15	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	3.44	3.49	0.3	—	—	—	—	—	4.15	Regional	0	—
Nitrate-Nitrite as Nitrogen	R-20	P1A	904.6	n/a	13	8	mg/L	93.632	748	0.25	10	EPA MCL	1	5	1	0.89	Regional	1	The maximum nitrate result of 748 mg/L above the standard is most likely a sample that was improperly preserved with nitric acid instead of the required sulfuric acid.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Nitrate-Nitrite as Nitrogen (continued)	R-20	P2A	1147.1	FD	3	3	mg/L	0.1807	0.196	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-20	P2A	1147.1	n/a	13	11	mg/L	0.1758	0.235	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	0.2813	0.321	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-21	Single	888.8	n/a	25	24	mg/L	0.3192	0.493	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-22	MP1A	907.1	n/a	5	2	mg/L	0.035	0.05	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	0.7234	0.895	0.25	10	EPA MCL	0	5	0	0.89	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	0.364	0.364	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	12	12	mg/L	0.521	0.985	0.25	10	EPA MCL	0	5	0	0.89	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	2	mg/L	0.0368	0.05	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	1	mg/L	0.01	0.01	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	1.2607	1.56	0.25	10	EPA MCL	0	5	0	0.89	Regional	12	—
	R-23	Single	816	n/a	25	25	mg/L	1.1868	1.95	0.25	10	EPA MCL	0	5	0	0.89	Regional	23	—
	R-23i	P1A	400.3	FD	1	1	mg/L	0.086	0.086	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	12	mg/L	0.3208	0.56	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-23i	P2A	470.2	FD	2	2	mg/L	0.7625	0.765	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-23i	P2A	470.2	n/a	18	17	mg/L	0.7139	0.97	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-23i	P3A	524	FD	2	2	mg/L	0.8245	0.929	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-23i	P3A	524	n/a	16	16	mg/L	0.8075	0.93	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-32	MP1A	870.9	n/a	8	8	mg/L	0.7925	0.99	0.25	10	EPA MCL	0	5	0	0.89	Regional	3	—
	R-32	MP3A	976	n/a	7	2	mg/L	0.0355	0.0399	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	5	mg/L	1.1052	1.25	0.25	10	EPA MCL	0	5	0	0.89	Regional	4	—
	R-32	Single	867.5	n/a	15	15	mg/L	0.844	1.16	0.25	10	EPA MCL	0	5	0	0.89	Regional	11	—
	R-37	P1A	929.3	FD	1	1	mg/L	0.476	0.476	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	mg/L	0.5286	0.81	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	mg/L	0.62	0.62	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	0.5972	0.77	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-38	Single	821.2	FD	4	4	mg/L	0.581	0.675	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	0.5856	0.63	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	0.58	0.58	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	0.6116	0.74	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-40	P1A	751.6	n/a	7	4	mg/L	0.1473	0.203	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-40	P2A	849.3	FD	2	2	mg/L	0.377	0.388	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Nitrate-Nitrite as Nitrogen (continued)	R-40	P2A	849.3	n/a	9	8	mg/L	0.3382	0.422	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-40	R-40i	649.7	n/a	7	1	mg/L	0.082	0.082	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	0	—
	R-41	P2A	965.3	FD	2	2	mg/L	0.62	0.675	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	0.5915	0.755	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	0.5481	0.685	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	0.5729	0.76	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	0.3317	0.407	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	0.3915	0.955	0.25	10	EPA MCL	0	5	0	0.89	Regional	1	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	0.5864	0.695	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-52	P2A	1107	n/a	5	4	mg/L	0.3953	0.447	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-53	P1A	849.2	n/a	5	4	mg/L	0.3653	0.471	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	0.293	0.346	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-53	P2A	959.7	n/a	5	4	mg/L	0.3445	0.435	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-54	P1A	830	n/a	6	5	mg/L	0.2756	0.332	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	0.3802	0.457	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	0.6873	0.76	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	0.585	0.7	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	3.855	3.88	0.25	10	EPA MCL	0	5	0	2.41	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	0.732	0.926	0.25	10	EPA MCL	0	5	0	0.89	Regional	1	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	0.6157	0.682	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	0.552	0.605	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	0.596	0.745	0.25	10	EPA MCL	0	5	0	0.89	Regional	0	—
Perchlorate	R-20	P1A	904.6	n/a	13	13	µg/L	0.1542	0.2	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	µg/L	0.155	0.184	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-20	P2A	1147.1	n/a	14	11	µg/L	0.1742	0.226	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-21	Single	888.8	FD	3	3	µg/L	0.278	0.292	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-21	Single	888.8	n/a	21	21	µg/L	0.281	0.317	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-22	MP1A	907.1	FD	2	2	µg/L	0.2585	0.281	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP1A	907.1	n/a	18	15	µg/L	0.2585	0.287	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	14	12	µg/L	0.363	0.399	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	0.282	0.282	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	10	8	µg/L	0.3423	0.394	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	2	2	µg/L	0.26	0.273	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Perchlorate (continued)	R-22	MP5A	1448.2	n/a	32	29	µg/L	0.281	0.319	0.2	4	NM GW	0	2	0	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	0.4424	0.488	0.2	4	NM GW	0	2	0	0.46	Regional	3	—
	R-23	Single	816	n/a	21	21	µg/L	0.4481	0.494	0.2	4	NM GW	0	2	0	0.46	Regional	5	—
	R-23i	P1A	400.3	FD	1	1	µg/L	0.181	0.181	0.2	4	NM GW	0	2	0	0.05	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	13	µg/L	0.2295	0.323	0.2	4	NM GW	0	2	0	0.05	Intermediate	13	—
	R-23i	P2A	470.2	FD	2	2	µg/L	0.2165	0.221	0.2	4	NM GW	0	2	0	0.05	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	19	µg/L	0.2205	0.263	0.2	4	NM GW	0	2	0	0.05	Intermediate	19	—
	R-23i	P3A	524	FD	2	2	µg/L	0.2445	0.259	0.2	4	NM GW	0	2	0	0.05	Intermediate	2	—
	R-23i	P3A	524	n/a	19	19	µg/L	0.2522	0.29	0.2	4	NM GW	0	2	0	0.05	Intermediate	19	
	R-32	MP1A	870.9	n/a	5	5	µg/L	0.3002	0.316	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-32	MP3A	976	n/a	5	1	µg/L	0.0535	0.0535	0.2	4	NM GW	0	2	0	0.46	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	0.3358	0.373	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-32	Single	867.5	n/a	15	15	µg/L	0.3459	0.387	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-37	P1A	929.3	FD	1	1	µg/L	0.514	0.514	0.2	4	NM GW	0	2	0	0.05	Intermediate	1	—
	R-37	P1A	929.3	n/a	11	11	µg/L	0.5215	0.613	0.2	4	NM GW	0	2	0	0.05	Intermediate	11	—
	R-37	P2A	1026	FD	1	1	µg/L	0.347	0.347	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-37	P2A	1026	n/a	10	10	µg/L	0.3892	0.465	0.2	4	NM GW	0	2	0	0.46	Regional	3	—
	R-38	Single	821.2	FD	4	4	µg/L	0.3815	0.397	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-38	Single	821.2	n/a	10	10	µg/L	0.3577	0.387	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-39	Single	859	FD	1	1	µg/L	0.335	0.335	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-39	Single	859	n/a	11	11	µg/L	0.3448	0.379	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-40	P1A	751.6	n/a	8	5	µg/L	0.0793	0.101	0.2	4	NM GW	0	2	0	0.05	Intermediate	5	—
	R-40	P2A	849.3	FD	2	2	µg/L	0.259	0.261	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	µg/L	0.2657	0.293	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-40	R-40i	649.7	n/a	7	1	µg/L	0.142	0.142	0.2	4	NM GW	0	2	0	0.05	Intermediate	1	—
	R-41	P2A	965.3	FD	2	2	µg/L	0.382	0.385	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	µg/L	0.3796	0.421	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-49	P1A	845	n/a	9	9	µg/L	0.3069	0.353	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	µg/L	0.3464	0.367	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	µg/L	0.2785	0.292	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-51	P2A	1031	n/a	6	6	µg/L	0.2868	0.304	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	0.3894	0.441	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-52	P2A	1107	n/a	5	5	µg/L	0.3278	0.344	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	µg/L	0.2626	0.287	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-53	P2A	959.7	FD	2	2	µg/L	0.2875	0.295	0.2	4	NM GW	0	2	0	0.46	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Perchlorate (continued)	R-53	P2A	959.7	n/a	5	5	µg/L	0.2872	0.302	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-54	P1A	830	n/a	6	6	µg/L	0.2085	0.248	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-54	P2A	915	n/a	6	6	µg/L	0.2818	0.304	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	0.4587	0.462	0.2	4	NM GW	0	2	0	0.46	Regional	1	—
	R-55	P2A	994.4	n/a	3	3	µg/L	0.4267	0.436	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	0.9335	0.987	0.2	4	NM GW	0	2	0	0.05	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	µg/L	0.3093	0.347	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	0.3023	0.328	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-57	P1A	910	n/a	2	2	µg/L	0.307	0.341	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	µg/L	0.3035	0.331	0.2	4	NM GW	0	2	0	0.46	Regional	0	—
pH	R-20	MP1A	904.6	n/a	1	1	SU[g]	8.85	8.85	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	1	1	SU	7.63	7.63	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	1	1	SU	6.54	6.54	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	SU	8.5331	8.79	n/a	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	SU	7.9567	8.08	n/a	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	14	14	SU	7.9907	8.11	n/a	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	SU	7.8767	8.07	n/a	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	21	21	SU	8.001	8.15	n/a	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	2	2	SU	6.845	6.9	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	12	12	SU	8.035	8.33	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	SU	8.32	8.32	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	9	9	SU	8.3622	8.69	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	2	2	SU	6.965	7.23	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	SU	7.045	7.29	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	SU	7.9908	8.13	n/a	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	21	21	SU	7.989	8.16	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	SU	8.14	8.14	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	SU	7.8107	8.15	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	SU	8.02	8.07	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	SU	8.1405	8.52	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	SU	8.245	8.25	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	17	17	SU	8.1635	8.35	n/a	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
pH (continued)	R-32	MP1A	870.9	n/a	5	5	SU	8.314	8.61	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	5	5	SU	7.586	8.48	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	SU	7.5733	7.69	n/a	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	SU	7.488	7.69	n/a	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	SU	8.09	8.09	n/a	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	11	11	SU	8.06	8.15	n/a	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	SU	8.06	8.06	n/a	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	10	10	SU	8.065	8.21	n/a	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	SU	7.665	7.76	n/a	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	SU	7.723	7.94	n/a	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	SU	8.1	8.1	n/a	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	SU	7.99	8.2	n/a	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	SU	7.9788	8.48	n/a	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	SU	7.83	7.87	n/a	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	SU	7.89	8.05	n/a	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	SU	7.53	7.66	n/a	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	SU	8.08	8.12	n/a	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	SU	7.829	8.16	n/a	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	SU	8.0356	8.13	n/a	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	SU	8.0244	8.11	n/a	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	SU	8.1917	8.32	n/a	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	SU	8.165	8.28	n/a	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	SU	8.286	8.46	n/a	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	SU	7.942	7.97	n/a	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	SU	7.95	8.03	n/a	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	SU	8.035	8.07	n/a	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	SU	8.038	8.08	n/a	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	SU	7.4717	7.8	n/a	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	SU	8.1483	8.3	n/a	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	SU	8.0667	8.16	n/a	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	SU	8.3033	8.46	n/a	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	SU	7.78	7.78	n/a	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	SU	7.9133	8.01	n/a	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	SU	7.9967	8.02	n/a	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	SU	7.845	8.06	n/a	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	SU	7.855	7.91	n/a	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Orthophosphate	R-22	MP4A	1378	n/a	1	1	mg/L	0.29	0.29	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	1	1	mg/L	0.12	0.12	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
Potassium	R-20	MP1A	904.6	n/a	5	5	mg/L	3.622	3.93	0.15	—	—	—	—	—	2.63	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	3.942	4.17	0.15	—	—	—	—	—	2.63	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	2.61	3.14	0.15	—	—	—	—	—	2.63	Regional	2	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	2.62	2.88	0.15	—	—	—	—	—	2.63	Regional	6	—
	R-20	P2A	1147.1	FD	3	3	mg/L	2.4033	2.5	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	2.3986	2.7	0.15	—	—	—	—	—	2.63	Regional	1	—
	R-21	Single	888.8	FD	3	3	mg/L	1.6767	1.71	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	1.6836	1.81	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	4.168	4.68	0.15	—	—	—	—	—	2.63	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	2.5775	3.99	0.15	—	—	—	—	—	2.63	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	6.85	6.85	0.15	—	—	—	—	—	2.63	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	6.5269	9.7	0.15	—	—	—	—	—	2.63	Regional	13	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	4.75	4.75	0.15	—	—	—	—	—	2.63	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	mg/L	4.83	5.6	0.15	—	—	—	—	—	2.63	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	4.65	4.65	0.15	—	—	—	—	—	2.63	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	4.408	5.27	0.15	—	—	—	—	—	2.63	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	1.7917	1.98	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-23	Single	816	n/a	25	25	mg/L	1.8212	1.98	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	2.43	2.43	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	3.745	5.37	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-23i	P2A	470.2	FD	2	2	mg/L	2.58	2.59	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	2.5495	2.78	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-23i	P3A	524	FD	2	2	mg/L	2.595	2.62	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-23i	P3A	524	n/a	17	17	mg/L	2.57	2.73	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	1.7078	1.86	0.15	—	—	—	—	—	2.63	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Potassium (continued)	R-32	MP3A	976	n/a	9	9	mg/L	1.5856	1.67	0.15	—	—	—	—	—	2.63	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	1.7067	1.85	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	2.154	8.42	0.15	—	—	—	—	—	2.63	Regional	1	—
	R-37	P1A	929.3	FD	1	1	mg/L	1.87	1.87	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	mg/L	1.869	2.11	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	mg/L	1.85	1.85	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	1.8356	2.07	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-38	Single	821.2	FD	4	4	mg/L	1.5475	1.62	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	1.523	1.61	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	1.35	1.35	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	1.4091	1.49	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	mg/L	1.7586	1.98	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-40	P2A	849.3	FD	2	2	mg/L	1.565	1.67	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	1.5311	1.67	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	1.8314	2.1	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-41	P2A	965.3	FD	2	2	mg/L	1.925	2	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	1.861	1.99	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	1.6178	1.9	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	1.4178	1.59	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	1.5083	1.66	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	1.725	1.79	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	1.86	1.9	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	1.71	1.82	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	1.616	1.75	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	1.745	1.79	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	1.724	1.87	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	1.62	2.07	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	1.8167	2.03	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	1.69	1.8	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	1.81	1.84	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	2.32	2.34	0.15	—	—	—	—	—	10.03	Intermediate	0	—
	R-56	P1A	945	n/a	3	3	mg/L	1.72	1.8	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	1.81	1.88	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	1.52	1.58	0.15	—	—	—	—	—	2.63	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	1.51	1.58	0.15	—	—	—	—	—	2.63	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Silicon Dioxide	R-20	MP1A	904.6	n/a	5	5	mg/L	44.34	58.5	0.1	—	—	—	—	—	88.5	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	47.8	64.4	0.1	—	—	—	—	—	88.5	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	51.48	71.1	0.1	—	—	—	—	—	88.5	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	FD	2	2	mg/L	69.95	70.7	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-21	Single	888.8	n/a	10	10	mg/L	59.02	73.5	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	31.767	52.5	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	8	8	mg/L	57.263	71.1	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	44.8	44.8	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	6	6	mg/L	40.717	55.4	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	25.6	25.6	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	36.633	61.6	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	22	22	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	3	3	mg/L	35.933	60.3	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	6	6	mg/L	63.983	65.7	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-23	Single	816	n/a	10	10	mg/L	55.04	64.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	38.8	38.8	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P1A	400.3	n/a	1	1	mg/L	40.2	40.2	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P2A	470.2	FD	1	1	mg/L	43.3	43.3	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P2A	470.2	n/a	4	4	mg/L	41.025	42.5	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P3A	524	FD	1	1	mg/L	43.7	43.7	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P3A	524	n/a	4	4	mg/L	42.75	43.5	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	55.3	66.4	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	72.7	88	0.1	—	—	—	—	—	88.5	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
Sodium	R-20	MP1A	904.6	n/a	5	5	mg/L	55.12	69.6	0.2	—	—	—	—	—	24.5	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	86.64	101	0.2	—	—	—	—	—	24.5	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	21.46	25.2	0.2	—	—	—	—	—	24.5	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	15.969	20.2	0.2	—	—	—	—	—	24.5	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sodium (continued)	R-20	P2A	1147.1	FD	3	3	mg/L	12.233	13.2	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	12.564	14.4	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	10.367	10.7	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	10.173	11	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	23.34	25.9	0.2	—	—	—	—	—	24.5	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	12.013	23.9	0.2	—	—	—	—	—	24.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	21.4	21.4	0.2	—	—	—	—	—	24.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	23.815	54	0.2	—	—	—	—	—	24.5	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	44.9	44.9	0.2	—	—	—	—	—	24.5	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	mg/L	36.64	44.9	0.2	—	—	—	—	—	24.5	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	19	19	0.2	—	—	—	—	—	24.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	17.28	21.7	0.2	—	—	—	—	—	24.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	11.233	12.3	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-23	Single	816	n/a	25	25	mg/L	11.156	12.1	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	16.7	16.7	0.2	—	—	—	—	—	12.19	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	17.486	33.7	0.2	—	—	—	—	—	12.19	Intermediate	14	—
	R-23i	P2A	470.2	FD	2	2	mg/L	13.55	14.2	0.2	—	—	—	—	—	12.19	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	13.6	20.6	0.2	—	—	—	—	—	12.19	Intermediate	14	—
	R-23i	P3A	524	FD	2	2	mg/L	10.55	10.7	0.2	—	—	—	—	—	12.19	Intermediate	0	—
	R-23i	P3A	524	n/a	17	17	mg/L	10.97	12.6	0.2	—	—	—	—	—	12.19	Intermediate	1	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	11.144	11.8	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	10.431	11.2	0.2	—	—	—	—	—	24.5	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	10.767	11.3	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	13.52	51.2	0.2	—	—	—	—	—	24.5	Regional	1	—
	R-37	P1A	929.3	FD	1	1	mg/L	14.7	14.7	0.2	—	—	—	—	—	12.19	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	mg/L	15.51	16.5	0.2	—	—	—	—	—	12.19	Intermediate	10	—
	R-37	P2A	1026	FD	1	1	mg/L	11.6	11.6	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	13.056	15.9	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-38	Single	821.2	FD	4	4	mg/L	10.845	11.4	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	10.8	11.6	0.2	—	—	—	—	—	24.5	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sodium (continued)	R-39	Single	859	FD	1	1	mg/L	11.4	11.4	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	11.091	12.2	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	mg/L	13.371	13.9	0.2	—	—	—	—	—	12.19	Intermediate	7	—
	R-40	P2A	849.3	FD	2	2	mg/L	11.4	12.1	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	11.689	16.3	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	21.2	24.1	0.2	—	—	—	—	—	12.19	Intermediate	7	—
	R-41	P2A	965.3	FD	2	2	mg/L	13.5	13.7	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	15.17	24.2	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	17.422	20.4	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	10.756	13.5	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	12.2	14.8	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	15.033	17.1	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	13.6	15.2	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	11.5	14.1	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	11.12	11.8	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	9.925	10	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	10.48	11.9	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	17.367	19.1	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	10.567	11	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	11.5	11.8	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	12.067	12.6	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	13.15	13.2	0.2	—	—	—	—	—	12.19	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	10.467	10.7	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	11.5	12.4	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	11.2	11.4	0.2	—	—	—	—	—	24.5	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	11.9	12.7	0.2	—	—	—	—	—	24.5	Regional	0	—
Specific Conductance	R-20	MP1A	904.6	n/a	1	1	µS/cm	223	223	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	1	1	µS/cm	500	500	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	1	1	µS/cm	146	146	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µS/cm	145.15	167	n/a	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µS/cm	140.67	144	n/a	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	14	14	µS/cm	140.79	154	n/a	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	µS/cm	125.67	128	n/a	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	21	21	µS/cm	125.95	136	n/a	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	1	1	µS/cm	443	443	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Specific Conductance (continued)	R-22	MP2A	962.8	n/a	12	12	µS/cm	143.83	152	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µS/cm	169	169	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	8	8	µS/cm	214.63	231	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	1	1	µS/cm	303	303	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	1	1	µS/cm	240	240	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µS/cm	169.83	177	n/a	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	21	21	µS/cm	168.1	178	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µS/cm	232	232	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	µS/cm	307.57	452	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µS/cm	208.5	211	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	µS/cm	323.63	2070	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	µS/cm	204	205	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	17	17	µS/cm	211.65	333	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	5	5	µS/cm	165.6	177	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	5	5	µS/cm	125.8	134	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	5	5	µS/cm	164.6	171	n/a	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	µS/cm	167.13	173	n/a	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µS/cm	228	228	n/a	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	11	11	µS/cm	230.27	241	n/a	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µS/cm	135	135	n/a	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	10	10	µS/cm	155	206	n/a	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	µS/cm	142.5	145	n/a	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	µS/cm	140.2	145	n/a	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µS/cm	132	132	n/a	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	µS/cm	137.82	147	n/a	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µS/cm	211.63	230	n/a	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µS/cm	122	122	n/a	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	µS/cm	130.67	165	n/a	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µS/cm	234.29	255	n/a	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µS/cm	167	170	n/a	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µS/cm	169	185	n/a	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	µS/cm	160.89	178	n/a	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Specific Conductance (continued)	R-49	P2A	905.6	n/a	9	9	µS/cm	136.78	144	n/a	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	µS/cm	134.67	147	n/a	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µS/cm	144	150	n/a	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µS/cm	149	157	n/a	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	µS/cm	130.6	140	n/a	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	µS/cm	125.4	129	n/a	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µS/cm	122.5	127	n/a	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	µS/cm	120.6	125	n/a	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µS/cm	159.67	182	n/a	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	µS/cm	126.83	132	n/a	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	µS/cm	172.33	174	n/a	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µS/cm	173	174	n/a	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	µS/cm	308.5	315	n/a	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	µS/cm	144	149	n/a	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µS/cm	139.67	142	n/a	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	µS/cm	139.5	140	n/a	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µS/cm	141.5	142	n/a	—	—	—	—	—	—	—	—	—
Sulfate	R-20	MP1A	904.6	n/a	5	4	mg/L	3.015	3.76	0.4	600	NM GW	0	300	0	7.2	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	1	mg/L	1.04	1.04	0.4	600	NM GW	0	300	0	7.2	Regional	0	Before well rehabilitation.
	R-20	P1A	904.6	n/a	13	13	mg/L	2.6085	3.38	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	1.82	1.84	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	2	2.96	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-21	Single	888.8	FD	3	3	mg/L	2.2067	2.56	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-21	Single	888.8	n/a	25	25	mg/L	2.094	2.5	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-22	MP1A	907.1	n/a	5	3	mg/L	0.3173	0.352	0.4	600	NM GW	0	300	0	7.2	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	mg/L	3.4469	4.21	0.4	600	NM GW	0	300	0	7.2	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	9.09	9.09	0.4	600	NM GW	0	300	0	7.2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	mg/L	12.387	31	0.4	600	NM GW	0	300	0	7.2	Regional	6	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	1.12	1.12	0.4	600	NM GW	0	300	0	7.2	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	4	mg/L	1.1375	2.04	0.4	600	NM GW	0	300	0	7.2	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	0.59	0.59	0.4	600	NM GW	0	300	0	7.2	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	6	3	mg/L	0.5797	0.709	0.4	600	NM GW	0	300	0	7.2	Regional	0	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sulfate (continued)	R-23	Single	816	FD	12	12	mg/L	5.1492	5.54	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-23	Single	816	n/a	25	25	mg/L	5.4008	7.22	0.4	600	NM GW	0	300	0	7.2	Regional	1	—
	R-23i	P1A	400.3	FD	1	1	mg/L	9.02	9.02	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	13.675	27.5	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-23i	P2A	470.2	FD	2	2	mg/L	7.365	7.51	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	8.1953	13.1	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-23i	P3A	524	FD	2	2	mg/L	7.595	7.7	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-23i	P3A	524	n/a	16	16	mg/L	7.5925	8.27	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	5.64	7.29	0.4	600	NM GW	0	300	0	7.2	Regional	1	—
	R-32	MP3A	976	n/a	9	9	mg/L	1.7311	2.4	0.4	600	NM GW	0	300	0	7.2	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	5	5	mg/L	4.988	5.26	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	5.106	5.61	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	9.8	9.8	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	mg/L	9.464	10.3	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	mg/L	2.76	2.76	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-37	P2A	1026	n/a	9	9	mg/L	4.1178	7.86	0.4	600	NM GW	0	300	0	7.2	Regional	1	—
	R-38	Single	821.2	FD	4	4	mg/L	2.9625	3.18	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	2.962	3.15	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	3.18	3.18	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	3.13	3.54	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-40	P1A	751.6	n/a	8	8	mg/L	4.7388	5.69	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-40	P2A	849.3	FD	2	2	mg/L	2.805	3.45	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	3.2044	6.27	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	2.81	8.07	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-41	P2A	965.3	FD	2	2	mg/L	4.615	4.67	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	4.952	6.53	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	5.0589	7.89	0.4	600	NM GW	0	300	0	7.2	Regional	1	—
	R-49	P2A	905.6	n/a	9	9	mg/L	3.8011	7.22	0.4	600	NM GW	0	300	0	7.2	Regional	1	—
	R-51	P1A	914.96	n/a	6	6	mg/L	4.24	7.18	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	5.6383	7	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	4.034	4.52	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	3.352	4.82	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	1.928	2.06	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	1.955	2	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	1.97	2.11	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	2	2.36	0.4	600	NM GW	0	300	0	7.2	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sulfate (continued)	R-54	P2A	915	n/a	6	6	mg/L	2.0283	2.19	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	7.4867	12.4	0.4	600	NM GW	0	300	0	7.2	Regional	1	—
	R-55	P2A	994.4	n/a	3	3	mg/L	4.5	4.8	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	20.7	21.1	0.4	600	NM GW	0	300	0	40.03	Intermediate	0	—
	R-56	P1A	945	n/a	3	3	mg/L	2.9867	3.23	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	3.0367	3.41	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	2.985	3.21	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	3.125	3.56	0.4	600	NM GW	0	300	0	7.2	Regional	0	—
Total Dissolved Solids	R-20	MP1A	904.6	n/a	1	1	mg/L	227	227	n/a	1000	NM GW	0	500	0	191.68	Regional	1	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	1	1	mg/L	578	578	n/a	1000	NM GW	0	500	1	191.68	Regional	1	Before well rehabilitation.
	R-20	MP3A	1330	n/a	1	1	mg/L	208	208	n/a	1000	NM GW	0	500	0	191.68	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	138.77	149	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	150.33	157	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	145.14	156	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-21	Single	888.8	FD	4	4	mg/L	126.5	129	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-21	Single	888.8	n/a	23	23	mg/L	136.35	268	n/a	1000	NM GW	0	500	0	191.68	Regional	1	—
	R-22	MP1A	907.1	n/a	4	4	mg/L	370.5	401	n/a	1000	NM GW	0	500	0	191.68	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	17	17	mg/L	136.12	170	n/a	1000	NM GW	0	500	0	191.68	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	173	173	n/a	1000	NM GW	0	500	0	191.68	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	12	mg/L	158.42	181	n/a	1000	NM GW	0	500	0	191.68	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	4	4	mg/L	270.75	348	n/a	1000	NM GW	0	500	0	191.68	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	3	3	mg/L	220.67	240	n/a	1000	NM GW	0	500	0	191.68	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	14	14	mg/L	347.57	2900	n/a	1000	NM GW	1	500	1	191.68	Regional	1	Maximum result may be an outlier (see text.)
	R-23	Single	816	n/a	23	23	mg/L	145.78	166	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	mg/L	153	153	n/a	1000	NM GW	0	500	0	127	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	210.21	271	n/a	1000	NM GW	0	500	0	127	Intermediate	14	—
	R-23i	P2A	470.2	FD	2	2	mg/L	142.5	146	n/a	1000	NM GW	0	500	0	127	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	148.95	169	n/a	1000	NM GW	0	500	0	127	Intermediate	19	—
	R-23i	P3A	524	FD	2	2	mg/L	144.5	145	n/a	1000	NM GW	0	500	0	127	Intermediate	2	—
	R-23i	P3A	524	n/a	17	17	mg/L	147.47	163	n/a	1000	NM GW	0	500	0	127	Intermediate	17	—
	R-32	MP1A	870.9	n/a	7	7	mg/L	155.14	178	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Dissolved Solids (continued)	R-32	MP3A	976	n/a	7	7	mg/L	148.14	157	n/a	1000	NM GW	0	500	0	191.68	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	5	5	mg/L	144.8	150	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-32	Single	867.5	n/a	15	15	mg/L	146.93	161	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	183	183	n/a	1000	NM GW	0	500	0	127	Intermediate	1	—
	R-37	P1A	929.3	n/a	11	11	mg/L	175.18	187	n/a	1000	NM GW	0	500	0	127	Intermediate	11	—
	R-37	P2A	1026	FD	1	1	mg/L	129	129	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-37	P2A	1026	n/a	10	10	mg/L	140.3	145	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-38	Single	821.2	FD	4	4	mg/L	133.5	147	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	137.7	152	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	115	115	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	133.27	144	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-40	P1A	751.6	n/a	8	8	mg/L	162.88	174	n/a	1000	NM GW	0	500	0	127	Intermediate	8	—
	R-40	P2A	849.3	FD	2	2	mg/L	134	140	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	141.33	158	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	162	191	n/a	1000	NM GW	0	500	0	127	Intermediate	6	—
	R-41	P2A	965.3	FD	2	2	mg/L	150.5	151	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	148.7	167	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	149.78	163	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	148.56	222	n/a	1000	NM GW	0	500	0	191.68	Regional	1	—
	R-51	P1A	914.96	n/a	6	6	mg/L	129.33	139	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	140.5	153	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	139.4	147	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	143.4	170	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	132.4	144	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	141	156	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	131	141	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	148.67	165	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	135.33	146	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	159.67	163	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	151	154	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	218	218	n/a	1000	NM GW	0	500	0	127	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	mg/L	137.33	144	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	138.67	148	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	128.5	137	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	142	157	n/a	1000	NM GW	0	500	0	191.68	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Kjeldahl Nitrogen	R-20	MP1A	904.6	n/a	5	5	mg/L	0.5802	1.01	0.1	—	—	—	—	—	0.1	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	1.145	2.33	0.1	—	—	—	—	—	0.1	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	0.7364	1.8	0.1	—	—	—	—	—	0.1	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	n/a	9	3	mg/L	0.1493	0.344	0.1	—	—	—	—	—	0.1	Regional	1	—
	R-22	MP1A	907.1	n/a	5	5	mg/L	1.1788	1.62	0.1	—	—	—	—	—	0.1	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	8	4	mg/L	0.215	0.28	0.1	—	—	—	—	—	0.1	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	0.91	0.91	0.1	—	—	—	—	—	0.1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	9	8	mg/L	0.6553	1.7	0.1	—	—	—	—	—	0.1	Regional	6	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	1.02	1.02	0.1	—	—	—	—	—	0.1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	4	mg/L	1.5325	2.3	0.1	—	—	—	—	—	0.1	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	1.11	1.11	0.1	—	—	—	—	—	0.1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	1.133	1.9	0.1	—	—	—	—	—	0.1	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	6	1	mg/L	0.01	0.01	0.1	—	—	—	—	—	0.1	Regional	0	—
	R-23	Single	816	n/a	10	6	mg/L	0.2122	0.475	0.1	—	—	—	—	—	0.1	Regional	5	—
	R-32	MP1A	870.9	n/a	7	4	mg/L	0.2565	0.52	0.1	—	—	—	—	—	0.1	Regional	3	—
	R-32	MP3A	976	n/a	9	9	mg/L	0.3732	1.05	0.1	—	—	—	—	—	0.1	Regional	6	Screen plugged and abandoned because of residual effects of drilling products.
Total Organic Carbon	R-22	MP2A	962.8	n/a	1	1	mg/L	0.29	0.29	1	—	—	—	—	—	0.46	Regional	0	R-22 is off-line and will undergo rehabilitation.
Total Phosphate as Phosphorus	R-20	MP1A	904.6	n/a	5	5	mg/L	0.283	0.403	0.05	—	—	—	—	—	0.16	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	0.6418	0.693	0.05	—	—	—	—	—	0.16	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	1.3458	1.94	0.05	—	—	—	—	—	0.16	Regional	4	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	7	mg/L	0.0859	0.249	0.05	—	—	—	—	—	0.16	Regional	1	—
	R-20	P2A	1147.1	n/a	13	5	mg/L	0.6618	2.95	0.05	—	—	—	—	—	0.16	Regional	2	—
	R-21	Single	888.8	n/a	24	7	mg/L	0.1063	0.277	0.05	—	—	—	—	—	0.16	Regional	1	—
	R-22	MP1A	907.1	n/a	3	1	mg/L	0.15	0.15	0.05	—	—	—	—	—	0.16	Regional	0	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Phosphate as Phosphorus (continued)	R-22	MP2A	962.8	n/a	14	4	mg/L	0.103	0.257	0.05	—	—	—	—	—	0.16	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	10	4	mg/L	0.053	0.11	0.05	—	—	—	—	—	0.16	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	1	mg/L	0.14	0.14	0.05	—	—	—	—	—	0.16	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	0.18	0.18	0.05	—	—	—	—	—	0.16	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	3	2	mg/L	0.1	0.18	0.05	—	—	—	—	—	0.16	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	mg/L	0.151	0.151	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-23	Single	816	n/a	25	5	mg/L	0.0804	0.132	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-23i	P1A	400.3	n/a	14	4	mg/L	0.1773	0.434	0.05	—	—	—	—	—	0.08	Intermediate	3	—
	R-23i	P2A	470.2	FD	2	1	mg/L	0.035	0.035	0.05	—	—	—	—	—	0.08	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	6	mg/L	0.1055	0.194	0.05	—	—	—	—	—	0.08	Intermediate	3	—
	R-23i	P3A	524	n/a	14	4	mg/L	0.0523	0.105	0.05	—	—	—	—	—	0.08	Intermediate	1	—
	R-32	MP1A	870.9	n/a	9	2	mg/L	0.0325	0.046	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-32	MP3A	976	n/a	9	9	mg/L	2.0456	3.16	0.05	—	—	—	—	—	0.16	Regional	9	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	1	mg/L	0.032	0.032	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-32	Single	867.5	n/a	15	5	mg/L	0.0892	0.259	0.05	—	—	—	—	—	0.16	Regional	1	—
	R-37	P1A	929.3	n/a	10	2	mg/L	0.0325	0.034	0.05	—	—	—	—	—	0.08	Intermediate	0	—
	R-37	P2A	1026	n/a	9	1	mg/L	0.0381	0.0381	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-38	Single	821.2	FD	4	1	mg/L	0.034	0.034	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-38	Single	821.2	n/a	10	2	mg/L	0.128	0.211	0.05	—	—	—	—	—	0.16	Regional	1	—
	R-39	Single	859	n/a	11	4	mg/L	0.043	0.064	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-40	P1A	751.6	n/a	7	2	mg/L	0.049	0.053	0.05	—	—	—	—	—	0.08	Intermediate	0	—
	R-40	P2A	849.3	n/a	9	1	mg/L	0.029	0.029	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-40	R-40i	649.7	n/a	7	4	mg/L	0.074	0.116	0.05	—	—	—	—	—	0.08	Intermediate	2	—
	R-41	P2A	965.3	n/a	10	3	mg/L	0.0609	0.116	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-49	P1A	845	n/a	9	2	mg/L	0.058	0.065	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-49	P2A	905.6	n/a	9	3	mg/L	0.0543	0.076	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-52	P1A	1035.2	n/a	5	2	mg/L	0.0375	0.044	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-52	P2A	1107	n/a	5	2	mg/L	0.068	0.108	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-53	P1A	849.2	n/a	5	1	mg/L	0.038	0.038	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-54	P1A	830	n/a	6	2	mg/L	0.0415	0.049	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-54	P2A	915	n/a	6	2	mg/L	0.026	0.037	0.05	—	—	—	—	—	0.16	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Phosphate as Phosphorus (continued)	R-55	P1A	860	n/a	3	1	mg/L	0.064	0.064	0.05	—	—	—	—	—	0.16	Regional	0	—
	R-56	P1A	945	n/a	3	1	mg/L	0.033	0.033	0.05	—	—	—	—	—	0.16	Regional	0	—
General Inorganic Not Filtered																			
Alkalinity-CO3	R-22	MP3A	1273.5	n/a	5	5	mg/L	5.03	9.23	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	1	mg/L	0.879	0.879	1	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	2	1	mg/L	0.733	0.733	1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	2	2	mg/L	2.49	3.04	1	—	—	—	—	—	—	—	—	—
Alkalinity-CO3+HCO3	R-21	Single	888.8	FD	1	1	mg/L	58.4	58.4	1	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	2	2	mg/L	58.45	58.5	1	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	190.67	289	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	5	mg/L	65.72	75.7	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	mg/L	131.52	280	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	233.67	248	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	mg/L	141	147	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	mg/L	68.1	68.7	1	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	2	2	mg/L	68.35	68.7	1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	2	2	mg/L	73.05	74	1	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	2	2	mg/L	57.4	58.1	1	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Alkalinity-HCO3	R-22	MP1A	907.1	n/a	3	3	mg/L	190.67	289	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	3	3	mg/L	67.5	75.3	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	3	3	mg/L	148.63	271	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	233	247	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	mg/L	140	146	1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
Ammonia as Nitrogen	R-20	MP1A	904.6	n/a	4	4	mg/L	0.3498	0.451	0.05	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	4	mg/L	0.6565	0.772	0.05	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	4	4	mg/L	0.3695	0.484	0.05	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Ammonia as Nitrogen (continued)	R-22	MP1A	907.1	n/a	2	2	mg/L	0.935	1.05	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	3	1	mg/L	0.021	0.021	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	2	2	mg/L	0.56	0.72	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	mg/L	0.4445	0.54	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	1	mg/L	0.089	0.089	0.05	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	5	2	mg/L	0.0365	0.043	0.05	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	5	1	mg/L	0.105	0.105	0.05	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	6	5	mg/L	0.2232	0.375	0.05	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Calcium	R-20	MP1A	904.6	n/a	5	5	mg/L	3.506	3.93	0.2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	36.52	43.3	0.2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	14.08	20.9	0.2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	11.4	12.8	0.2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	mg/L	13.3	14.3	0.2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	13.162	15	0.2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	mg/L	11.6	11.8	0.2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	25	mg/L	11.58	12.6	0.2	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	mg/L	66.586	74.9	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	19	mg/L	11.179	11.9	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	17.1	17.1	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	16	mg/L	17.103	33	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	43.3	43.3	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	mg/L	42.829	55	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	37.3	37.3	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	mg/L	35.243	39	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	16.558	17	0.2	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	25	mg/L	16.856	17.7	0.2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Calcium (continued)	R-23i	P1A	400.3	FD	1	1	mg/L	21.7	21.7	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	28.107	40.5	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	mg/L	20.55	21.3	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	20.732	23.2	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	mg/L	20.15	20.5	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	16	mg/L	22.025	39.7	0.2	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	16.411	17.2	0.2	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	mg/L	10.978	11.7	0.2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	16.133	16.5	0.2	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	mg/L	16.307	18.4	0.2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	mg/L	25	25	0.2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	mg/L	24.72	26.4	0.2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	11.8	11.8	0.2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	mg/L	14.144	21.4	0.2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	mg/L	12.525	13	0.2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	mg/L	12.62	13.3	0.2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	mg/L	12.4	12.4	0.2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	mg/L	12.764	14.6	0.2	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	mg/L	21.25	24.6	0.2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	mg/L	11.15	11.4	0.2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	mg/L	11.378	12.5	0.2	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	18.143	19.6	0.2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	mg/L	14.65	15.1	0.2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	mg/L	13.956	15.9	0.2	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	mg/L	13.156	15.9	0.2	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	mg/L	12.389	13.9	0.2	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	mg/L	11.8	12.6	0.2	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	mg/L	10.717	11.4	0.2	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	13.22	14.6	0.2	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	mg/L	11.14	11.4	0.2	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	mg/L	10.566	11.2	0.2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	mg/L	10.95	11.2	0.2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	mg/L	10.58	11.3	0.2	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	mg/L	11.352	14.6	0.2	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	mg/L	11.55	12.3	0.2	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	mg/L	17.467	17.8	0.2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Calcium (continued)	R-55	P2A	994.4	n/a	3	3	mg/L	17.6	18.2	0.2	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	mg/L	35	35.8	0.2	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	mg/L	12.633	13.4	0.2	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	12.2	12.5	0.2	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	mg/L	12.9	13.3	0.2	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	mg/L	12.9	13.3	0.2	—	—	—	—	—	—	—	—	—
Chemical Oxygen Demand	R-22	MP3A	1273.5	n/a	1	1	mg/L	3.17	3.17	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	1	1	mg/L	21.5	21.5	n/a	—	—	—	—	—	—	—	—	—
Chloride	R-21	Single	888.8	FD	1	1	mg/L	1.97	1.97	0.2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	2	2	mg/L	1.93	1.98	0.2	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	3.8367	4.1	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	5	mg/L	2.622	2.7	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	mg/L	4.458	4.66	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	8.4233	9.08	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	mg/L	2.915	2.97	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	mg/L	3.715	3.74	0.2	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	2	2	mg/L	3.73	3.76	0.2	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	2	2	mg/L	2.845	2.86	0.2	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	2	2	mg/L	1.95	1.97	0.2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Cyanide (Total)	R-20	MP1A	904.6	n/a	4	1	mg/L	0.0031	0.0031	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	2	mg/L	0.0043	0.0055	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	4	1	mg/L	0.0068	0.0068	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-22	MP1A	907.1	n/a	7	1	mg/L	0.0024	0.0024	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	14	1	mg/L	0.0025	0.0025	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	12	1	mg/L	0.0019	0.0019	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	0.0053	0.0053	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	3	mg/L	0.0057	0.0111	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Cyanide (Total) (continued)	R-23	Single	816	FD	10	1	mg/L	0.004	0.004	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	—
	R-23i	P2A	470.2	n/a	13	1	mg/L	0.0048	0.0048	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	—
	R-23i	P3A	524	FD	2	1	mg/L	0.002	0.002	0.005	0.2	EPA MCL	0	0.1	0	—	—	—	—
Fluoride	R-21	Single	888.8	FD	1	1	mg/L	0.303	0.303	0.1	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	2	2	mg/L	0.2835	0.303	0.1	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	0.3053	0.361	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	5	mg/L	0.288	0.314	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	mg/L	0.4518	0.479	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	0.602	0.628	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	mg/L	0.293	0.302	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	mg/L	0.3765	0.383	0.1	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	2	2	mg/L	0.38	0.388	0.1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	2	2	mg/L	0.3	0.335	0.1	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	2	2	mg/L	0.5555	0.618	0.1	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Hardness	R-20	MP1A	904.6	n/a	1	1	mg/L	11.2	11.2	2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	1	1	mg/L	105	105	2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	1	1	mg/L	37.3	37.3	2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	37.385	41.5	2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	mg/L	43.767	47.4	2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	43.731	50	2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	mg/L	40.367	41.5	2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	21	21	mg/L	41.295	45.2	2	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	4	4	mg/L	264.75	277	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	15	15	mg/L	47.373	50.1	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	64.6	64.6	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	12	12	mg/L	61.192	74.5	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	4	4	mg/L	137	157	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Hardness (continued)	R-22	MP5A	1448.2	n/a	3	3	mg/L	109	111	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	58.217	60	2	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	21	21	mg/L	58.705	61.6	2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	mg/L	79.4	79.4	2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	111.21	159	2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	mg/L	75.3	77.4	2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	75.395	84.5	2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	mg/L	73.8	75.3	2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	16	mg/L	79.981	138	2	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	5	5	mg/L	61.38	64.3	2	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	5	5	mg/L	39.4	39.9	2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	59.35	61	2	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	mg/L	60.613	66.7	2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	mg/L	86.2	86.2	2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	mg/L	84.96	90.9	2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	41.3	41.3	2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	mg/L	49.056	73	2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	mg/L	46.275	48.3	2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	mg/L	46.55	49.4	2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	mg/L	45.8	45.8	2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	mg/L	46.473	52.8	2	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	mg/L	80.038	89.5	2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	mg/L	39.7	40.3	2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	mg/L	41.144	48	2	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	76.871	83.5	2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	mg/L	52.9	54.5	2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	mg/L	50.51	57.4	2	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	mg/L	48.933	60.4	2	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	mg/L	45.1	50.5	2	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	mg/L	40.9	43.7	2	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	mg/L	38.467	41.2	2	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	45.92	49.1	2	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	mg/L	39.68	40.5	2	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	mg/L	39.1	41	2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	mg/L	40.6	41.5	2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Hardness (continued)	R-53	P2A	959.7	n/a	5	5	mg/L	39.04	41.8	2	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	mg/L	46.4	59.7	2	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	mg/L	41.517	43.2	2	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	mg/L	61.167	62.2	2	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	mg/L	61.833	64	2	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	mg/L	124.5	127	2	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	mg/L	46.9	50.9	2	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	45.333	46.8	2	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	mg/L	46.3	47.9	2	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	mg/L	46.45	47.4	2	—	—	—	—	—	—	—	—	—
Magnesium	R-20	MP1A	904.6	n/a	5	5	mg/L	0.467	0.549	0.3	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	3.826	4.32	0.3	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	3.788	5.54	0.3	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	2.1623	2.34	0.3	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	mg/L	2.5767	2.81	0.3	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	2.6446	3.07	0.3	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	mg/L	2.94	3	0.3	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	25	mg/L	3.0024	3.32	0.3	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	mg/L	18.557	21.8	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	19	mg/L	4.6211	5.13	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	4.65	4.65	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	16	mg/L	5.0763	11	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	11.5	11.5	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	mg/L	11.391	14	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	5.82	5.82	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	mg/L	6.0229	6.37	0.3	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	4.1133	4.27	0.3	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	25	mg/L	4.1708	4.63	0.3	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	mg/L	6.14	6.14	0.3	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	9.99	14.1	0.3	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Magnesium (continued)	R-23i	P2A	470.2	FD	2	2	mg/L	5.82	5.9	0.3	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	5.7342	6.44	0.3	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	mg/L	5.715	5.86	0.3	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	16	mg/L	6.07	9.54	0.3	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	4.9644	5.2	0.3	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	mg/L	3.1956	3.39	0.3	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	4.6367	4.84	0.3	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	mg/L	4.832	5.07	0.3	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	mg/L	5.78	5.78	0.3	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	mg/L	5.639	6.05	0.3	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	2.87	2.87	0.3	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	mg/L	3.3444	4.77	0.3	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	mg/L	3.645	3.84	0.3	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	mg/L	3.654	3.95	0.3	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	mg/L	3.59	3.59	0.3	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	mg/L	3.5527	3.99	0.3	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	mg/L	6.555	7.5	0.3	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	mg/L	2.88	2.88	0.3	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	mg/L	3.09	4.08	0.3	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	7.6614	8.38	0.3	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	mg/L	3.975	4.09	0.3	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	mg/L	3.808	4.28	0.3	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	mg/L	3.9067	5.04	0.3	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	mg/L	3.4322	3.83	0.3	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	mg/L	2.7783	2.95	0.3	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	mg/L	2.8467	3.08	0.3	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	3.154	3.52	0.3	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	mg/L	2.884	2.94	0.3	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	mg/L	3.09	3.22	0.3	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	mg/L	3.195	3.27	0.3	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	mg/L	3.062	3.3	0.3	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	mg/L	4.38	5.66	0.3	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	mg/L	3.0817	3.27	0.3	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	mg/L	4.2433	4.36	0.3	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	mg/L	4.3233	4.47	0.3	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	mg/L	8.95	9.09	0.3	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Magnesium (continued)	R-56	P1A	945	n/a	3	3	mg/L	3.7267	4.24	0.3	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	3.5933	3.76	0.3	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	mg/L	3.42	3.53	0.3	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	mg/L	3.46	3.47	0.3	—	—	—	—	—	—	—	—	—
Nitrate-Nitrite as Nitrogen	R-21	Single	888.8	FD	1	1	mg/L	0.301	0.301	0.25	10	EPA MCL	0	5	0	—	—	—	—
	R-21	Single	888.8	n/a	6	6	mg/L	0.3175	0.39	0.25	10	EPA MCL	0	5	0	—	—	—	—
	R-22	MP2A	962.8	n/a	5	5	mg/L	0.686	0.781	0.25	10	EPA MCL	0	5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	mg/L	0.463	0.641	0.25	10	EPA MCL	0	5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	mg/L	1.425	1.47	0.25	10	EPA MCL	0	5	0	—	—	—	—
	R-23	Single	816	n/a	6	6	mg/L	1.0717	1.47	0.25	10	EPA MCL	0	5	0	—	—	—	—
	R-32	MP1A	870.9	n/a	6	6	mg/L	0.6527	1	0.25	10	EPA MCL	0	5	0	—	—	—	—
	R-32	MP3A	976	n/a	3	1	mg/L	0.0304	0.0304	0.25	10	EPA MCL	0	5	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Perchlorate	R-21	Single	888.8	n/a	4	4	µg/L	0.2688	0.299	0.2	4	NM GW	0	2	0	0.05	Regional	4	—
	R-22	MP2A	962.8	n/a	1	1	µg/L	0.317	0.317	0.2	4	NM GW	0	2	0	0.05	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	1	1	µg/L	0.205	0.205	0.2	4	NM GW	0	2	0	0.05	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	4	4	µg/L	0.3318	0.409	0.2	4	NM GW	0	2	0	0.05	Regional	4	—
	R-32	MP1A	870.9	n/a	4	4	µg/L	0.2668	0.315	0.2	4	NM GW	0	2	0	0.05	Regional	4	—
pH	R-21	Single	888.8	FD	1	1	SU	8.08	8.08	n/a	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	2	2	SU	8.005	8.13	n/a	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	3	SU	6.7967	6.99	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	5	SU	7.878	8.09	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	SU	8.62	8.91	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	SU	7.26	7.6	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	SU	7.485	7.52	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	SU	8.01	8.19	n/a	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	2	2	SU	8.055	8.06	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	2	2	SU	8.415	8.51	n/a	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	2	2	SU	7.29	7.31	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Potassium	R-20	MP1A	904.6	n/a	5	5	mg/L	3.544	3.82	0.15	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	3.79	3.98	0.15	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	2.608	3.13	0.15	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	2.5954	2.94	0.15	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	mg/L	2.3967	2.51	0.15	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	2.4092	2.65	0.15	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	mg/L	1.62	1.64	0.15	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	25	mg/L	1.688	1.82	0.15	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	mg/L	4.38	4.66	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	19	mg/L	2.5316	3.2	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	6.85	6.85	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	16	mg/L	6.39	10	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	4.59	4.59	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	mg/L	4.6071	5.7	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	4.53	4.53	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	mg/L	4.4229	5.07	0.15	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	1.8208	2.18	0.15	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	25	mg/L	1.842	2.03	0.15	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	mg/L	2.47	2.47	0.15	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	3.7929	5.51	0.15	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	mg/L	2.58	2.6	0.15	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	2.5821	3.06	0.15	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	mg/L	2.57	2.6	0.15	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	16	mg/L	2.6631	3.95	0.15	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	1.6944	1.76	0.15	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	mg/L	1.5567	1.64	0.15	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	1.6833	1.78	0.15	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	mg/L	1.7187	1.85	0.15	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	mg/L	1.89	1.89	0.15	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Potassium (continued)	R-37	P1A	929.3	n/a	10	10	mg/L	1.891	2.17	0.15	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	1.83	1.83	0.15	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	mg/L	1.87	2.14	0.15	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	mg/L	1.585	1.66	0.15	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	mg/L	1.541	1.64	0.15	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	mg/L	1.4	1.4	0.15	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	mg/L	1.4618	1.9	0.15	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	mg/L	1.77	2.05	0.15	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	mg/L	1.525	1.57	0.15	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	mg/L	1.5656	1.69	0.15	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	1.8671	2.19	0.15	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	mg/L	1.985	2	0.15	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	mg/L	1.7098	2.06	0.15	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	mg/L	1.7844	2.33	0.15	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	mg/L	1.4467	1.66	0.15	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	mg/L	1.525	1.63	0.15	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	mg/L	1.6817	1.78	0.15	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	1.876	1.95	0.15	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	mg/L	1.708	1.83	0.15	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	mg/L	1.612	1.7	0.15	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	mg/L	1.775	1.81	0.15	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	mg/L	1.668	1.77	0.15	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	mg/L	1.805	2.07	0.15	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	mg/L	1.83	2.02	0.15	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	mg/L	1.7033	1.79	0.15	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	mg/L	1.84	1.94	0.15	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	mg/L	2.32	2.4	0.15	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	mg/L	1.55	1.81	0.15	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	1.79	1.98	0.15	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	mg/L	1.465	1.52	0.15	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	mg/L	1.475	1.53	0.15	—	—	—	—	—	—	—	—	—
Silicon Dioxide	R-20	MP1A	904.6	n/a	5	5	mg/L	44.44	56.3	0.1	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	51.26	68.2	0.1	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	50.64	70.2	0.1	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	FD	2	2	mg/L	70.5	70.6	0.1	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	7	7	mg/L	52.443	72.1	0.1	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Silicon Dioxide (continued)	R-22	MP1A	907.1	n/a	6	6	mg/L	42.433	57.2	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	8	8	mg/L	58.55	70.5	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	44.5	44.5	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	7	7	mg/L	37.457	55.6	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	25.9	25.9	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	6	mg/L	49.467	64.2	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	22.3	22.3	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	mg/L	42.64	59.2	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	3	3	mg/L	64.433	66	0.1	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	7	7	mg/L	52.171	65.4	0.1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	7	7	mg/L	54.143	68.1	0.1	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	7	7	mg/L	70	84.3	0.1	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Sodium	R-20	MP1A	904.6	n/a	5	5	mg/L	54.28	65.6	0.2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	mg/L	81.16	99.8	0.2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	mg/L	21.64	25.9	0.2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	mg/L	15.838	20.7	0.2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	mg/L	12.133	13	0.2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	mg/L	12.485	13.9	0.2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	mg/L	9.9033	10.2	0.2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	25	mg/L	10.173	11	0.2	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	mg/L	24.486	26.2	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	19	mg/L	11.179	12.6	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	mg/L	21.5	21.5	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	16	mg/L	23.919	60	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	42.9	42.9	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sodium (continued)	R-22	MP4A	1378	n/a	7	7	mg/L	45.257	55.7	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	18.7	18.7	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	mg/L	17.786	20.7	0.2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	mg/L	11.283	11.8	0.2	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	25	mg/L	11.256	12	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	mg/L	15.4	15.4	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	mg/L	17.336	32.7	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	mg/L	13.7	14	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	mg/L	60.616	903	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	mg/L	10.55	10.9	0.2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	16	mg/L	11.036	13.1	0.2	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	mg/L	11.111	11.6	0.2	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	mg/L	10.45	11.2	0.2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	10.717	11	0.2	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	mg/L	10.913	11.4	0.2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	mg/L	14.7	14.7	0.2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	mg/L	15.59	16.6	0.2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	11.2	11.2	0.2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	mg/L	13.133	16.2	0.2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	mg/L	10.975	11.3	0.2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	mg/L	10.94	11.8	0.2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	mg/L	10.9	10.9	0.2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	mg/L	11.216	14.1	0.2	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	mg/L	13.45	14.7	0.2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	mg/L	10.9	11.5	0.2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	mg/L	11.789	15.8	0.2	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	21.157	23.4	0.2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	mg/L	13.75	13.9	0.2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	mg/L	13.92	18.6	0.2	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	mg/L	17.333	21.1	0.2	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	mg/L	10.976	13.8	0.2	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	mg/L	12.183	14.8	0.2	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	mg/L	14.783	17	0.2	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	13.56	14.4	0.2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sodium (continued)	R-52	P2A	1107	n/a	5	5	mg/L	11.42	13.6	0.2	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	mg/L	11.1	11.6	0.2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	mg/L	10.125	10.3	0.2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	mg/L	10.19	11.5	0.2	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	mg/L	17.367	19.7	0.2	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	mg/L	10.462	10.9	0.2	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	mg/L	11.533	12	0.2	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	mg/L	11.933	12.7	0.2	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	mg/L	12.9	13.2	0.2	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	mg/L	10.41	10.8	0.2	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	mg/L	11.367	11.7	0.2	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	mg/L	11	11.2	0.2	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	mg/L	11.95	12.6	0.2	—	—	—	—	—	—	—	—	—
Specific Conductance	R-21	Single	888.8	FD	1	1	µS/cm	123	123	n/a	—	—	—	—	—	287.21	Regional	0	—
	R-21	Single	888.8	n/a	2	2	µS/cm	125	126	n/a	—	—	—	—	—	287.21	Regional	0	—
	R-22	MP1A	907.1	n/a	3	3	µS/cm	562	627	n/a	—	—	—	—	—	287.21	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	5	µS/cm	143.4	150	n/a	—	—	—	—	—	287.21	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	µS/cm	209.6	224	n/a	—	—	—	—	—	287.21	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	µS/cm	445.67	478	n/a	—	—	—	—	—	287.21	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	µS/cm	287	306	n/a	—	—	—	—	—	287.21	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	µS/cm	169.5	171	n/a	—	—	—	—	—	287.21	Regional	0	—
	R-23	Single	816	n/a	2	2	µS/cm	170	170	n/a	—	—	—	—	—	287.21	Regional	0	—
	R-32	MP1A	870.9	n/a	2	2	µS/cm	195	219	n/a	—	—	—	—	—	287.21	Regional	0	—
	R-32	MP3A	976	n/a	2	2	µS/cm	128	130	n/a	—	—	—	—	—	287.21	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
Sulfate	R-21	Single	888.8	FD	1	1	mg/L	2.51	2.51	0.4	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	2	2	mg/L	2.36	2.54	0.4	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	2	mg/L	0.408	0.428	0.4	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	5	mg/L	3.37	3.51	0.4	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	5	5	mg/L	6.55	7.53	0.4	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Sulfate (continued)	R-22	MP4A	1378	n/a	3	3	mg/L	1.38	1.67	0.4	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	mg/L	0.5775	0.688	0.4	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	2	2	mg/L	5.41	5.47	0.4	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	2	2	mg/L	5.43	5.49	0.4	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	2	2	mg/L	4.88	5	0.4	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	2	2	mg/L	1.455	1.61	0.4	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Suspended Sediment Concentration	R-20	MP1A	904.6	n/a	1	1	mg/L	8	8	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	1	1	mg/L	1.2	1.2	n/a	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	1	1	mg/L	4	4	n/a	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-22	MP1A	907.1	n/a	2	2	mg/L	40.85	47	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	3	1	mg/L	1.6	1.6	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	3	1	mg/L	0.4	0.4	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	2	2	mg/L	7.75	11.5	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	1	1	mg/L	1.03	1.03	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	1	1	mg/L	7.2	7.2	n/a	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	1	1	mg/L	1000	1000	n/a	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	1	1	mg/L	2.4	2.4	n/a	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	2	2	mg/L	4.6	4.8	n/a	—	—	—	—	—	—	—	—	—
Total Kjeldahl Nitrogen	R-20	MP1A	904.6	n/a	4	4	mg/L	0.5665	0.729	0.1	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	4	mg/L	1.5135	3.55	0.1	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	4	4	mg/L	1.2913	3.54	0.1	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	14	3	mg/L	0.0403	0.057	0.1	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	14	2	mg/L	0.109	0.182	0.1	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	23	5	mg/L	0.135	0.425	0.1	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	0.3447	0.483	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	7	4	mg/L	0.1655	0.283	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	24	6	mg/L	0.2053	0.596	0.1	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Kjeldahl Nitrogen (continued)	R-23i	P1A	400.3	FD	1	1	mg/L	0.175	0.175	0.1	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	1	mg/L	0.111	0.111	0.1	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	18	2	mg/L	0.077	0.08	0.1	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	15	2	mg/L	0.054	0.054	0.1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	8	3	mg/L	1.4457	3.98	0.1	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	8	7	mg/L	0.4321	1.2	0.1	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	n/a	15	1	mg/L	0.031	0.031	0.1	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	11	1	mg/L	0.045	0.045	0.1	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	1	mg/L	2.51	2.51	0.1	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	6	2	mg/L	0.1075	0.173	0.1	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	1	mg/L	0.062	0.062	0.1	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	5	mg/L	0.1838	0.34	0.1	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	1	mg/L	0.035	0.035	0.1	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	3	mg/L	0.2987	0.747	0.1	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	1	mg/L	0.033	0.033	0.1	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	2	mg/L	0.0625	0.079	0.1	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	1	mg/L	0.16	0.16	0.1	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	1	mg/L	0.048	0.048	0.1	—	—	—	—	—	—	—	—	—
Total Organic Carbon	R-20	MP1A	904.6	FD	1	1	mg/L	16.2	16.2	1	—	—	—	—	—	0.33	Regional	1	Before well rehabilitation.
	R-20	MP1A	904.6	n/a	4	4	mg/L	19.15	32.4	1	—	—	—	—	—	0.33	Regional	4	Before well rehabilitation.
	R-20	MP2A	1147.1	FD	2	2	mg/L	38.15	39.4	1	—	—	—	—	—	0.33	Regional	2	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	4	mg/L	42.85	51.7	1	—	—	—	—	—	0.33	Regional	4	Before well rehabilitation.
	R-20	MP3A	1330	FD	1	1	mg/L	5.02	5.02	1	—	—	—	—	—	0.33	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	MP3A	1330	n/a	4	4	mg/L	3.4725	5.13	1	—	—	—	—	—	0.33	Regional	4	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	12	11	mg/L	1.1706	3.51	1	—	—	—	—	—	0.33	Regional	11	—
	R-20	P2A	1147.1	FD	3	3	mg/L	2.1767	2.23	1	—	—	—	—	—	0.33	Regional	3	—
	R-20	P2A	1147.1	n/a	12	10	mg/L	1.956	2.53	1	—	—	—	—	—	0.33	Regional	10	—
	R-21	Single	888.8	FD	4	1	mg/L	0.431	0.431	1	—	—	—	—	—	0.33	Regional	1	—
	R-21	Single	888.8	n/a	24	15	mg/L	0.5659	0.792	1	—	—	—	—	—	0.33	Regional	15	—
	R-22	MP1A	907.1	n/a	6	6	mg/L	7.5017	11	1	—	—	—	—	—	0.33	Regional	6	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	17	11	mg/L	0.5047	0.885	1	—	—	—	—	—	0.33	Regional	8	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Organic Carbon (continued)	R-22	MP3A	1273.5	n/a	13	12	mg/L	1.6674	4.11	1	—	—	—	—	—	0.33	Regional	11	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	mg/L	18	18	1	—	—	—	—	—	0.33	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	6	mg/L	18.5	23	1	—	—	—	—	—	0.33	Regional	6	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	mg/L	4.98	4.98	1	—	—	—	—	—	0.33	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	6	6	mg/L	5.69	13	1	—	—	—	—	—	0.33	Regional	6	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	9	mg/L	1.1248	2.44	1	—	—	—	—	—	0.33	Regional	9	—
	R-23	Single	816	n/a	23	18	mg/L	1.1202	2.62	1	—	—	—	—	—	0.33	Regional	18	—
	R-23i	P1A	400.3	FD	1	1	mg/L	1.58	1.58	1	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	13	13	mg/L	1.0176	2.01	1	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	1	mg/L	0.853	0.853	1	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	18	16	mg/L	1.0334	1.71	1	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	1	mg/L	0.762	0.762	1	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	15	13	mg/L	0.9438	1.72	1	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	7	5	mg/L	0.4374	0.495	1	—	—	—	—	—	0.33	Regional	5	—
	R-32	MP3A	976	n/a	7	6	mg/L	0.6457	0.757	1	—	—	—	—	—	0.33	Regional	6	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	mg/L	1.891	4.87	1	—	—	—	—	—	0.33	Regional	6	—
	R-32	Single	867.5	n/a	14	14	mg/L	1.3045	4.3	1	—	—	—	—	—	0.33	Regional	14	—
	R-37	P1A	929.3	FD	1	1	mg/L	0.841	0.841	1	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	mg/L	0.8778	1.31	1	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	mg/L	0.784	0.784	1	—	—	—	—	—	0.33	Regional	1	—
	R-37	P2A	1026	n/a	9	6	mg/L	0.5222	0.771	1	—	—	—	—	—	0.33	Regional	6	—
	R-38	Single	821.2	FD	4	4	mg/L	0.59	0.703	1	—	—	—	—	—	0.33	Regional	4	—
	R-38	Single	821.2	n/a	10	10	mg/L	0.7243	1.44	1	—	—	—	—	—	0.33	Regional	10	—
	R-39	Single	859	n/a	10	5	mg/L	0.4868	0.724	1	—	—	—	—	—	0.33	Regional	5	—
	R-40	P1A	751.6	n/a	6	6	mg/L	2.0735	3.24	1	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	1	mg/L	0.539	0.539	1	—	—	—	—	—	0.33	Regional	1	—
	R-40	P2A	849.3	n/a	8	8	mg/L	0.6664	1.6	1	—	—	—	—	—	0.33	Regional	8	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	11.954	14.7	1	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	9	4	mg/L	0.6123	0.895	1	—	—	—	—	—	0.33	Regional	4	—
	R-49	P1A	845	n/a	8	8	mg/L	1.3626	3.54	1	—	—	—	—	—	0.33	Regional	8	—
	R-49	P2A	905.6	n/a	8	3	mg/L	0.665	0.738	1	—	—	—	—	—	0.33	Regional	3	—
	R-51	P1A	914.96	n/a	6	5	mg/L	0.488	0.702	1	—	—	—	—	—	0.33	Regional	5	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Total Organic Carbon (continued)	R-51	P2A	1031	n/a	6	6	mg/L	0.6232	0.953	1	—	—	—	—	—	0.33	Regional	6	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	0.7656	1.52	1	—	—	—	—	—	0.33	Regional	5	—
	R-52	P2A	1107	n/a	5	4	mg/L	0.4628	0.586	1	—	—	—	—	—	0.33	Regional	4	—
	R-53	P1A	849.2	n/a	5	5	mg/L	0.5424	0.847	1	—	—	—	—	—	0.33	Regional	5	—
	R-53	P2A	959.7	FD	2	1	mg/L	0.366	0.366	1	—	—	—	—	—	0.33	Regional	1	—
	R-53	P2A	959.7	n/a	5	2	mg/L	0.557	0.746	1	—	—	—	—	—	0.33	Regional	2	—
	R-54	P1A	830	n/a	6	6	mg/L	2.1873	7.02	1	—	—	—	—	—	0.33	Regional	6	—
	R-54	P2A	915	n/a	6	6	mg/L	0.6097	0.961	1	—	—	—	—	—	0.33	Regional	6	—
	R-55	P1A	860	n/a	3	3	mg/L	0.8397	1.11	1	—	—	—	—	—	0.33	Regional	3	—
	R-55	P2A	994.4	n/a	3	1	mg/L	0.464	0.464	1	—	—	—	—	—	0.33	Regional	1	—
	R-55i	Single	510	n/a	2	2	mg/L	2.51	2.64	1	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	mg/L	0.885	1.44	1	—	—	—	—	—	0.33	Regional	3	—
	R-56	P2A	1046.6	n/a	3	2	mg/L	0.653	0.933	1	—	—	—	—	—	0.33	Regional	2	—
	R-57	P1A	910	n/a	2	2	mg/L	0.5825	0.693	1	—	—	—	—	—	0.33	Regional	2	—
	R-57	P2A	971.5	n/a	2	2	mg/L	0.445	0.537	1	—	—	—	—	—	0.33	Regional	2	—
Total Phosphate as Phosphorus	R-20	MP1A	904.6	n/a	4	4	mg/L	0.2783	0.316	0.05	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	4	mg/L	0.807	0.823	0.05	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	4	4	mg/L	1.9125	2.08	0.05	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	n/a	6	2	mg/L	0.067	0.121	0.05	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	3	3	mg/L	0.1723	0.233	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	5	2	mg/L	0.028	0.037	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	3	3	mg/L	0.1477	0.157	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	1	mg/L	0.03	0.03	0.05	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-32	MP1A	870.9	n/a	6	1	mg/L	0.061	0.061	0.05	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	6	6	mg/L	1.9967	2.86	0.05	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
Total Suspended Solids	R-22	MP1A	907.1	n/a	2	2	mg/L	51.8	53.6	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	2	2	mg/L	7.4	8.4	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	1	1	mg/L	3.4	3.4	n/a	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23i	P2A	470.2	FD	1	1	mg/L	6	6	n/a	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Filtered Metals																			
Aluminum	R-20	MP1A	904.6	n/a	5	3	µg/L	49.067	64.9	200	5000	NM GW	0	2500	0	68	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	1	µg/L	28.4	28.4	200	5000	NM GW	0	2500	0	68	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	34.58	75.6	200	5000	NM GW	0	2500	0	68	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P2A	1147.1	n/a	14	1	µg/L	70.4	70.4	200	5000	NM GW	0	2500	0	68	Regional	1	—
	R-22	MP5A	1448.2	n/a	5	1	µg/L	175	175	200	5000	NM GW	0	2500	0	68	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	24	3	µg/L	79.333	168	200	5000	NM GW	0	2500	0	68	Regional	1	—
	R-23i	P3A	524	n/a	17	1	µg/L	173	173	200	5000	NM GW	0	2500	0	1065.84	Intermediate	0	—
	R-32	MP1A	870.9	n/a	7	1	µg/L	15.6	15.6	200	5000	NM GW	0	2500	0	68	Regional	0	—
	R-32	Single	867.5	n/a	15	1	µg/L	6850	6850	200	5000	NM GW	1	2500	1	68	Regional	1	The reanalysis of the one detected result exceeding the NM GW standard was not detected. The 6850 µg/L result is therefore suspect.
	R-37	P1A	929.3	n/a	10	1	µg/L	89.6	89.6	200	5000	NM GW	0	2500	0	1065.84	Intermediate	0	—
	R-40	R-40i	649.7	n/a	7	1	µg/L	76.1	76.1	200	5000	NM GW	0	2500	0	1065.84	Intermediate	0	—
	R-41	P2A	965.3	n/a	10	2	µg/L	350	537	200	5000	NM GW	0	2500	0	68	Regional	2	—
	R-49	P1A	845	n/a	9	1	µg/L	331	331	200	5000	NM GW	0	2500	0	68	Regional	1	—
	R-51	P2A	1031	n/a	6	1	µg/L	283	283	200	5000	NM GW	0	2500	0	68	Regional	1	—
	R-53	P1A	849.2	n/a	5	1	µg/L	109	109	200	5000	NM GW	0	2500	0	68	Regional	1	—
	R-54	P1A	830	n/a	6	1	µg/L	87.3	87.3	200	5000	NM GW	0	2500	0	68	Regional	1	—
	R-57	P1A	910	n/a	2	1	µg/L	201	201	200	5000	NM GW	0	2500	0	68	Regional	1	—
Antimony	R-22	MP3A	1273.5	n/a	13	1	µg/L	1.29	1.29	2	6	EPA MCL	0	3	0	1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	1	µg/L	0.22	0.22	2	6	EPA MCL	0	3	0	1	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	1	µg/L	0.48	0.48	2	6	EPA MCL	0	3	0	1	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-38	Single	821.2	n/a	10	4	µg/L	0.7095	0.823	2	6	EPA MCL	0	3	0	1	Regional	0	—
	R-40	P1A	751.6	n/a	7	5	µg/L	4.49	9.26	2	6	EPA MCL	2	3	3	0.5	Intermediate	5	The 2 results above the EPA MCL were collected on 10/20/2010. There were not results above the MCL before this sampling event, or after this sampling event.
	R-53	P1A	849.2	n/a	5	1	µg/L	0.56	0.56	2	6	EPA MCL	0	3	0	1	Regional	0	—
Arsenic	R-20	MP1A	904.6	n/a	5	2	µg/L	5.515	5.6	5	10	EPA MCL	0	5	2	10	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	1	µg/L	2.96	2.96	5	10	EPA MCL	0	5	0	10	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	9.21	10.6	5	10	EPA MCL	1	5	4	10	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Arsenic (continued)	R-20	P1A	904.6	n/a	13	3	µg/L	2.2267	3.32	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-21	Single	888.8	n/a	25	7	µg/L	2.3086	3.63	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-22	MP3A	1273.5	n/a	13	4	µg/L	2.325	3.4	5	10	EPA MCL	0	5	0	10	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	3	µg/L	2.4667	3.6	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-23	Single	816	n/a	25	4	µg/L	3.4475	6.79	5	10	EPA MCL	0	5	1	10	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	µg/L	4.5	4.5	5	10	EPA MCL	0	5	0	4.32	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	3	µg/L	3.4933	4.7	5	10	EPA MCL	0	5	0	4.32	Intermediate	1	—
	R-23i	P2A	470.2	n/a	19	5	µg/L	2.176	2.7	5	10	EPA MCL	0	5	0	4.32	Intermediate	0	—
	R-23i	P3A	524	FD	2	1	µg/L	1.8	1.8	5	10	EPA MCL	0	5	0	4.32	Intermediate	0	—
	R-23i	P3A	524	n/a	17	5	µg/L	2.488	5.36	5	10	EPA MCL	0	5	1	4.32	Intermediate	1	—
	R-32	MP3A	976	n/a	9	3	µg/L	3.5	6.7	5	10	EPA MCL	0	5	1	10	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	n/a	15	1	µg/L	1.77	1.77	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-37	P1A	929.3	n/a	10	4	µg/L	2.25	3.15	5	10	EPA MCL	0	5	0	4.32	Intermediate	0	—
	R-37	P2A	1026	n/a	9	2	µg/L	2.255	2.28	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-38	Single	821.2	FD	4	1	µg/L	3.08	3.08	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-38	Single	821.2	n/a	10	1	µg/L	2.7	2.7	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-39	Single	859	n/a	11	1	µg/L	1.86	1.86	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-40	P1A	751.6	n/a	7	2	µg/L	2.935	3.38	5	10	EPA MCL	0	5	0	4.32	Intermediate	0	—
	R-40	R-40i	649.7	n/a	7	3	µg/L	2.85	3.75	5	10	EPA MCL	0	5	0	4.32	Intermediate	0	—
	R-49	P1A	845	n/a	9	4	µg/L	2.3875	3.45	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-49	P2A	905.6	n/a	9	1	µg/L	4.89	4.89	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-51	P1A	914.96	n/a	6	1	µg/L	1.67	1.67	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-51	P2A	1031	n/a	6	1	µg/L	2.41	2.41	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-52	P1A	1035.2	n/a	5	2	µg/L	2.385	2.59	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-52	P2A	1107	n/a	5	1	µg/L	2.35	2.35	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-53	P1A	849.2	n/a	5	1	µg/L	3.19	3.19	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-54	P1A	830	n/a	6	2	µg/L	2.81	2.83	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-54	P2A	915	n/a	6	2	µg/L	2.525	3.01	5	10	EPA MCL	0	5	0	10	Regional	0	—
	R-55i	Single	510	n/a	2	1	µg/L	2.11	2.11	5	10	EPA MCL	0	5	0	4.32	Intermediate	0	—
Barium	R-20	MP1A	904.6	n/a	5	5	µg/L	26.34	31.4	5	1000	NM GW	0	500	0	56.83	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	220.2	253	5	1000	NM GW	0	500	0	56.83	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	91.26	108	5	1000	NM GW	0	500	0	56.83	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µg/L	76.7	92.7	5	1000	NM GW	0	500	0	56.83	Regional	13	—
	R-20	P2A	1147.1	FD	3	3	µg/L	182	188	5	1000	NM GW	0	500	0	56.83	Regional	3	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Barium (continued)	R-20	P2A	1147.1	n/a	14	14	µg/L	157.71	202	5	1000	NM GW	0	500	0	56.83	Regional	14	—
	R-21	Single	888.8	FD	3	3	µg/L	13.8	14	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-21	Single	888.8	n/a	25	25	µg/L	14	15.6	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	µg/L	171.8	198	5	1000	NM GW	0	500	0	56.83	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	14	µg/L	25.464	171	5	1000	NM GW	0	500	0	56.83	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	150	150	5	1000	NM GW	0	500	0	56.83	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	12	µg/L	143.2	175	5	1000	NM GW	0	500	0	56.83	Regional	12	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	314	314	5	1000	NM GW	0	500	0	56.83	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	µg/L	319.2	360	5	1000	NM GW	0	500	0	56.83	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	142	142	5	1000	NM GW	0	500	0	56.83	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	µg/L	130.8	144	5	1000	NM GW	0	500	0	56.83	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	22.542	26.8	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-23	Single	816	n/a	25	25	µg/L	24.016	37.8	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	µg/L	9.2	9.2	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	14	µg/L	51.364	77.6	5	1000	NM GW	0	500	0	71.83	Intermediate	1	—
	R-23i	P2A	470.2	FD	2	2	µg/L	7.805	8.5	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	19	µg/L	8.5958	12.2	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-23i	P3A	524	FD	2	2	µg/L	8.935	9.6	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-23i	P3A	524	n/a	17	17	µg/L	9.4041	17.5	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	9	µg/L	63.367	85.4	5	1000	NM GW	0	500	0	56.83	Regional	5	—
	R-32	MP3A	976	n/a	9	9	µg/L	81.711	93.4	5	1000	NM GW	0	500	0	56.83	Regional	9	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	45.517	49	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-32	Single	867.5	n/a	15	15	µg/L	44.38	64.7	5	1000	NM GW	0	500	0	56.83	Regional	1	—
	R-37	P1A	929.3	FD	1	1	µg/L	9.05	9.05	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	µg/L	13.512	30.8	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	µg/L	30.4	30.4	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-37	P2A	1026	n/a	9	9	µg/L	31.144	35.8	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-38	Single	821.2	FD	4	4	µg/L	29.4	30.7	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-38	Single	821.2	n/a	10	10	µg/L	30.13	33	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-39	Single	859	FD	1	1	µg/L	16.2	16.2	5	1000	NM GW	0	500	0	56.83	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Barium (continued)	R-39	Single	859	n/a	11	11	µg/L	15.982	18.2	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	µg/L	31.5	37.8	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-40	P2A	849.3	FD	2	2	µg/L	23.3	25	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	µg/L	24.322	31.3	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	25.229	29.8	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-41	P2A	965.3	FD	2	2	µg/L	28.9	29.6	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	µg/L	31.29	47	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-49	P1A	845	n/a	9	9	µg/L	28.756	42.4	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	µg/L	22.678	36	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	µg/L	25.167	28.7	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-51	P2A	1031	n/a	6	6	µg/L	20.75	24.2	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	28.92	30.3	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-52	P2A	1107	n/a	5	5	µg/L	27.6	29.8	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	µg/L	25.4	30	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-53	P2A	959.7	FD	2	2	µg/L	28.75	28.8	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	µg/L	28.56	29.5	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-54	P1A	830	n/a	6	6	µg/L	12.733	14.3	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-54	P2A	915	n/a	6	6	µg/L	11.812	19.9	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	35.3	36.1	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	µg/L	30.7	32.1	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	44.25	51	5	1000	NM GW	0	500	0	71.83	Intermediate	0	—
	R-56	P1A	945	n/a	3	3	µg/L	31.833	32.5	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	27.367	30	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-57	P1A	910	n/a	2	2	µg/L	17.1	17.4	5	1000	NM GW	0	500	0	56.83	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	µg/L	19.75	20	5	1000	NM GW	0	500	0	56.83	Regional	0	—
Beryllium	R-20	MP3A	1330	n/a	5	1	µg/L	3.9	3.9	0.5	4	EPA MCL	0	2	1	1	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-22	MP3A	1273.5	n/a	13	1	µg/L	1.63	1.63	0.5	4	EPA MCL	0	2	0	1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	1	µg/L	1.6	1.6	0.5	4	EPA MCL	0	2	0	1	Regional	1	—
	R-38	Single	821.2	FD	4	1	µg/L	1.53	1.53	0.5	4	EPA MCL	0	2	0	1	Regional	1	—
Boron	R-20	MP1A	904.6	n/a	5	4	µg/L	40.175	59.4	50	750	NM GW	0	375	0	38.77	Regional	1	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	88.94	97.1	50	750	NM GW	0	375	0	38.77	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	34.65	38.1	50	750	NM GW	0	375	0	38.77	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	8	µg/L	15.65	20	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-20	P2A	1147.1	FD	3	1	µg/L	20.5	20.5	50	750	NM GW	0	375	0	38.77	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Boron (continued)	R-20	P2A	1147.1	n/a	14	6	µg/L	19.3	29.3	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-21	Single	888.8	FD	3	2	µg/L	12.65	13	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-21	Single	888.8	n/a	25	12	µg/L	14.083	22.8	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-22	MP1A	907.1	n/a	5	1	µg/L	30.9	30.9	50	750	NM GW	0	375	0	38.77	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	9	µg/L	12.278	14.4	50	750	NM GW	0	375	0	38.77	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	30.3	30.3	50	750	NM GW	0	375	0	38.77	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	9	µg/L	23.989	46	50	750	NM GW	0	375	0	38.77	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	95.7	95.7	50	750	NM GW	0	375	0	38.77	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	3	µg/L	95.067	97.3	50	750	NM GW	0	375	0	38.77	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	1	µg/L	34.4	34.4	50	750	NM GW	0	375	0	38.77	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	7	µg/L	13.5	15.6	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-23	Single	816	n/a	25	18	µg/L	14.708	18.7	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	µg/L	17.1	17.1	50	750	NM GW	0	375	0	15.12	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	9	µg/L	15.978	21.2	50	750	NM GW	0	375	0	15.12	Intermediate	6	—
	R-23i	P2A	470.2	FD	2	2	µg/L	17.35	18.3	50	750	NM GW	0	375	0	15.12	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	15	µg/L	17.153	23.6	50	750	NM GW	0	375	0	15.12	Intermediate	14	—
	R-23i	P3A	524	FD	2	1	µg/L	15.2	15.2	50	750	NM GW	0	375	0	15.12	Intermediate	1	—
	R-23i	P3A	524	n/a	17	14	µg/L	16.807	20	50	750	NM GW	0	375	0	15.12	Intermediate	11	—
	R-32	MP1A	870.9	n/a	9	6	µg/L	12.87	15.4	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-32	MP3A	976	n/a	9	8	µg/L	14.45	16.4	50	750	NM GW	0	375	0	38.77	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	4	µg/L	15.775	18.5	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-32	Single	867.5	n/a	15	6	µg/L	24.783	64.4	50	750	NM GW	0	375	0	38.77	Regional	1	—
	R-37	P1A	929.3	FD	1	1	µg/L	30.6	30.6	50	750	NM GW	0	375	0	15.12	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	µg/L	28.06	34	50	750	NM GW	0	375	0	15.12	Intermediate	10	—
	R-37	P2A	1026	n/a	9	4	µg/L	16.275	21.6	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-39	Single	859	n/a	11	1	µg/L	15.1	15.1	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	µg/L	18.086	21.2	50	750	NM GW	0	375	0	15.12	Intermediate	7	—
	R-40	R-40i	649.7	n/a	7	6	µg/L	18.083	20.3	50	750	NM GW	0	375	0	15.12	Intermediate	6	—
	R-41	P2A	965.3	FD	2	1	µg/L	15.2	15.2	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-41	P2A	965.3	n/a	10	6	µg/L	19.483	24.7	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-49	P1A	845	n/a	9	7	µg/L	19.014	34.8	50	750	NM GW	0	375	0	38.77	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Boron (continued)	R-49	P2A	905.6	n/a	9	1	µg/L	11.4	11.4	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-51	P1A	914.96	n/a	6	2	µg/L	17.2	18.2	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-51	P2A	1031	n/a	6	1	µg/L	16.3	16.3	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-52	P1A	1035.2	n/a	5	2	µg/L	16.95	17.5	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-52	P2A	1107	n/a	5	1	µg/L	17.1	17.1	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-54	P1A	830	n/a	6	4	µg/L	16.675	19	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-54	P2A	915	n/a	6	1	µg/L	15.9	15.9	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	19.7	21.1	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	µg/L	20.433	21.4	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	17.7	18.6	50	750	NM GW	0	375	0	15.12	Intermediate	2	—
	R-56	P1A	945	n/a	3	1	µg/L	15	15	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	16.1	16.1	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-57	P1A	910	n/a	2	1	µg/L	15.8	15.8	50	750	NM GW	0	375	0	38.77	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	µg/L	17.7	20	50	750	NM GW	0	375	0	38.77	Regional	0	—
Cadmium	R-22	MP3A	1273.5	n/a	13	1	µg/L	1.18	1.18	1	5	EPA MCL	0	2.5	0	1	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-32	MP1A	870.9	n/a	9	1	µg/L	0.06	0.06	1	5	EPA MCL	0	2.5	0	1	Regional	0	—
Chromium	R-20	MP1A	904.6	n/a	5	1	µg/L	0.63	0.63	5	50	NM GW	0	25	0	5.75	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	2	µg/L	0.805	0.85	5	50	NM GW	0	25	0	5.75	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	1.82	3.7	5	50	NM GW	0	25	0	5.75	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	4	µg/L	3.1825	4.5	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-20	P2A	1147.1	FD	3	2	µg/L	3.21	3.73	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-20	P2A	1147.1	n/a	14	8	µg/L	3.02	3.85	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-21	Single	888.8	FD	3	2	µg/L	2.15	2.7	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-21	Single	888.8	n/a	25	17	µg/L	3.4882	6.45	5	50	NM GW	0	25	0	5.75	Regional	1	—
	R-22	MP1A	907.1	n/a	5	1	µg/L	1.8	1.8	5	50	NM GW	0	25	0	5.75	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	9	µg/L	3.0556	3.9	5	50	NM GW	0	25	0	5.75	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	2.3	2.3	5	50	NM GW	0	25	0	5.75	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	7	µg/L	4.1429	7	5	50	NM GW	0	25	0	5.75	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	5.88	5.88	5	50	NM GW	0	25	0	5.75	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	10	µg/L	2.966	4.66	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-23	Single	816	n/a	25	18	µg/L	2.8161	5.11	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	µg/L	1.2	1.2	5	50	NM GW	0	25	0	1	Intermediate	1	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Chromium (continued)	R-23i	P1A	400.3	n/a	14	3	µg/L	2.7267	4.28	5	50	NM GW	0	25	0	1	Intermediate	3	—
	R-23i	P2A	470.2	n/a	19	5	µg/L	3.07	3.9	5	50	NM GW	0	25	0	1	Intermediate	5	—
	R-23i	P3A	524	FD	2	2	µg/L	2.765	4.43	5	50	NM GW	0	25	0	1	Intermediate	2	—
	R-23i	P3A	524	n/a	17	7	µg/L	2.9043	4.39	5	50	NM GW	0	25	0	1	Intermediate	7	—
	R-32	MP1A	870.9	n/a	9	1	µg/L	1.9	1.9	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-32	MP3A	976	n/a	9	2	µg/L	1.85	2.4	5	50	NM GW	0	25	0	5.75	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	3	µg/L	2.5667	3.5	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-32	Single	867.5	n/a	14	3	µg/L	3.97	5.18	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-37	P1A	929.3	n/a	10	2	µg/L	3.08	3.14	5	50	NM GW	0	25	0	1	Intermediate	2	—
	R-37	P2A	1026	FD	1	1	µg/L	3.54	3.54	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-37	P2A	1026	n/a	9	6	µg/L	3.3183	4.36	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-38	Single	821.2	FD	4	2	µg/L	3.845	4.48	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-38	Single	821.2	n/a	10	6	µg/L	4.7333	6.77	5	50	NM GW	0	25	0	5.75	Regional	1	—
	R-39	Single	859	FD	1	1	µg/L	2.54	2.54	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-39	Single	859	n/a	11	7	µg/L	3.4157	4.33	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-40	P1A	751.6	n/a	7	1	µg/L	4.05	4.05	5	50	NM GW	0	25	0	1	Intermediate	1	—
	R-40	P2A	849.3	n/a	9	4	µg/L	3.47	5	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-40	R-40i	649.7	n/a	7	2	µg/L	2.765	3.63	5	50	NM GW	0	25	0	1	Intermediate	2	—
	R-41	P2A	965.3	FD	2	2	µg/L	4.66	5.35	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-41	P2A	965.3	n/a	11	7	µg/L	3.5757	5.7	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-49	P1A	845	n/a	9	6	µg/L	3.0867	4.17	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-49	P2A	905.6	n/a	9	7	µg/L	3.2129	4.58	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-51	P1A	914.96	n/a	6	3	µg/L	3.9	5.2	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-51	P2A	1031	n/a	6	5	µg/L	3.564	4.37	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-52	P1A	1035.2	n/a	5	4	µg/L	3.6775	4.82	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-52	P2A	1107	n/a	5	3	µg/L	4.5333	5.66	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-53	P1A	849.2	n/a	5	2	µg/L	2.93	3.79	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-53	P2A	959.7	FD	2	1	µg/L	2.61	2.61	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-53	P2A	959.7	n/a	5	3	µg/L	3.38	5.23	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-54	P1A	830	n/a	6	2	µg/L	7.045	11.1	5	50	NM GW	0	25	0	5.75	Regional	1	—
	R-54	P2A	915	n/a	6	3	µg/L	3.75	4.15	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-55	P1A	860	n/a	3	1	µg/L	2.76	2.76	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-55	P2A	994.4	n/a	3	2	µg/L	4.25	6.47	5	50	NM GW	0	25	0	5.75	Regional	1	—
	R-55i	Single	510	n/a	2	1	µg/L	3.81	3.81	5	50	NM GW	0	25	0	1	Intermediate	1	—
	R-56	P1A	945	n/a	3	1	µg/L	2.05	2.05	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	4.83	4.83	5	50	NM GW	0	25	0	5.75	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Chromium (continued)	R-57	P1A	910	n/a	2	1	µg/L	4.55	4.55	5	50	NM GW	0	25	0	5.75	Regional	0	—
	R-57	P2A	971.5	n/a	2	1	µg/L	3.86	3.86	5	50	NM GW	0	25	0	5.75	Regional	0	—
Chromium hexavalent ion	R-23i	P2A	470.2	FD	1	1	µg/L	0.3	0.3	10	50	NM GW	0	25	0	—	—	—	—
	R-23i	P2A	470.2	n/a	1	1	µg/L	0.3	0.3	10	50	NM GW	0	25	0	—	—	—	—
	R-23i	P3A	524	n/a	1	1	µg/L	0.7	0.7	10	50	NM GW	0	25	0	—	—	—	—
Cobalt	R-20	MP1A	904.6	n/a	5	1	µg/L	3.3	3.3	5	50	NM GW	0	25	0	0.5	Regional	1	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	2	µg/L	3.9	4	5	50	NM GW	0	25	0	0.5	Regional	2	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P2A	1147.1	n/a	14	1	µg/L	1	1	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-21	Single	888.8	n/a	25	1	µg/L	5.7	5.7	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-22	MP2A	962.8	n/a	16	1	µg/L	2.7	2.7	5	50	NM GW	0	25	0	0.5	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	1	µg/L	1.6	1.6	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	1.1	1.1	5	50	NM GW	0	25	0	0.5	Intermediate	1	—
	R-23i	P3A	524	n/a	17	1	µg/L	1.05	1.05	5	50	NM GW	0	25	0	0.5	Intermediate	1	—
	R-32	MP1A	870.9	n/a	9	4	µg/L	2.2625	3.9	5	50	NM GW	0	25	0	0.5	Regional	4	—
	R-32	MP3A	976	n/a	9	5	µg/L	2.678	4.05	5	50	NM GW	0	25	0	0.5	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	n/a	15	1	µg/L	2.17	2.17	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-37	P1A	929.3	n/a	10	1	µg/L	1.17	1.17	5	50	NM GW	0	25	0	0.5	Intermediate	1	—
	R-38	Single	821.2	FD	4	1	µg/L	1.12	1.12	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-38	Single	821.2	n/a	10	3	µg/L	1.4867	2.14	5	50	NM GW	0	25	0	0.5	Regional	3	—
	R-40	P1A	751.6	n/a	7	2	µg/L	1.94	2.69	5	50	NM GW	0	25	0	0.5	Intermediate	2	—
	R-40	P2A	849.3	n/a	9	1	µg/L	1.01	1.01	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-40	R-40i	649.7	n/a	7	1	µg/L	1.01	1.01	5	50	NM GW	0	25	0	0.5	Intermediate	1	—
	R-41	P2A	965.3	n/a	10	2	µg/L	1.43	1.59	5	50	NM GW	0	25	0	0.5	Regional	2	—
	R-49	P1A	845	n/a	9	1	µg/L	1.24	1.24	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-49	P2A	905.6	n/a	9	1	µg/L	1.02	1.02	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-52	P1A	1035.2	n/a	5	1	µg/L	1.03	1.03	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-52	P2A	1107	n/a	5	1	µg/L	1.62	1.62	5	50	NM GW	0	25	0	0.5	Regional	1	—
	R-54	P1A	830	n/a	6	5	µg/L	2.044	3.08	5	50	NM GW	0	25	0	0.5	Regional	5	—
	R-55i	Single	510	n/a	2	1	µg/L	1.26	1.26	5	50	NM GW	0	25	0	0.5	Intermediate	1	—
Copper	R-20	MP2A	1147.1	n/a	5	1	µg/L	2.8	2.8	10	1000	NM GW	0	500	0	3	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	1	µg/L	15.6	15.6	10	1000	NM GW	0	500	0	3	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	n/a	24	1	µg/L	7.57	7.57	10	1000	NM GW	0	500	0	3	Regional	1	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Copper (continued)	R-23	Single	816	FD	11	1	µg/L	27.4	27.4	10	1000	NM GW	0	500	0	3	Regional	1	—
	R-32	MP1A	870.9	n/a	5	1	µg/L	1.4	1.4	10	1000	NM GW	0	500	0	3	Regional	0	—
	R-32	MP3A	976	n/a	7	1	µg/L	2.95	2.95	10	1000	NM GW	0	500	0	3	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	n/a	15	1	µg/L	3.58	3.58	10	1000	NM GW	0	500	0	3	Regional	1	—
	R-37	P1A	929.3	n/a	10	1	µg/L	8.28	8.28	10	1000	NM GW	0	500	0	5.32	Intermediate	1	—
	R-39	Single	859	n/a	11	1	µg/L	4	4	10	1000	NM GW	0	500	0	3	Regional	1	—
	R-40	P1A	751.6	n/a	7	2	µg/L	3.32	3.33	10	1000	NM GW	0	500	0	5.32	Intermediate	0	—
	R-40	R-40i	649.7	n/a	7	2	µg/L	11.85	14	10	1000	NM GW	0	500	0	5.32	Intermediate	2	—
Iron	R-20	MP1A	904.6	n/a	5	4	µg/L	115.48	123	100	1000	NM GW	0	500	0	21	Regional	4	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	245.4	495	100	1000	NM GW	0	500	0	21	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	7116	9450	100	1000	NM GW	5	500	5	21	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	3	µg/L	73.567	120	100	1000	NM GW	0	500	0	21	Regional	3	—
	R-20	P2A	1147.1	FD	3	2	µg/L	35.2	35.7	100	1000	NM GW	0	500	0	21	Regional	2	—
	R-20	P2A	1147.1	n/a	14	9	µg/L	51.411	103	100	1000	NM GW	0	500	0	21	Regional	9	—
	R-21	Single	888.8	FD	3	1	µg/L	27.9	27.9	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-21	Single	888.8	n/a	25	8	µg/L	25.275	36.7	100	1000	NM GW	0	500	0	21	Regional	5	—
	R-22	MP1A	907.1	n/a	7	7	µg/L	10447	14900	100	1000	NM GW	7	500	7	21	Regional	7	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	1	µg/L	7840	7840	100	1000	NM GW	1	500	1	21	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	22.7	22.7	100	1000	NM GW	0	500	0	21	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	3	µg/L	91.7	200	100	1000	NM GW	0	500	0	21	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	2390	2390	100	1000	NM GW	1	500	1	21	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	µg/L	3445.4	5700	100	1000	NM GW	4	500	5	21	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	2200	2200	100	1000	NM GW	1	500	1	21	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	µg/L	2042.7	4300	100	1000	NM GW	4	500	4	21	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	3	µg/L	47.5	74	100	1000	NM GW	0	500	0	21	Regional	3	—
	R-23	Single	816	n/a	25	3	µg/L	71.333	169	100	1000	NM GW	0	500	0	21	Regional	2	—
	R-23i	P1A	400.3	FD	1	1	µg/L	26.5	26.5	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	72	72	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-23i	P2A	470.2	FD	2	1	µg/L	24.2	24.2	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Iron (continued)	R-23i	P2A	470.2	n/a	19	5	µg/L	67.22	116	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-23i	P3A	524	FD	2	1	µg/L	55.6	55.6	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-23i	P3A	524	n/a	17	3	µg/L	118.67	211	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	3	µg/L	55.6	121	100	1000	NM GW	0	500	0	21	Regional	2	—
	R-32	MP3A	976	n/a	9	9	µg/L	658.33	1070	100	1000	NM GW	2	500	6	21	Regional	9	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	3	µg/L	87.733	143	100	1000	NM GW	0	500	0	21	Regional	3	—
	R-32	Single	867.5	n/a	15	5	µg/L	833.58	3850	100	1000	NM GW	1	500	1	21	Regional	5	The result above the NM groundwater standard is suspect because the unfiltered sample taken at the same time was nondetect.
	R-37	P1A	929.3	n/a	10	2	µg/L	35.45	37.9	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-38	Single	821.2	n/a	10	1	µg/L	107	107	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-40	P1A	751.6	n/a	7	5	µg/L	71.18	201	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-40	P2A	849.3	n/a	9	2	µg/L	92.2	140	100	1000	NM GW	0	500	0	21	Regional	2	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	1094.4	1420	100	1000	NM GW	5	500	6	839.99	Intermediate	6	Results above the NM groundwater standard may be attributed to reducing condition at this screen (see text).
	R-41	P2A	965.3	n/a	10	2	µg/L	73.05	116	100	1000	NM GW	0	500	0	21	Regional	2	—
	R-49	P1A	845	n/a	9	1	µg/L	78.5	78.5	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-51	P2A	1031	n/a	6	3	µg/L	118.5	271	100	1000	NM GW	0	500	0	21	Regional	3	—
	R-52	P2A	1107	n/a	5	1	µg/L	68.1	68.1	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-54	P1A	830	n/a	6	6	µg/L	1548	3850	100	1000	NM GW	3	500	4	21	Regional	6	Iron was detected above the NM groundwater standard in 3 of the 6 samples at this screen.
	R-55	P1A	860	n/a	3	1	µg/L	36.1	36.1	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-55	P2A	994.4	n/a	3	1	µg/L	35.4	35.4	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-55i	Single	510	n/a	2	2	µg/L	256.65	431	100	1000	NM GW	0	500	0	839.99	Intermediate	0	—
	R-56	P2A	1046.6	n/a	3	2	µg/L	58.55	69.3	100	1000	NM GW	0	500	0	21	Regional	2	—
	R-57	P1A	910	n/a	2	1	µg/L	54	54	100	1000	NM GW	0	500	0	21	Regional	1	—
	R-57	P2A	971.5	n/a	2	1	µg/L	35.8	35.8	100	1000	NM GW	0	500	0	21	Regional	1	—
Lead	R-20	MP1A	904.6	n/a	5	4	µg/L	0.6725	0.84	2	15	EPA MCL	0	7.5	0	1.83	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	2	µg/L	0.0855	0.089	2	15	EPA MCL	0	7.5	0	1.83	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	2	µg/L	0.1475	0.17	2	15	EPA MCL	0	7.5	0	1.83	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	n/a	25	2	µg/L	0.1065	0.123	2	15	EPA MCL	0	7.5	0	1.83	Regional	0	—
	R-22	MP3A	1273.5	n/a	13	1	µg/L	19.7	19.7	2	15	EPA MCL	1	7.5	1	1.83	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	4	µg/L	1.365	2.04	2	15	EPA MCL	0	7.5	0	1.83	Regional	1	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Lead (continued)	R-32	MP3A	976	n/a	9	3	µg/L	0.337	0.441	2	15	EPA MCL	0	7.5	0	1.83	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-40	P1A	751.6	n/a	7	1	µg/L	0.885	0.885	2	15	EPA MCL	0	7.5	0	0.5	Intermediate	1	—
	R-54	P1A	830	n/a	6	1	µg/L	0.918	0.918	2	15	EPA MCL	0	7.5	0	1.83	Regional	0	—
Manganese	R-20	MP1A	904.6	n/a	5	5	µg/L	18.68	28.5	10	200	NM GW	0	100	0	2.94	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	356.6	382	10	200	NM GW	5	100	5	2.94	Regional	5	Detected above NM groundwater standard before well rehabilitation. Results were below New Mexico groundwater standard after well rehabilitation
	R-20	MP3A	1330	n/a	5	5	µg/L	764	1050	10	200	NM GW	5	100	5	2.94	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µg/L	19.015	27.5	10	200	NM GW	0	100	0	2.94	Regional	13	—
	R-20	P2A	1147.1	FD	3	3	µg/L	68.1	69.3	10	200	NM GW	0	100	0	2.94	Regional	3	—
	R-20	P2A	1147.1	n/a	14	14	µg/L	64.543	78.4	10	200	NM GW	0	100	0	2.94	Regional	14	—
	R-21	Single	888.8	FD	3	3	µg/L	8.7667	10.4	10	200	NM GW	0	100	0	2.94	Regional	3	—
	R-21	Single	888.8	n/a	25	25	µg/L	7.6492	18.2	10	200	NM GW	0	100	0	2.94	Regional	25	—
	R-22	MP1A	907.1	n/a	7	7	µg/L	3365.7	4410	10	200	NM GW	7	100	7	2.94	Regional	7	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	4	µg/L	860.78	3430	10	200	NM GW	1	100	1	2.94	Regional	3	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	4	µg/L	63.325	200	10	200	NM GW	1	100	1	2.94	Regional	4	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	1230	1230	10	200	NM GW	1	100	1	2.94	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	µg/L	1244.4	1600	10	200	NM GW	5	100	5	2.94	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	534	534	10	200	NM GW	1	100	1	2.94	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	µg/L	537	630	10	200	NM GW	5	100	5	2.94	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	2	µg/L	2.86	3.2	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-23	Single	816	n/a	25	6	µg/L	41.193	207	10	200	NM GW	1	100	1	2.94	Regional	5	The one result above the NM groundwater standard was detected in the first sampling event, December 2003.
	R-23i	P1A	400.3	FD	1	1	µg/L	6.2	6.2	10	200	NM GW	0	100	0	2	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	5	µg/L	13.56	44.8	10	200	NM GW	0	100	0	2	Intermediate	5	—
	R-23i	P2A	470.2	FD	2	1	µg/L	18.2	18.2	10	200	NM GW	0	100	0	2	Intermediate	1	—
	R-23i	P2A	470.2	n/a	19	6	µg/L	6.85	18.4	10	200	NM GW	0	100	0	2	Intermediate	6	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Manganese (continued)	R-23i	P3A	524	n/a	17	2	µg/L	9.725	13.7	10	200	NM GW	0	100	0	2	Intermediate	2	—
	R-32	MP1A	870.9	n/a	9	6	µg/L	23.467	73.8	10	200	NM GW	0	100	0	2.94	Regional	5	—
	R-32	MP3A	976	n/a	9	9	µg/L	1774.4	2120	10	200	NM GW	9	100	9	2.94	Regional	9	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	9.3667	20.4	10	200	NM GW	0	100	0	2.94	Regional	6	—
	R-32	Single	867.5	n/a	15	12	µg/L	8.0817	19.7	10	200	NM GW	0	100	0	2.94	Regional	10	—
	R-37	P1A	929.3	n/a	10	5	µg/L	5.152	7.47	10	200	NM GW	0	100	0	2	Intermediate	5	—
	R-37	P2A	1026	n/a	9	3	µg/L	3.1067	4.7	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-38	Single	821.2	FD	4	2	µg/L	3.35	4.65	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-38	Single	821.2	n/a	10	9	µg/L	6.5567	14.4	10	200	NM GW	0	100	0	2.94	Regional	6	—
	R-39	Single	859	n/a	11	3	µg/L	3.5167	6.5	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-40	P1A	751.6	n/a	7	7	µg/L	93.664	400	10	200	NM GW	1	100	2	2	Intermediate	7	One result was detected above the NM groundwater standard in December 2009.
	R-40	P2A	849.3	n/a	9	4	µg/L	29.133	104	10	200	NM GW	0	100	1	2.94	Regional	4	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	300.57	398	10	200	NM GW	6	100	7	2	Intermediate	7	Consistently detected above NM groundwater standard at this port.
	R-41	P2A	965.3	FD	2	2	µg/L	4.83	6.83	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-41	P2A	965.3	n/a	10	8	µg/L	18.69	55.3	10	200	NM GW	0	100	0	2.94	Regional	7	—
	R-49	P1A	845	n/a	9	9	µg/L	10.098	27.1	10	200	NM GW	0	100	0	2.94	Regional	8	—
	R-49	P2A	905.6	n/a	9	2	µg/L	3.205	4.09	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-51	P1A	914.96	n/a	6	1	µg/L	7.24	7.24	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-51	P2A	1031	n/a	6	3	µg/L	5.8033	12.2	10	200	NM GW	0	100	0	2.94	Regional	2	—
	R-52	P1A	1035.2	n/a	5	2	µg/L	3.94	5.18	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-52	P2A	1107	n/a	5	2	µg/L	8.435	14.5	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-53	P1A	849.2	n/a	5	2	µg/L	20.21	37.1	10	200	NM GW	0	100	0	2.94	Regional	2	—
	R-53	P2A	959.7	n/a	5	1	µg/L	6.31	6.31	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-54	P1A	830	n/a	6	6	µg/L	167.72	280	10	200	NM GW	3	100	4	2.94	Regional	6	Detected above the NM groundwater standard in 3 of the 6 samples at this screen.
	R-54	P2A	915	n/a	6	3	µg/L	4.0433	6.95	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-55	P1A	860	n/a	3	3	µg/L	9.96	16.2	10	200	NM GW	0	100	0	2.94	Regional	3	—
	R-55	P2A	994.4	n/a	3	2	µg/L	7.945	13.6	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-55i	Single	510	n/a	2	2	µg/L	528	621	10	200	NM GW	2	100	2	2	Intermediate	2	Consistently detected above NM groundwater standard at this port.
	R-56	P1A	945	n/a	3	3	µg/L	8.7367	17.6	10	200	NM GW	0	100	0	2.94	Regional	3	—
	R-56	P2A	1046.6	n/a	3	2	µg/L	9.215	16.3	10	200	NM GW	0	100	0	2.94	Regional	1	—
	R-57	P1A	910	n/a	2	2	µg/L	46.15	78.6	10	200	NM GW	0	100	0	2.94	Regional	2	—
	R-57	P2A	971.5	n/a	2	2	µg/L	12.96	16.5	10	200	NM GW	0	100	0	2.94	Regional	2	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Mercury	R-22	MP2A	962.8	n/a	16	1	µg/L	0.079	0.079	0.2	2	EPA MCL	0	1	0	0.07	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	µg/L	0.0715	0.0715	0.2	2	EPA MCL	0	1	0	0.07	Regional	1	—
	R-32	MP3A	976	n/a	9	1	µg/L	0.53	0.53	0.2	2	EPA MCL	0	1	0	0.07	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
Molybdenum	R-20	MP1A	904.6	n/a	5	5	µg/L	14.1	27.7	0.5	1000	NM GW	0	500	0	2	Regional	5	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	5.35	7.4	0.5	1000	NM GW	0	500	0	2	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	21.26	31.3	0.5	1000	NM GW	0	500	0	2	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	10	µg/L	1.425	1.8	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	µg/L	1.7733	2	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-20	P2A	1147.1	n/a	14	14	µg/L	1.6586	1.98	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-21	Single	888.8	FD	3	2	µg/L	2.45	3.7	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-21	Single	888.8	n/a	25	20	µg/L	1.9465	3.85	0.5	1000	NM GW	0	500	0	2	Regional	8	—
	R-22	MP1A	907.1	n/a	5	5	µg/L	27.92	40	0.5	1000	NM GW	0	500	0	2	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	5	µg/L	6.04	24.8	0.5	1000	NM GW	0	500	0	2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	3.4	3.4	0.5	1000	NM GW	0	500	0	2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	8	µg/L	7.5613	16	0.5	1000	NM GW	0	500	0	2	Regional	7	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	10.3	10.3	0.5	1000	NM GW	0	500	0	2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	µg/L	18.98	42	0.5	1000	NM GW	0	500	0	2	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	28.8	28.8	0.5	1000	NM GW	0	500	0	2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	µg/L	24.16	30.8	0.5	1000	NM GW	0	500	0	2	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	5	µg/L	1.692	1.99	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-23	Single	816	n/a	25	17	µg/L	1.6294	2.12	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-23i	P1A	400.3	n/a	14	12	µg/L	3.1681	23.4	0.5	1000	NM GW	0	500	0	2	Intermediate	2	—
	R-23i	P2A	470.2	FD	2	2	µg/L	1.96	2	0.5	1000	NM GW	0	500	0	2	Intermediate	1	—
	R-23i	P2A	470.2	n/a	19	15	µg/L	2.3353	4	0.5	1000	NM GW	0	500	0	2	Intermediate	10	—
	R-23i	P3A	524	FD	2	1	µg/L	2.3	2.3	0.5	1000	NM GW	0	500	0	2	Intermediate	1	—
	R-23i	P3A	524	n/a	17	14	µg/L	1.5807	2.5	0.5	1000	NM GW	0	500	0	2	Intermediate	2	—
	R-32	MP1A	870.9	n/a	9	7	µg/L	2.8371	3.5	0.5	1000	NM GW	0	500	0	2	Regional	7	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Molybdenum (continued)	R-32	MP3A	976	n/a	9	6	µg/L	2.1983	3.7	0.5	1000	NM GW	0	500	0	2	Regional	2	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	2.2667	2.5	0.5	1000	NM GW	0	500	0	2	Regional	6	—
	R-32	Single	867.5	n/a	15	15	µg/L	2.2607	3.1	0.5	1000	NM GW	0	500	0	2	Regional	15	—
	R-37	P1A	929.3	FD	1	1	µg/L	4.12	4.12	0.5	1000	NM GW	0	500	0	2	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	µg/L	3.742	4.34	0.5	1000	NM GW	0	500	0	2	Intermediate	10	—
	R-37	P2A	1026	FD	1	1	µg/L	1.63	1.63	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-37	P2A	1026	n/a	9	9	µg/L	2.1133	3.17	0.5	1000	NM GW	0	500	0	2	Regional	4	—
	R-38	Single	821.2	FD	4	3	µg/L	1.6833	1.73	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-38	Single	821.2	n/a	10	9	µg/L	1.9333	2.9	0.5	1000	NM GW	0	500	0	2	Regional	2	—
	R-39	Single	859	FD	1	1	µg/L	1.82	1.82	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-39	Single	859	n/a	11	11	µg/L	1.8855	2.71	0.5	1000	NM GW	0	500	0	2	Regional	4	—
	R-40	P1A	751.6	n/a	7	7	µg/L	9.1343	12.9	0.5	1000	NM GW	0	500	0	2	Intermediate	7	—
	R-40	P2A	849.3	FD	2	2	µg/L	2.465	3.67	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-40	P2A	849.3	n/a	9	9	µg/L	3.0122	6.1	0.5	1000	NM GW	0	500	0	2	Regional	6	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	17.3	22	0.5	1000	NM GW	0	500	0	2	Intermediate	7	—
	R-41	P2A	965.3	FD	2	2	µg/L	3.9	4.09	0.5	1000	NM GW	0	500	0	2	Regional	2	—
	R-41	P2A	965.3	n/a	10	10	µg/L	4.826	8.69	0.5	1000	NM GW	0	500	0	2	Regional	10	—
	R-49	P1A	845	n/a	9	9	µg/L	2.9956	5.93	0.5	1000	NM GW	0	500	0	2	Regional	9	—
	R-49	P2A	905.6	n/a	9	8	µg/L	1.4825	1.66	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	µg/L	1.32	1.44	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-51	P2A	1031	n/a	6	6	µg/L	1.2533	1.39	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	1.758	2.23	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-52	P2A	1107	n/a	5	4	µg/L	1.23	1.36	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	µg/L	1.552	2.29	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-53	P2A	959.7	FD	2	1	µg/L	1.12	1.12	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-53	P2A	959.7	n/a	5	4	µg/L	1.239	1.59	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-54	P1A	830	n/a	6	6	µg/L	3.4467	5.1	0.5	1000	NM GW	0	500	0	2	Regional	6	—
	R-54	P2A	915	n/a	6	6	µg/L	1.115	1.17	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-55	P1A	860	n/a	3	2	µg/L	1.11	1.15	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	µg/L	1.49	1.76	0.5	1000	NM GW	0	500	0	2	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	8.63	9.5	0.5	1000	NM GW	0	500	0	2	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	µg/L	1.9433	2.01	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	2.6733	3.14	0.5	1000	NM GW	0	500	0	2	Regional	3	—
	R-57	P1A	910	n/a	2	2	µg/L	2.08	2.33	0.5	1000	NM GW	0	500	0	2	Regional	1	—
	R-57	P2A	971.5	n/a	2	2	µg/L	1.655	1.89	0.5	1000	NM GW	0	500	0	2	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Nickel	R-20	MP1A	904.6	n/a	5	1	µg/L	0.7	0.7	2	200	NM GW	0	100	0	3.09	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	3	µg/L	5.5333	12.1	2	200	NM GW	0	100	0	3.09	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	12	µg/L	1.6551	5.63	2	200	NM GW	0	100	0	3.09	Regional	1	—
	R-20	P2A	1147.1	FD	3	3	µg/L	2.9667	3.31	2	200	NM GW	0	100	0	3.09	Regional	1	—
	R-20	P2A	1147.1	n/a	14	13	µg/L	2.4858	3.71	2	200	NM GW	0	100	0	3.09	Regional	4	—
	R-21	Single	888.8	FD	3	3	µg/L	3.1467	8.3	2	200	NM GW	0	100	0	3.09	Regional	1	—
	R-21	Single	888.8	n/a	25	14	µg/L	0.796	2.7	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-22	MP1A	907.1	n/a	5	2	µg/L	17.4	24.8	2	200	NM GW	0	100	0	3.09	Regional	2	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	5	µg/L	1.284	3.7	2	200	NM GW	0	100	0	3.09	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	1.5	1.5	2	200	NM GW	0	100	0	3.09	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	9	µg/L	1.4211	1.9	2	200	NM GW	0	100	0	3.09	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	1	µg/L	2.6	2.6	2	200	NM GW	0	100	0	3.09	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	1	µg/L	2.5	2.5	2	200	NM GW	0	100	0	3.09	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	5	µg/L	0.7004	1	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-23	Single	816	n/a	24	13	µg/L	1.3768	8.79	2	200	NM GW	0	100	0	3.09	Regional	1	—
	R-23i	P1A	400.3	FD	1	1	µg/L	1.3	1.3	2	200	NM GW	0	100	0	1	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	13	µg/L	1.1161	3.5	2	200	NM GW	0	100	0	1	Intermediate	5	—
	R-23i	P2A	470.2	FD	2	2	µg/L	0.79	0.89	2	200	NM GW	0	100	0	1	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	18	µg/L	0.9483	1.8	2	200	NM GW	0	100	0	1	Intermediate	7	—
	R-23i	P3A	524	FD	2	2	µg/L	1.545	1.8	2	200	NM GW	0	100	0	1	Intermediate	2	—
	R-23i	P3A	524	n/a	17	15	µg/L	1.1409	2.5	2	200	NM GW	0	100	0	1	Intermediate	7	—
	R-32	MP1A	870.9	n/a	9	4	µg/L	1.18	2.3	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-32	MP3A	976	n/a	9	6	µg/L	1.23	2.1	2	200	NM GW	0	100	0	3.09	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	3.0167	6	2	200	NM GW	0	100	0	3.09	Regional	2	—
	R-32	Single	867.5	n/a	15	14	µg/L	2.0243	5.6	2	200	NM GW	0	100	0	3.09	Regional	2	—
	R-37	P1A	929.3	FD	1	1	µg/L	1.51	1.51	2	200	NM GW	0	100	0	1	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	µg/L	1.2123	1.51	2	200	NM GW	0	100	0	1	Intermediate	9	—
	R-37	P2A	1026	FD	1	1	µg/L	0.771	0.771	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-37	P2A	1026	n/a	9	8	µg/L	0.8791	1.27	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-38	Single	821.2	FD	4	4	µg/L	4.78	8.91	2	200	NM GW	0	100	0	3.09	Regional	3	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Nickel (continued)	R-38	Single	821.2	n/a	10	10	µg/L	10.549	27.5	2	200	NM GW	0	100	0	3.09	Regional	9	—
	R-39	Single	859	FD	1	1	µg/L	0.751	0.751	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-39	Single	859	n/a	11	10	µg/L	0.9508	2.1	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	µg/L	12.421	49.8	2	200	NM GW	0	100	0	1	Intermediate	7	—
	R-40	P2A	849.3	FD	2	2	µg/L	0.9815	1.43	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-40	P2A	849.3	n/a	9	8	µg/L	1.4714	3.84	2	200	NM GW	0	100	0	3.09	Regional	1	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	0.9411	1.17	2	200	NM GW	0	100	0	1	Intermediate	2	—
	R-41	P2A	965.3	FD	2	2	µg/L	2.535	2.99	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	µg/L	2.0538	3.26	2	200	NM GW	0	100	0	3.09	Regional	1	—
	R-49	P1A	845	n/a	9	9	µg/L	1.4459	2.31	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-49	P2A	905.6	n/a	9	6	µg/L	0.7182	1.05	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-51	P1A	914.96	n/a	6	3	µg/L	1.0357	1.84	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-51	P2A	1031	n/a	6	4	µg/L	0.6685	0.861	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-52	P1A	1035.2	n/a	5	3	µg/L	0.9313	1.35	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-52	P2A	1107	n/a	5	5	µg/L	0.8734	1.24	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-53	P1A	849.2	n/a	5	4	µg/L	1.0095	1.49	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-53	P2A	959.7	FD	2	2	µg/L	0.627	0.732	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-53	P2A	959.7	n/a	5	3	µg/L	0.6987	0.821	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-54	P1A	830	n/a	6	6	µg/L	3.2883	8.3	2	200	NM GW	0	100	0	3.09	Regional	3	—
	R-54	P2A	915	n/a	6	4	µg/L	0.7963	1.01	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	1.615	2.94	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-55	P2A	994.4	n/a	3	1	µg/L	0.906	0.906	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	3.88	3.9	2	200	NM GW	0	100	0	1	Intermediate	2	—
	R-56	P1A	945	n/a	3	2	µg/L	0.717	0.828	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	0.6793	0.909	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-57	P1A	910	n/a	2	2	µg/L	1.149	1.62	2	200	NM GW	0	100	0	3.09	Regional	0	—
	R-57	P2A	971.5	n/a	2	1	µg/L	0.763	0.763	2	200	NM GW	0	100	0	3.09	Regional	0	—
Selenium	R-20	MP1A	904.6	n/a	5	1	µg/L	3.3	3.3	5	50	EPA MCL	0	25	0	6	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	1	µg/L	3.5	3.5	5	50	EPA MCL	0	25	0	6	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-22	MP2A	962.8	n/a	16	1	µg/L	1.1	1.1	5	50	EPA MCL	0	25	0	6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	1	µg/L	1	1	5	50	EPA MCL	0	25	0	6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	2	µg/L	1.935	2.6	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-23	Single	816	n/a	25	3	µg/L	2.22	4.2	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	1.55	1.55	5	50	EPA MCL	0	25	0	6	Intermediate	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Selenium (continued)	R-23i	P2A	470.2	n/a	19	1	µg/L	1.16	1.16	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	2	µg/L	2.8	4.5	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-32	Single	867.5	FD	6	1	µg/L	1.2	1.2	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-32	Single	867.5	n/a	15	2	µg/L	1.37	1.56	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-37	P1A	929.3	n/a	10	1	µg/L	1.25	1.25	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
	R-49	P2A	905.6	n/a	9	1	µg/L	1.58	1.58	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-55i	Single	510	n/a	2	1	µg/L	2.91	2.91	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
Silicon	R-22	MP1A	907.1	n/a	2	2	µg/L	14000	16000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	2	2	µg/L	31000	32000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	2	2	µg/L	21500	27000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	2	2	µg/L	18500	21000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	µg/L	23000	23000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
Silicon Dioxide	R-20	P1A	904.6	n/a	13	13	mg/L	69.046	71.8	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	mg/L	74.767	76.1	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-20	P2A	1147.1	n/a	14	14	mg/L	74.307	79	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-21	Single	888.8	FD	1	1	mg/L	73.3	73.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-21	Single	888.8	n/a	15	15	mg/L	70.927	77.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-22	MP2A	962.8	n/a	6	6	mg/L	65.917	68.6	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	3	3	mg/L	56.533	58.4	0.1	—	—	—	—	—	88.5	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	6	6	mg/L	62.817	64	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-23	Single	816	n/a	15	15	mg/L	63.84	69.9	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-23i	P1A	400.3	n/a	13	13	mg/L	50.162	54.9	0.1	—	—	—	—	—	50.72	Intermediate	9	—
	R-23i	P2A	470.2	FD	1	1	mg/L	42.4	42.4	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P2A	470.2	n/a	15	15	mg/L	41.173	44.2	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P3A	524	FD	1	1	mg/L	41.6	41.6	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-23i	P3A	524	n/a	13	13	mg/L	43.492	46.9	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-32	Single	867.5	FD	6	6	mg/L	63.533	67.6	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-32	Single	867.5	n/a	15	14	mg/L	64.843	69.6	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-37	P1A	929.3	FD	1	1	mg/L	60.1	60.1	0.1	—	—	—	—	—	50.72	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	mg/L	53.88	60.1	0.1	—	—	—	—	—	50.72	Intermediate	8	—
	R-37	P2A	1026	FD	1	1	mg/L	69.8	69.8	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-37	P2A	1026	n/a	9	8	mg/L	64.588	71.5	0.1	—	—	—	—	—	88.5	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Silicon Dioxide (continued)	R-38	Single	821.2	FD	4	4	mg/L	66.6	70.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-38	Single	821.2	n/a	10	10	mg/L	66.6	69.4	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-39	Single	859	FD	1	1	mg/L	67.6	67.6	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-39	Single	859	n/a	11	11	mg/L	67.373	72.5	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-40	P1A	751.6	n/a	8	8	mg/L	55.713	58.9	0.1	—	—	—	—	—	50.72	Intermediate	8	—
	R-40	P2A	849.3	FD	2	2	mg/L	71.65	74.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	mg/L	69.2	75.2	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	mg/L	53.186	62.2	0.1	—	—	—	—	—	50.72	Intermediate	5	—
	R-41	P2A	965.3	FD	2	2	mg/L	63.05	64.7	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	mg/L	62.93	64.8	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-49	P1A	845	n/a	9	9	mg/L	69.2	73.1	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	mg/L	68.244	71	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	mg/L	68.583	72.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-51	P2A	1031	n/a	6	6	mg/L	70.583	73.6	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	mg/L	68.46	76	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-52	P2A	1107	n/a	5	5	mg/L	70.36	71.9	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	mg/L	69.72	71.9	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-53	P2A	959.7	FD	2	2	mg/L	72.55	72.8	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	mg/L	72.48	75.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-54	P1A	830	n/a	6	6	mg/L	69.967	72.1	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-54	P2A	915	n/a	6	6	mg/L	72.317	74.7	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-55	P1A	860	n/a	3	3	mg/L	70.4	73.5	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	mg/L	67.267	69.8	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-55i	Single	510	n/a	2	2	mg/L	45.1	46.2	0.1	—	—	—	—	—	50.72	Intermediate	0	—
	R-56	P1A	945	n/a	3	2	mg/L	65.05	65.3	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-56	P2A	1046.6	n/a	3	2	mg/L	65.15	65.9	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-57	P1A	910	n/a	2	2	mg/L	66.45	68	0.1	—	—	—	—	—	88.5	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	mg/L	69.55	70	0.1	—	—	—	—	—	88.5	Regional	0	—
Silver	R-20	MP3A	1330	n/a	5	1	µg/L	0.92	0.92	1	50	NM GW	0	25	0	1	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
Strontium	R-20	MP1A	904.6	n/a	5	5	µg/L	39.32	42.2	5	22000	EPA Tap	0	11000	0	540	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	1912	2070	5	22000	EPA Tap	0	11000	0	540	Regional	5	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	131	191	5	22000	EPA Tap	0	11000	0	540	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µg/L	139.54	157	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	µg/L	222.67	231	5	22000	EPA Tap	0	11000	0	540	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Strontium (continued)	R-20	P2A	1147.1	n/a	14	14	µg/L	207.43	232	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-21	Single	888.8	FD	3	3	µg/L	44.867	45.6	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-21	Single	888.8	n/a	25	25	µg/L	45.14	48.3	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-22	MP1A	907.1	n/a	5	5	µg/L	313.2	366	5	22000	EPA Tap	0	11000	0	540	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	16	16	µg/L	67.444	311	5	22000	EPA Tap	0	11000	0	540	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	634	634	5	22000	EPA Tap	0	11000	0	540	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	13	µg/L	561.77	940	5	22000	EPA Tap	0	11000	0	540	Regional	7	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	960	960	5	22000	EPA Tap	0	11000	0	540	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	5	5	µg/L	936	1100	5	22000	EPA Tap	0	11000	0	540	Regional	5	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	312	312	5	22000	EPA Tap	0	11000	0	540	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	5	5	µg/L	287.4	312	5	22000	EPA Tap	0	11000	0	540	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	80.767	83	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-23	Single	816	n/a	25	25	µg/L	81.428	88	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	µg/L	97.3	97.3	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	14	µg/L	164.96	254	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	13	—
	R-23i	P2A	470.2	FD	2	2	µg/L	94.45	96.3	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	19	µg/L	95.295	111	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-23i	P3A	524	FD	2	2	µg/L	93.3	95.4	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-23i	P3A	524	n/a	17	17	µg/L	96.371	113	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	9	µg/L	84.056	90.8	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-32	MP3A	976	n/a	9	9	µg/L	101.12	109	5	22000	EPA Tap	0	11000	0	540	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	82.35	93	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-32	Single	867.5	n/a	15	15	µg/L	77.307	90.5	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-37	P1A	929.3	FD	1	1	µg/L	103	103	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	µg/L	102.96	109	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-37	P2A	1026	FD	1	1	µg/L	54.7	54.7	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-37	P2A	1026	n/a	9	9	µg/L	63.044	94.6	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-38	Single	821.2	FD	4	4	µg/L	51.275	53.2	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-38	Single	821.2	n/a	10	10	µg/L	51.25	53.9	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-39	Single	859	FD	1	1	µg/L	54.9	54.9	5	22000	EPA Tap	0	11000	0	540	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Strontium (continued)	R-39	Single	859	n/a	11	11	µg/L	55.655	60.7	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	µg/L	102.46	114	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-40	P2A	849.3	FD	2	2	µg/L	50.8	51.6	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	µg/L	52.978	68.8	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	94.814	106	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	0	—
	R-41	P2A	965.3	FD	2	2	µg/L	76.65	77.4	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	µg/L	75.12	81.7	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-49	P1A	845	n/a	9	9	µg/L	74.978	107	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-49	P2A	905.6	n/a	9	9	µg/L	57.356	65.9	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	µg/L	81.5	98.3	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-51	P2A	1031	n/a	6	6	µg/L	54.15	57.9	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	62.36	67.4	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-52	P2A	1107	n/a	5	5	µg/L	48.84	49.7	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	µg/L	44.66	48.3	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-53	P2A	959.7	FD	2	2	µg/L	45.8	46.5	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	µg/L	45.72	46.9	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-54	P1A	830	n/a	6	6	µg/L	54.233	66.1	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-54	P2A	915	n/a	6	6	µg/L	53.117	56.6	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	72.967	73.4	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	µg/L	80.233	86.6	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	166	166	5	22000	EPA Tap	0	11000	0	154.76	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	µg/L	57.033	58	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	54.4	55.6	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-57	P1A	910	n/a	2	2	µg/L	59.9	61.4	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	µg/L	60.45	61.7	5	22000	EPA Tap	0	11000	0	540	Regional	0	—
Thallium	R-20	MP1A	904.6	n/a	5	3	µg/L	0.2767	0.42	1	2	EPA MCL	0	1	0	1	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	2	µg/L	0.309	0.33	1	2	EPA MCL	0	1	0	1	Regional	0	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	3	µg/L	0.236	0.41	1	2	EPA MCL	0	1	0	1	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	3	µg/L	0.4333	0.5	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-20	P2A	1147.1	n/a	14	1	µg/L	0.4	0.4	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-21	Single	888.8	n/a	25	6	µg/L	0.5335	0.83	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-22	MP3A	1273.5	n/a	13	2	µg/L	0.525	0.62	1	2	EPA MCL	0	1	0	1	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	4	µg/L	0.413	0.57	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-23i	P1A	400.3	n/a	14	2	µg/L	0.415	0.47	1	2	EPA MCL	0	1	0	1	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	2	µg/L	0.53	0.65	1	2	EPA MCL	0	1	0	1	Intermediate	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Thallium (continued)	R-32	MP1A	870.9	n/a	9	3	µg/L	0.3753	0.53	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-32	MP3A	976	n/a	9	3	µg/L	0.3707	0.442	1	2	EPA MCL	0	1	0	1	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	n/a	15	1	µg/L	0.47	0.47	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-40	P2A	849.3	n/a	9	1	µg/L	0.557	0.557	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-49	P1A	845	n/a	9	1	µg/L	0.328	0.328	1	2	EPA MCL	0	1	0	1	Regional	0	—
	R-52	P1A	1035.2	n/a	5	1	µg/L	0.338	0.338	1	2	EPA MCL	0	1	0	1	Regional	0	—
Tin	R-20	P1A	904.6	n/a	13	1	µg/L	3.86	3.86	10	22000	EPA Tap	0	11000	0	3.26	Regional	1	—
	R-23i	P1A	400.3	FD	1	1	µg/L	2.6	2.6	10	22000	EPA Tap	0	11000	0	3.26	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	4.03	4.03	10	22000	EPA Tap	0	11000	0	3.26	Intermediate	1	—
	R-32	Single	867.5	n/a	15	2	µg/L	9.205	15.5	10	22000	EPA Tap	0	11000	0	3.26	Regional	1	—
	R-37	P1A	929.3	n/a	10	1	µg/L	3.48	3.48	10	22000	EPA Tap	0	11000	0	3.26	Intermediate	1	—
	R-37	P2A	1026	n/a	9	1	µg/L	3.65	3.65	10	22000	EPA Tap	0	11000	0	3.26	Regional	1	—
	R-39	Single	859	n/a	11	1	µg/L	5.96	5.96	10	22000	EPA Tap	0	11000	0	3.26	Regional	1	—
	R-49	P1A	845	n/a	9	1	µg/L	3.74	3.74	10	22000	EPA Tap	0	11000	0	3.26	Regional	1	—
	R-49	P2A	905.6	n/a	9	1	µg/L	5.68	5.68	10	22000	EPA Tap	0	11000	0	3.26	Regional	1	—
Uranium	R-20	MP1A	904.6	n/a	5	4	µg/L	0.1413	0.16	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	0.0954	0.175	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	Before well rehabilitation.
	R-20	P1A	904.6	n/a	13	11	µg/L	0.6927	1.09	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	µg/L	0.542	0.615	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-20	P2A	1147.1	n/a	14	13	µg/L	0.5873	0.69	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-21	Single	888.8	FD	3	2	µg/L	0.345	0.36	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-21	Single	888.8	n/a	25	22	µg/L	0.3634	0.61	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-22	MP1A	907.1	n/a	4	2	µg/L	0.095	0.14	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	15	11	µg/L	0.3809	0.47	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	3.8	3.8	0.2	30	EPA MCL	0	15	0	1.9	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	12	12	µg/L	4.0433	15.2	0.2	30	EPA MCL	0	15	1	1.9	Regional	11	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	0.28	0.28	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	4	2	µg/L	0.21	0.29	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	4	1	µg/L	0.16	0.16	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	10	µg/L	0.4853	0.533	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-23	Single	816	n/a	25	21	µg/L	0.528	0.802	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Uranium (continued)	R-23i	P1A	400.3	FD	1	1	µg/L	1.4	1.4	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	12	µg/L	2.4348	18.9	0.2	30	EPA MCL	0	15	1	0.72	Intermediate	10	—
	R-23i	P2A	470.2	FD	2	2	µg/L	0.943	0.98	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	18	µg/L	1.0252	1.7	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	17	—
	R-23i	P3A	524	FD	2	1	µg/L	0.55	0.55	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	0	—
	R-23i	P3A	524	n/a	17	15	µg/L	0.6601	1.1	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	3	—
	R-32	MP1A	870.9	n/a	9	9	µg/L	1.0767	1.8	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-32	MP3A	976	n/a	9	8	µg/L	0.2005	0.56	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	0.7883	0.89	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-32	Single	867.5	n/a	15	14	µg/L	0.7296	0.88	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-37	P1A	929.3	FD	1	1	µg/L	1.32	1.32	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	10	µg/L	1.558	1.84	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	10	—
	R-37	P2A	1026	FD	1	1	µg/L	0.497	0.497	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-37	P2A	1026	n/a	9	9	µg/L	0.7297	1.75	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-38	Single	821.2	FD	4	4	µg/L	0.401	0.427	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-38	Single	821.2	n/a	10	10	µg/L	0.4235	0.556	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-39	Single	859	FD	1	1	µg/L	0.413	0.413	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-39	Single	859	n/a	11	10	µg/L	0.4161	0.478	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-40	P1A	751.6	n/a	7	7	µg/L	0.9651	1.1	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	7	—
	R-40	P2A	849.3	FD	2	2	µg/L	0.3185	0.354	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-40	P2A	849.3	n/a	9	9	µg/L	0.3323	0.49	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-40	R-40i	649.7	n/a	7	6	µg/L	0.5045	0.96	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	1	—
	R-41	P2A	965.3	FD	2	2	µg/L	0.6275	0.648	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	µg/L	0.7577	1.29	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-49	P1A	845	n/a	9	9	µg/L	1.162	1.47	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-49	P2A	905.6	n/a	9	8	µg/L	0.3719	0.553	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	µg/L	0.3395	0.5	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-51	P2A	1031	n/a	6	6	µg/L	0.3848	0.551	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	0.558	0.751	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-52	P2A	1107	n/a	5	4	µg/L	0.372	0.45	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	µg/L	0.4806	0.509	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-53	P2A	959.7	FD	2	2	µg/L	0.429	0.452	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	µg/L	0.4718	0.595	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-54	P1A	830	n/a	6	6	µg/L	0.5465	0.682	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-54	P2A	915	n/a	6	5	µg/L	0.433	0.503	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	0.6357	0.645	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Uranium (continued)	R-55	P2A	994.4	n/a	3	3	µg/L	0.6307	0.683	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-55i	Single	510	n/a	2	2	µg/L	1.175	1.23	0.2	30	EPA MCL	0	15	0	0.72	Intermediate	2	—
	R-56	P1A	945	n/a	3	3	µg/L	0.6597	0.666	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	0.5977	0.66	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-57	P1A	910	n/a	2	1	µg/L	0.372	0.372	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	µg/L	0.3825	0.454	0.2	30	EPA MCL	0	15	0	1.9	Regional	0	—
Vanadium	R-20	MP3A	1330	n/a	5	1	µg/L	3.9	3.9	5	180	EPA Tap	0	90	0	13.41	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	12	µg/L	4.6708	7.76	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-20	P2A	1147.1	FD	3	3	µg/L	3.0733	3.45	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-20	P2A	1147.1	n/a	14	9	µg/L	4.3133	5.24	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-21	Single	888.8	FD	3	2	µg/L	5.35	5.4	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-21	Single	888.8	n/a	25	23	µg/L	5.1783	6.4	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-22	MP2A	962.8	n/a	16	10	µg/L	4.929	5.6	5	180	EPA Tap	0	90	0	13.41	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	6.1	6.1	5	180	EPA Tap	0	90	0	13.41	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	9	µg/L	7.2667	8.7	5	180	EPA Tap	0	90	0	13.41	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	6.375	7.4	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-23	Single	816	n/a	25	24	µg/L	6.4421	8.1	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-23i	P1A	400.3	FD	1	1	µg/L	4.2	4.2	5	180	EPA Tap	0	90	0	4.91	Intermediate	0	—
	R-23i	P1A	400.3	n/a	14	11	µg/L	3.2873	5.5	5	180	EPA Tap	0	90	0	4.91	Intermediate	1	—
	R-23i	P2A	470.2	FD	2	2	µg/L	4.715	5.53	5	180	EPA Tap	0	90	0	4.91	Intermediate	1	—
	R-23i	P2A	470.2	n/a	19	18	µg/L	4.6522	6.03	5	180	EPA Tap	0	90	0	4.91	Intermediate	6	—
	R-23i	P3A	524	FD	2	1	µg/L	4.73	4.73	5	180	EPA Tap	0	90	0	4.91	Intermediate	0	—
	R-23i	P3A	524	n/a	17	16	µg/L	5.2925	8	5	180	EPA Tap	0	90	0	4.91	Intermediate	9	—
	R-32	MP1A	870.9	n/a	9	6	µg/L	4.0667	5.5	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-32	MP3A	976	n/a	9	3	µg/L	1.9	2.6	5	180	EPA Tap	0	90	0	13.41	Regional	0	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	4	µg/L	3.6	4.1	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-32	Single	867.5	n/a	15	13	µg/L	3.5146	4.39	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-37	P1A	929.3	FD	1	1	µg/L	4.71	4.71	5	180	EPA Tap	0	90	0	4.91	Intermediate	0	—
	R-37	P1A	929.3	n/a	10	10	µg/L	5.093	5.95	5	180	EPA Tap	0	90	0	4.91	Intermediate	5	—
	R-37	P2A	1026	FD	1	1	µg/L	5.77	5.77	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-37	P2A	1026	n/a	9	8	µg/L	5.9	6.44	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-38	Single	821.2	FD	4	4	µg/L	4.4275	4.96	5	180	EPA Tap	0	90	0	13.41	Regional	0	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Vanadium (continued)	R-38	Single	821.2	n/a	10	9	µg/L	4.2911	4.86	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-39	Single	859	FD	1	1	µg/L	4.95	4.95	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-39	Single	859	n/a	11	10	µg/L	5.531	6.13	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-40	P1A	751.6	n/a	7	6	µg/L	2.88	4.69	5	180	EPA Tap	0	90	0	4.91	Intermediate	0	—
	R-40	P2A	849.3	FD	2	1	µg/L	5.2	5.2	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-40	P2A	849.3	n/a	9	8	µg/L	4.5675	5.81	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-41	P2A	965.3	FD	2	2	µg/L	5.82	5.83	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-41	P2A	965.3	n/a	10	10	µg/L	6.232	6.81	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-49	P1A	845	n/a	9	9	µg/L	4.42	5.96	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-49	P2A	905.6	n/a	9	8	µg/L	4.6775	5.39	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-51	P1A	914.96	n/a	6	6	µg/L	5.6667	6.33	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-51	P2A	1031	n/a	6	6	µg/L	5.7217	6.53	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	6.08	6.61	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-52	P2A	1107	n/a	5	5	µg/L	6.046	6.3	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-53	P1A	849.2	n/a	5	5	µg/L	4.626	5.48	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-53	P2A	959.7	FD	2	2	µg/L	5.45	5.47	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-53	P2A	959.7	n/a	5	5	µg/L	5.144	5.7	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-54	P1A	830	n/a	6	5	µg/L	2.466	4.22	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-54	P2A	915	n/a	6	6	µg/L	5.1817	5.66	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-55	P1A	860	n/a	3	3	µg/L	5.2367	5.65	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-55	P2A	994.4	n/a	3	3	µg/L	4.9433	5.54	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-55i	Single	510	n/a	2	1	µg/L	2.91	2.91	5	180	EPA Tap	0	90	0	4.91	Intermediate	0	—
	R-56	P1A	945	n/a	3	2	µg/L	3.68	3.91	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-56	P2A	1046.6	n/a	3	2	µg/L	3.81	3.88	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-57	P1A	910	n/a	2	2	µg/L	4.665	5.06	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
	R-57	P2A	971.5	n/a	2	2	µg/L	4.475	5.04	5	180	EPA Tap	0	90	0	13.41	Regional	0	—
Zinc	R-20	MP2A	1147.1	n/a	4	2	µg/L	30.82	59.5	10	10000	NM GW	0	5000	0	3.89	Regional	1	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	8.1075	13.1	10	10000	NM GW	0	5000	0	3.89	Regional	3	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	9	µg/L	7.1011	19.4	10	10000	NM GW	0	5000	0	3.89	Regional	6	—
	R-20	P2A	1147.1	n/a	14	5	µg/L	4.126	8.1	10	10000	NM GW	0	5000	0	3.89	Regional	2	—
	R-21	Single	888.8	n/a	25	7	µg/L	5.9043	7.81	10	10000	NM GW	0	5000	0	3.89	Regional	6	—
	R-22	MP2A	962.8	n/a	16	4	µg/L	5.3	11	10	10000	NM GW	0	5000	0	3.89	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	2.9	2.9	10	10000	NM GW	0	5000	0	3.89	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	4	µg/L	14.825	51	10	10000	NM GW	0	5000	0	3.89	Regional	1	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Zinc (continued)	R-22	MP4A	1378	n/a	5	1	µg/L	12.3	12.3	10	10000	NM GW	0	5000	0	3.89	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	µg/L	16.1	16.1	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
	R-23	Single	816	n/a	25	9	µg/L	10.981	30.5	10	10000	NM GW	0	5000	0	3.89	Regional	6	—
	R-23i	P1A	400.3	FD	1	1	µg/L	3.6	3.6	10	10000	NM GW	0	5000	0	2	Intermediate	1	—
	R-23i	P1A	400.3	n/a	14	10	µg/L	8.719	21.2	10	10000	NM GW	0	5000	0	2	Intermediate	10	—
	R-23i	P2A	470.2	FD	2	2	µg/L	13.565	22.6	10	10000	NM GW	0	5000	0	2	Intermediate	2	—
	R-23i	P2A	470.2	n/a	19	12	µg/L	7.0875	31.3	10	10000	NM GW	0	5000	0	2	Intermediate	12	—
	R-23i	P3A	524	n/a	17	5	µg/L	4.354	7	10	10000	NM GW	0	5000	0	2	Intermediate	5	—
	R-32	MP1A	870.9	n/a	9	5	µg/L	6.14	9.6	10	10000	NM GW	0	5000	0	3.89	Regional	4	—
	R-32	MP3A	976	n/a	9	6	µg/L	6.9817	11.2	10	10000	NM GW	0	5000	0	3.89	Regional	5	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	65	103	10	10000	NM GW	0	5000	0	3.89	Regional	6	—
	R-32	Single	867.5	n/a	15	15	µg/L	47.48	102	10	10000	NM GW	0	5000	0	3.89	Regional	15	—
	R-37	P1A	929.3	FD	1	1	µg/L	9.35	9.35	10	10000	NM GW	0	5000	0	2	Intermediate	1	—
	R-37	P1A	929.3	n/a	10	7	µg/L	26.654	115	10	10000	NM GW	0	5000	0	2	Intermediate	7	—
	R-37	P2A	1026	n/a	9	4	µg/L	7.78	12.8	10	10000	NM GW	0	5000	0	3.89	Regional	4	—
	R-38	Single	821.2	FD	4	4	µg/L	8.0575	12.8	10	10000	NM GW	0	5000	0	3.89	Regional	4	—
	R-38	Single	821.2	n/a	10	9	µg/L	21.446	69	10	10000	NM GW	0	5000	0	3.89	Regional	9	—
	R-39	Single	859	FD	1	1	µg/L	3.5	3.5	10	10000	NM GW	0	5000	0	3.89	Regional	0	—
	R-39	Single	859	n/a	11	6	µg/L	12.925	28.1	10	10000	NM GW	0	5000	0	3.89	Regional	5	—
	R-40	P1A	751.6	n/a	7	7	µg/L	143.39	909	10	10000	NM GW	0	5000	0	2	Intermediate	7	—
	R-40	P2A	849.3	FD	2	1	µg/L	5.5	5.5	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
	R-40	P2A	849.3	n/a	9	8	µg/L	26.615	158	10	10000	NM GW	0	5000	0	3.89	Regional	7	—
	R-40	R-40i	649.7	n/a	7	3	µg/L	116.52	343	10	10000	NM GW	0	5000	0	2	Intermediate	3	—
	R-41	P2A	965.3	n/a	10	2	µg/L	4.805	5.38	10	10000	NM GW	0	5000	0	3.89	Regional	2	—
	R-49	P1A	845	n/a	9	3	µg/L	7.2167	9.47	10	10000	NM GW	0	5000	0	3.89	Regional	3	—
	R-49	P2A	905.6	n/a	9	3	µg/L	3.4	4.15	10	10000	NM GW	0	5000	0	3.89	Regional	2	—
	R-51	P1A	914.96	n/a	6	6	µg/L	14.415	32.4	10	10000	NM GW	0	5000	0	3.89	Regional	5	—
	R-51	P2A	1031	n/a	6	4	µg/L	5.905	8.73	10	10000	NM GW	0	5000	0	3.89	Regional	3	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	17.256	40.6	10	10000	NM GW	0	5000	0	3.89	Regional	5	—
	R-52	P2A	1107	n/a	5	1	µg/L	8.61	8.61	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
	R-53	P1A	849.2	n/a	5	4	µg/L	94.35	221	10	10000	NM GW	0	5000	0	3.89	Regional	4	—
	R-53	P2A	959.7	FD	2	1	µg/L	3.8	3.8	10	10000	NM GW	0	5000	0	3.89	Regional	0	—
	R-53	P2A	959.7	n/a	5	3	µg/L	6.66	10.5	10	10000	NM GW	0	5000	0	3.89	Regional	3	—
	R-54	P1A	830	n/a	6	6	µg/L	22.328	60.5	10	10000	NM GW	0	5000	0	3.89	Regional	5	—
	R-55	P1A	860	n/a	3	1	µg/L	4.05	4.05	10	10000	NM GW	0	5000	0	3.89	Regional	1	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Zinc (continued)	R-55	P2A	994.4	n/a	3	1	µg/L	4.84	4.84	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
	R-55i	Single	510	n/a	2	1	µg/L	10.4	10.4	10	10000	NM GW	0	5000	0	2	Intermediate	1	—
	R-56	P1A	945	n/a	3	2	µg/L	60	106	10	10000	NM GW	0	5000	0	3.89	Regional	2	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	14.1	14.1	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
	R-57	P1A	910	n/a	2	1	µg/L	29.2	29.2	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
	R-57	P2A	971.5	n/a	2	1	µg/L	4.31	4.31	10	10000	NM GW	0	5000	0	3.89	Regional	1	—
Not Filtered Metals																			
Aluminum	R-20	MP1A	904.6	n/a	5	3	µg/L	69.033	110	200	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	4	1	µg/L	45.8	45.8	200	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	45.425	104	200	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P2A	1147.1	FD	3	1	µg/L	417	417	200	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	3	µg/L	123.63	216	200	—	—	—	—	—	—	—	—	—
	R-22	MP2A	962.8	n/a	18	1	µg/L	48.7	48.7	200	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	3	µg/L	25.533	37.5	200	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	2	µg/L	34.25	53.2	200	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	6	1	µg/L	43.3	43.3	200	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	24	3	µg/L	45.4	69.6	200	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	10	µg/L	307.88	1050	200	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	1	µg/L	654	654	200	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	2	µg/L	382.8	679	200	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	3	µg/L	2123.3	6080	200	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	8	1	µg/L	20.3	20.3	200	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	1	µg/L	23.3	23.3	200	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-37	P1A	929.3	n/a	10	2	µg/L	126.15	163	200	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	245	245	200	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	7	µg/L	170.51	267	200	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	157	157	200	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	7	µg/L	170.27	261	200	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	1	µg/L	85.3	85.3	200	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	4	µg/L	330.68	901	200	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	2	µg/L	406.5	711	200	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	3	µg/L	270	361	200	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Aluminum (continued)	R-49	P1A	845	n/a	9	9	µg/L	785.69	3020	200	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	3	µg/L	198.1	424	200	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	2	µg/L	1386.4	2690	200	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	1	µg/L	118	118	200	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	1	µg/L	69.1	69.1	200	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	1	µg/L	374	374	200	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	4	µg/L	511.28	1710	200	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	1	µg/L	78.7	78.7	200	—	—	—	—	—	—	—	—	—
Antimony	R-22	MP2A	962.8	n/a	19	1	µg/L	3.7	3.7	2	6	EPA MCL	0	3	1	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	1	µg/L	0.28	0.28	2	6	EPA MCL	0	3	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	1	µg/L	1.51	1.51	2	6	EPA MCL	0	3	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-37	P1A	929.3	n/a	10	1	µg/L	0.506	0.506	2	6	EPA MCL	0	3	0	—	—	—	—
	R-38	Single	821.2	FD	4	1	µg/L	0.561	0.561	2	6	EPA MCL	0	3	0	—	—	—	—
	R-38	Single	821.2	n/a	10	5	µg/L	0.7554	0.916	2	6	EPA MCL	0	3	0	—	—	—	—
	R-40	P1A	751.6	n/a	8	5	µg/L	4.2724	8.94	2	6	EPA MCL	2	3	2	—	—	—	Antimony was detected above the EPA MCL standard in 2 of the 8 samples at this screen.
	R-49	P1A	845	n/a	9	1	µg/L	0.509	0.509	2	6	EPA MCL	0	3	0	—	—	—	—
	R-53	P1A	849.2	n/a	5	1	µg/L	0.506	0.506	2	6	EPA MCL	0	3	0	—	—	—	—
Arsenic	R-20	MP1A	904.6	n/a	5	3	µg/L	4.2867	5.06	5	10	EPA MCL	0	5	1	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	1	µg/L	4.03	4.03	5	10	EPA MCL	0	5	0	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	3	µg/L	6.7333	8.2	5	10	EPA MCL	0	5	3	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	2	µg/L	2.835	3.25	5	10	EPA MCL	0	5	0	—	—	—	—
	R-20	P2A	1147.1	n/a	13	1	µg/L	1.8	1.8	5	10	EPA MCL	0	5	0	—	—	—	—
	R-21	Single	888.8	n/a	25	7	µg/L	2.1814	3.71	5	10	EPA MCL	0	5	0	—	—	—	—
	R-22	MP2A	962.8	n/a	19	1	µg/L	1.5	1.5	5	10	EPA MCL	0	5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	5	µg/L	3.058	4.99	5	10	EPA MCL	0	5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	3	µg/L	3.0233	3.61	5	10	EPA MCL	0	5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	1	µg/L	2.51	2.51	5	10	EPA MCL	0	5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	3	µg/L	2.5667	3.2	5	10	EPA MCL	0	5	0	—	—	—	—
	R-23	Single	816	n/a	25	4	µg/L	2.3475	2.9	5	10	EPA MCL	0	5	0	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Arsenic (continued)	R-23i	P1A	400.3	FD	1	1	µg/L	4.4	4.4	5	10	EPA MCL	0	5	0	—	—	—	—
	R-23i	P1A	400.3	n/a	14	4	µg/L	3.685	4.9	5	10	EPA MCL	0	5	0	—	—	—	—
	R-23i	P2A	470.2	n/a	19	7	µg/L	2.1929	3.03	5	10	EPA MCL	0	5	0	—	—	—	—
	R-23i	P3A	524	FD	2	1	µg/L	1.8	1.8	5	10	EPA MCL	0	5	0	—	—	—	—
	R-23i	P3A	524	n/a	16	6	µg/L	2.6217	3.84	5	10	EPA MCL	0	5	0	—	—	—	—
	R-32	MP3A	976	n/a	9	1	µg/L	2	2	5	10	EPA MCL	0	5	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	2	µg/L	1.6	1.6	5	10	EPA MCL	0	5	0	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	2.17	2.17	5	10	EPA MCL	0	5	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	3	µg/L	3.02	3.94	5	10	EPA MCL	0	5	0	—	—	—	—
	R-37	P2A	1026	n/a	9	1	µg/L	1.97	1.97	5	10	EPA MCL	0	5	0	—	—	—	—
	R-38	Single	821.2	FD	4	1	µg/L	3.38	3.38	5	10	EPA MCL	0	5	0	—	—	—	—
	R-38	Single	821.2	n/a	10	2	µg/L	2.615	2.93	5	10	EPA MCL	0	5	0	—	—	—	—
	R-39	Single	859	n/a	11	1	µg/L	2.14	2.14	5	10	EPA MCL	0	5	0	—	—	—	—
	R-40	P1A	751.6	n/a	8	1	µg/L	2.27	2.27	5	10	EPA MCL	0	5	0	—	—	—	—
	R-40	P2A	849.3	n/a	9	1	µg/L	1.95	1.95	5	10	EPA MCL	0	5	0	—	—	—	—
	R-40	R-40i	649.7	n/a	7	3	µg/L	3.1267	4.07	5	10	EPA MCL	0	5	0	—	—	—	—
	R-41	P2A	965.3	n/a	10	1	µg/L	1.53	1.53	5	10	EPA MCL	0	5	0	—	—	—	—
	R-49	P1A	845	n/a	9	3	µg/L	3.22	3.91	5	10	EPA MCL	0	5	0	—	—	—	—
	R-49	P2A	905.6	n/a	9	1	µg/L	3.34	3.34	5	10	EPA MCL	0	5	0	—	—	—	—
	R-51	P1A	914.96	n/a	6	2	µg/L	2.17	2.78	5	10	EPA MCL	0	5	0	—	—	—	—
	R-51	P2A	1031	n/a	6	1	µg/L	4.18	4.18	5	10	EPA MCL	0	5	0	—	—	—	—
	R-52	P2A	1107	n/a	5	1	µg/L	2.44	2.44	5	10	EPA MCL	0	5	0	—	—	—	—
	R-54	P1A	830	n/a	6	3	µg/L	1.9467	2.44	5	10	EPA MCL	0	5	0	—	—	—	—
	R-54	P2A	915	n/a	6	2	µg/L	2.515	2.77	5	10	EPA MCL	0	5	0	—	—	—	—
Barium	R-20	MP1A	904.6	n/a	5	5	µg/L	24.96	29.6	5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	215	261	5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	106.56	153	5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µg/L	77.2	90.5	5	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	180	185	5	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	µg/L	156.77	199	5	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	µg/L	13.6	13.7	5	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	25	µg/L	14.06	15.7	5	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	µg/L	217.71	239	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Barium (continued)	R-22	MP2A	962.8	n/a	19	17	µg/L	14.276	16.7	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	149	149	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	15	µg/L	128.22	187	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	337	337	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	µg/L	343.71	362	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	143	143	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	µg/L	132.86	141	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	24.633	32.9	5	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	25	µg/L	25.784	39.9	5	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	7.9	7.9	5	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	µg/L	54.279	87.8	5	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	9.31	10.5	5	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	µg/L	8.9832	12.6	5	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	µg/L	9.025	9.7	5	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	16	µg/L	13.039	64.3	5	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	µg/L	64.089	86.5	5	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	µg/L	81.1	92	5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	45.783	49.6	5	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	µg/L	43.253	50.6	5	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	9.5	9.5	5	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	13.913	32	5	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	32.9	32.9	5	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	µg/L	32.578	37.7	5	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	µg/L	29.8	30.6	5	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	µg/L	30.73	34.1	5	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	17.6	17.6	5	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	µg/L	18.473	31.7	5	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	31.663	39.1	5	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µg/L	23.15	23.9	5	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	µg/L	25.367	34.2	5	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	25.757	29.3	5	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Barium (continued)	R-41	P2A	965.3	FD	2	2	µg/L	29.1	29.4	5	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µg/L	26.444	35.7	5	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	44.533	121	5	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	µg/L	23.156	36.5	5	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	µg/L	25.517	27.7	5	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µg/L	21.217	26.5	5	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	30.1	31.8	5	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	5	µg/L	27.64	30.3	5	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	µg/L	25.06	28.8	5	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µg/L	29.45	29.6	5	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	µg/L	28.18	30	5	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	22.683	66	5	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	µg/L	12.152	19.4	5	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	µg/L	36.233	36.9	5	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µg/L	30.833	32	5	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	45.75	52.9	5	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	µg/L	27.5	33.6	5	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	27.633	30.6	5	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	17.1	17.5	5	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	20.05	20.1	5	—	—	—	—	—	—	—	—	—
Beryllium	R-23i	P3A	524	n/a	16	1	µg/L	1.4	1.4	0.5	4	EPA MCL	0	2	0	—	—	—	—
Boron	R-20	MP1A	904.6	n/a	5	4	µg/L	39	51.7	50	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	82.72	94.9	50	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	32.5	35.4	50	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	8	µg/L	15.7	21.8	50	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	1	µg/L	20.6	20.6	50	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	6	µg/L	18.033	24.5	50	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	2	µg/L	11.2	12.2	50	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	14	µg/L	13.369	18.9	50	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	4	µg/L	34.45	42.5	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	10	µg/L	13.13	19.3	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	30.5	30.5	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	12	µg/L	27.483	51	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Boron (continued)	R-22	MP4A	1378	FD	1	1	µg/L	93.9	93.9	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	µg/L	102.54	115	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	3	µg/L	35.733	45.3	50	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	6	µg/L	13.75	15.6	50	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	17	µg/L	13.82	18.2	50	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	17.2	17.2	50	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	9	µg/L	16.344	20.7	50	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	16.85	17.8	50	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	15	µg/L	20.6	63.9	50	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	µg/L	15.05	15.5	50	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	14	µg/L	16.907	23	50	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	7	µg/L	12.076	17.3	50	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	8	µg/L	13.45	15.1	50	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	3	µg/L	15.533	17.4	50	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	4	µg/L	16.925	19.4	50	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	30.6	30.6	50	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	28.38	35.3	50	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	5	µg/L	16.42	22.7	50	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	1	µg/L	17.5	17.5	50	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	17.963	22.7	50	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	6	µg/L	17.317	21.9	50	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	1	µg/L	15	15	50	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	5	µg/L	19.7	20.7	50	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	6	µg/L	20.317	35.5	50	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	2	µg/L	13.85	15	50	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	1	µg/L	16.9	16.9	50	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	1	µg/L	16.2	16.2	50	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	2	µg/L	16.85	18.5	50	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	1	µg/L	18.2	18.2	50	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	1	µg/L	15.1	15.1	50	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	4	µg/L	18.85	22.9	50	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	1	µg/L	16.7	16.7	50	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	µg/L	19.867	20.9	50	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µg/L	21.133	23.1	50	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Boron (continued)	R-55i	Single	510	n/a	2	2	µg/L	18.7	19	50	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	2	µg/L	16.1	16.2	50	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	15.6	15.6	50	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	1	µg/L	16.9	16.9	50	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	16.45	17.8	50	—	—	—	—	—	—	—	—	—
Cadmium	R-23	Single	816	FD	12	1	µg/L	0.159	0.159	1	5	EPA MCL	0	2.5	0	—	—	—	—
	R-23	Single	816	n/a	25	2	µg/L	0.167	0.224	1	5	EPA MCL	0	2.5	0	—	—	—	—
	R-23i	P3A	524	n/a	16	1	µg/L	0.36	0.36	1	5	EPA MCL	0	2.5	0	—	—	—	—
Chromium	R-20	MP1A	904.6	n/a	5	1	µg/L	1.4	1.4	5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	3	µg/L	4.8967	9.49	5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	3	µg/L	4.93	6.5	5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	6	µg/L	3.32	4.9	5	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	2	µg/L	5.64	7.73	5	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	10	µg/L	3.735	5.9	5	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	1	µg/L	2.8	2.8	5	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	16	µg/L	3.3306	5.25	5	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	2	µg/L	16.245	31.4	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	10	µg/L	6.949	20.1	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	14.6	14.6	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	11	µg/L	10.357	47	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	1	µg/L	5.24	5.24	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	1	µg/L	2.23	2.23	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	10	µg/L	3.659	5.35	5	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	20	µg/L	4.8369	20.1	5	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	1.5	1.5	5	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	9	µg/L	5.8478	18	5	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	4	µg/L	2.5375	4.05	5	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	µg/L	2.73	3.86	5	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	10	µg/L	11.075	82.4	5	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	4	µg/L	7.384	24.3	5	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Chromium (continued)	R-32	MP3A	976	n/a	9	4	µg/L	5.6	10.4	5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	4	µg/L	5.15	9.6	5	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	8	µg/L	3.94	6.14	5	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	3	µg/L	3.1733	3.35	5	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	35.6	35.6	5	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	5	µg/L	7.942	21.5	5	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	1	µg/L	4.67	4.67	5	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	7	µg/L	6.7229	11.9	5	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	2.75	2.75	5	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	7	µg/L	3.6329	4.57	5	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	3	µg/L	4.6967	5.55	5	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	5	µg/L	3.722	5.45	5	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	2	µg/L	2.48	2.66	5	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	4.27	4.96	5	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	7	µg/L	4.1771	6.66	5	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	7	µg/L	4.3471	7.82	5	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	6	µg/L	3.4633	4.89	5	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	3	µg/L	3.7433	4.27	5	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	5	µg/L	3.518	4.64	5	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	4	µg/L	3.875	4.9	5	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	3	µg/L	4.5933	6.32	5	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	3	µg/L	2.7633	3.8	5	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µg/L	2.5	2.75	5	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	3	µg/L	3.4733	5.4	5	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	2	µg/L	73.25	143	5	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	4	µg/L	3.595	4.42	5	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	2	µg/L	3.045	3.21	5	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	2	µg/L	4.43	6.43	5	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	1	µg/L	5.32	5.32	5	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	5.55	5.55	5	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	3.54	4.85	5	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	1	µg/L	3.8	3.8	5	—	—	—	—	—	—	—	—	—
Cobalt	R-20	MP1A	904.6	n/a	5	1	µg/L	0.898	0.898	5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-22	MP1A	907.1	n/a	7	1	µg/L	1.3	1.3	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Cobalt (continued)	R-22	MP4A	1378	n/a	7	1	µg/L	0.709	0.709	5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	µg/L	1.9	1.9	5	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	1.04	1.04	5	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	2	µg/L	1.06	1.49	5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-40	P1A	751.6	n/a	8	1	µg/L	1.42	1.42	5	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	3	µg/L	2.0167	2.66	5	—	—	—	—	—	—	—	—	—
Copper	R-20	MP1A	904.6	n/a	5	1	µg/L	1.4	1.4	10	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	2	µg/L	2.55	3.2	10	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-21	Single	888.8	n/a	24	1	µg/L	13.1	13.1	10	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	6	2	µg/L	2.7	3.4	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	13	1	µg/L	4.11	4.11	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	1	µg/L	3.03	3.03	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	11	1	µg/L	3.2	3.2	10	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	23	1	µg/L	3.16	3.16	10	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	13	4	µg/L	3.5375	4.03	10	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	18	1	µg/L	3.1	3.1	10	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	15	1	µg/L	25	25	10	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	7	1	µg/L	1.98	1.98	10	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	n/a	15	2	µg/L	5.15	6.61	10	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	1	µg/L	15.4	15.4	10	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	1	µg/L	6.4	6.4	10	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	2	µg/L	7.815	8.93	10	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	5	µg/L	8.312	13.5	10	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	1	µg/L	14	14	10	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	2	µg/L	11.37	15	10	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	1	µg/L	3.24	3.24	10	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	1	µg/L	10.2	10.2	10	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	1	µg/L	16.2	16.2	10	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	1	µg/L	4.27	4.27	10	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Iron	R-20	MP1A	904.6	n/a	5	4	µg/L	126	143	100	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	4	µg/L	1006.5	1090	100	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	8830	12900	100	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	7	µg/L	60.329	181	100	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	111.37	252	100	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	12	µg/L	61.717	152	100	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	1	µg/L	21.1	21.1	100	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	9	µg/L	28.744	48.9	100	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	8	8	µg/L	17063	21500	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	3	µg/L	66.167	114	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	162	162	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	8	µg/L	119.58	320	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	4850	4850	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	µg/L	4912.9	8300	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	2420	2420	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	µg/L	2424.3	5200	100	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	11	µg/L	52.818	125	100	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	17	µg/L	82.565	327	100	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	80.4	80.4	100	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	12	µg/L	267.11	1090	100	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	1	µg/L	666	666	100	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	5	µg/L	243.68	667	100	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	1	µg/L	112	112	100	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	8	µg/L	1172.1	8890	100	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	3	µg/L	59.967	138	100	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	µg/L	685	1090	100	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	4	µg/L	144.38	280	100	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	8	µg/L	108.85	250	100	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	7	µg/L	77.371	229	100	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Iron (continued)	R-37	P2A	1026	FD	1	1	µg/L	328	328	100	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	8	µg/L	158.33	272	100	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	3	µg/L	122.83	265	100	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	127	127	100	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	µg/L	107.36	199	100	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	6	µg/L	360.22	1050	100	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µg/L	65.2	98.4	100	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	8	µg/L	193.79	612	100	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	1168.9	1470	100	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	4	µg/L	200.58	398	100	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	387.63	1510	100	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	2	µg/L	37.1	39.4	100	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	4	µg/L	50.45	55.1	100	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	5	µg/L	156.38	478	100	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	4	µg/L	364.4	1320	100	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	1	µg/L	118	118	100	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	1	µg/L	227	227	100	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	1	µg/L	184	184	100	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	2016.5	4600	100	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	4	µg/L	44.05	55.3	100	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	1	µg/L	64.3	64.3	100	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	2	µg/L	49.35	57.6	100	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	421.5	675	100	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	1	µg/L	55.1	55.1	100	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	71.533	103	100	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	72.05	89.3	100	—	—	—	—	—	—	—	—	—
Lead	R-20	MP1A	904.6	n/a	5	5	µg/L	0.7012	0.946	2	15	EPA MCL	0	7.5	0	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	3	µg/L	0.2047	0.224	2	15	EPA MCL	0	7.5	0	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	3	µg/L	0.1577	0.223	2	15	EPA MCL	0	7.5	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	1	µg/L	0.51	0.51	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-20	P2A	1147.1	FD	3	2	µg/L	5.8435	10.8	2	15	EPA MCL	0	7.5	1	—	—	—	—
	R-20	P2A	1147.1	n/a	13	1	µg/L	0.569	0.569	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-21	Single	888.8	n/a	25	2	µg/L	0.117	0.137	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-22	MP1A	907.1	n/a	7	2	µg/L	0.11	0.117	2	15	EPA MCL	0	7.5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Lead (continued)	R-22	MP3A	1273.5	n/a	16	1	µg/L	0.073	0.073	2	15	EPA MCL	0	7.5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	2	µg/L	0.097	0.104	2	15	EPA MCL	0	7.5	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	7	µg/L	1.2514	2.2	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-23	Single	816	n/a	25	17	µg/L	2.1155	14.2	2	15	EPA MCL	0	7.5	1	—	—	—	—
	R-23i	P1A	400.3	n/a	14	4	µg/L	1.0443	1.47	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-23i	P3A	524	n/a	16	1	µg/L	21.9	21.9	2	15	EPA MCL	1	7.5	1	—	—	—	Lead was detected during the first sampling event in October 2006 above the EPA MCL and has not been detected after the first sampling event.
	R-32	MP3A	976	n/a	9	3	µg/L	0.4067	0.46	2	15	EPA MCL	0	7.5	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	1	µg/L	0.53	0.53	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-32	Single	867.5	n/a	15	1	µg/L	0.51	0.51	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	1	µg/L	1.78	1.78	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-38	Single	821.2	n/a	10	1	µg/L	0.83	0.83	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-40	P1A	751.6	n/a	8	3	µg/L	1.4597	2.68	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-40	P2A	849.3	n/a	9	1	µg/L	0.9	0.9	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-40	R-40i	649.7	n/a	7	1	µg/L	0.61	0.61	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-41	P2A	965.3	n/a	10	1	µg/L	0.539	0.539	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-49	P1A	845	n/a	9	8	µg/L	2.6198	8.85	2	15	EPA MCL	0	7.5	1	—	—	—	—
	R-51	P1A	914.96	n/a	6	1	µg/L	0.98	0.98	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-52	P1A	1035.2	n/a	5	1	µg/L	0.698	0.698	2	15	EPA MCL	0	7.5	0	—	—	—	—
	R-54	P1A	830	n/a	6	2	µg/L	5.178	9.8	2	15	EPA MCL	0	7.5	1	—	—	—	—
Manganese	R-20	MP1A	904.6	n/a	5	5	µg/L	15.14	20.5	10	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	346.2	388	10	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	777.4	1120	10	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µg/L	19.854	31.4	10	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	68.133	72	10	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	µg/L	63.608	80.7	10	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	µg/L	7.9	10	10	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	25	µg/L	7.1356	11.7	10	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	8	8	µg/L	3470	4320	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	12	µg/L	5.2625	20.5	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Manganese (continued)	R-22	MP3A	1273.5	FD	1	1	µg/L	5.7	5.7	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	10	µg/L	27.571	160	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	1390	1390	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	µg/L	1025.9	1600	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	449	449	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	µg/L	509.14	650	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	64.967	383	10	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	25	µg/L	65.392	604	10	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	2.6	2.6	10	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	µg/L	22.408	77.4	10	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	1	µg/L	18.8	18.8	10	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	6	µg/L	9.6333	19.2	10	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	3	µg/L	153.73	453	10	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	5	µg/L	25.4	72.5	10	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	9	µg/L	1770	2170	10	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	11.25	22.9	10	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	11	µg/L	7.42	21.9	10	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	28.4	28.4	10	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	8	µg/L	27.048	81.3	10	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	5	5	10	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	5	µg/L	4.584	6.44	10	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	1	µg/L	4.66	4.66	10	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	9	µg/L	6.3611	13.6	10	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	6.94	6.94	10	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	µg/L	6.9582	19.1	10	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	88.291	383	10	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	1	µg/L	2.53	2.53	10	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	5	µg/L	25.344	108	10	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	303	392	10	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	5.28	7.12	10	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	8	µg/L	10.918	50.9	10	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	18.95	51.4	10	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Manganese (continued)	R-49	P2A	905.6	n/a	9	1	µg/L	4.26	4.26	10	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	2	µg/L	5.1	7.7	10	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	4	µg/L	7.0325	18.3	10	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	1	µg/L	13.4	13.4	10	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	2	µg/L	6.88	11.7	10	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	2	µg/L	19.615	36.2	10	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	1	µg/L	6.14	6.14	10	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	173.38	306	10	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	2	µg/L	4.49	6.37	10	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	3	µg/L	10.24	16.5	10	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	2	µg/L	7.925	13.6	10	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	525	644	10	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	µg/L	12.94	19.8	10	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	16.5	16.5	10	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	46.3	79.2	10	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	14.34	19	10	—	—	—	—	—	—	—	—	—
Mercury	R-20	P2A	1147.1	n/a	13	1	µg/L	0.29	0.29	0.2	2	EPA MCL	0	1	0	0.2	Regional	1	—
	R-22	MP3A	1273.5	n/a	16	2	µg/L	0.4485	0.84	0.2	2	EPA MCL	0	1	0	0.2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-23i	P1A	400.3	n/a	14	1	µg/L	0.096	0.096	0.2	2	EPA MCL	0	1	0	0.06	Intermediate	1	—
	R-23i	P3A	524	n/a	16	1	µg/L	0.13	0.13	0.2	2	EPA MCL	0	1	0	0.06	Intermediate	1	—
	R-32	MP3A	976	n/a	9	1	µg/L	0.32	0.32	0.2	2	EPA MCL	0	1	0	0.2	Regional	1	Screen plugged and abandoned because of residual effects of drilling products.
Molybdenum	R-20	MP1A	904.6	n/a	5	5	µg/L	12.8	22.6	0.5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	5.362	6.1	0.5	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	20.42	30.8	0.5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	10	µg/L	1.427	1.9	0.5	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	1.8	2.01	0.5	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	µg/L	1.6677	2.02	0.5	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	20	µg/L	1.851	3.67	0.5	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	µg/L	24.286	32	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	7	µg/L	1.6371	1.9	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	5	5	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Molybdenum (continued)	R-22	MP3A	1273.5	n/a	16	12	µg/L	7.7317	22	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	10.6	10.6	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	µg/L	9.76	23	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	26.3	26.3	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	µg/L	22.9	28	0.5	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	4	µg/L	1.73	2.07	0.5	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	16	µg/L	1.6625	2.09	0.5	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	12	µg/L	3.6842	28.8	0.5	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	2.35	2.5	0.5	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	16	µg/L	2.1806	3.4	0.5	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	1	µg/L	2	2	0.5	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	12	µg/L	1.515	2.2	0.5	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	5	µg/L	2.882	3.31	0.5	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	5	µg/L	1.974	2.67	0.5	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	2.4	2.8	0.5	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	µg/L	2.2713	2.6	0.5	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	4.19	4.19	0.5	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	3.701	4.22	0.5	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	1.84	1.84	0.5	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	µg/L	2.1756	3.2	0.5	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	3	µg/L	1.6833	1.73	0.5	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	9	µg/L	1.9622	3	0.5	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	1.61	1.61	0.5	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	11	µg/L	2.1045	4.98	0.5	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	9.1913	14.4	0.5	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µg/L	2.56	3.76	0.5	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	µg/L	2.9689	6.1	0.5	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	17.5	21.8	0.5	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	3.65	3.97	0.5	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µg/L	3.866	7.4	0.5	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	2.9167	5.64	0.5	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	8	µg/L	1.4438	1.59	0.5	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Molybdenum (continued)	R-51	P1A	914.96	n/a	6	6	µg/L	1.3917	1.54	0.5	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µg/L	1.2767	1.39	0.5	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	1.746	2.29	0.5	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	4	µg/L	1.2025	1.34	0.5	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	µg/L	1.528	2.22	0.5	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	1	µg/L	1.03	1.03	0.5	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	4	µg/L	1.22	1.53	0.5	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	3.81	7.53	0.5	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	6	µg/L	1.1302	1.2	0.5	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	2	µg/L	1.135	1.23	0.5	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µg/L	1.52	1.8	0.5	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	8.4	9.41	0.5	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	3	µg/L	1.7867	1.99	0.5	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	2.71	3.11	0.5	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	2.085	2.28	0.5	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	1.7	1.81	0.5	—	—	—	—	—	—	—	—	—
Nickel	R-20	MP1A	904.6	n/a	5	2	µg/L	1.125	1.5	2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	1	µg/L	3.5	3.5	2	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	3	µg/L	6.7667	12.8	2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	12	µg/L	1.8097	5.93	2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	3.4167	4.53	2	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	12	µg/L	2.7328	3.9	2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	FD	3	3	µg/L	0.57	0.61	2	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	11	µg/L	0.6112	0.88	2	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	5	µg/L	23.06	31.5	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	9	µg/L	2.1383	7.7	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	2.2	2.2	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	11	µg/L	5.0936	27	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	6	µg/L	4.5467	7.01	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	2	µg/L	8.45	14.8	2	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	10	µg/L	1.3833	3.77	2	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	20	µg/L	2.1495	9.4	2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Nickel (continued)	R-23i	P1A	400.3	FD	1	1	µg/L	1.2	1.2	2	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	13	µg/L	1.8014	5.18	2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	0.8575	0.91	2	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	µg/L	1.2312	5.8	2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	2	µg/L	1.585	1.9	2	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	15	µg/L	3.5746	36.3	2	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	6	µg/L	3.155	11.4	2	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	6	µg/L	3.65	6.9	2	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	3.55	7	2	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	14	µg/L	2.3671	6.5	2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	1.97	1.97	2	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	1.3264	1.84	2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	15.6	15.6	2	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	9	µg/L	2.1506	9.65	2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	µg/L	4.81	8.77	2	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	10	µg/L	11.64	30.1	2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	0.904	0.904	2	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	10	µg/L	1.1475	3.28	2	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	14.59	76.9	2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µg/L	1.0975	1.59	2	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	8	µg/L	1.0878	1.8	2	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	1.0036	1.4	2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	2.425	2.72	2	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µg/L	1.8781	2.85	2	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	2.1127	6.24	2	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	4	µg/L	0.6638	0.732	2	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	4	µg/L	0.7415	0.993	2	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µg/L	0.695	0.901	2	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	4	µg/L	0.6808	0.859	2	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	4	µg/L	0.7655	1.26	2	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	4	µg/L	0.9595	1.46	2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µg/L	0.5995	0.647	2	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	2	µg/L	0.766	0.801	2	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	10.043	49.4	2	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	4	µg/L	0.7345	1.06	2	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	2	µg/L	0.9575	0.958	2	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Nickel (continued)	R-55	P2A	994.4	n/a	3	2	µg/L	0.8605	1.19	2	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	3.945	4.04	2	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	2	µg/L	0.7885	1.01	2	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	0.7043	0.839	2	—	—	—	—	—	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	1.074	1.54	2	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	1	µg/L	0.887	0.887	2	—	—	—	—	—	—	—	—	—
Selenium	R-20	MP1A	904.6	n/a	5	2	µg/L	5.035	5.3	5	50	EPA MCL	0	25	0	6	Regional	0	Before well rehabilitation.
	R-22	MP2A	962.8	n/a	19	2	µg/L	2.985	4.87	5	50	EPA MCL	0	25	0	6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	3	µg/L	1.3667	1.6	5	50	EPA MCL	0	25	0	6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	1	µg/L	2.6	2.6	5	50	EPA MCL	0	25	0	6	Regional	0	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	1	µg/L	1.03	1.03	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-23	Single	816	n/a	25	3	µg/L	2.3867	4.35	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	1.44	1.44	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
	R-23i	P2A	470.2	n/a	19	2	µg/L	1.14	1.27	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
	R-23i	P3A	524	n/a	16	1	µg/L	1.03	1.03	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
	R-32	MP1A	870.9	n/a	9	2	µg/L	2.25	3.4	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-32	Single	867.5	n/a	15	2	µg/L	1.445	1.75	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-37	P1A	929.3	n/a	10	1	µg/L	1.53	1.53	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
	R-38	Single	821.2	n/a	10	1	µg/L	1.19	1.19	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-49	P1A	845	n/a	9	1	µg/L	1.07	1.07	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-49	P2A	905.6	n/a	9	1	µg/L	1.17	1.17	5	50	EPA MCL	0	25	0	6	Regional	0	—
	R-55i	Single	510	n/a	2	1	µg/L	2.85	2.85	5	50	EPA MCL	0	25	0	6	Intermediate	0	—
Silicon	R-22	MP1A	907.1	n/a	1	1	µg/L	16000	16000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	2	2	µg/L	30500	31000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	2	2	µg/L	22500	28000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	1	1	µg/L	22000	22000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	2	2	µg/L	23500	25000	0.1	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
Silicon Dioxide	R-53	P2A	959.7	n/a	1	1	mg/L	73.3	73.3	0.1	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Silver	R-22	MP2A	962.8	n/a	19	1	µg/L	2.3	2.3	1	—	—	—	—	—	2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	1	µg/L	2.77	2.77	1	—	—	—	—	—	2	Regional	1	R-22 is off-line and will undergo rehabilitation.
	R-54	P1A	830	n/a	6	1	µg/L	0.764	0.764	1	—	—	—	—	—	2	Regional	0	—
Strontium	R-20	MP1A	904.6	n/a	5	5	µg/L	35.12	40.4	5	22000	EPA Tap	0	11000	0	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	1710	2070	5	22000	EPA Tap	0	11000	0	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	5	µg/L	130.5	191	5	22000	EPA Tap	0	11000	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	13	µg/L	138.85	152	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	218	228	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-20	P2A	1147.1	n/a	13	13	µg/L	206.85	230	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-21	Single	888.8	FD	3	3	µg/L	44.067	45	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-21	Single	888.8	n/a	25	25	µg/L	45.28	49.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-22	MP1A	907.1	n/a	7	7	µg/L	351	394	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	19	µg/L	50.621	55.5	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	633	633	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	16	µg/L	542.13	1000	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	933	933	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	7	µg/L	885.29	1100	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	FD	1	1	µg/L	327	327	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	7	µg/L	287.57	330	5	22000	EPA Tap	0	11000	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	12	µg/L	80.708	84.1	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23	Single	816	n/a	25	25	µg/L	81.772	86.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	94.9	94.9	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P1A	400.3	n/a	14	14	µg/L	165.61	256	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	94.85	98.4	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P2A	470.2	n/a	19	19	µg/L	96.342	113	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P3A	524	FD	2	2	µg/L	91.5	93.7	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P3A	524	n/a	16	16	µg/L	101.03	176	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	µg/L	84.656	91.1	5	22000	EPA Tap	0	11000	0	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Strontium (continued)	R-32	MP3A	976	n/a	9	9	µg/L	99.689	106	5	22000	EPA Tap	0	11000	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	81.35	91	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-32	Single	867.5	n/a	15	15	µg/L	79.46	90.8	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	105	105	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	103.77	108	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	53.6	53.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P2A	1026	n/a	9	9	µg/L	63.967	99.1	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-38	Single	821.2	FD	4	4	µg/L	51.975	53.4	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-38	Single	821.2	n/a	10	10	µg/L	51.98	55.3	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	55.2	55.2	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-39	Single	859	n/a	11	11	µg/L	58.155	79.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	103.15	117	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µg/L	49.7	49.8	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	µg/L	53.589	68.8	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-40	R-40i	649.7	n/a	7	7	µg/L	94.771	104	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	77.25	77.3	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µg/L	73.38	80.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	83.067	118	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-49	P2A	905.6	n/a	9	9	µg/L	58.522	67.3	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	µg/L	82.783	101	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µg/L	53.783	57.7	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	63.22	68.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-52	P2A	1107	n/a	5	5	µg/L	49.14	50.7	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	µg/L	44.46	47.7	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µg/L	46.35	46.8	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	µg/L	45	46.9	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	60.283	80.7	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-54	P2A	915	n/a	6	6	µg/L	52.667	55.6	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-55	P1A	860	n/a	3	3	µg/L	73.633	74.8	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µg/L	79.933	84.5	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	163.5	167	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-56	P1A	945	n/a	3	3	µg/L	54.8	58.1	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	54.567	55.5	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	58.6	59.8	5	22000	EPA Tap	0	11000	0	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	61.15	61.4	5	22000	EPA Tap	0	11000	0	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Thallium	R-20	MP1A	904.6	n/a	5	1	µg/L	0.082	0.082	1	2	EPA MCL	0	1	0	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	1	µg/L	0.026	0.026	1	2	EPA MCL	0	1	0	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	2	µg/L	0.0675	0.092	1	2	EPA MCL	0	1	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	2	µg/L	0.405	0.41	1	2	EPA MCL	0	1	0	—	—	—	—
	R-20	P2A	1147.1	n/a	13	2	µg/L	0.415	0.43	1	2	EPA MCL	0	1	0	—	—	—	—
	R-21	Single	888.8	FD	3	1	µg/L	0.4	0.4	1	2	EPA MCL	0	1	0	—	—	—	—
	R-21	Single	888.8	n/a	25	3	µg/L	0.6913	1.56	1	2	EPA MCL	0	1	1	—	—	—	—
	R-22	MP2A	962.8	n/a	19	3	µg/L	0.4263	0.53	1	2	EPA MCL	0	1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	3	µg/L	0.5083	0.52	1	2	EPA MCL	0	1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	1	µg/L	0.526	0.526	1	2	EPA MCL	0	1	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	n/a	25	1	µg/L	0.052	0.052	1	2	EPA MCL	0	1	0	—	—	—	—
	R-23i	P2A	470.2	n/a	19	4	µg/L	0.4353	0.538	1	2	EPA MCL	0	1	0	—	—	—	—
	R-23i	P3A	524	n/a	16	1	µg/L	0.47	0.47	1	2	EPA MCL	0	1	0	—	—	—	—
	R-32	MP1A	870.9	n/a	9	1	µg/L	0.05	0.05	1	2	EPA MCL	0	1	0	—	—	—	—
	R-32	Single	867.5	n/a	15	1	µg/L	0.4	0.4	1	2	EPA MCL	0	1	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	1	µg/L	0.581	0.581	1	2	EPA MCL	0	1	0	—	—	—	—
	R-38	Single	821.2	n/a	10	2	µg/L	0.359	0.41	1	2	EPA MCL	0	1	0	—	—	—	—
	R-40	R-40i	649.7	n/a	7	2	µg/L	0.391	0.435	1	2	EPA MCL	0	1	0	—	—	—	—
	R-49	P1A	845	n/a	9	1	µg/L	0.469	0.469	1	2	EPA MCL	0	1	0	—	—	—	—
	R-54	P1A	830	n/a	6	1	µg/L	0.575	0.575	1	2	EPA MCL	0	1	0	—	—	—	—
Tin	R-23	Single	816	FD	12	2	µg/L	3.33	3.56	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23	Single	816	n/a	21	2	µg/L	2.86	3.02	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-23i	P1A	400.3	n/a	14	1	µg/L	4.22	4.22	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-32	Single	867.5	n/a	15	1	µg/L	3.46	3.46	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	2.84	2.84	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	1	µg/L	3.19	3.19	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-37	P2A	1026	n/a	9	1	µg/L	3.53	3.53	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-49	P2A	905.6	n/a	9	1	µg/L	4.69	4.69	10	22000	EPA Tap	0	11000	0	—	—	—	—
	R-51	P1A	914.96	n/a	6	1	µg/L	7.72	7.72	10	22000	EPA Tap	0	11000	0	—	—	—	—
Uranium	R-20	MP1A	904.6	n/a	5	4	µg/L	0.1498	0.18	0.2	30	EPA MCL	0	15	0	—	—	—	Before well rehabilitation.
	R-20	MP2A	1147.1	n/a	5	5	µg/L	0.1168	0.18	0.2	30	EPA MCL	0	15	0	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	1	µg/L	0.021	0.021	0.2	30	EPA MCL	0	15	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Uranium (continued)	R-20	P1A	904.6	n/a	13	11	µg/L	0.6811	1.09	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	0.5587	0.669	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-20	P2A	1147.1	n/a	13	12	µg/L	0.5913	0.76	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-21	Single	888.8	FD	3	3	µg/L	0.32	0.35	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-21	Single	888.8	n/a	25	21	µg/L	0.3618	0.568	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-22	MP1A	907.1	n/a	6	3	µg/L	0.131	0.197	0.2	30	EPA MCL	0	15	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	18	15	µg/L	0.3645	0.43	0.2	30	EPA MCL	0	15	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	3.6	3.6	0.2	30	EPA MCL	0	15	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	15	15	µg/L	3.2413	16	0.2	30	EPA MCL	0	15	1	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	FD	1	1	µg/L	0.32	0.32	0.2	30	EPA MCL	0	15	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	6	3	µg/L	0.1833	0.26	0.2	30	EPA MCL	0	15	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	6	2	µg/L	0.1335	0.14	0.2	30	EPA MCL	0	15	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	10	µg/L	0.4825	0.52	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-23	Single	816	n/a	25	21	µg/L	0.527	0.854	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	1.3	1.3	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-23i	P1A	400.3	n/a	14	13	µg/L	2.6462	22.7	0.2	30	EPA MCL	0	15	1	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	0.9415	1	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-23i	P2A	470.2	n/a	19	18	µg/L	1.0594	1.7	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-23i	P3A	524	FD	2	1	µg/L	0.56	0.56	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-23i	P3A	524	n/a	16	14	µg/L	0.9103	4.6	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-32	MP1A	870.9	n/a	9	9	µg/L	1.04	1.7	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-32	MP3A	976	n/a	9	8	µg/L	0.1699	0.51	0.2	30	EPA MCL	0	15	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	6	µg/L	0.8117	0.87	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-32	Single	867.5	n/a	15	14	µg/L	0.7568	0.912	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	1.34	1.34	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	1.578	1.87	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	0.522	0.522	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-37	P2A	1026	n/a	9	9	µg/L	0.7517	1.8	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-38	Single	821.2	FD	4	4	µg/L	0.408	0.454	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-38	Single	821.2	n/a	10	10	µg/L	0.4359	0.614	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	0.458	0.458	0.2	30	EPA MCL	0	15	0	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Uranium (continued)	R-39	Single	859	n/a	11	10	µg/L	0.469	0.67	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	1.0684	1.44	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-40	P2A	849.3	FD	2	2	µg/L	0.3705	0.428	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	µg/L	0.4028	0.87	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-40	R-40i	649.7	n/a	7	6	µg/L	0.5347	1.1	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	0.62	0.645	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µg/L	0.6618	1.2	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	1.9978	4.59	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-49	P2A	905.6	n/a	9	8	µg/L	0.3691	0.541	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	µg/L	0.3458	0.515	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µg/L	0.4153	0.602	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	0.6282	0.89	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-52	P2A	1107	n/a	5	4	µg/L	0.3718	0.446	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	µg/L	0.4958	0.554	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µg/L	0.4395	0.483	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	µg/L	0.5302	0.708	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	1.0058	3.25	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-54	P2A	915	n/a	6	6	µg/L	0.4562	0.526	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-55	P1A	860	n/a	3	3	µg/L	0.6607	0.673	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µg/L	0.6373	0.682	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-55i	Single	510	n/a	2	2	µg/L	1.11	1.15	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-56	P1A	945	n/a	3	3	µg/L	0.599	0.647	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-56	P2A	1046.6	n/a	3	3	µg/L	0.6053	0.656	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-57	P1A	910	n/a	2	1	µg/L	0.366	0.366	0.2	30	EPA MCL	0	15	0	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	0.3885	0.454	0.2	30	EPA MCL	0	15	0	—	—	—	—
Vanadium	R-20	MP3A	1330	n/a	5	1	µg/L	0.753	0.753	5	180	EPA Tap	0	90	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	12	µg/L	4.6117	7.56	5	180	EPA Tap	0	90	0	—	—	—	—
	R-20	P2A	1147.1	FD	3	3	µg/L	3.1633	3.33	5	180	EPA Tap	0	90	0	—	—	—	—
	R-20	P2A	1147.1	n/a	13	9	µg/L	4.2011	5.15	5	180	EPA Tap	0	90	0	—	—	—	—
	R-21	Single	888.8	FD	3	2	µg/L	5.35	5.5	5	180	EPA Tap	0	90	0	—	—	—	—
	R-21	Single	888.8	n/a	25	22	µg/L	5.1686	6	5	180	EPA Tap	0	90	0	—	—	—	—
	R-22	MP2A	962.8	n/a	19	13	µg/L	5.0169	6.1	5	180	EPA Tap	0	90	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	5.6	5.6	5	180	EPA Tap	0	90	0	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	10	µg/L	6.56	9.1	5	180	EPA Tap	0	90	0	—	—	—	R-22 is off-line and will undergo rehabilitation.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Vanadium (continued)	R-23	Single	816	FD	12	12	µg/L	6.4483	7.6	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23	Single	816	n/a	25	25	µg/L	6.542	7.56	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	3.9	3.9	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23i	P1A	400.3	n/a	14	11	µg/L	3.2818	4.3	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	4.875	5.35	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23i	P2A	470.2	n/a	19	18	µg/L	4.5556	5.64	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23i	P3A	524	FD	2	1	µg/L	4.89	4.89	5	180	EPA Tap	0	90	0	—	—	—	—
	R-23i	P3A	524	n/a	16	15	µg/L	6.6613	25.1	5	180	EPA Tap	0	90	0	—	—	—	—
	R-32	MP1A	870.9	n/a	9	6	µg/L	3.7833	5	5	180	EPA Tap	0	90	0	—	—	—	—
	R-32	MP3A	976	n/a	9	2	µg/L	2.05	2.1	5	180	EPA Tap	0	90	0	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-32	Single	867.5	FD	6	4	µg/L	3.5	3.9	5	180	EPA Tap	0	90	0	—	—	—	—
	R-32	Single	867.5	n/a	15	13	µg/L	3.5662	4.12	5	180	EPA Tap	0	90	0	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	4.84	4.84	5	180	EPA Tap	0	90	0	—	—	—	—
	R-37	P1A	929.3	n/a	10	10	µg/L	5.012	6.26	5	180	EPA Tap	0	90	0	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	6.07	6.07	5	180	EPA Tap	0	90	0	—	—	—	—
	R-37	P2A	1026	n/a	9	8	µg/L	6.0238	6.62	5	180	EPA Tap	0	90	0	—	—	—	—
	R-38	Single	821.2	FD	4	4	µg/L	4.4575	4.94	5	180	EPA Tap	0	90	0	—	—	—	—
	R-38	Single	821.2	n/a	10	9	µg/L	4.4733	5.01	5	180	EPA Tap	0	90	0	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	5.13	5.13	5	180	EPA Tap	0	90	0	—	—	—	—
	R-39	Single	859	n/a	11	9	µg/L	5.7511	6.27	5	180	EPA Tap	0	90	0	—	—	—	—
	R-40	P1A	751.6	n/a	8	7	µg/L	3.0857	4.4	5	180	EPA Tap	0	90	0	—	—	—	—
	R-40	P2A	849.3	FD	2	1	µg/L	4.8	4.8	5	180	EPA Tap	0	90	0	—	—	—	—
	R-40	P2A	849.3	n/a	9	8	µg/L	4.5825	5.57	5	180	EPA Tap	0	90	0	—	—	—	—
	R-40	R-40i	649.7	n/a	7	1	µg/L	1.5	1.5	5	180	EPA Tap	0	90	0	—	—	—	—
	R-41	P2A	965.3	FD	2	2	µg/L	5.71	5.85	5	180	EPA Tap	0	90	0	—	—	—	—
	R-41	P2A	965.3	n/a	10	10	µg/L	5.786	7.19	5	180	EPA Tap	0	90	0	—	—	—	—
	R-49	P1A	845	n/a	9	9	µg/L	4.6367	6.47	5	180	EPA Tap	0	90	0	—	—	—	—
	R-49	P2A	905.6	n/a	9	8	µg/L	4.7925	5.66	5	180	EPA Tap	0	90	0	—	—	—	—
	R-51	P1A	914.96	n/a	6	6	µg/L	5.79	6.38	5	180	EPA Tap	0	90	0	—	—	—	—
	R-51	P2A	1031	n/a	6	6	µg/L	5.545	5.97	5	180	EPA Tap	0	90	0	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	6.124	6.88	5	180	EPA Tap	0	90	0	—	—	—	—
	R-52	P2A	1107	n/a	5	5	µg/L	5.944	6.09	5	180	EPA Tap	0	90	0	—	—	—	—
	R-53	P1A	849.2	n/a	5	5	µg/L	4.546	5.2	5	180	EPA Tap	0	90	0	—	—	—	—
	R-53	P2A	959.7	FD	2	2	µg/L	5.2	5.52	5	180	EPA Tap	0	90	0	—	—	—	—
	R-53	P2A	959.7	n/a	5	5	µg/L	5.27	6.5	5	180	EPA Tap	0	90	0	—	—	—	—
	R-54	P1A	830	n/a	6	5	µg/L	2.658	4.18	5	180	EPA Tap	0	90	0	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Vanadium (continued)	R-54	P2A	915	n/a	6	6	µg/L	5.1833	5.64	5	180	EPA Tap	0	90	0	—	—	—	—
	R-55	P1A	860	n/a	3	3	µg/L	5.4033	5.79	5	180	EPA Tap	0	90	0	—	—	—	—
	R-55	P2A	994.4	n/a	3	3	µg/L	5.22	5.56	5	180	EPA Tap	0	90	0	—	—	—	—
	R-55i	Single	510	n/a	2	1	µg/L	3.28	3.28	5	180	EPA Tap	0	90	0	—	—	—	—
	R-56	P1A	945	n/a	3	2	µg/L	3.75	3.92	5	180	EPA Tap	0	90	0	—	—	—	—
	R-56	P2A	1046.6	n/a	3	2	µg/L	3.515	3.77	5	180	EPA Tap	0	90	0	—	—	—	—
	R-57	P1A	910	n/a	2	2	µg/L	4.735	4.93	5	180	EPA Tap	0	90	0	—	—	—	—
	R-57	P2A	971.5	n/a	2	2	µg/L	4.78	5.03	5	180	EPA Tap	0	90	0	—	—	—	—
Zinc	R-20	MP2A	1147.1	n/a	5	3	µg/L	6.94	12.6	10	—	—	—	—	—	—	—	—	Before well rehabilitation.
	R-20	MP3A	1330	n/a	5	4	µg/L	14.15	22	10	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.
	R-20	P1A	904.6	n/a	13	10	µg/L	11.5	40.3	10	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	FD	3	1	µg/L	23.7	23.7	10	—	—	—	—	—	—	—	—	—
	R-20	P2A	1147.1	n/a	13	8	µg/L	6.85	16.2	10	—	—	—	—	—	—	—	—	—
	R-21	Single	888.8	n/a	25	5	µg/L	6.882	16	10	—	—	—	—	—	—	—	—	—
	R-22	MP1A	907.1	n/a	7	1	µg/L	6.55	6.55	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP2A	962.8	n/a	19	6	µg/L	4.3783	9.2	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	FD	1	1	µg/L	5.8	5.8	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP3A	1273.5	n/a	16	7	µg/L	6.12	17.8	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP4A	1378	n/a	7	2	µg/L	9.685	14.9	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-22	MP5A	1448.2	n/a	7	4	µg/L	5.425	10	10	—	—	—	—	—	—	—	—	R-22 is off-line and will undergo rehabilitation.
	R-23	Single	816	FD	12	2	µg/L	3.15	3.7	10	—	—	—	—	—	—	—	—	—
	R-23	Single	816	n/a	25	10	µg/L	9.651	40.1	10	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	FD	1	1	µg/L	3.2	3.2	10	—	—	—	—	—	—	—	—	—
	R-23i	P1A	400.3	n/a	14	11	µg/L	15.598	29.2	10	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	FD	2	2	µg/L	24.74	43.1	10	—	—	—	—	—	—	—	—	—
	R-23i	P2A	470.2	n/a	19	13	µg/L	8.1723	42.2	10	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	FD	2	1	µg/L	3.56	3.56	10	—	—	—	—	—	—	—	—	—
	R-23i	P3A	524	n/a	16	5	µg/L	55.04	262	10	—	—	—	—	—	—	—	—	—
	R-32	MP1A	870.9	n/a	9	5	µg/L	6.22	8.6	10	—	—	—	—	—	—	—	—	—
	R-32	MP3A	976	n/a	9	6	µg/L	10.513	18.8	10	—	—	—	—	—	—	—	—	Screen plugged and abandoned because of residual effects of drilling products.

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Zinc (continued)	R-32	Single	867.5	FD	6	6	µg/L	83.167	134	10	—	—	—	—	—	—	—	—	—
	R-32	Single	867.5	n/a	15	15	µg/L	56.987	128	10	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	FD	1	1	µg/L	12.8	12.8	10	—	—	—	—	—	—	—	—	—
	R-37	P1A	929.3	n/a	10	8	µg/L	32.16	154	10	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	FD	1	1	µg/L	16.2	16.2	10	—	—	—	—	—	—	—	—	—
	R-37	P2A	1026	n/a	9	8	µg/L	10.639	19.5	10	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	FD	4	4	µg/L	9.545	14.3	10	—	—	—	—	—	—	—	—	—
	R-38	Single	821.2	n/a	10	9	µg/L	26.233	86.5	10	—	—	—	—	—	—	—	—	—
	R-39	Single	859	FD	1	1	µg/L	15.4	15.4	10	—	—	—	—	—	—	—	—	—
	R-39	Single	859	n/a	11	10	µg/L	22.47	52.6	10	—	—	—	—	—	—	—	—	—
	R-40	P1A	751.6	n/a	8	8	µg/L	148.15	978	10	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	FD	2	1	µg/L	18.4	18.4	10	—	—	—	—	—	—	—	—	—
	R-40	P2A	849.3	n/a	9	9	µg/L	38.439	171	10	—	—	—	—	—	—	—	—	—
	R-40	R-40i	649.7	n/a	7	5	µg/L	75.244	341	10	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	FD	2	1	µg/L	4.19	4.19	10	—	—	—	—	—	—	—	—	—
	R-41	P2A	965.3	n/a	10	4	µg/L	9.195	19.2	10	—	—	—	—	—	—	—	—	—
	R-49	P1A	845	n/a	9	7	µg/L	11.351	18.4	10	—	—	—	—	—	—	—	—	—
	R-49	P2A	905.6	n/a	9	1	µg/L	4.17	4.17	10	—	—	—	—	—	—	—	—	—
	R-51	P1A	914.96	n/a	6	5	µg/L	19.228	34	10	—	—	—	—	—	—	—	—	—
	R-51	P2A	1031	n/a	6	4	µg/L	7.51	12.5	10	—	—	—	—	—	—	—	—	—
	R-52	P1A	1035.2	n/a	5	5	µg/L	22.84	47	10	—	—	—	—	—	—	—	—	—
	R-52	P2A	1107	n/a	5	1	µg/L	8.54	8.54	10	—	—	—	—	—	—	—	—	—
	R-53	P1A	849.2	n/a	5	4	µg/L	93.35	207	10	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	FD	2	1	µg/L	5.2	5.2	10	—	—	—	—	—	—	—	—	—
	R-53	P2A	959.7	n/a	5	4	µg/L	6.1975	10.1	10	—	—	—	—	—	—	—	—	—
	R-54	P1A	830	n/a	6	6	µg/L	46.195	186	10	—	—	—	—	—	—	—	—	—
	R-54	P2A	915	n/a	6	1	µg/L	3.38	3.38	10	—	—	—	—	—	—	—	—	—
	R-55	P1A	860	n/a	3	2	µg/L	4.5	5.27	10	—	—	—	—	—	—	—	—	—
	R-55	P2A	994.4	n/a	3	2	µg/L	4.48	5.23	10	—	—	—	—	—	—	—	—	—
	R-55i	Single	510	n/a	2	1	µg/L	21.9	21.9	10	—	—	—	—	—	—	—	—	—
	R-56	P1A	945	n/a	3	2	µg/L	61.3	109	10	—	—	—	—	—	—	—	—	—
	R-56	P2A	1046.6	n/a	3	1	µg/L	15.4	15.4	10	—	—	—	—	—	—	—	—	—

Table D-4.3-1 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field QC Type	Number of Analyses	Number of Detects	Units	Average Detected Concentration	Maximum Detected Concentration	PQL[a]	Standard[b]	Standard Source[c]	Value > Standard	1/2 Standard	Value > 1/2 Standard	BV	BV Type	Value > BV	Comment
Zinc (continued)	R-57	P1A	910	n/a	2	2	µg/L	7.79	9.34	10	—	—	—	—	—	—	—	—	—
	R-57	P2A	971.5	n/a	2	1	µg/L	4.99	4.99	10	—	—	—	—	—	—	—	—	—

Source: Attachment D-1.

[a] PQL = Practical quantitation limit (LANL 2010, 109830, section C-4.1).

[b] Standard = Lowest applicable regulatory standard or other type of screening level.

[c] Standard Source = Reference for lowest-applicable water-quality screening level, as prescribed by the Consent Order and implemented as documented in Appendix B of the 2010 IFGMP (LANL 2010, 109830):

- EPA MCL = EPA maximum contaminant level (40 Code of Federal Regulations Part 141).
- EPA TAP SCRN LVL = EPA regional screening level for tapwater June 2011 (EPA 2011, 204336). Available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm).
- NM GW STD = New Mexico Groundwater Human Health Standards (New Mexico Administrative Code 20.6.2).

[d] n/a = Not applicable.

[e] — = None.

[f] FD = Field duplicate.

[g] SU = Standard Unit.

Table D-4.3-2
Number of Sampling Events for Inorganic Constituents Detected Above ½-Standard at Least Twice in the Same Screened Interval

Suite	Analyte	Single or Dual Screen Wells				Westbay Wells						
		R-40 40i port	R-40 P1A	R-54 P1A	R-55i	R-20 MP1A	R-20 MP2A	R-20 MP3A	R-22 MP1A	R-22 MP4A	R-22 MP5A	R-32 MP3A
Filtered General Inorganic	Fluoride	—*	—	—	—	—	—	5	—	—	—	2
Filtered Metals	Antimony	—	3	—	—	—	—	—	—	—	—	—
	Arsenic	—	—	—	—	2	—	4	—	—	—	—
	Iron	6	—	4	—	—	—	5	7	5	4	6
	Manganese	7	2	4	2	—	5	5	7	5	5	9
Not Filtered Metals	Antimony	—	2	—	—	—	—	—	—	—	—	—
	Arsenic	—	—	—	—	—	—	3	—	—	—	—

Source: Table D-4.3-1 and raw data tables in Attachment D-1.
*— = No events.

Table D-4.3-3
Statistical Summary of Radionuclides Detected in
TA-54 Groundwater Monitoring Wells, Extending from Well Completion to May 2011

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Americium-241	R-23i	P2A	470.2	F[a]	n/a[b]	11	1	0.0554	0.0554
	R-22	MP1A	907.1	UF[c]	n/a	6	1	0.00648	0.00648
	R-22	MP2A	962.8	UF	n/a	18	1	0.00705	0.00705
	R-22	MP3A	1273.5	UF	n/a	14	1	0.03	0.03
	R-22	MP4A	1378	UF	n/a	6	1	0.011	0.011
	R-22	MP5A	1448.2	UF	n/a	6	1	0.0228	0.0228
	R-23i	P2A	470.2	UF	n/a	16	1	0.0458	0.0458
Gross alpha	R-20	MP1A	904.6	F	n/a	1	1	5.37	5.37
	R-22	MP3A	1273.5	F	FD[d]	1	1	2.69	2.69
	R-22	MP3A	1273.5	F	n/a	7	5	2.756	3.12
	R-23	Single	816	F	n/a	8	2	0.869	0.891
	R-23i	P2A	470.2	F	n/a	6	1	2.3	2.3
	R-37	P1A	929.3	F	n/a	1	1	2.91	2.91
	R-20	MP2A	1147.1	UF	n/a	1	1	2.11	2.11
	R-20	P1A	904.6	UF	n/a	4	1	13.5	13.5
	R-22	MP1A	907.1	UF	n/a	6	2	2.845	3.55
	R-22	MP2A	962.8	UF	n/a	10	1	1.69	1.69
	R-22	MP3A	1273.5	UF	FD	1	1	3.27	3.27
	R-22	MP3A	1273.5	UF	n/a	9	6	2.555	3.75
	R-22	MP4A	1378	UF	n/a	4	1	2.54	2.54
	R-23	Single	816	UF	FD	8	1	0.793	0.793
	R-23	Single	816	UF	n/a	10	1	3.41	3.41
	R-23i	P1A	400.3	UF	n/a	8	1	3.38	3.38
	R-23i	P2A	470.2	UF	n/a	11	2	2.78	3.5
	R-23i	P3A	524	UF	n/a	11	1	17	17
	R-32	MP1A	870.9	UF	n/a	5	1	2.26	2.26
	R-32	MP3A	976	UF	n/a	5	2	0.9685	1.43
	R-37	P1A	929.3	UF	n/a	7	2	4.405	4.44
	R-49	P1A	845	UF	n/a	9	7	5.73857	14
	R-49	P2A	905.6	UF	n/a	9	1	3.94	3.94
	R-54	P1A	830	UF	n/a	6	1	11	11
Gross beta	R-20	MP1A	904.6	F	n/a	1	1	8.67	8.67
	R-20	MP2A	1147.1	F	n/a	1	1	5.89	5.89
	R-20	P1A	904.6	F	n/a	2	2	4.4	7.37
	R-21	Single	888.8	F	n/a	5	1	10.4	10.4

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Gross beta (continued)	R-22	MP1A	907.1	F	n/a	1	1	7.95	7.95
	R-22	MP2A	962.8	F	n/a	7	4	3.9025	4.81
	R-22	MP3A	1273.5	F	FD	1	1	7.89	7.89
	R-22	MP3A	1273.5	F	n/a	7	7	15.6086	71
	R-22	MP4A	1378	F	n/a	1	1	4.18	4.18
	R-22	MP5A	1448.2	F	n/a	1	1	5.65	5.65
	R-23	Single	816	F	FD	6	2	3.095	3.2
	R-23	Single	816	F	n/a	8	3	2.74	3.29
	R-23i	P1A	400.3	F	n/a	3	2	4.84	5.2
	R-23i	P2A	470.2	F	n/a	6	2	4.1	4.75
	R-23i	P3A	524	F	n/a	6	4	3.875	4.68
	R-32	MP1A	870.9	F	n/a	5	4	2.3575	3.05
	R-32	MP3A	976	F	n/a	5	3	3.80333	4.08
	R-32	Single	867.5	F	n/a	2	2	4.755	6.34
	R-38	Single	821.2	F	n/a	1	1	5.26	5.26
	R-39	Single	859	F	n/a	2	1	6.7	6.7
	R-40	P1A	751.6	F	n/a	1	1	1.09	1.09
	R-40	R-40i	649.7	F	n/a	2	1	2	2
	R-41	P2A	965.3	F	n/a	2	2	2.615	2.83
	R-20	MP1A	904.6	UF	n/a	1	1	3.06	3.06
	R-20	MP2A	1147.1	UF	n/a	1	1	5.62	5.62
	R-20	MP3A	1330	UF	n/a	1	1	3.61	3.61
	R-20	P1A	904.6	UF	n/a	4	4	4.605	9.55
	R-20	P2A	1147.1	UF	FD	1	1	4.35	4.35
	R-20	P2A	1147.1	UF	n/a	5	4	3.6575	5.84
	R-21	Single	888.8	UF	n/a	7	2	3.93	4.57
	R-22	MP1A	907.1	UF	n/a	6	6	7.22167	10.3
	R-22	MP2A	962.8	UF	n/a	10	6	2.59167	3.73
	R-22	MP3A	1273.5	UF	FD	1	1	9.87	9.87
	R-22	MP3A	1273.5	UF	n/a	9	8	6.9125	8.67
	R-22	MP4A	1378	UF	n/a	4	3	4.58333	5.03
	R-22	MP5A	1448.2	UF	n/a	3	3	5.05667	5.66
	R-23	Single	816	UF	FD	8	1	2.6	2.6
	R-23	Single	816	UF	n/a	10	4	3.185	4.04
	R-23i	P1A	400.3	UF	n/a	8	7	3.55286	5.12
	R-23i	P2A	470.2	UF	FD	2	1	2.74	2.74

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Gross beta (continued)	R-23i	P2A	470.2	UF	n/a	11	2	3.195	3.6
	R-23i	P3A	524	UF	n/a	11	5	8.426	24.8
	R-32	MP1A	870.9	UF	n/a	5	2	2.11	2.17
	R-32	MP3A	976	UF	n/a	5	1	4.57	4.57
	R-32	Single	867.5	UF	n/a	4	2	2.18	2.36
	R-37	P1A	929.3	UF	n/a	7	3	3.69667	4.41
	R-38	Single	821.2	UF	n/a	6	2	3.165	3.55
	R-39	Single	859	UF	n/a	7	2	2.8	3.65
	R-40	P1A	751.6	UF	n/a	6	3	18.26	45.4
	R-40	P2A	849.3	UF	n/a	6	1	4.3	4.3
	R-40	R-40i	649.7	UF	n/a	5	2	3.51	3.94
	R-41	P2A	965.3	UF	n/a	7	4	2.9275	3.35
	R-49	P1A	845	UF	n/a	9	6	4.66333	8.13
	R-51	P1A	914.96	UF	n/a	6	1	2.97	2.97
	R-51	P2A	1031	UF	n/a	6	2	3.46	3.47
	R-52	P1A	1035.2	UF	n/a	5	3	2.94	3.1
	R-53	P2A	959.7	UF	FD	2	1	3.45	3.45
	R-53	P2A	959.7	UF	n/a	5	1	3.34	3.34
	R-54	P1A	830	UF	n/a	6	2	3.29	3.57
	R-54	P2A	915	UF	n/a	6	1	7.86	7.86
	R-55	P1A	860	UF	n/a	3	2	2.945	3.22
	R-55	P2A	994.4	UF	n/a	3	1	5.65	5.65
	R-56	P1A	945	UF	n/a	3	1	3.97	3.97
	R-56	P2A	1046.6	UF	n/a	3	1	3.32	3.32
Gross gamma	R-20	P2A	1147.1	F	n/a	2	1	75.3	75.3
	R-23i	P2A	470.2	F	FD	2	1	85	85
	R-20	P1A	904.6	UF	n/a	5	1	77.5	77.5
	R-20	P2A	1147.1	UF	FD	1	1	10.8	10.8
	R-21	Single	888.8	UF	n/a	11	1	114	114
	R-22	MP1A	907.1	UF	n/a	6	1	251	251
	R-23i	P2A	470.2	UF	FD	2	1	86.1	86.1
	R-23i	P3A	524	UF	n/a	13	1	51.3	51.3
	R-37	P1A	929.3	UF	n/a	7	1	6.32	6.32
	R-38	Single	821.2	UF	n/a	7	1	50.1	50.1
	R-40	P2A	849.3	UF	n/a	6	1	75.3	75.3
	R-49	P2A	905.6	UF	n/a	8	1	12.4	12.4

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Gross gamma (continued)	R-51	P2A	1031	UF	n/a	5	3	61.9333	97.4
	R-52	P1A	1035.2	UF	n/a	4	1	21.6	21.6
	R-54	P2A	915	UF	n/a	5	1	12.9	12.9
	R-57	P2A	971.5	UF	n/a	1	1	50.1	50.1
Plutonium-238	R-22	MP1A	907.1	UF	n/a	7	1	-0.004	-0.004
	R-22	MP2A	962.8	UF	n/a	19	1	0.00072	0.00072
	R-22	MP3A	1273.5	UF	n/a	15	1	0.00564	0.00564
	R-22	MP4A	1378	UF	FD	1	1	0.04	0.04
	R-22	MP4A	1378	UF	n/a	7	1	0.00369	0.00369
	R-22	MP5A	1448.2	UF	n/a	7	1	0.00916	0.00916
Plutonium-239/240	R-20	MP1A	904.6	UF	n/a	5	1	0.0443	0.0443
	R-20	MP3A	1330	UF	n/a	5	1	0.06	0.06
	R-22	MP1A	907.1	UF	n/a	7	1	0.012	0.012
	R-22	MP2A	962.8	UF	n/a	19	1	0.00627	0.00627
	R-22	MP3A	1273.5	UF	n/a	15	1	0.0254	0.0254
	R-22	MP4A	1378	UF	n/a	7	1	0.00369	0.00369
	R-22	MP5A	1448.2	UF	n/a	7	1	0.0061	0.0061
Potassium-40	R-22	MP2A	962.8	UF	n/a	17	1	66.4	66.4
	R-22	MP5A	1448.2	UF	FD	1	1	54.29	54.29
	R-32	MP1A	870.9	UF	n/a	7	1	46	46
Radium-226	R-22	MP1A	907.1	F	n/a	2	1	1.53	1.53
	R-20	P2A	1147.1	UF	n/a	3	2	0.8345	1.11
	R-21	Single	888.8	UF	n/a	5	1	0.679	0.679
	R-22	MP1A	907.1	UF	n/a	6	4	0.69475	0.848
	R-22	MP2A	962.8	UF	n/a	6	2	0.5225	0.648
	R-22	MP3A	1273.5	UF	n/a	5	2	0.5285	0.655
	R-22	MP4A	1378	UF	n/a	5	3	0.783	0.949
	R-22	MP5A	1448.2	UF	n/a	4	2	0.3985	0.442
	R-23	Single	816	UF	n/a	5	1	1.1	1.1
	R-23i	P1A	400.3	UF	n/a	5	2	0.7775	0.906
	R-23i	P2A	470.2	UF	n/a	5	1	1.35	1.35
	R-23i	P3A	524	UF	n/a	4	2	0.7945	0.932
	R-32	Single	867.5	UF	FD	2	1	1.2	1.2
	R-39	Single	859	UF	n/a	4	1	0.469	0.469

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Radium-228	R-22	MP1A	907.1	F	n/a	2	2	1.64	1.99
	R-20	P1A	904.6	UF	n/a	3	2	0.674	0.776
	R-22	MP1A	907.1	UF	n/a	3	3	3.43	4.45
	R-22	MP3A	1273.5	UF	n/a	2	1	0.696	0.696
	R-22	MP4A	1378	UF	n/a	2	1	2	2
Radium-228 (continued)	R-22	MP5A	1448.2	UF	n/a	2	1	1.19	1.19
	R-23	Single	816	UF	n/a	5	1	0.599	0.599
	R-23i	P1A	400.3	UF	n/a	5	3	1.25467	1.88
	R-23i	P3A	524	UF	n/a	4	1	1.14	1.14
	R-32	Single	867.5	UF	FD	2	1	0.93	0.93
	R-37	P1A	929.3	UF	n/a	3	1	3.05	3.05
	R-37	P2A	1026	UF	n/a	3	1	1.37	1.37
	R-38	Single	821.2	UF	n/a	3	1	1.34	1.34
	R-39	Single	859	UF	n/a	4	1	0.722	0.722
	R-40	R-40i	649.7	UF	n/a	2	1	1.71	1.71
	R-49	P1A	845	UF	n/a	2	1	1.57	1.57
	R-49	P2A	905.6	UF	n/a	2	1	0.717	0.717
Strontium-90	R-22	MP2A	962.8	F	n/a	13	1	0.7	0.7
	R-22	MP4A	1378	F	n/a	2	1	0.8	0.8
	R-20	MP1A	904.6	UF	n/a	5	1	0.229	0.229
	R-20	MP2A	1147.1	UF	n/a	6	1	0.237	0.237
	R-20	MP3A	1330	UF	n/a	6	1	4.15	4.15
	R-23i	P3A	524	UF	n/a	13	1	0.612	0.612
	R-37	P1A	929.3	UF	n/a	7	1	1.65	1.65
Technetium-99	R-22	MP3A	1273.5	UF	n/a	7	1	4.9	4.9
	R-22	MP5A	1448.2	UF	n/a	6	1	4.3	4.3
Thorium-228	R-22	MP1A	907.1	UF	n/a	4	2	0.1655	0.189
	R-22	MP5A	1448.2	UF	n/a	2	1	0.0492	0.0492
	R-49	P1A	845	UF	n/a	1	1	0.172	0.172
	R-22	MP1A	907.1	UF	n/a	4	1	0.0606	0.0606
	R-22	MP3A	1273.5	UF	n/a	3	2	0.1174	0.198
	R-22	MP4A	1378	UF	n/a	3	1	0.0724	0.0724
	R-49	P1A	845	UF	n/a	1	1	0.267	0.267
Thorium-232	R-49	P1A	845	UF	n/a	1	1	0.238	0.238

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Tritium	R-20	MP2A	1147.1	UF	n/a	5	1	7.40776	7.40776
	R-20	MP3A	1330	UF	n/a	5	1	1.97966	1.97966
	R-21	Single	888.8	UF	n/a	23	1	4.56599	4.56599
	R-22	MP1A	907.1	UF	n/a	26	19	30.3112	523
	R-22	MP2A	962.8	UF	n/a	22	3	25.6019	76.8
	R-22	MP3A	1273.5	UF	n/a	22	4	0.53237	1.24527
	R-22	MP4A	1378	UF	FD	1	1	582.4	582.4
	R-22	MP4A	1378	UF	n/a	22	2	0.16	0.44
Tritium (continued)	R-22	MP5A	1448.2	UF	FD	3	1	16.67	16.67
	R-22	MP5A	1448.2	UF	n/a	56	17	9.4308	18.49
	R-23	Single	816	UF	FD	12	3	1.69229	3.60809
	R-23	Single	816	UF	n/a	21	2	2.283	3.67195
	R-23i	P1A	400.3	UF	FD	2	1	22.2552	22.2552
	R-23i	P1A	400.3	UF	n/a	13	12	168.683	302
	R-23i	P2A	470.2	UF	FD	3	2	26.4221	29.3756
	R-23i	P2A	470.2	UF	n/a	18	13	36.6399	162
	R-23i	P3A	524	UF	FD	3	2	34.6281	34.8037
	R-23i	P3A	524	UF	n/a	20	17	32.7433	37.6774
	R-32	MP3A	976	UF	n/a	8	2	2.05949	2.84177
	R-37	P1A	929.3	UF	FD	1	1	27.2044	27.2044
	R-37	P1A	929.3	UF	n/a	9	9	32.8382	51.2477
	R-37	P2A	1026	UF	n/a	9	3	14.145	24.4265
	R-38	Single	821.2	UF	n/a	9	1	40.5511	40.5511
	R-39	Single	859	UF	n/a	11	1	4.40634	4.40634
	R-40	P1A	751.6	UF	n/a	8	1	17.1464	17.1464
	R-40	R-40i	649.7	UF	n/a	7	1	4.56599	4.56599
	R-41	P2A	965.3	UF	FD	2	1	3.92739	3.92739
	R-41	P2A	965.3	UF	n/a	10	1	6.25828	6.25828
	R-49	P1A	845	UF	n/a	9	1	3.38458	3.38458
	R-52	P1A	1035.2	UF	n/a	4	1	5.97091	5.97091
	R-53	P1A	849.2	UF	n/a	4	1	9.54707	9.54707
	R-55	P1A	860	UF	n/a	3	1	4.24669	4.24669
	R-55	P2A	994.4	UF	n/a	3	1	3.09721	3.09721
	R-56	P1A	945	UF	n/a	2	2	3.08125	3.35265
	R-56	P2A	1046.6	UF	n/a	2	1	3.44844	3.44844

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Uranium-234	R-20	MP2A	1147.1	F	n/a	1	1	0.216	0.216
	R-20	P1A	904.6	F	n/a	2	2	0.431	0.476
	R-20	P2A	1147.1	F	n/a	2	2	0.3065	0.335
	R-21	Single	888.8	F	FD	1	1	0.238	0.238
	R-21	Single	888.8	F	n/a	6	6	0.21733	0.276
	R-22	MP1A	907.1	F	FD	2	2	0.538	0.586
	R-22	MP1A	907.1	F	n/a	5	3	0.51367	0.605
	R-22	MP2A	962.8	F	n/a	13	13	0.25262	0.29
	R-22	MP3A	1273.5	F	FD	1	1	2.01	2.01
	R-22	MP3A	1273.5	F	n/a	10	10	1.943	7.6
	R-22	MP4A	1378	F	n/a	2	2	0.0995	0.1
	R-22	MP5A	1448.2	F	n/a	2	1	0.107	0.107
	R-23	Single	816	F	FD	6	6	0.386	0.443
	R-23	Single	816	F	n/a	13	13	0.37892	0.498
	R-23i	P1A	400.3	F	FD	1	1	0.738	0.738
	R-23i	P1A	400.3	F	n/a	6	6	2.57883	12.4
	R-23i	P2A	470.2	F	FD	2	2	0.5525	0.64
	R-23i	P2A	470.2	F	n/a	11	11	0.68891	1.09
	R-23i	P3A	524	F	n/a	8	8	0.4485	0.842
	R-32	MP1A	870.9	F	n/a	5	5	0.5634	0.622
	R-32	MP3A	976	F	n/a	5	4	0.17068	0.273
	R-32	Single	867.5	F	FD	6	6	0.50117	0.577
	R-32	Single	867.5	F	n/a	7	7	0.51171	0.547
	R-37	P1A	929.3	F	n/a	1	1	1.02	1.02
	R-37	P2A	1026	F	n/a	1	1	0.62	0.62
	R-38	Single	821.2	F	n/a	2	2	0.3185	0.319
	R-39	Single	859	F	n/a	3	3	0.292	0.334
	R-40	P1A	751.6	F	n/a	1	1	0.612	0.612
	R-40	P2A	849.3	F	n/a	1	1	0.466	0.466
	R-40	R-40i	649.7	F	n/a	2	2	0.409	0.552
	R-41	P2A	965.3	F	n/a	2	2	1.133	1.39
	R-49	P1A	845	F	n/a	1	1	0.553	0.553
	R-49	P2A	905.6	F	n/a	1	1	0.448	0.448
	R-20	MP1A	904.6	UF	n/a	5	2	0.1435	0.168
	R-20	MP2A	1147.1	UF	n/a	5	3	0.1379	0.229
	R-20	P1A	904.6	UF	n/a	5	5	0.4332	0.555

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Uranium-234 (continued)	R-20	P2A	1147.1	UF	FD	1	1	0.272	0.272
	R-20	P2A	1147.1	UF	n/a	5	5	0.2446	0.309
	R-21	Single	888.8	UF	FD	1	1	0.261	0.261
	R-21	Single	888.8	UF	n/a	13	13	0.23562	0.294
	R-22	MP1A	907.1	UF	n/a	8	4	0.06925	0.124
	R-22	MP2A	962.8	UF	n/a	18	18	0.27522	0.34
	R-22	MP3A	1273.5	UF	FD	1	1	2.1	2.1
	R-22	MP3A	1273.5	UF	n/a	15	15	1.6608	7.8
	R-22	MP4A	1378	UF	FD	1	1	0.13	0.13
	R-22	MP4A	1378	UF	n/a	7	5	0.08936	0.0991
	R-22	MP5A	1448.2	UF	FD	1	1	0.04	0.04
	R-22	MP5A	1448.2	UF	n/a	7	5	0.1058	0.14
	R-23	Single	816	UF	FD	8	8	0.37	0.439
	R-23	Single	816	UF	n/a	20	20	0.39185	0.706
	R-23i	P1A	400.3	UF	FD	1	1	0.68	0.68
	R-23i	P1A	400.3	UF	n/a	11	11	1.66273	13.1
	R-23i	P2A	470.2	UF	FD	2	2	0.652	0.683
	R-23i	P2A	470.2	UF	n/a	16	16	0.65113	1.1
	R-23i	P3A	524	UF	FD	1	1	0.4	0.4
	R-23i	P3A	524	UF	n/a	13	13	0.50354	1.61
	R-32	MP1A	870.9	UF	n/a	9	9	0.67467	1.03
	R-32	MP3A	976	UF	n/a	9	4	0.08908	0.131
	R-32	Single	867.5	UF	FD	6	6	0.514	0.542
	R-32	Single	867.5	UF	n/a	10	10	0.4978	0.577
	R-37	P1A	929.3	UF	n/a	7	7	1.14086	1.38
	R-37	P2A	1026	UF	n/a	6	6	0.59217	1.05
	R-38	Single	821.2	UF	FD	2	2	0.2875	0.293
	R-38	Single	821.2	UF	n/a	7	7	0.28229	0.331
	R-39	Single	859	UF	FD	1	1	0.266	0.266
	R-39	Single	859	UF	n/a	8	8	0.31675	0.456
	R-40	P1A	751.6	UF	n/a	4	4	0.84025	0.961
	R-40	P2A	849.3	UF	FD	1	1	0.33	0.33
	R-40	P2A	849.3	UF	n/a	6	6	0.32	0.482
	R-40	R-40i	649.7	UF	n/a	5	5	0.3284	0.515
	R-41	P2A	965.3	UF	FD	1	1	0.449	0.449
	R-41	P2A	965.3	UF	n/a	7	7	0.70786	1.36

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Uranium-234 (continued)	R-49	P1A	845	UF	n/a	9	9	1.17289	2.17
	R-49	P2A	905.6	UF	n/a	9	9	0.30733	0.664
	R-51	P1A	914.96	UF	n/a	6	6	0.234	0.379
	R-51	P2A	1031	UF	n/a	6	6	0.26117	0.392
	R-52	P1A	1035.2	UF	n/a	5	5	0.3704	0.429
	R-52	P2A	1107	UF	n/a	5	5	0.2716	0.335
	R-53	P1A	849.2	UF	n/a	5	5	0.3064	0.376
	R-53	P2A	959.7	UF	FD	2	2	0.2745	0.321
	R-53	P2A	959.7	UF	n/a	5	5	0.2866	0.443
	R-54	P1A	830	UF	n/a	6	6	0.50733	1.15
	R-54	P2A	915	UF	n/a	6	6	0.30133	0.363
	R-55	P1A	860	UF	n/a	3	2	0.463	0.485
	R-55	P2A	994.4	UF	n/a	3	3	0.389	0.445
	R-55i	Single	510	UF	n/a	2	2	0.6665	0.672
	R-56	P1A	945	UF	n/a	3	3	0.41433	0.442
	R-56	P2A	1046.6	UF	n/a	3	3	0.381	0.437
	R-57	P1A	910	UF	n/a	2	2	0.272	0.321
	R-57	P2A	971.5	UF	n/a	2	2	0.256	0.295
Uranium-235/236	R-22	MP2A	962.8	F	n/a	13	1	0.0472	0.0472
	R-22	MP3A	1273.5	F	FD	1	1	0.0956	0.0956
	R-22	MP3A	1273.5	F	n/a	10	6	0.11448	0.26
	R-23	Single	816	F	n/a	13	1	0.0336	0.0336
	R-23i	P1A	400.3	F	FD	1	1	0.0471	0.0471
	R-23i	P1A	400.3	F	n/a	6	3	0.14377	0.285
	R-23i	P2A	470.2	F	FD	2	1	0.039	0.039
	R-23i	P2A	470.2	F	n/a	11	3	0.04273	0.0464
	R-32	MP1A	870.9	F	n/a	5	2	0.0474	0.0612
	R-32	Single	867.5	F	FD	6	1	0.0291	0.0291
	R-32	Single	867.5	F	n/a	7	2	0.04025	0.0471
	R-20	P1A	904.6	UF	n/a	5	1	0.0399	0.0399
	R-21	Single	888.8	UF	n/a	13	2	0.04475	0.054
	R-22	MP2A	962.8	UF	n/a	19	1	0.0447	0.0447
	R-22	MP3A	1273.5	UF	n/a	16	10	0.08259	0.28
	R-23	Single	816	UF	n/a	20	2	0.03765	0.0439
	R-23i	P1A	400.3	UF	n/a	11	2	0.2583	0.473
	R-23i	P2A	470.2	UF	FD	2	1	0.061	0.061

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Uranium-235/236 (continued)	R-23i	P2A	470.2	UF	n/a	16	2	0.05265	0.0548
	R-32	MP1A	870.9	UF	n/a	9	4	0.06355	0.119
	R-32	Single	867.5	UF	n/a	10	2	0.0378	0.0391
	R-37	P1A	929.3	UF	n/a	7	1	0.0548	0.0548
	R-41	P2A	965.3	UF	n/a	7	1	0.0334	0.0334
	R-49	P1A	845	UF	n/a	9	2	0.0918	0.129
	R-49	P2A	905.6	UF	n/a	9	1	0.0589	0.0589
	R-52	P1A	1035.2	UF	n/a	5	1	0.0321	0.0321
	R-52	P2A	1107	UF	n/a	5	1	0.0258	0.0258
	R-54	P1A	830	UF	n/a	6	1	0.0462	0.0462
	R-55	P1A	860	UF	n/a	3	1	0.036	0.036
	R-56	P2A	1046.6	UF	n/a	3	2	0.0298	0.0303
Uranium-238	R-20	MP2A	1147.1	F	n/a	1	1	0.207	0.207
	R-20	P1A	904.6	F	n/a	2	2	0.2655	0.301
	R-20	P2A	1147.1	F	n/a	2	2	0.187	0.195
	R-21	Single	888.8	F	FD	1	1	0.104	0.104
	R-21	Single	888.8	F	n/a	6	6	0.1148	0.144
	R-22	MP1A	907.1	F	FD	2	2	0.3025	0.356
	R-22	MP1A	907.1	F	n/a	5	3	0.27833	0.338
	R-22	MP2A	962.8	F	n/a	13	13	0.12644	0.173
	R-22	MP3A	1273.5	F	FD	1	1	1.14	1.14
	R-22	MP3A	1273.5	F	n/a	10	10	1.1736	4.92
	R-23	Single	816	F	FD	6	6	0.17317	0.247
	R-23	Single	816	F	n/a	13	13	0.17454	0.227
	R-23i	P1A	400.3	F	FD	1	1	0.406	0.406
	R-23i	P1A	400.3	F	n/a	6	6	1.2765	5.86
	R-23i	P2A	470.2	F	FD	2	2	0.312	0.323
	R-23i	P2A	470.2	F	n/a	11	11	0.38227	0.632
	R-23i	P3A	524	F	n/a	8	8	0.2105	0.387
	R-32	MP1A	870.9	F	n/a	5	5	0.2742	0.289
	R-32	MP3A	976	F	n/a	5	3	0.14333	0.185
	R-32	Single	867.5	F	FD	6	6	0.24833	0.261
	R-32	Single	867.5	F	n/a	7	7	0.22943	0.263
	R-37	P1A	929.3	F	n/a	1	1	0.47	0.47
	R-37	P2A	1026	F	n/a	1	1	0.28	0.28
	R-38	Single	821.2	F	n/a	2	2	0.1445	0.152

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Uranium-238 (continued)	R-39	Single	859	F	n/a	3	3	0.119	0.136
	R-40	P1A	751.6	F	n/a	1	1	0.248	0.248
	R-40	P2A	849.3	F	n/a	1	1	0.15	0.15
	R-40	R-40i	649.7	F	n/a	2	2	0.1758	0.253
	R-41	P2A	965.3	F	n/a	2	2	0.3915	0.417
	R-49	P1A	845	F	n/a	1	1	0.257	0.257
	R-49	P2A	905.6	F	n/a	1	1	0.164	0.164
	R-20	MP1A	904.6	UF	n/a	5	3	0.07473	0.084
	R-20	MP2A	1147.1	UF	n/a	5	2	0.10925	0.161
	R-20	P1A	904.6	UF	n/a	5	5	0.2154	0.265
	R-20	P2A	1147.1	UF	FD	1	1	0.116	0.116
	R-20	P2A	1147.1	UF	n/a	5	5	0.1768	0.205
	R-21	Single	888.8	UF	FD	1	1	0.171	0.171
	R-21	Single	888.8	UF	n/a	13	12	0.11174	0.147
	R-22	MP2A	962.8	UF	n/a	18	17	0.11826	0.15
	R-22	MP3A	1273.5	UF	FD	1	1	1.31	1.31
	R-22	MP3A	1273.5	UF	n/a	15	15	0.9964	5.31
	R-22	MP4A	1378	UF	FD	1	1	0.05	0.05
	R-22	MP4A	1378	UF	n/a	7	3	0.05303	0.0735
	R-22	MP5A	1448.2	UF	FD	1	1	0.02	0.02
	R-22	MP5A	1448.2	UF	n/a	7	2	0.0516	0.0532
	R-23	Single	816	UF	FD	8	8	0.16763	0.196
	R-23	Single	816	UF	n/a	20	20	0.1727	0.3
	R-23i	P1A	400.3	UF	FD	1	1	0.358	0.358
	R-23i	P1A	400.3	UF	n/a	11	11	0.83618	6.35
	R-23i	P2A	470.2	UF	FD	2	2	0.3	0.317
	R-23i	P2A	470.2	UF	n/a	16	16	0.34781	0.582
	R-23i	P3A	524	UF	FD	1	1	0.175	0.175
	R-23i	P3A	524	UF	n/a	13	13	0.27162	1.03
	R-32	MP1A	870.9	UF	n/a	9	9	0.33911	0.528
	R-32	MP3A	976	UF	n/a	9	3	0.04847	0.0614
	R-32	Single	867.5	UF	FD	6	6	0.23417	0.293
	R-32	Single	867.5	UF	n/a	10	10	0.2284	0.289
	R-37	P1A	929.3	UF	n/a	7	7	0.48114	0.56
	R-37	P2A	1026	UF	n/a	6	6	0.2595	0.482
	R-38	Single	821.2	UF	FD	2	2	0.134	0.135

Table D-4.3-3 (continued)

Analyte	Well	Port Name	Port Depth (ft)	Field Prep	Field QC Type	Number of Analyses	Number of Detects	Average Detected Activity (pCi/L)	Maximum Detected Activity (pCi/L)
Uranium-238 (continued)	R-38	Single	821.2	UF	n/a	7	7	0.13029	0.159
	R-39	Single	859	UF	FD	1	1	0.147	0.147
	R-39	Single	859	UF	n/a	8	8	0.15113	0.261
	R-40	P1A	751.6	UF	n/a	4	4	0.36025	0.423
	R-40	P2A	849.3	UF	FD	1	1	0.128	0.128
	R-40	P2A	849.3	UF	n/a	6	6	0.1495	0.278
	R-40	R-40i	649.7	UF	n/a	5	5	0.1724	0.262
	R-41	P2A	965.3	UF	FD	1	1	0.189	0.189
	R-41	P2A	965.3	UF	n/a	7	7	0.30057	0.61
	R-49	P1A	845	UF	n/a	9	9	0.63222	1.53
	R-49	P2A	905.6	UF	n/a	9	9	0.1521	0.399
	R-51	P1A	914.96	UF	n/a	6	6	0.1039	0.14
	R-51	P2A	1031	UF	n/a	6	6	0.13972	0.274
	R-52	P1A	1035.2	UF	n/a	5	5	0.1908	0.294
	R-52	P2A	1107	UF	n/a	5	5	0.12358	0.143
	R-53	P1A	849.2	UF	n/a	5	5	0.1574	0.181
	R-53	P2A	959.7	UF	FD	2	2	0.1145	0.135
	R-53	P2A	959.7	UF	n/a	5	5	0.15762	0.289
	R-54	P1A	830	UF	n/a	6	6	0.33183	1.2
	R-54	P2A	915	UF	n/a	6	6	0.1445	0.172
	R-55	P1A	860	UF	n/a	3	2	0.1945	0.213
	R-55	P2A	994.4	UF	n/a	3	3	0.209	0.239
	R-55i	Single	510	UF	n/a	2	2	0.3015	0.314
	R-56	P1A	945	UF	n/a	3	3	0.20367	0.216
	R-56	P2A	1046.6	UF	n/a	3	3	0.194	0.215
	R-57	P1A	910	UF	n/a	2	2	0.1355	0.145
	R-57	P2A	971.5	UF	n/a	2	2	0.124	0.128

Source: Attachment D-1.

[a] F = Filtered.

[b] n/a = Not applicable.

[c] UF= Unfitered.

[d] FD = Field duplicate.

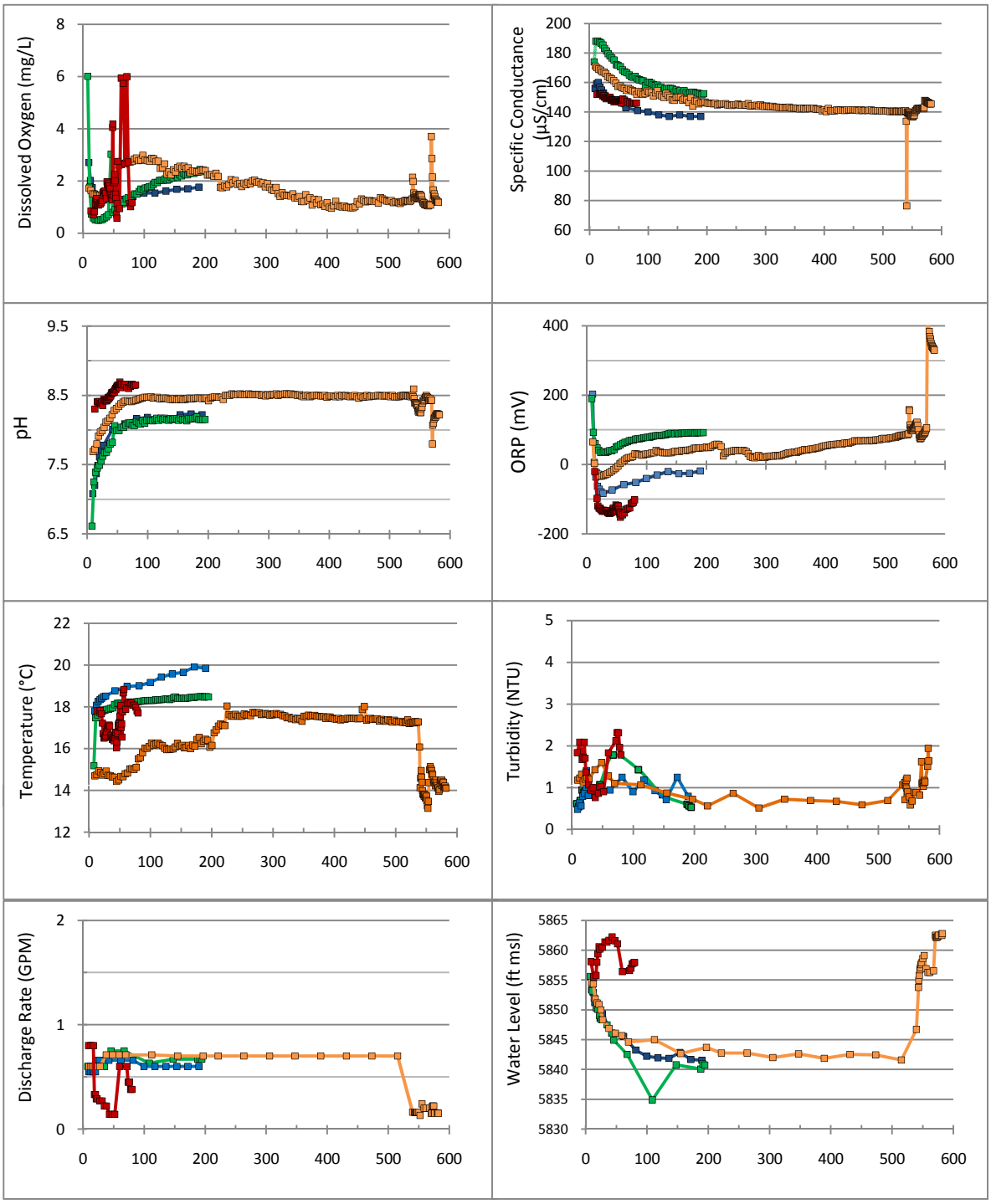
Attachment D-1

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

Attachment D-2

Geochemical Trend Plots for
Technical Area 54 Monitoring Network Wells

R-20 screen 1 (port P1A), port depth 905 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

3-Aug-10 20-Oct-10 26-Jan-11 20-Apr-11

Figure D2-R20-1. Time-series plots of field parameters monitored during purging of R-20 screen 1 (port P1A)

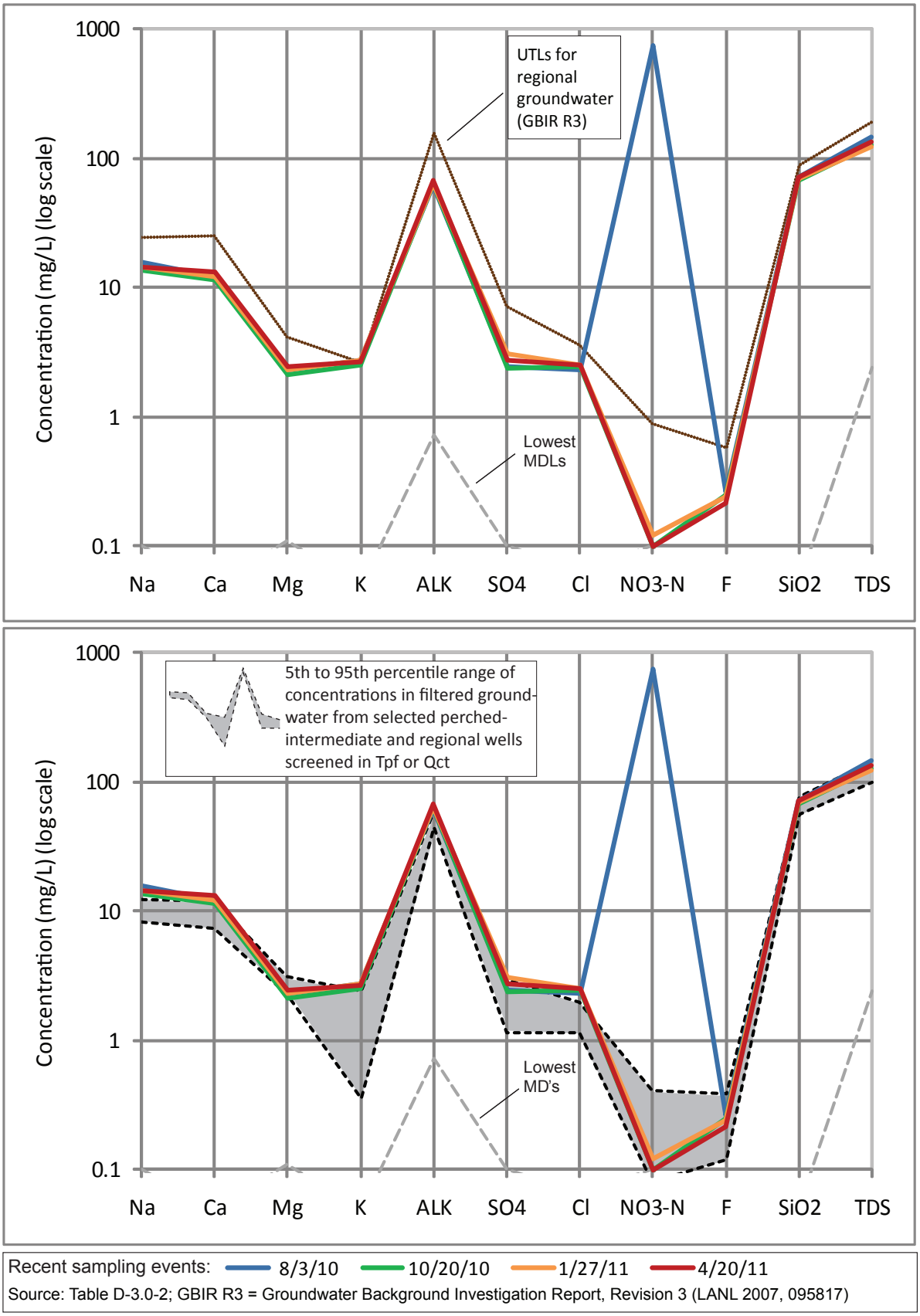


Figure D2-R20-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-20 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

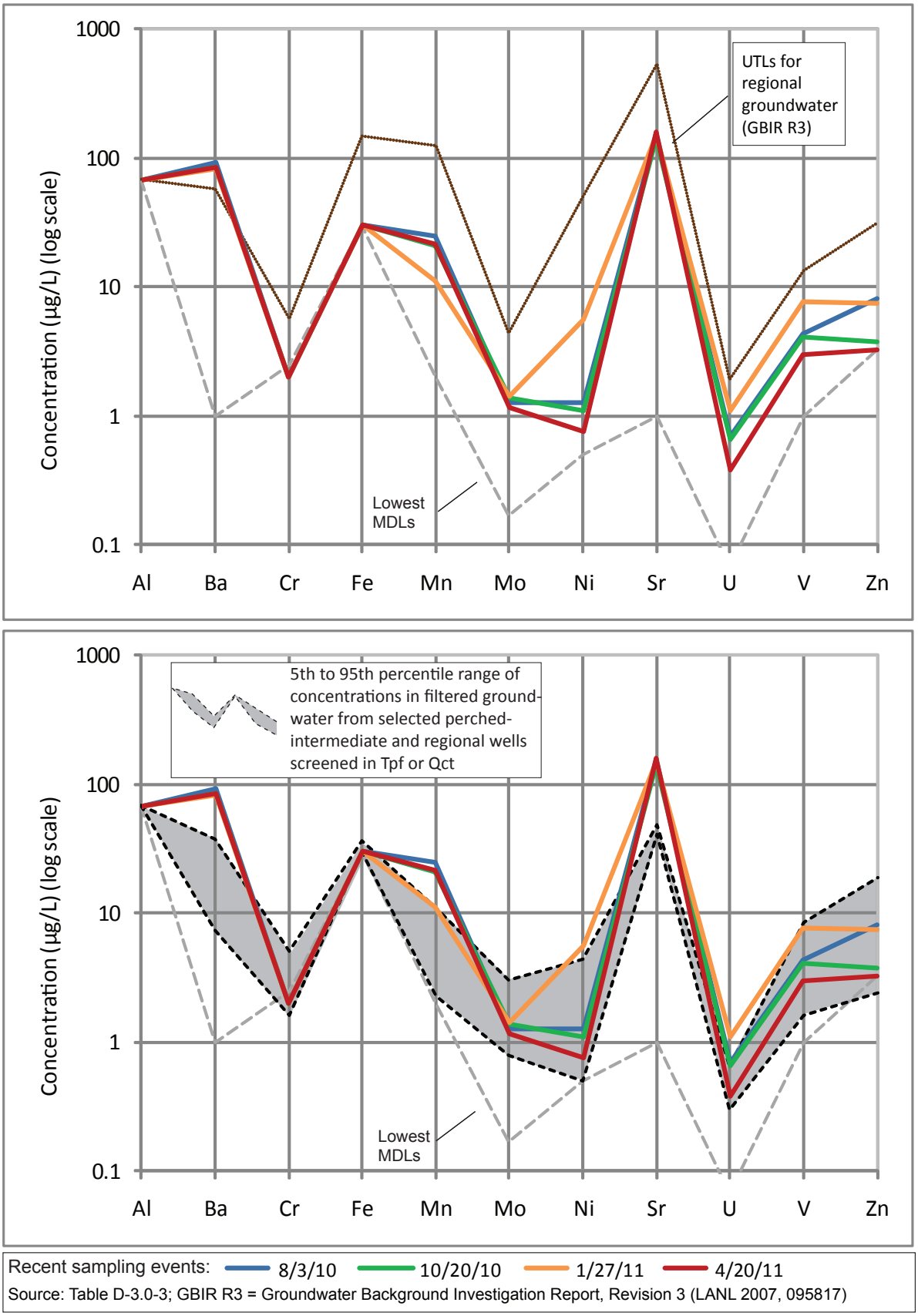
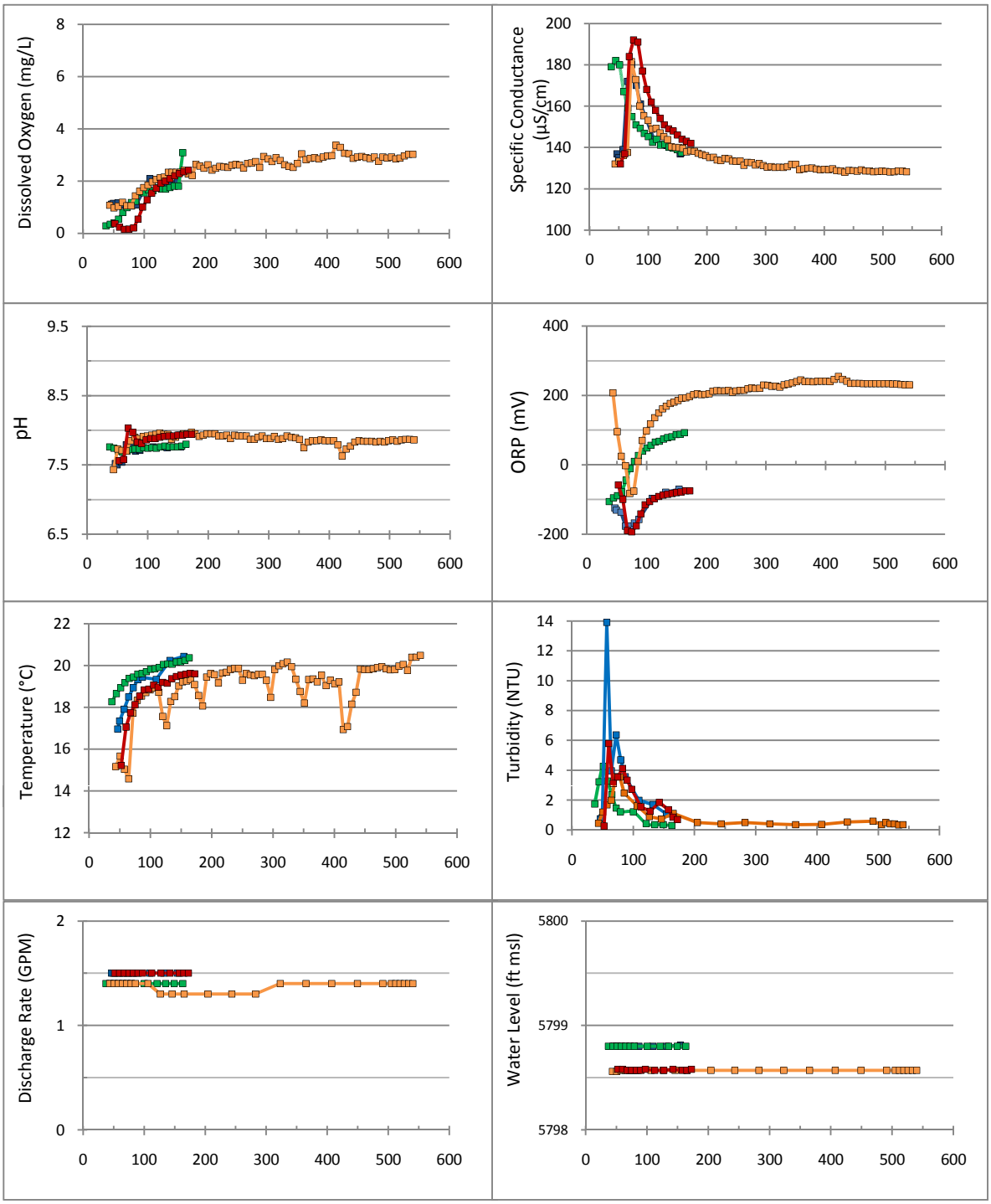


Figure D2-R20-3. Concentrations of trace metals in filtered groundwater from well R-20 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows"background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-20 screen 2 (port P2A), port depth 1147 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

30-Jul-10 11-Oct-10 21-Jan-11 25-Apr-11

Figure D2-R20-4. Time-series plots of field parameters monitored during purging of R-20 screen 2 (port P2A)

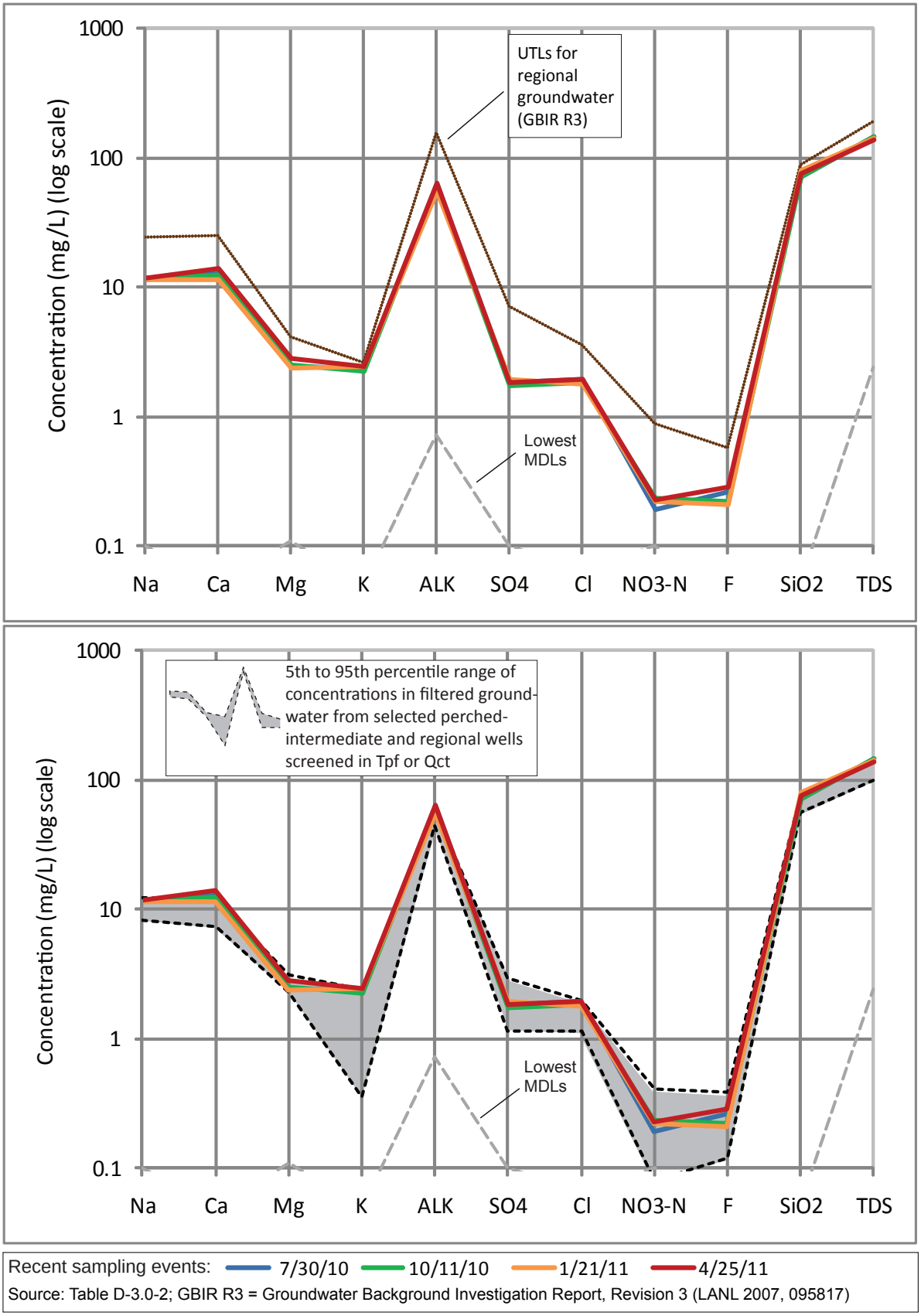


Figure D2-R20-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-20 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

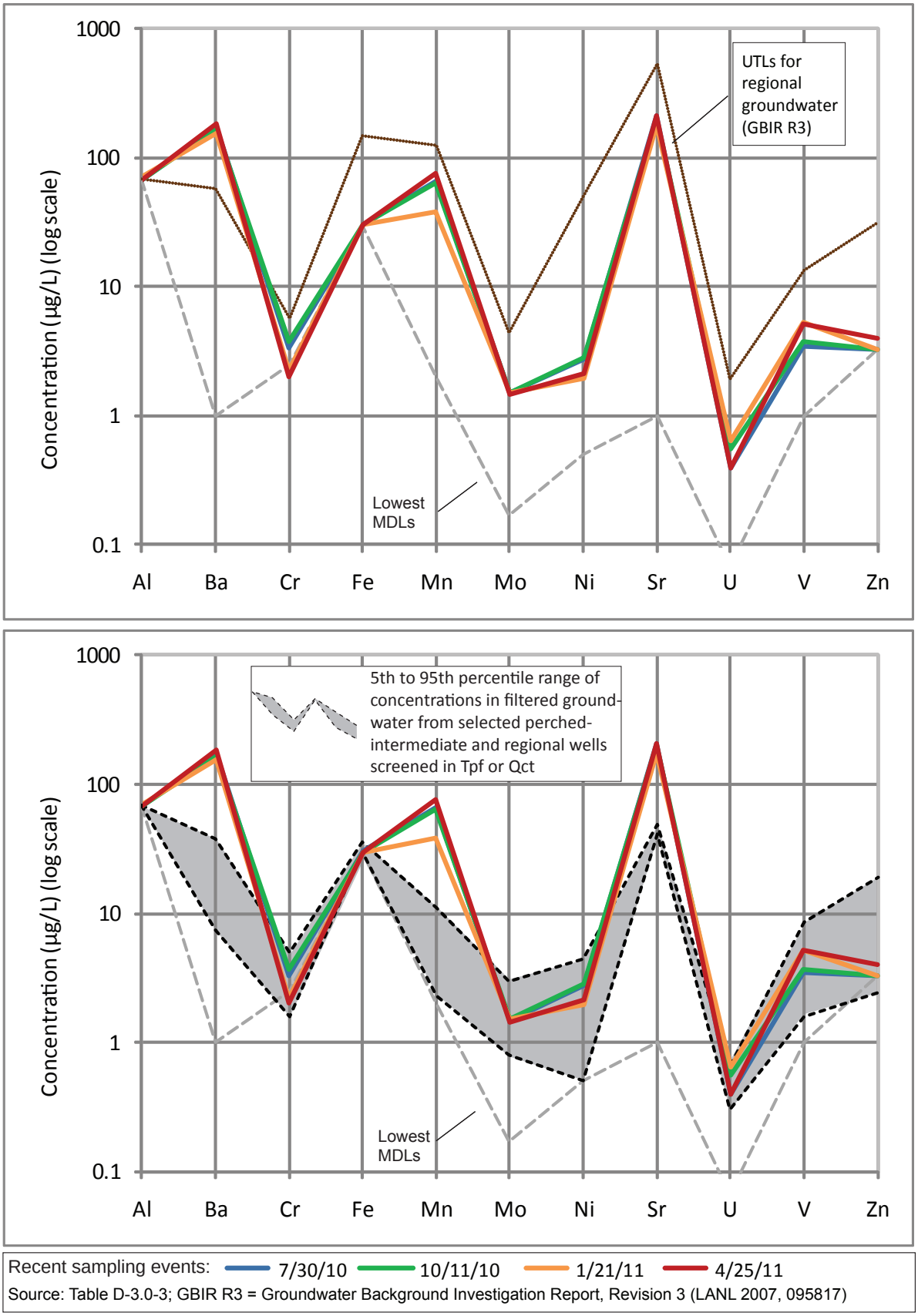
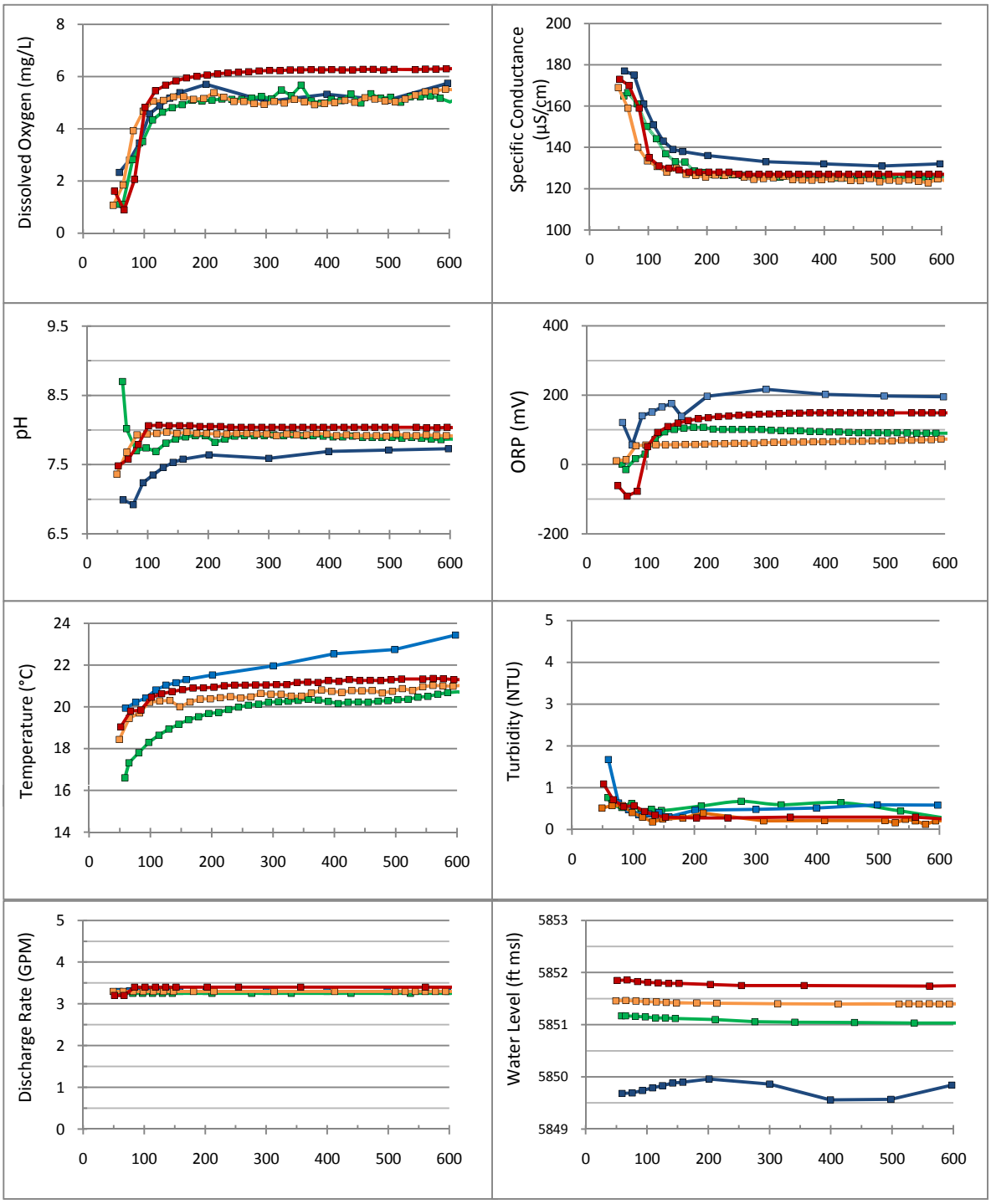


Figure D2-R20-6. Concentrations of trace metals in filtered groundwater from well R-20 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-21 (single screen), port depth 889 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

11-Aug-10 11-Oct-10 27-Jan-11 19-Apr-11

Figure D2-R21-1. Time-series plots of field parameters monitored during purging of R-21 (single screen)

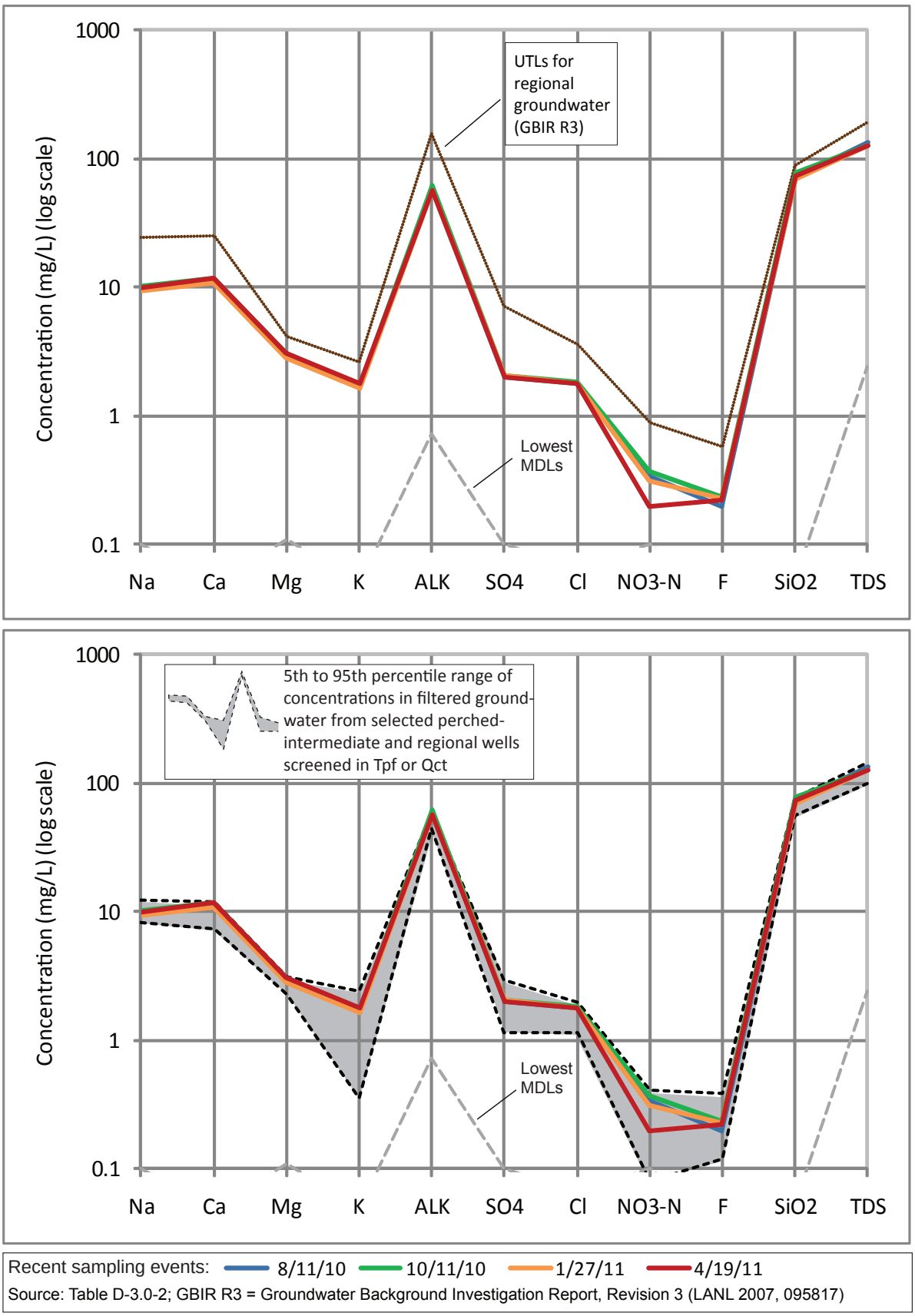


Figure D2-R21-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-21 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

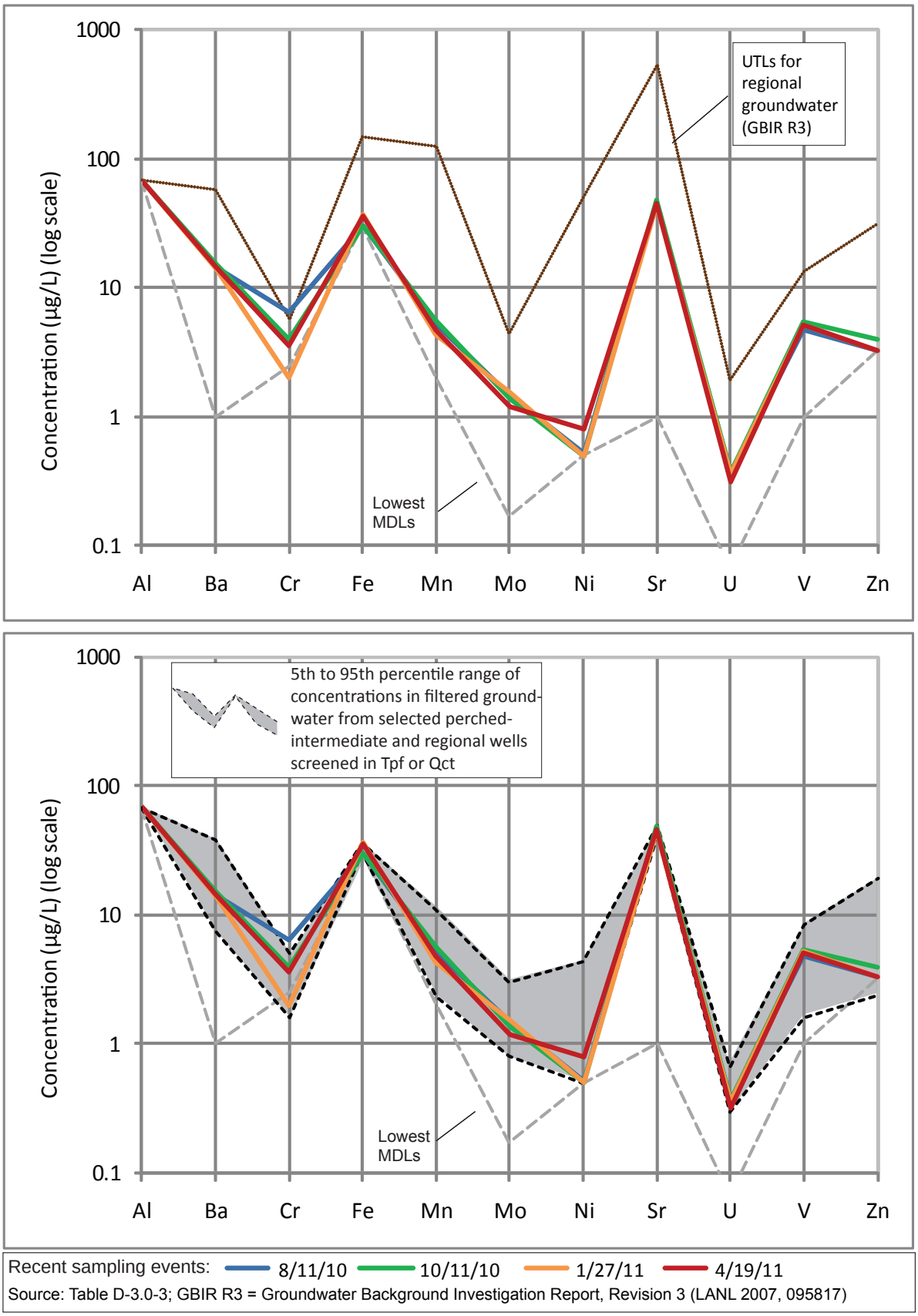
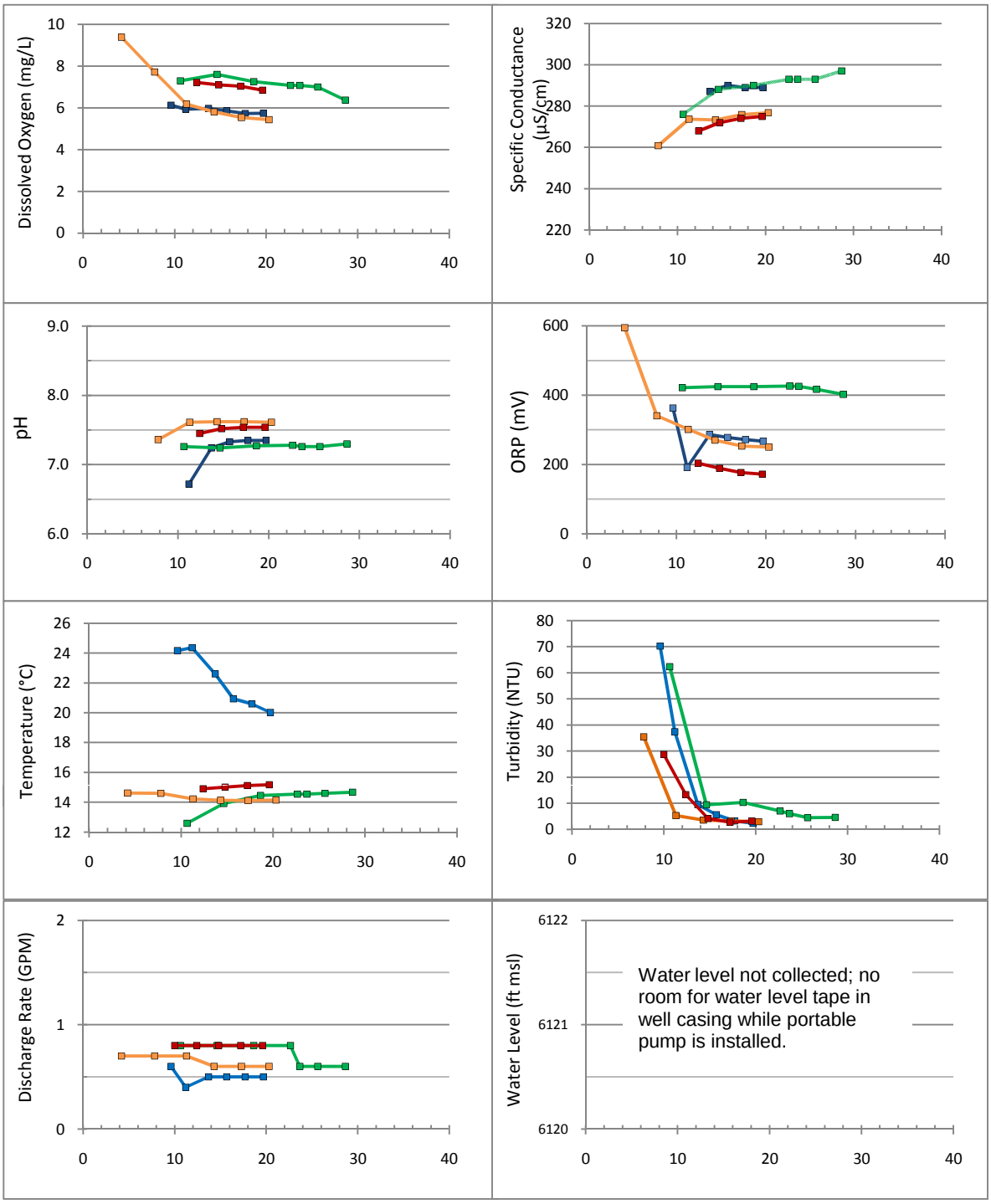


Figure D2-R21-3. Concentrations of trace metals in filtered groundwater from well R-21 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23i piezometer (port P1A), port depth 400 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

9-Aug-10 21-Oct-10 14-Jan-11 28-Apr-11

Figure D2-R23i-1. Time-series plots of field parameters monitored during purging of R-23i piezometer

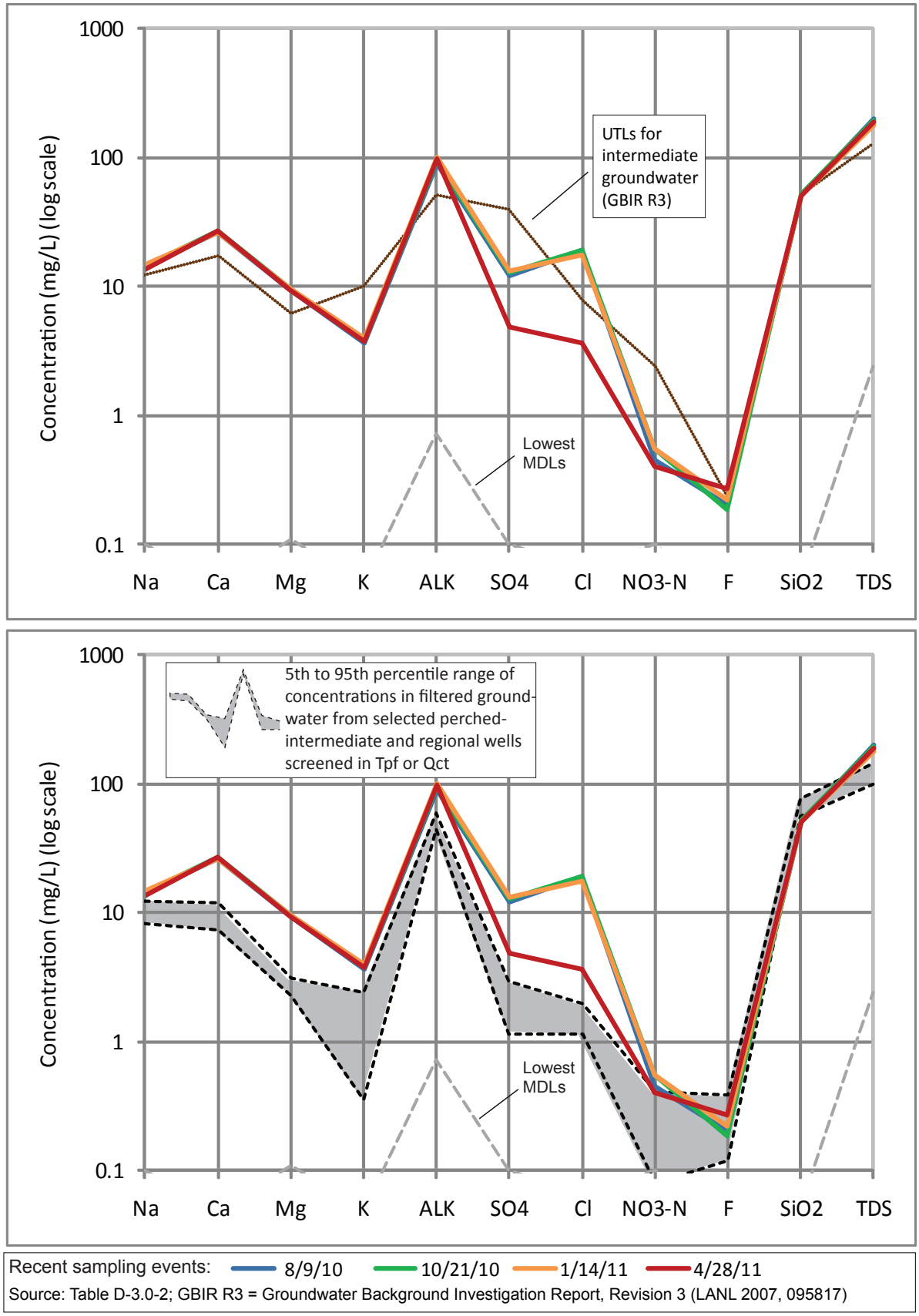


Figure D2-R23i-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

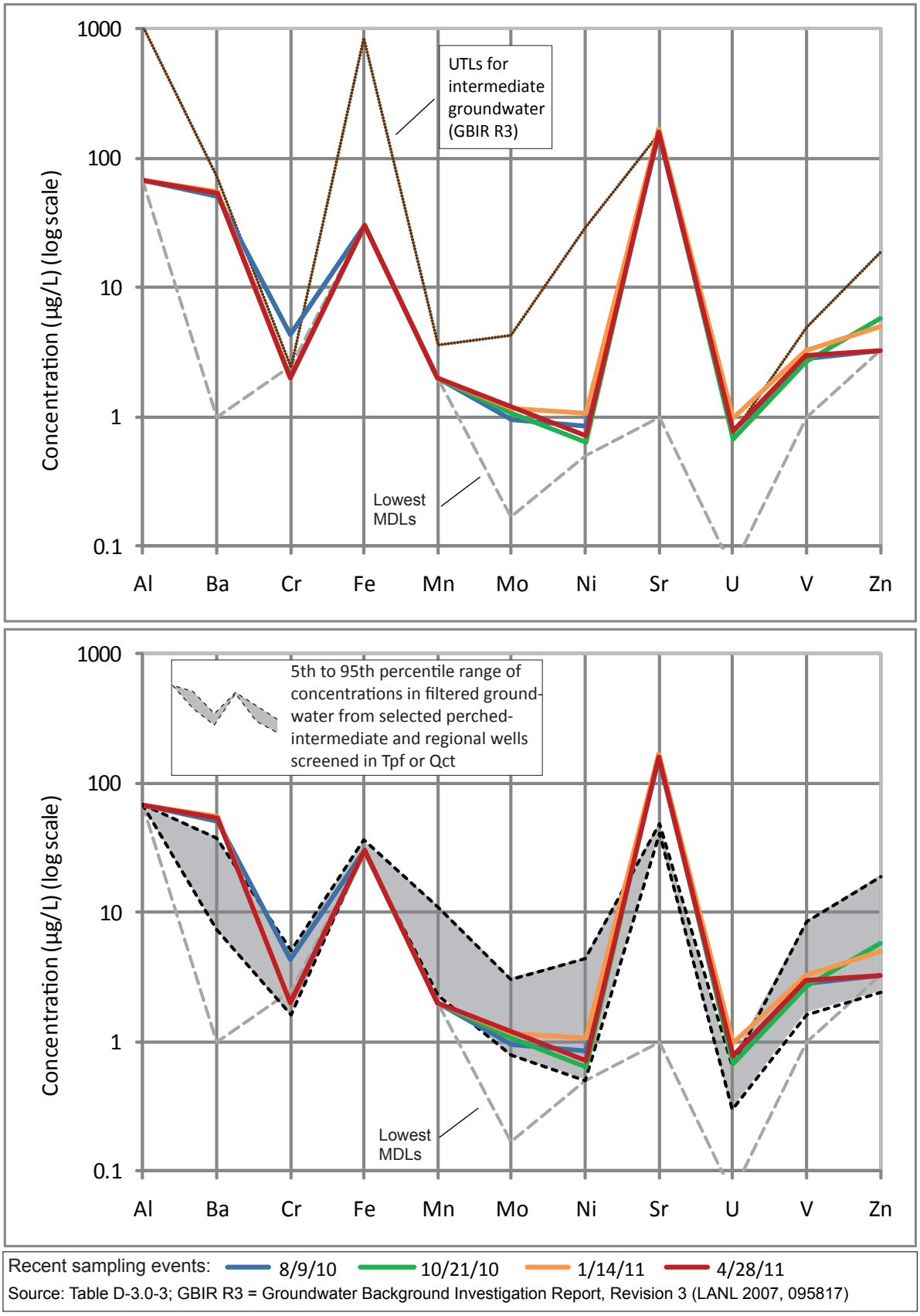
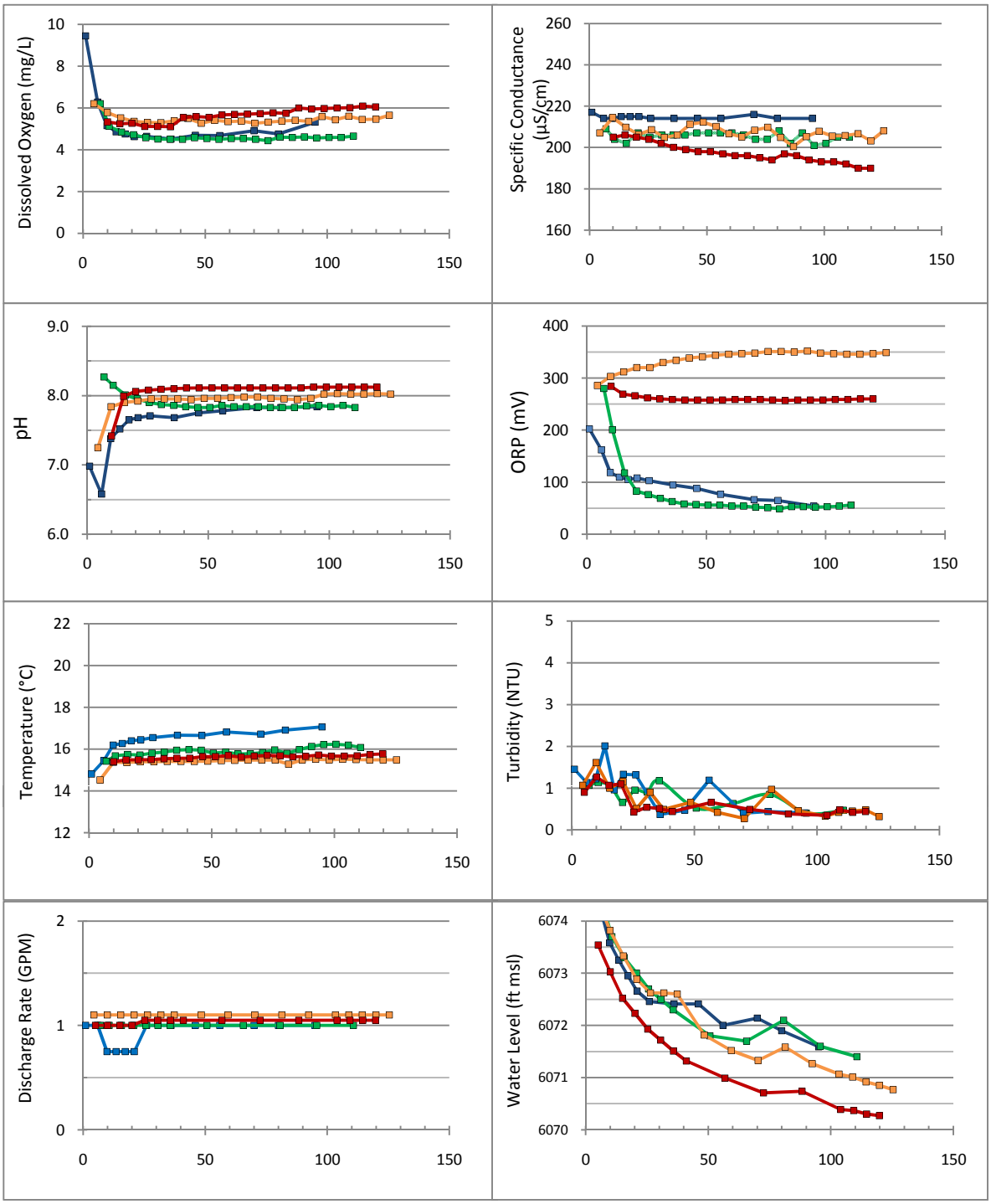


Figure D2-R23i-3. Concentrations of trace metals in filtered groundwater from well R-23i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23i screen 1 (port P2A), port depth 470 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

9-Aug-10 18-Oct-10 18-Jan-11 3-May-11

Figure D2-R23i-4. Time-series plots of field parameters monitored during purging of R-23i screen 1 (port P2A)

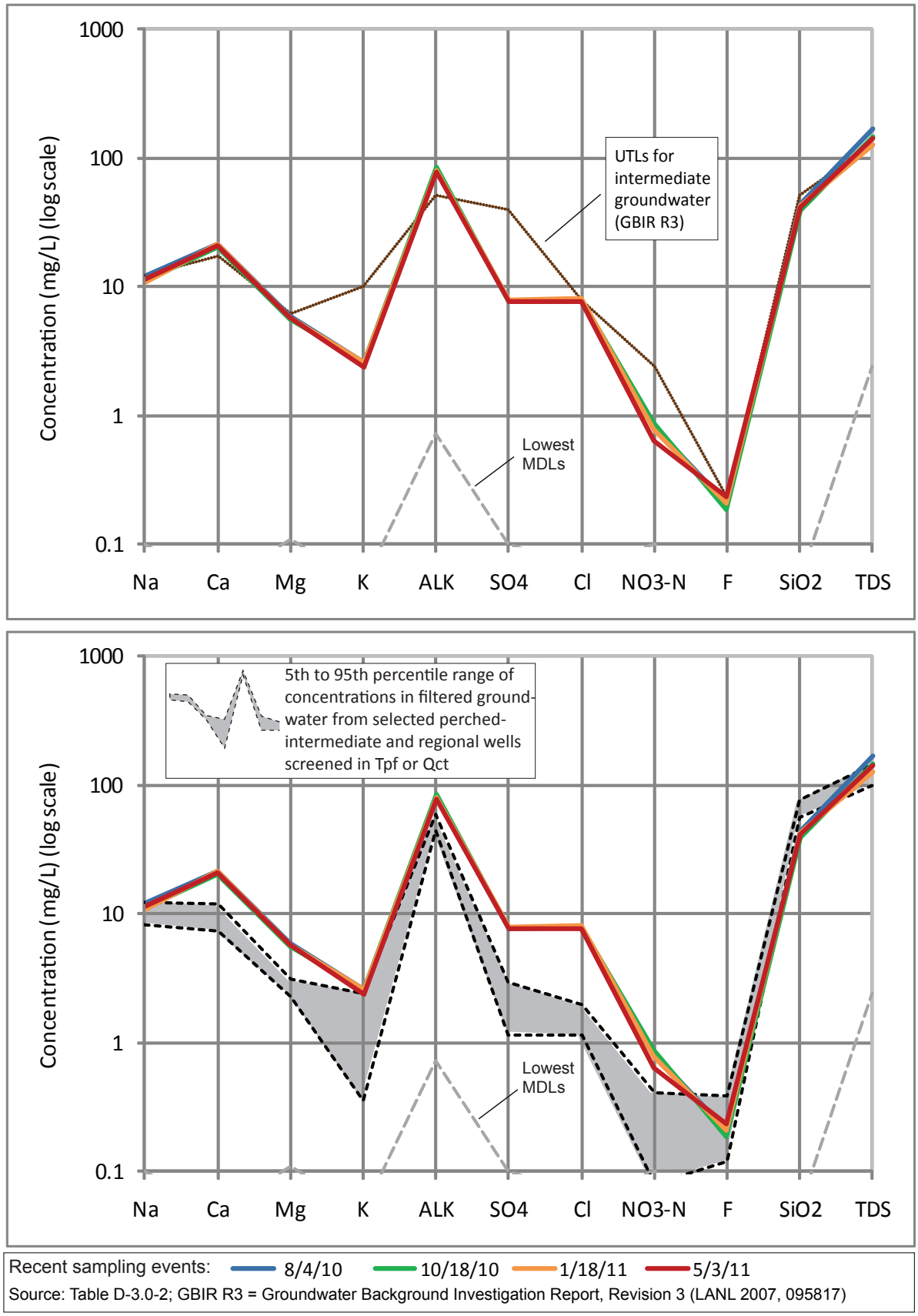


Figure D2-R23i-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23i screen 2 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

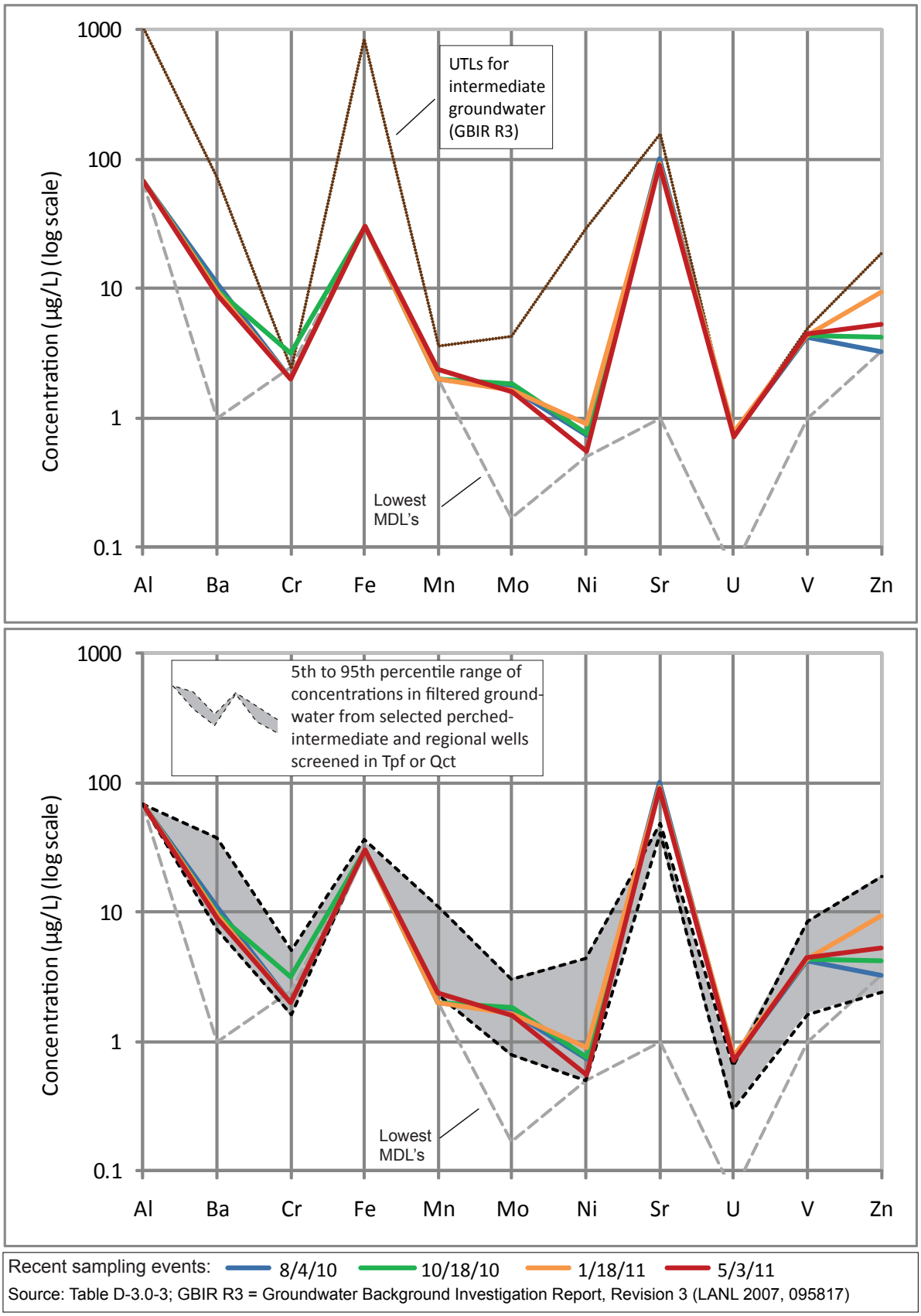
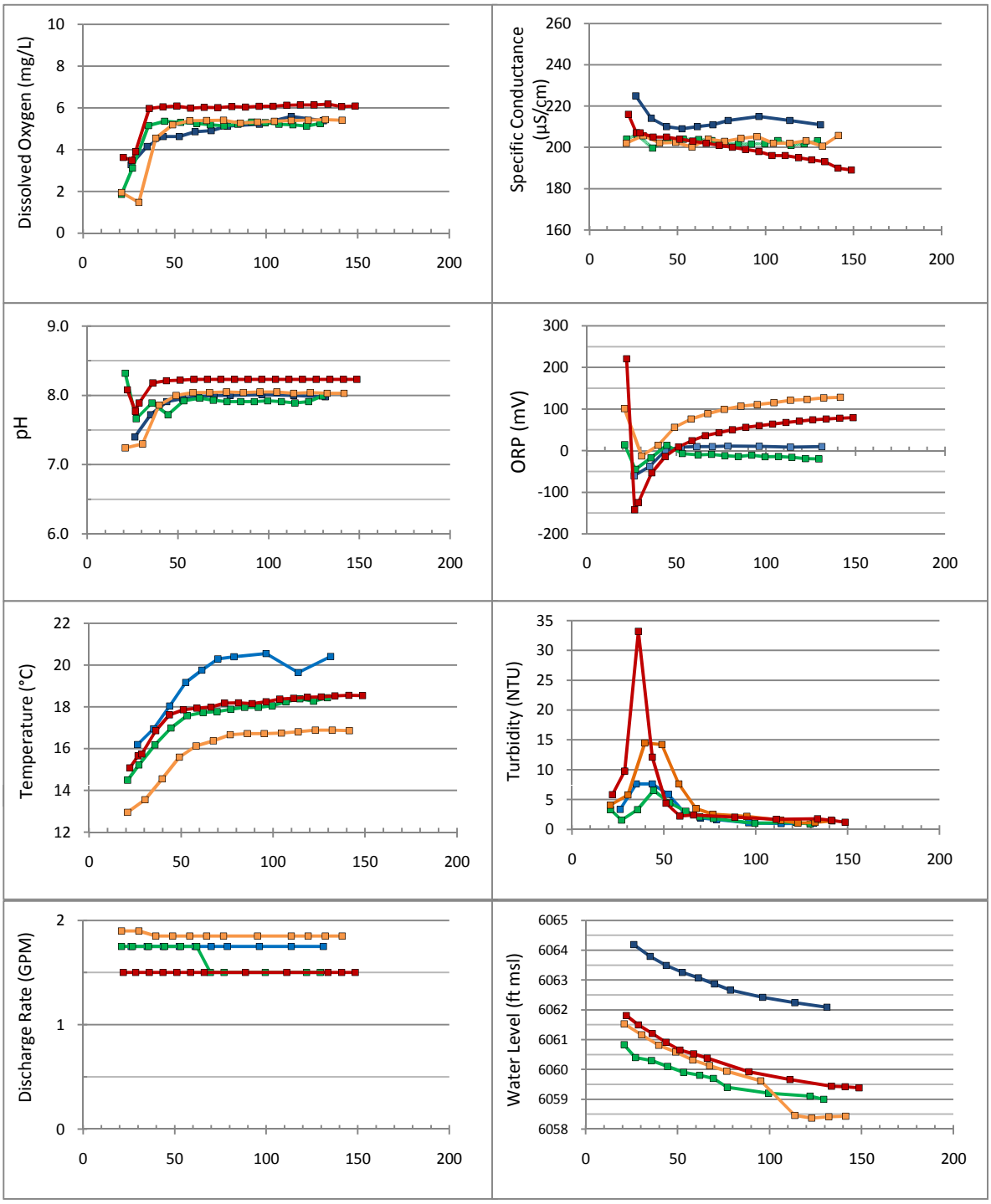


Figure D2-R23i-6. Concentrations of trace metals in filtered groundwater from well R-23i screen 2 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23i screen 2 (port P3A), port depth 524 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

4-Aug-10 18-Oct-10 24-Jan-11 18-Apr-11

Figure D2-R23i-7. Time-series plots of field parameters monitored during purging of R-23i screen 2 (port P3A)

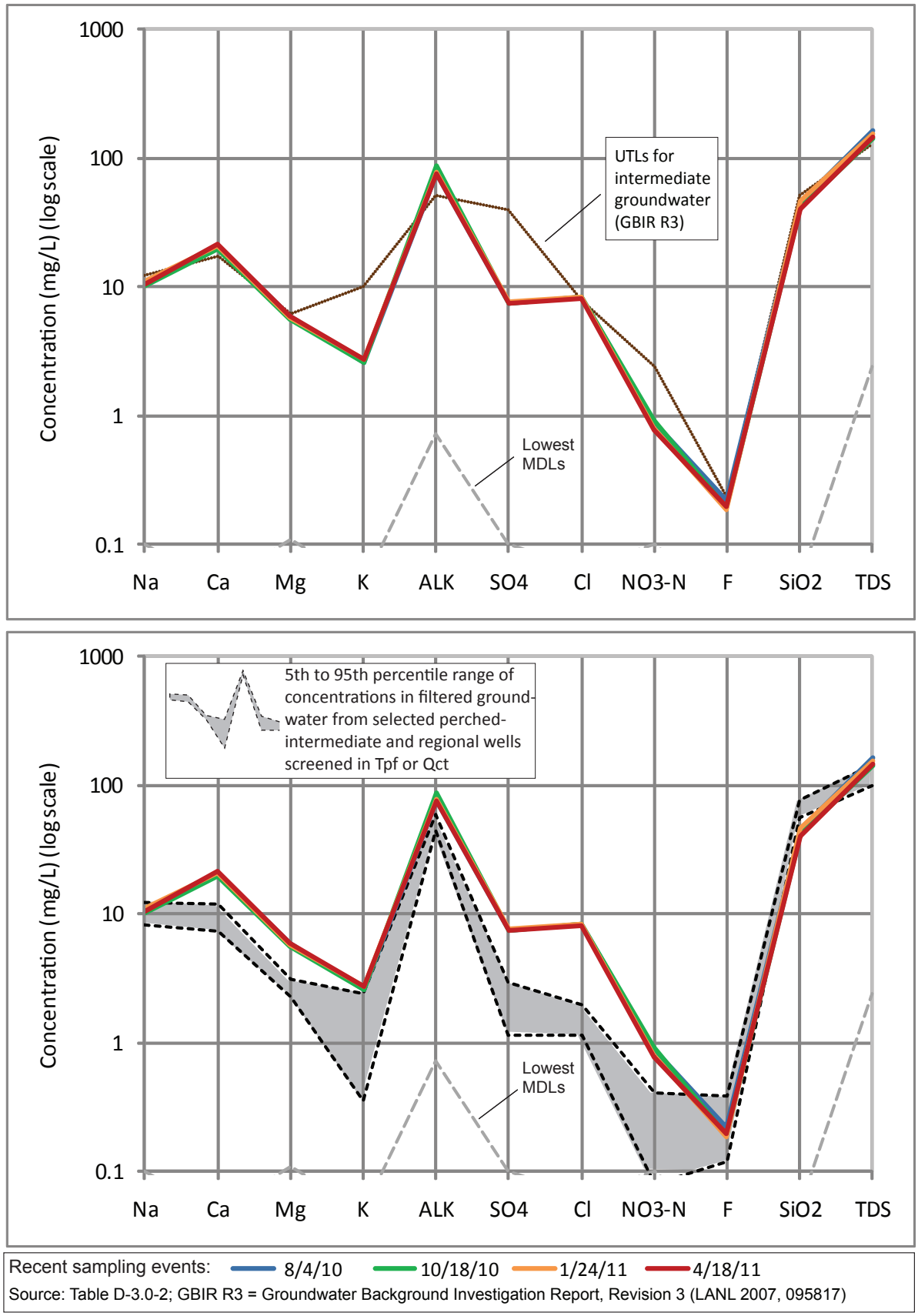


Figure D2-R-23i-8. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23i screen 3 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

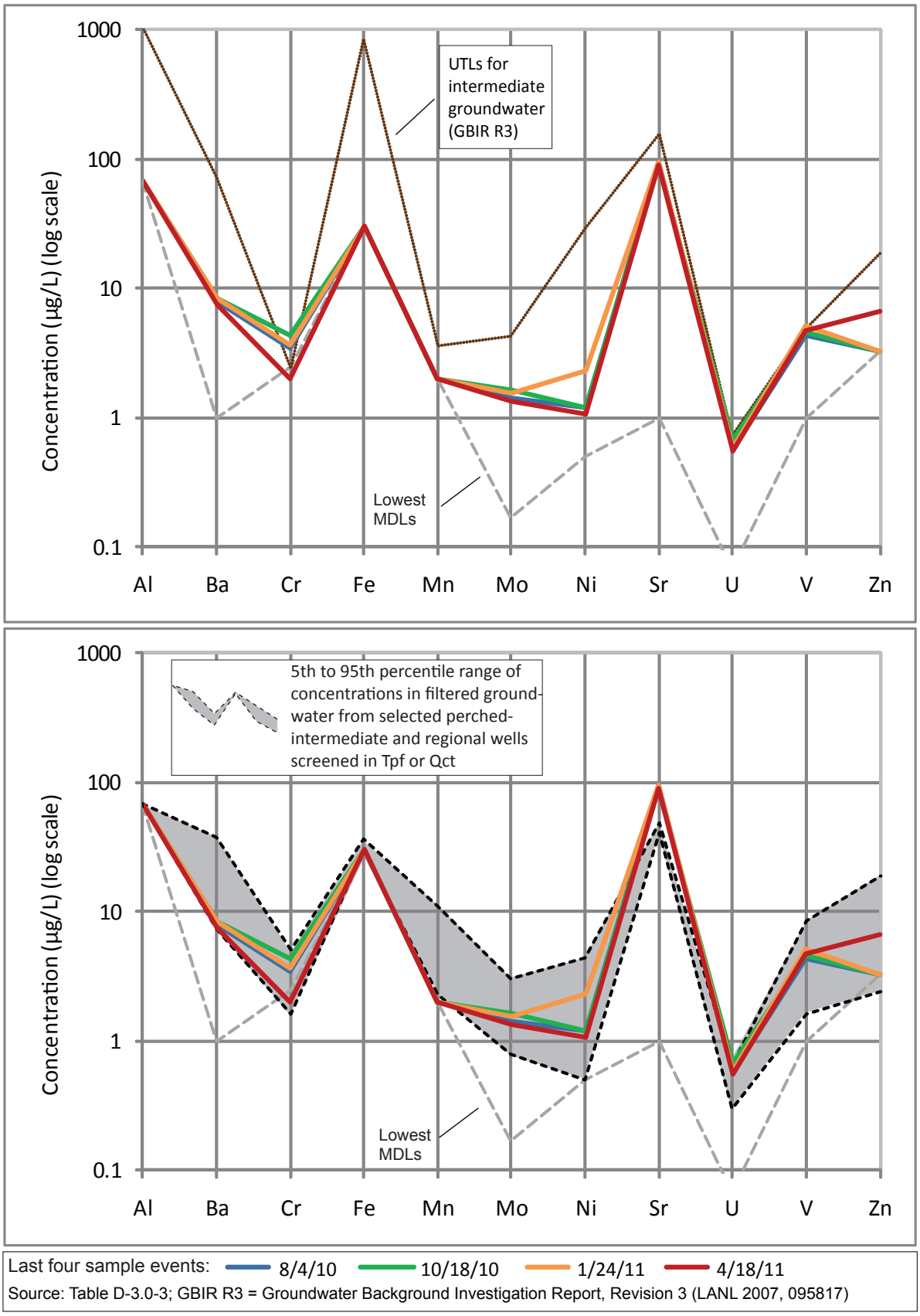
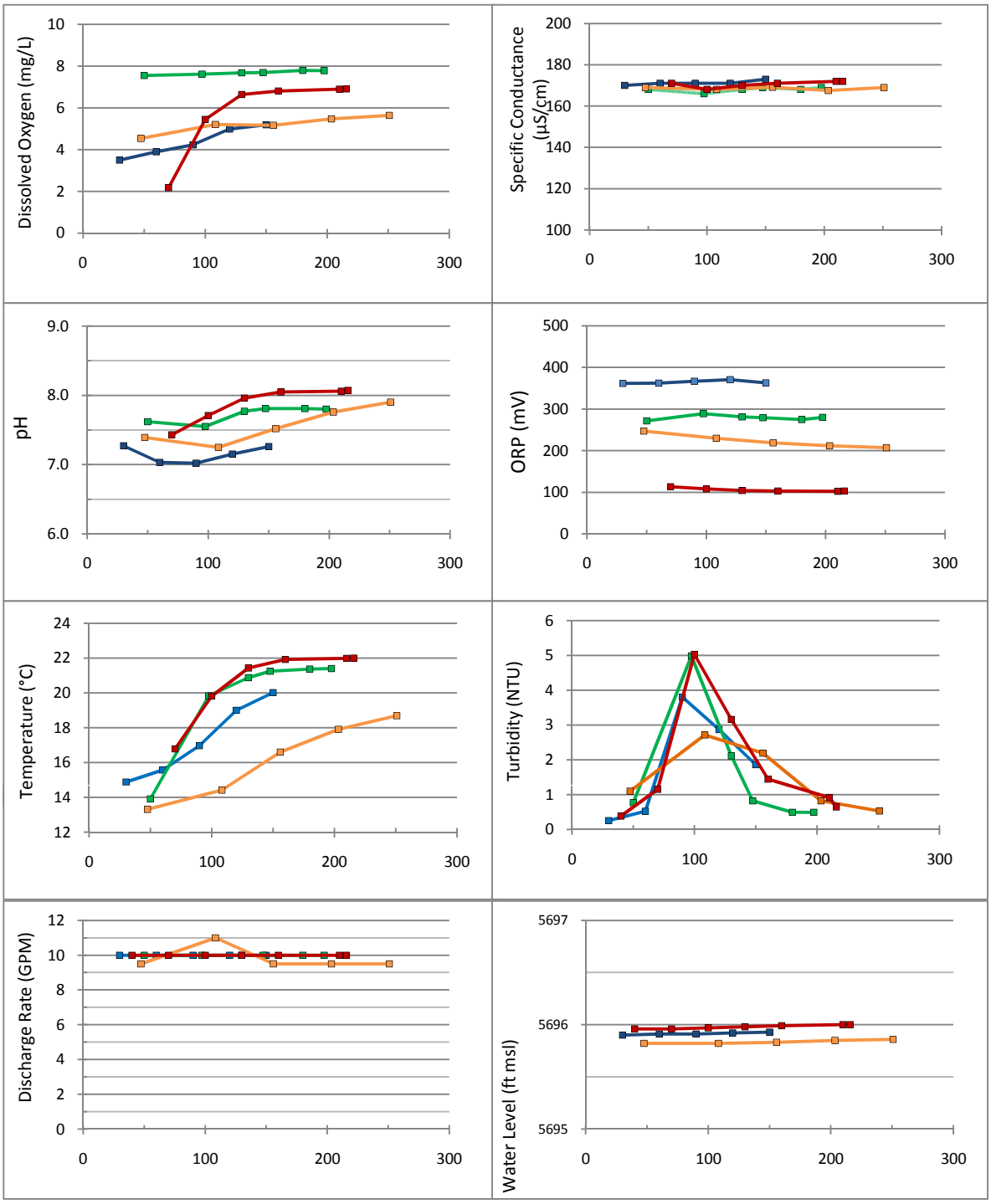


Figure D2-R23i-9. Concentrations of trace metals in filtered groundwater from well R-23i screen 3 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23 (single screen), port depth 816 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

12-Aug-10 22-Oct-10 24-Jan-11 18-Apr-11

Figure D2-R23-1. Time-series plots of field parameters monitored during purging of R-23 (single screen)

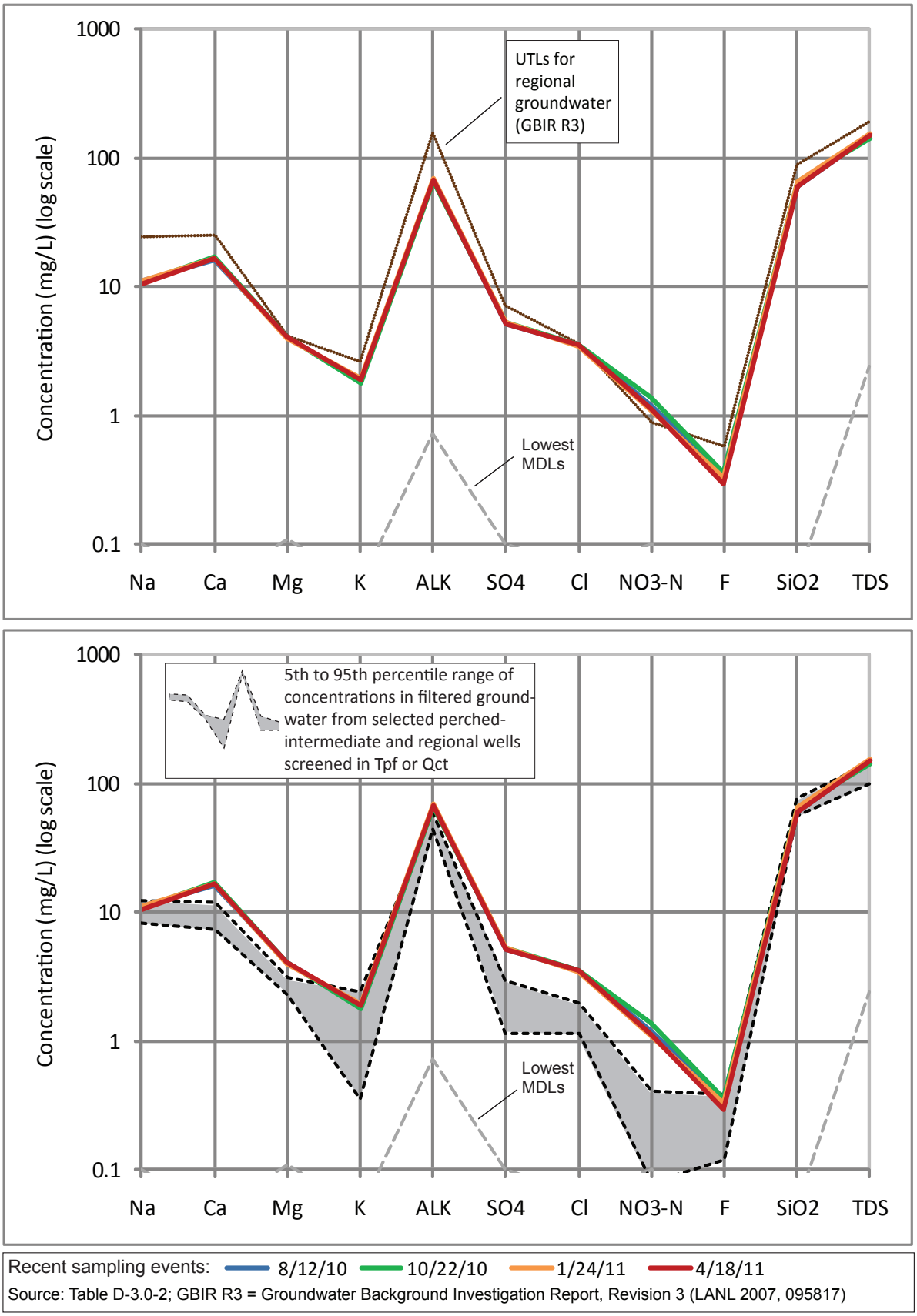


Figure D2-R23-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

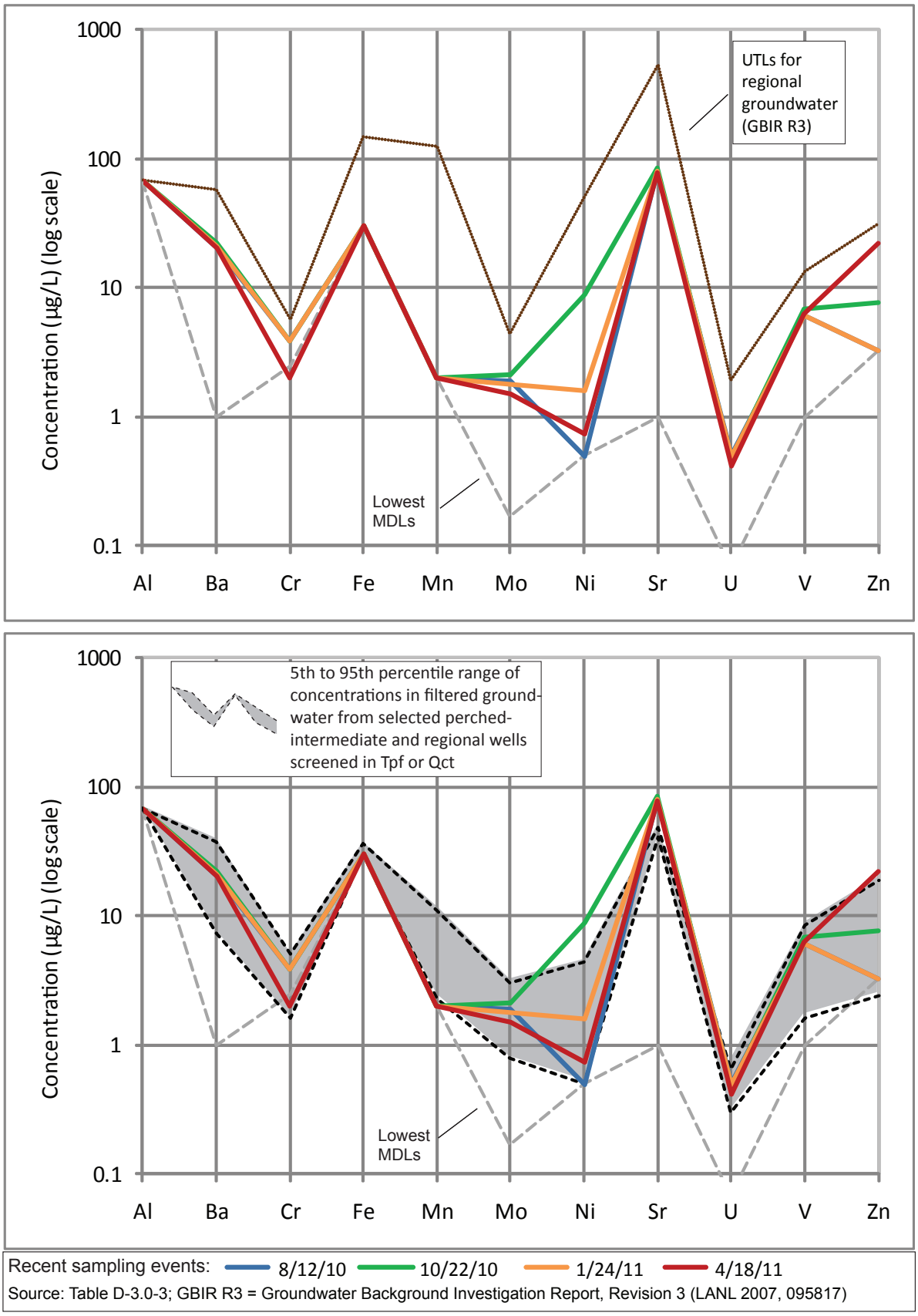


Figure D2-R23-3. Concentrations of trace metals in filtered groundwater from well R-23 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-32 (single screen), port depth 868 ft bgs

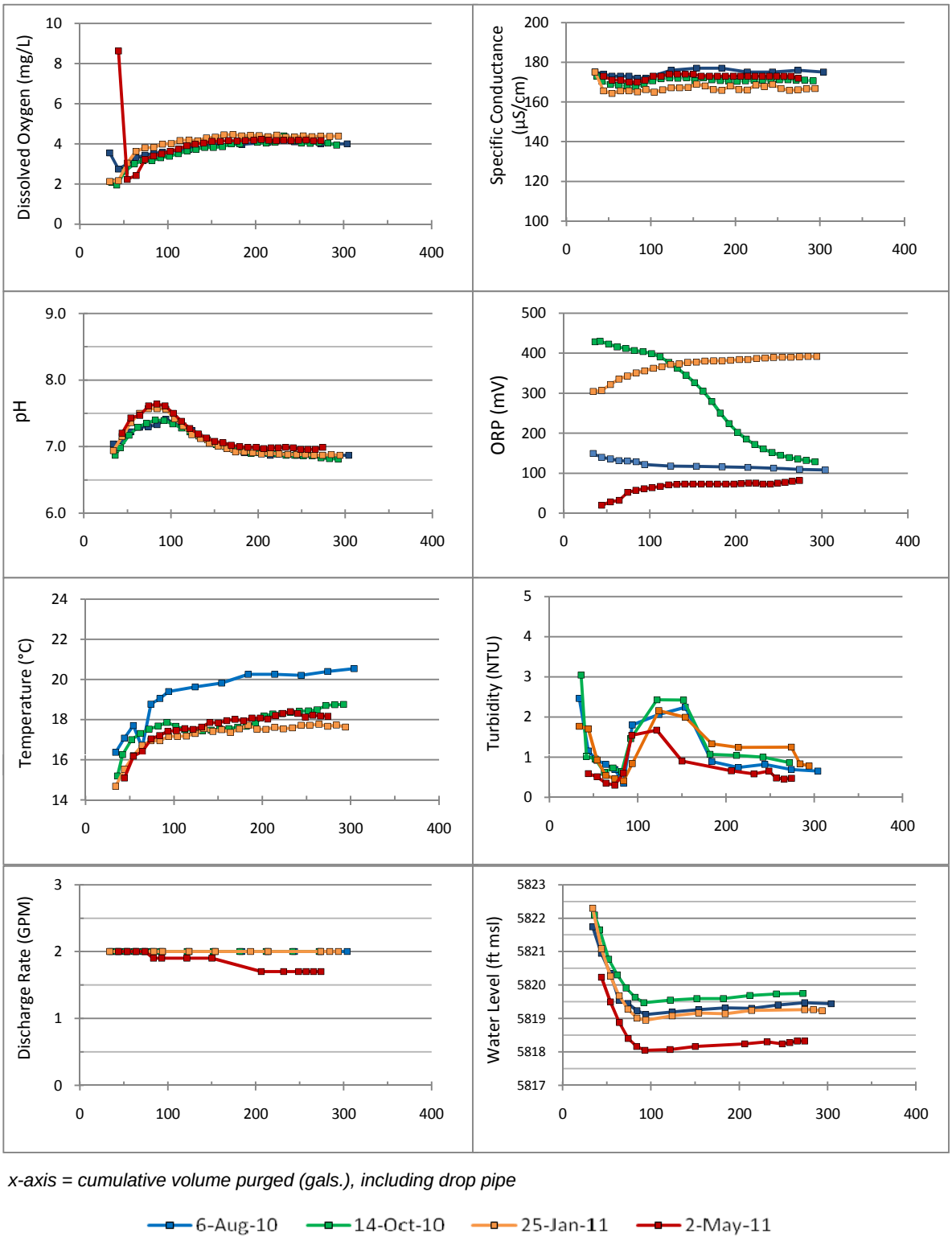


Figure D2-R32-1. **Time-series plots of field parameters monitored during purging of R-32 (single screen)**

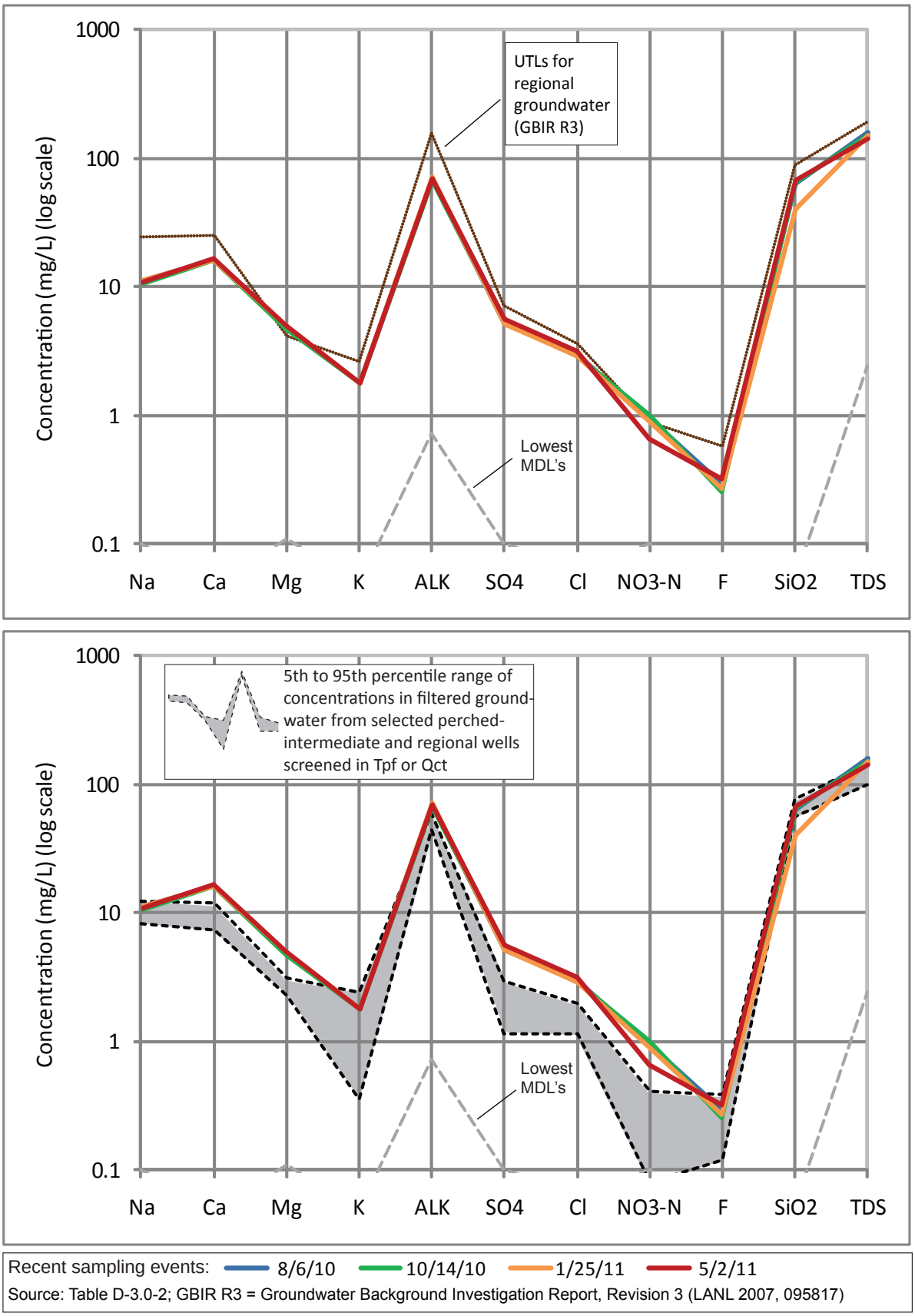


Figure D2-R32-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-32 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

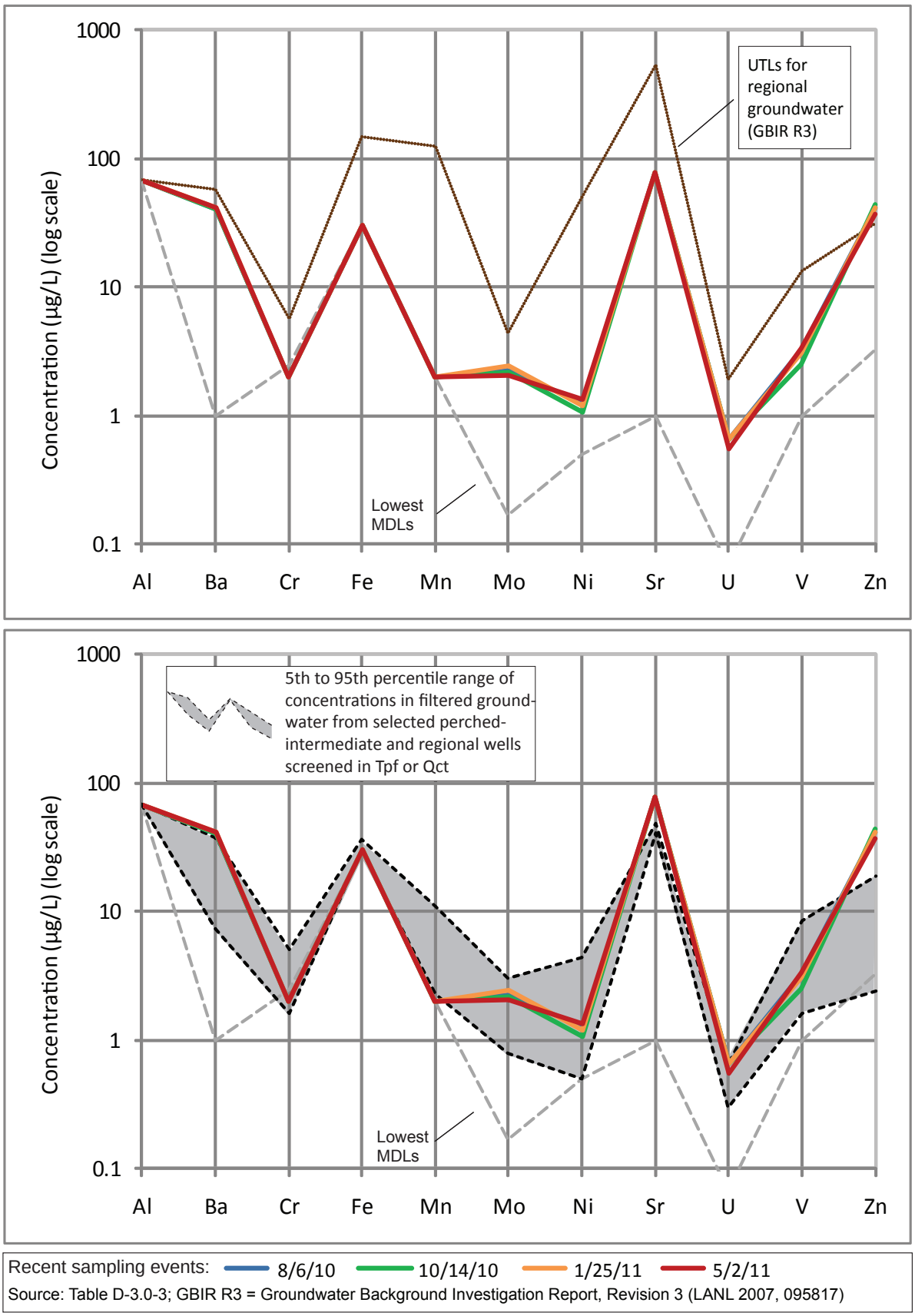
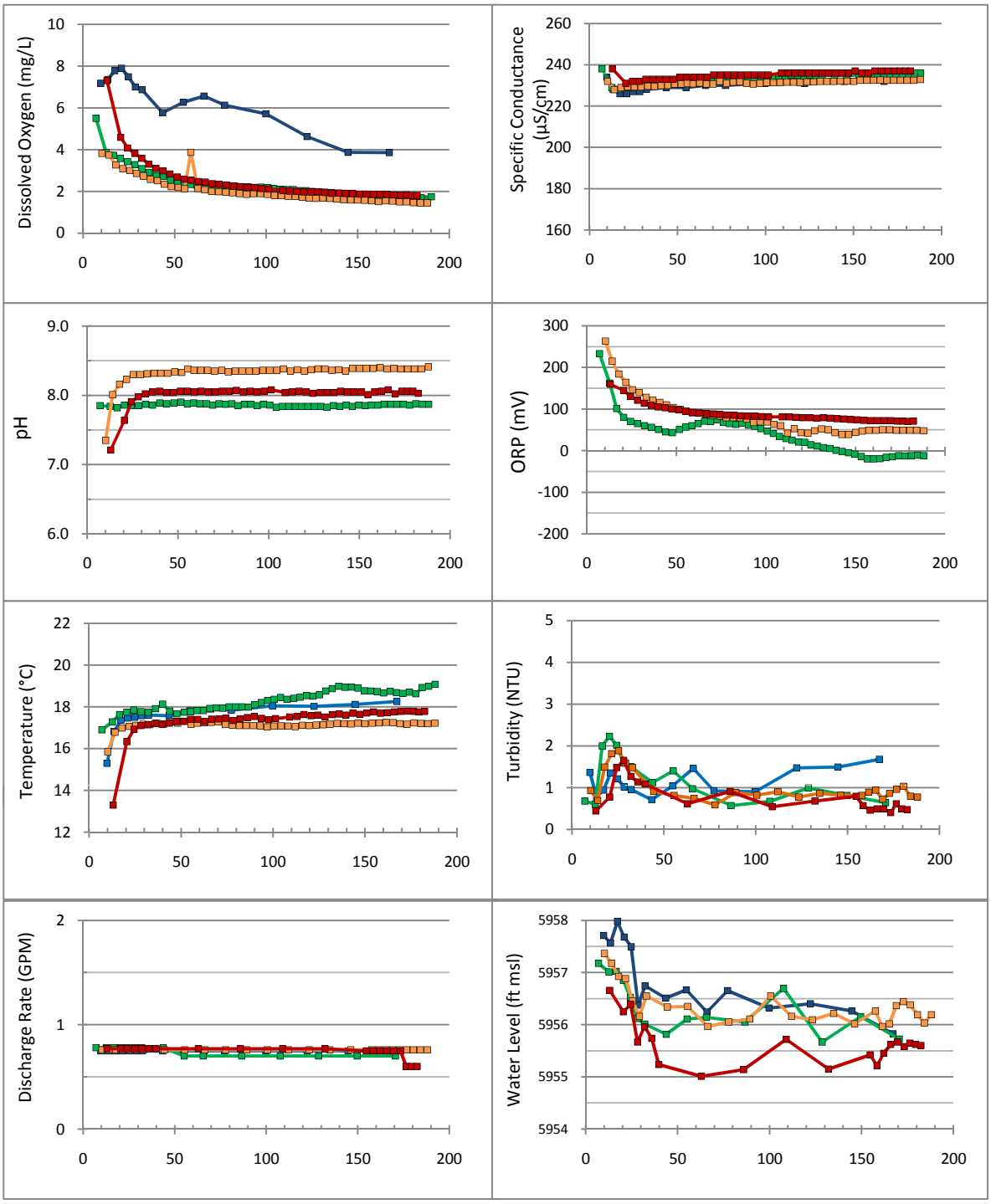


Figure D2-R32-3. Concentrations of trace metals in filtered groundwater from well R-32 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-37 screen 1 (port P1A), port depth 929 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

5-Aug-10 12-Oct-10 21-Jan-11 3-May-11

Figure D2-R37-1. Time-series plots of field parameters monitored during purging of R-37 screen 1 (port P1A)

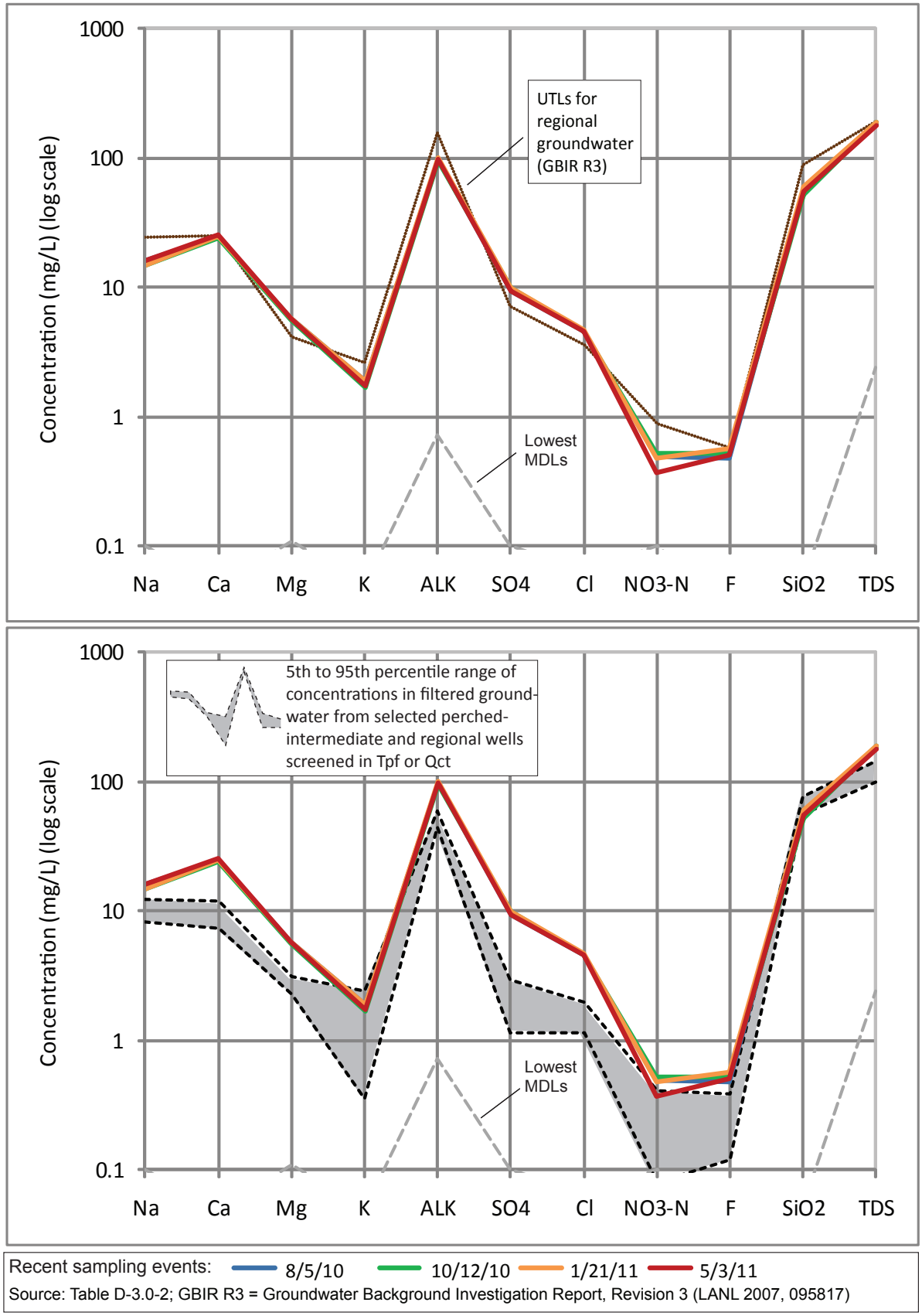


Figure D2-R37-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-37 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

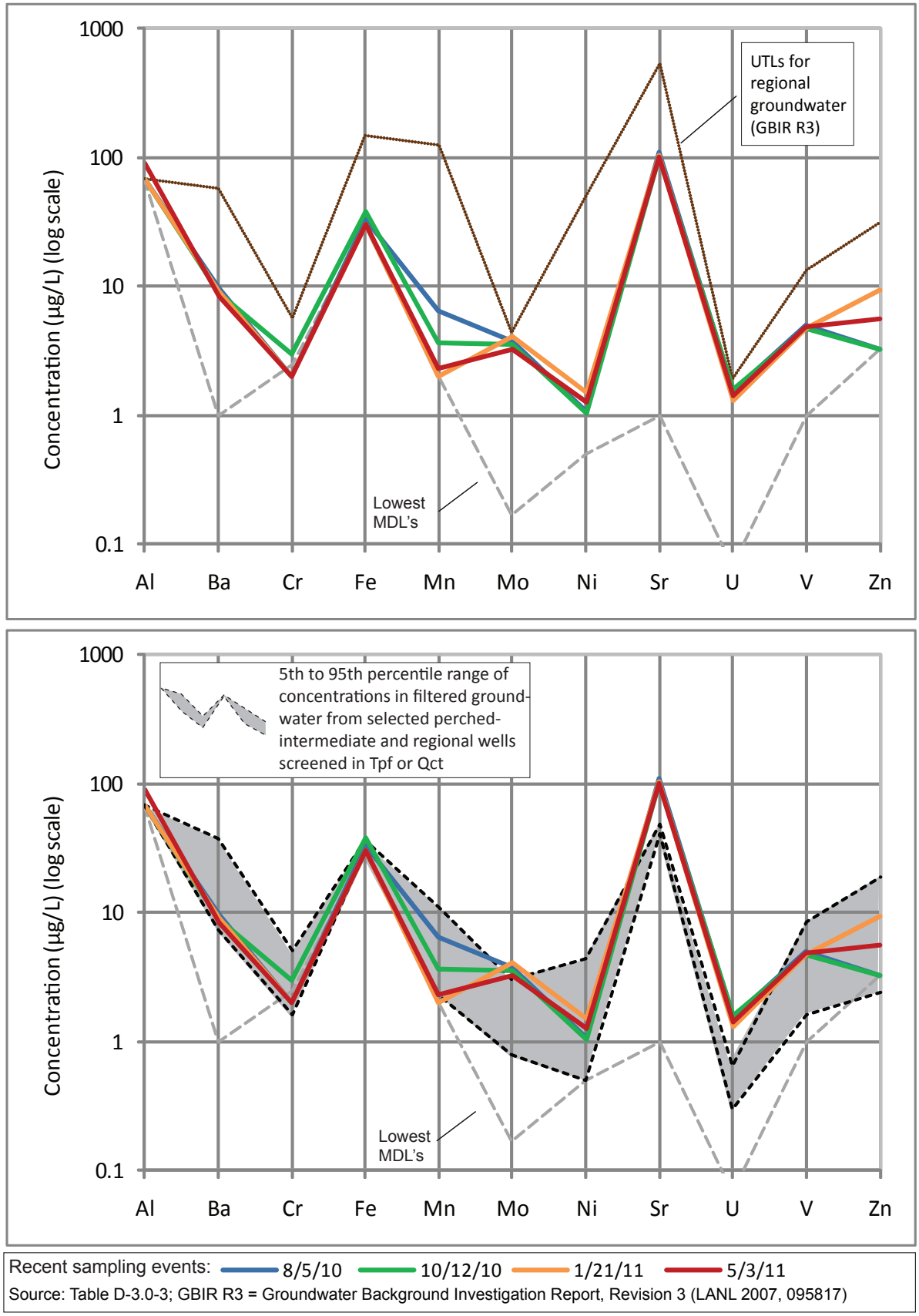
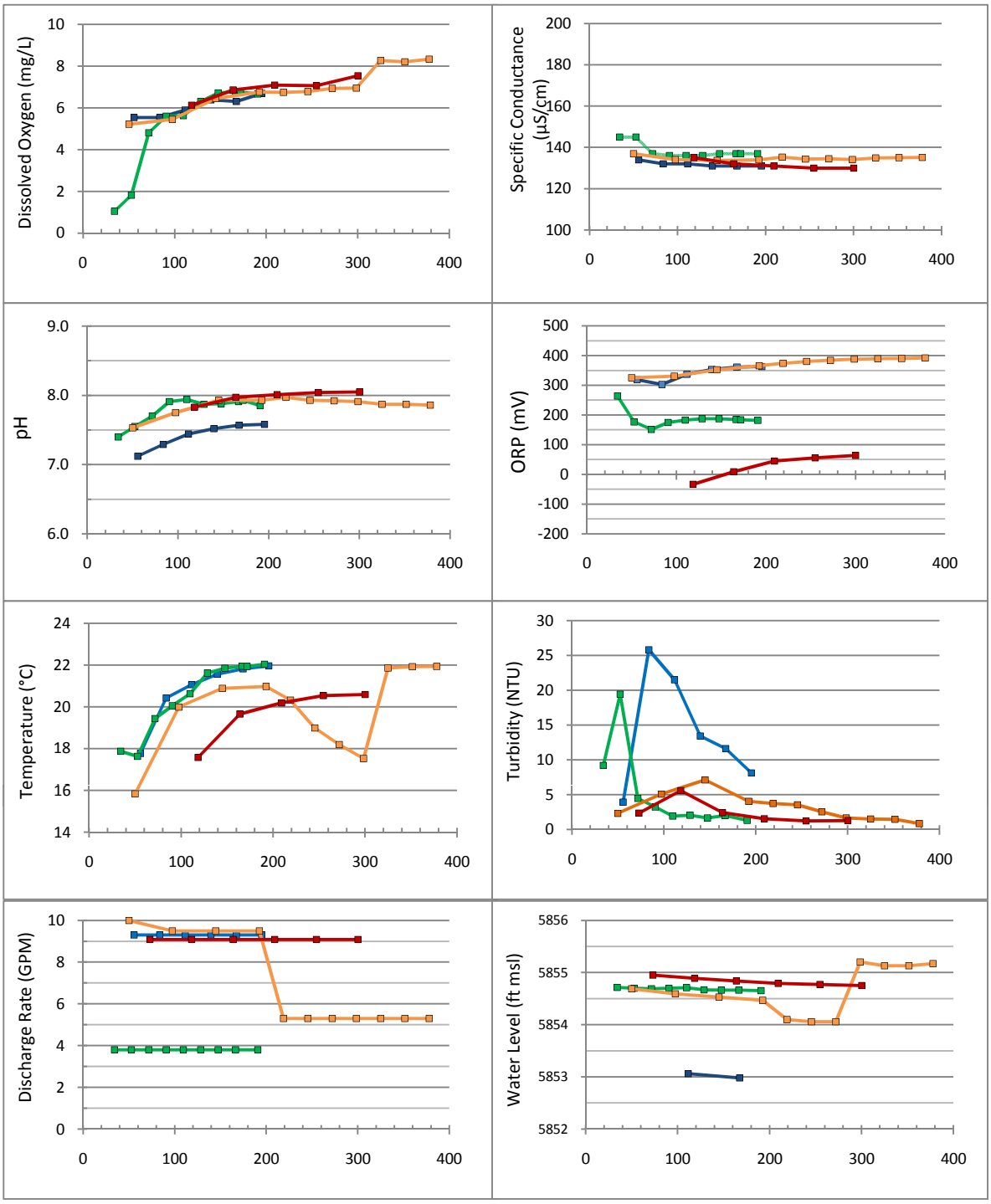


Figure D2-R37-3. Concentrations of trace metals in filtered groundwater from well R-37 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

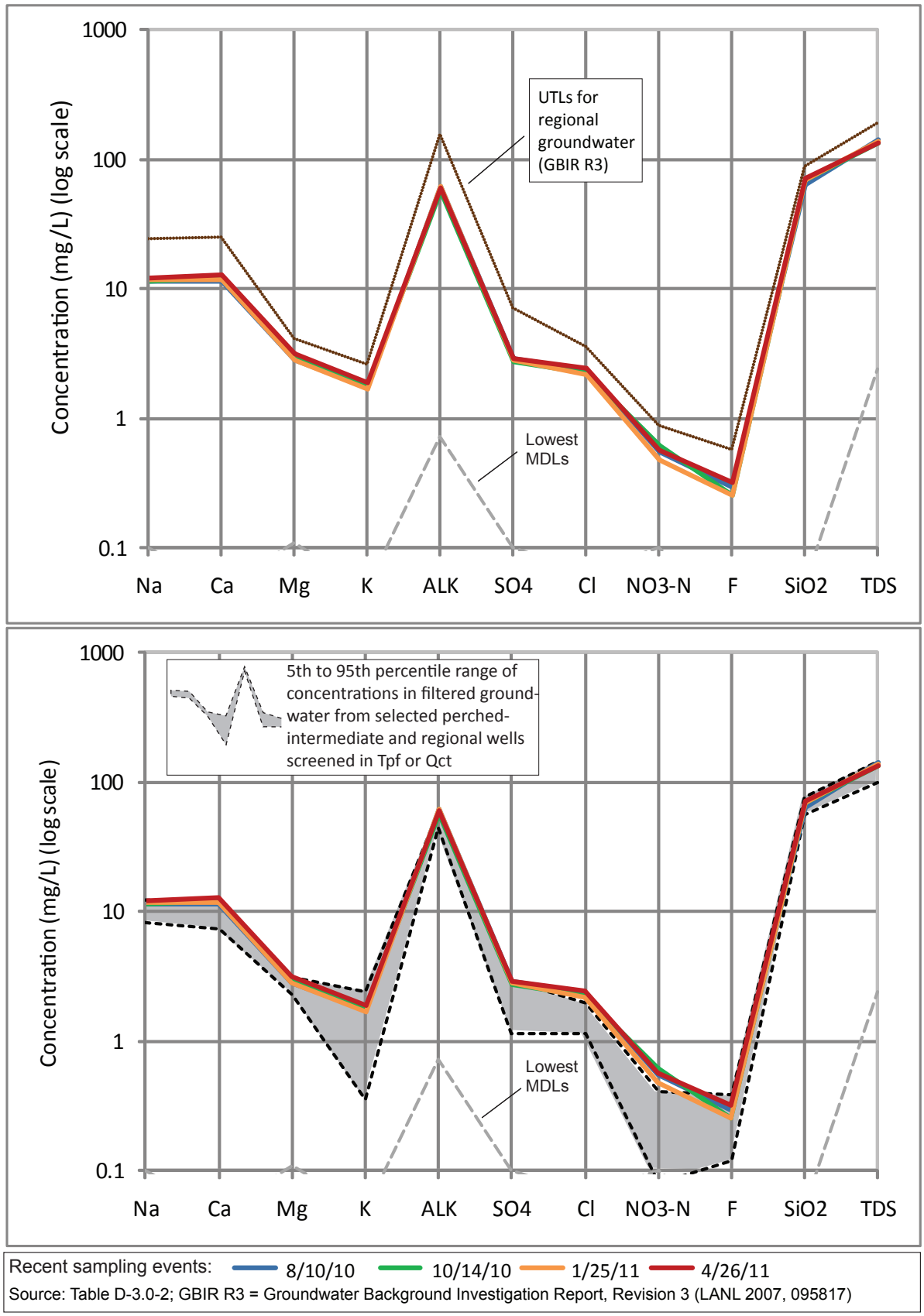
R-37 screen 2 (port P2A), port depth 1026 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

10-Aug-10 14-Oct-10 25-Jan-11 26-Apr-11

Figure D2-R37-4. Time-series plots of field parameters monitored during purging of R-37 screen 2 (port P2A)



Source: Table D-3.0-2; GBIR R3 = Groundwater Background Investigation Report, Revision 3 (LANL 2007, 095817)

Figure D2-R37-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-37 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

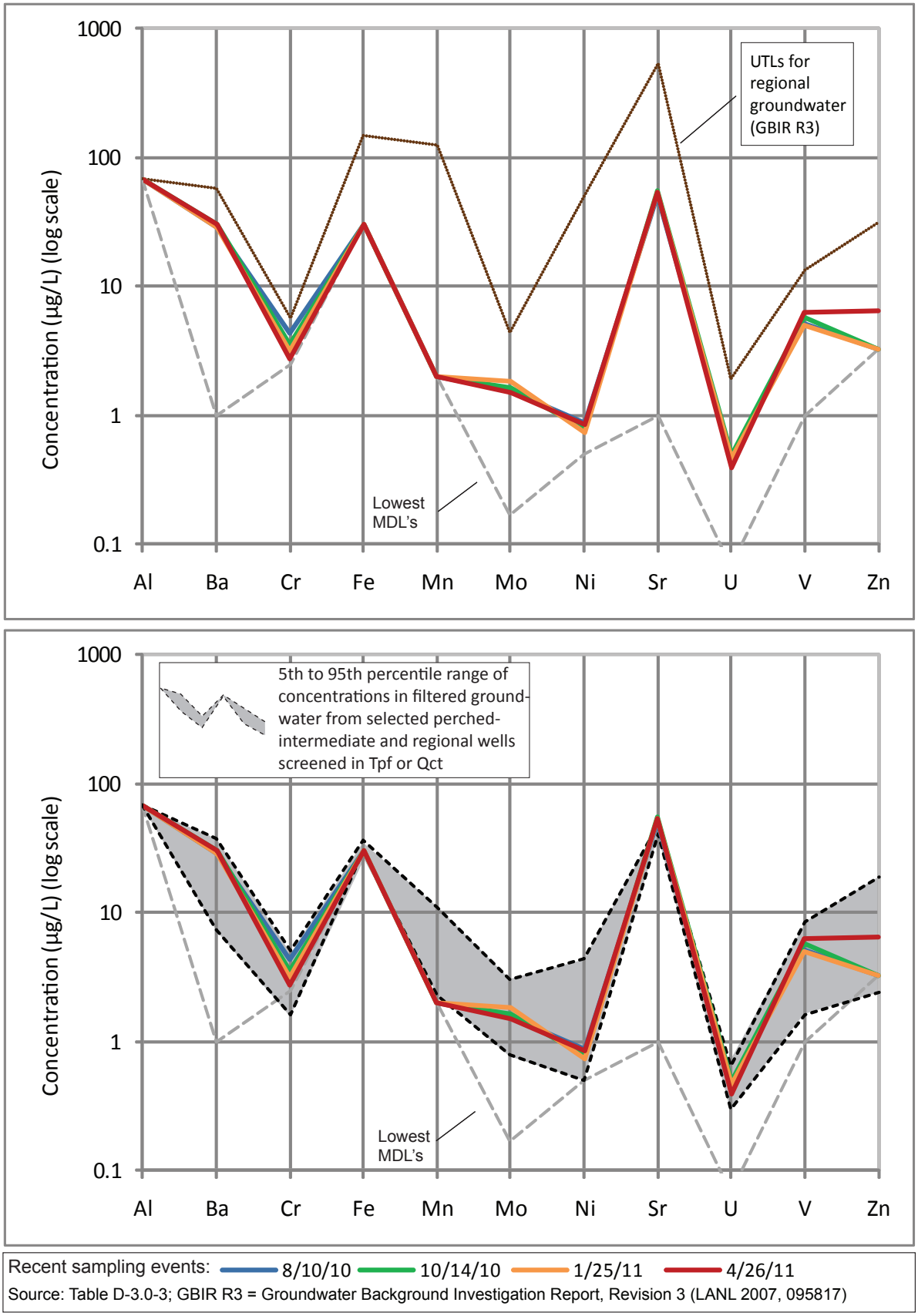
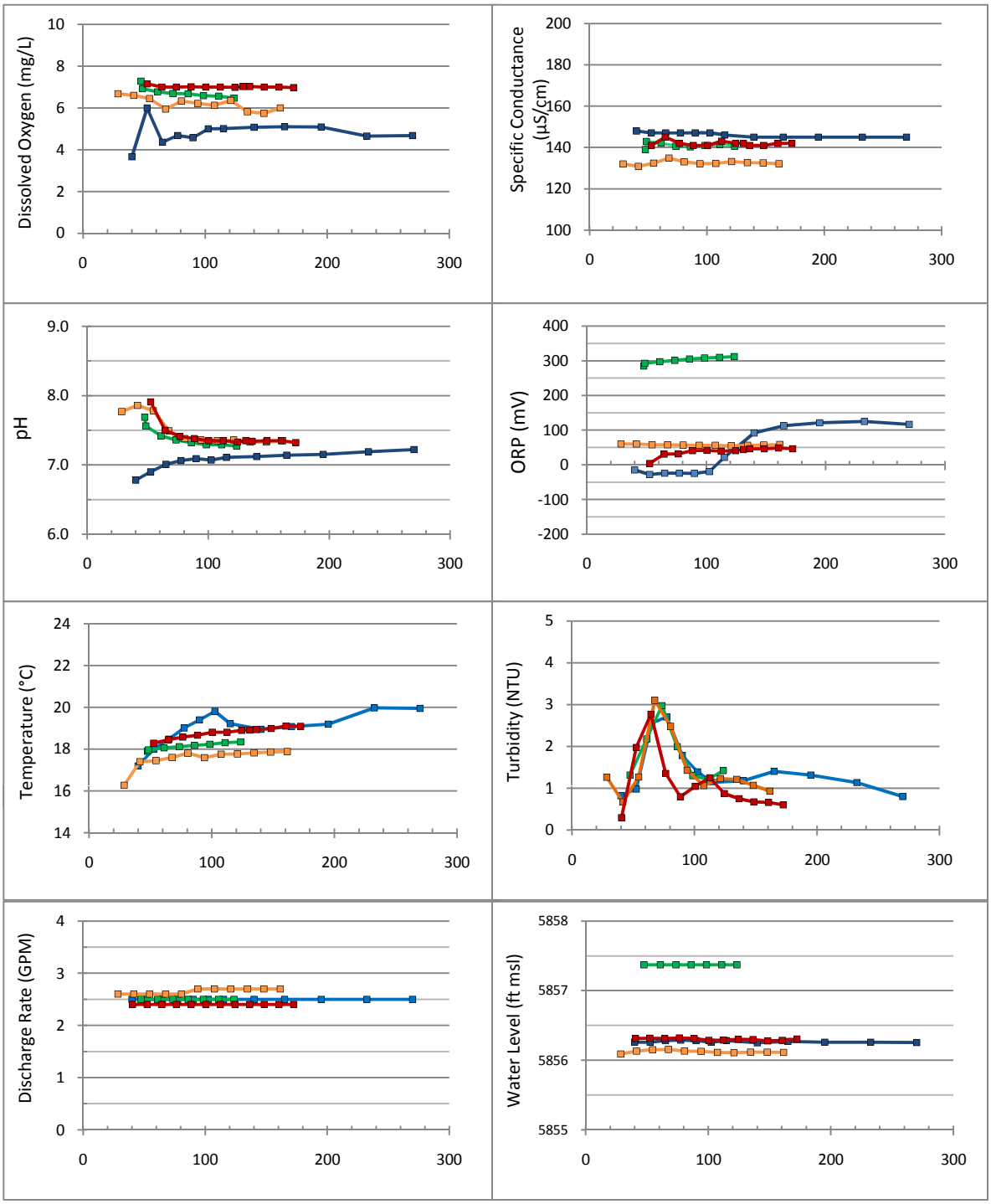


Figure D2-R37-6. Concentrations of trace metals in filtered groundwater from well R-37 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-38 (single screen), port depth 821 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

6-Aug-10 11-Oct-10 27-Jan-11 6-May-11

Figure D2-R38-1. Time-series plots of field parameters monitored during purging of R-38 (single screen)

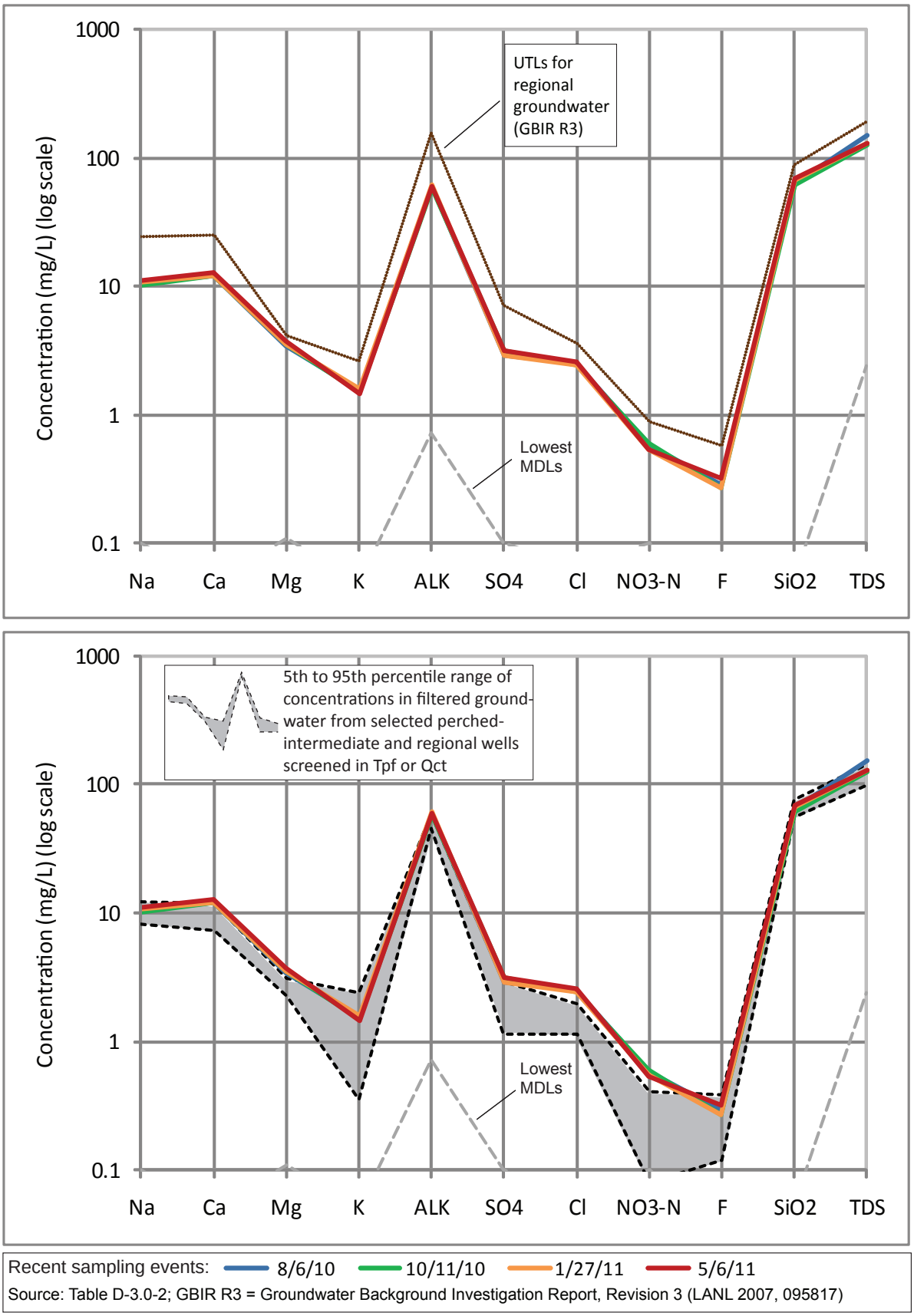


Figure D2-R38-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-38 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

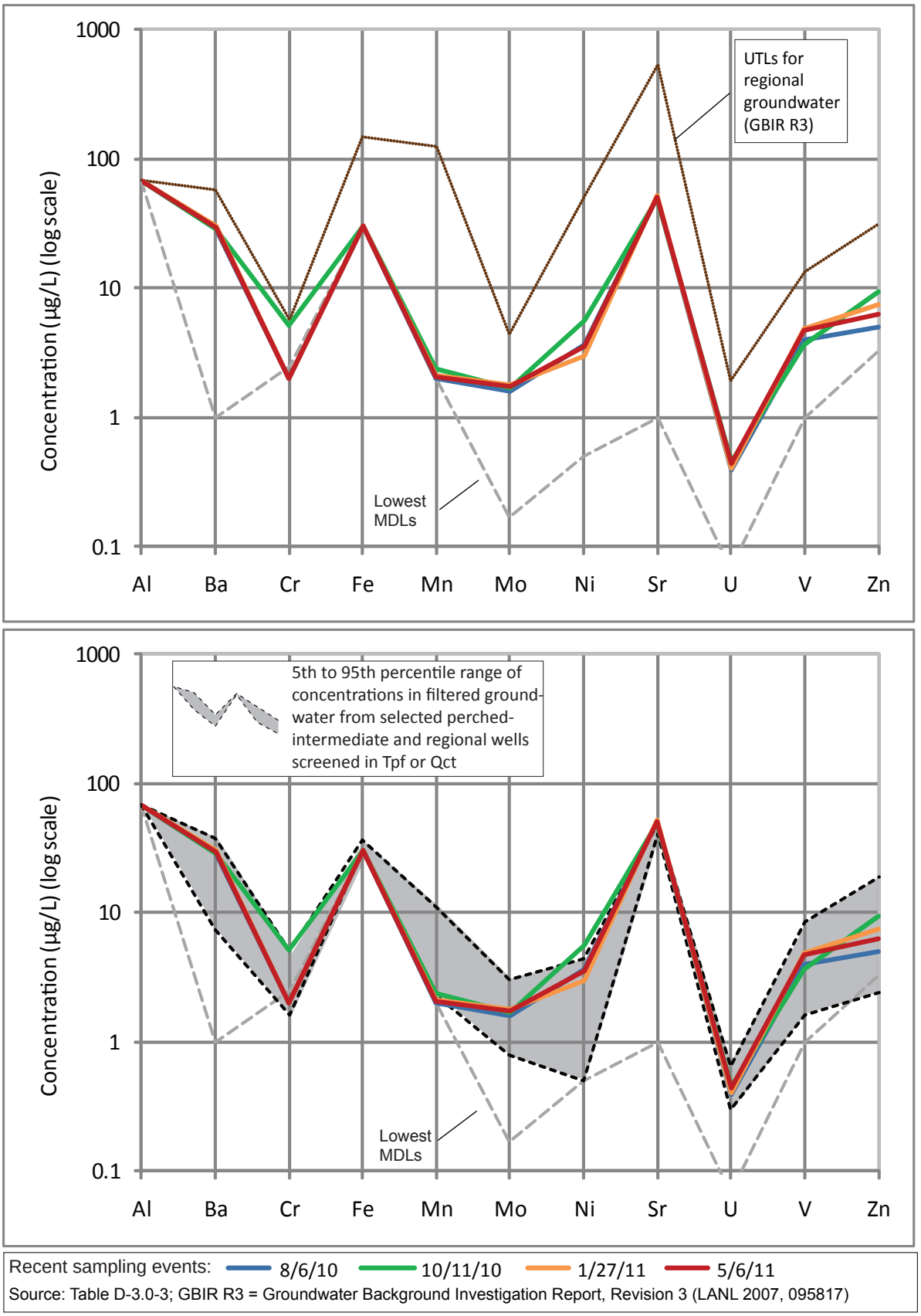
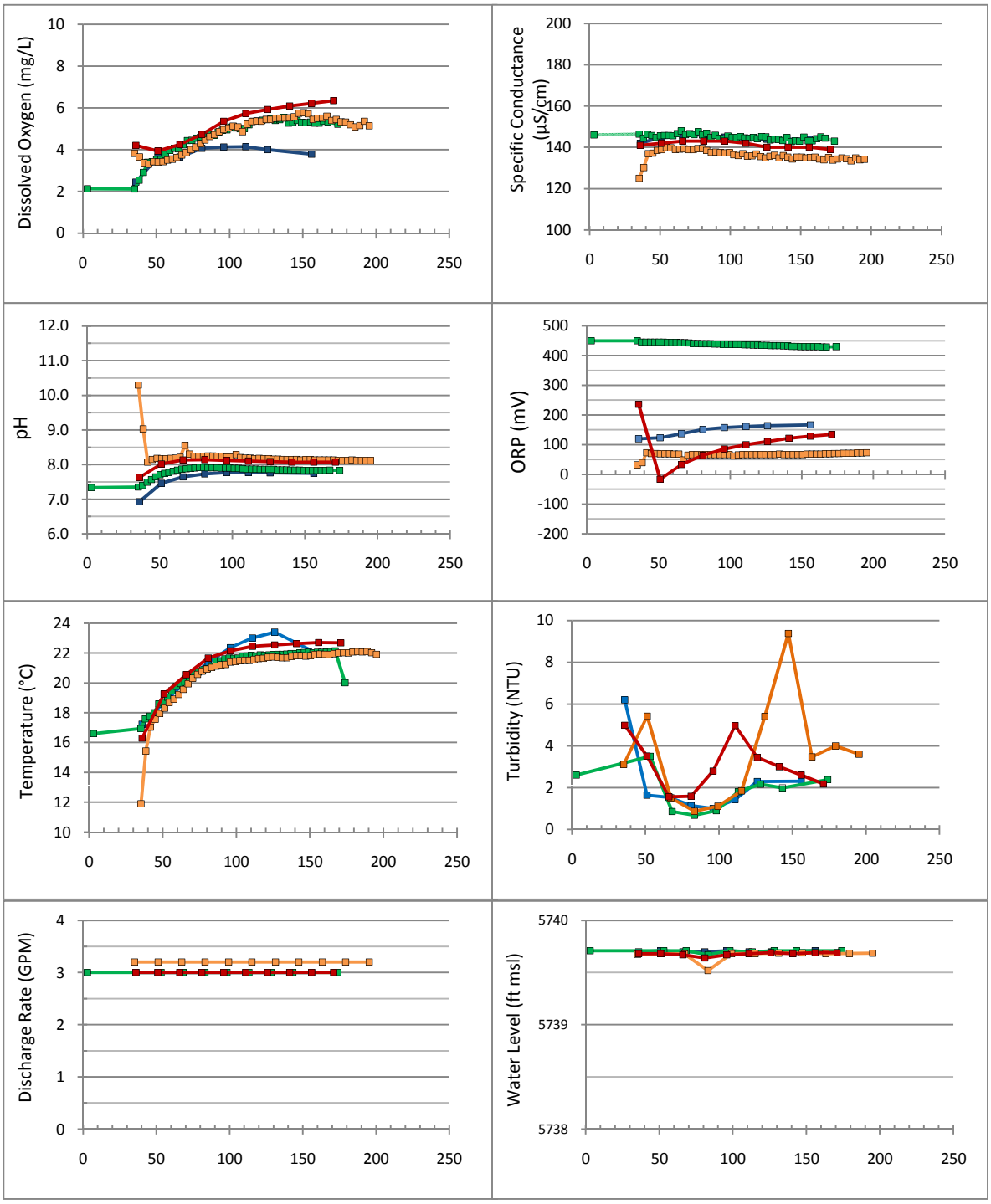


Figure D2-R38-3. Concentrations of trace metals in filtered groundwater from well R-38 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-39 (single screen), port depth 859 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

12-Aug-10 8-Oct-10 26-Jan-11 21-Apr-11

Figure D2-R39-1. Time-series plots of field parameters monitored during purging of R-39 (single screen)

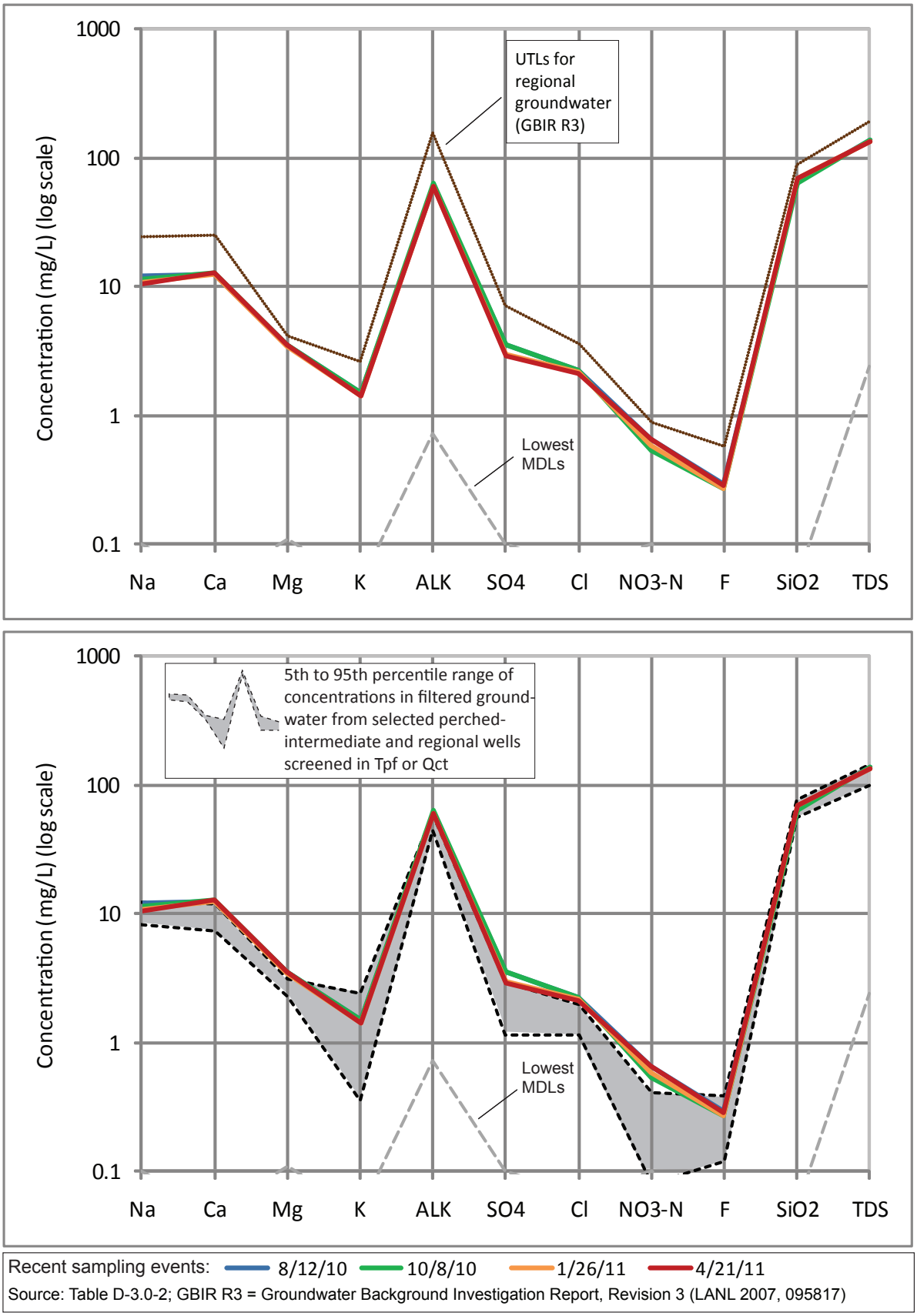


Figure D2-R39-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-39 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

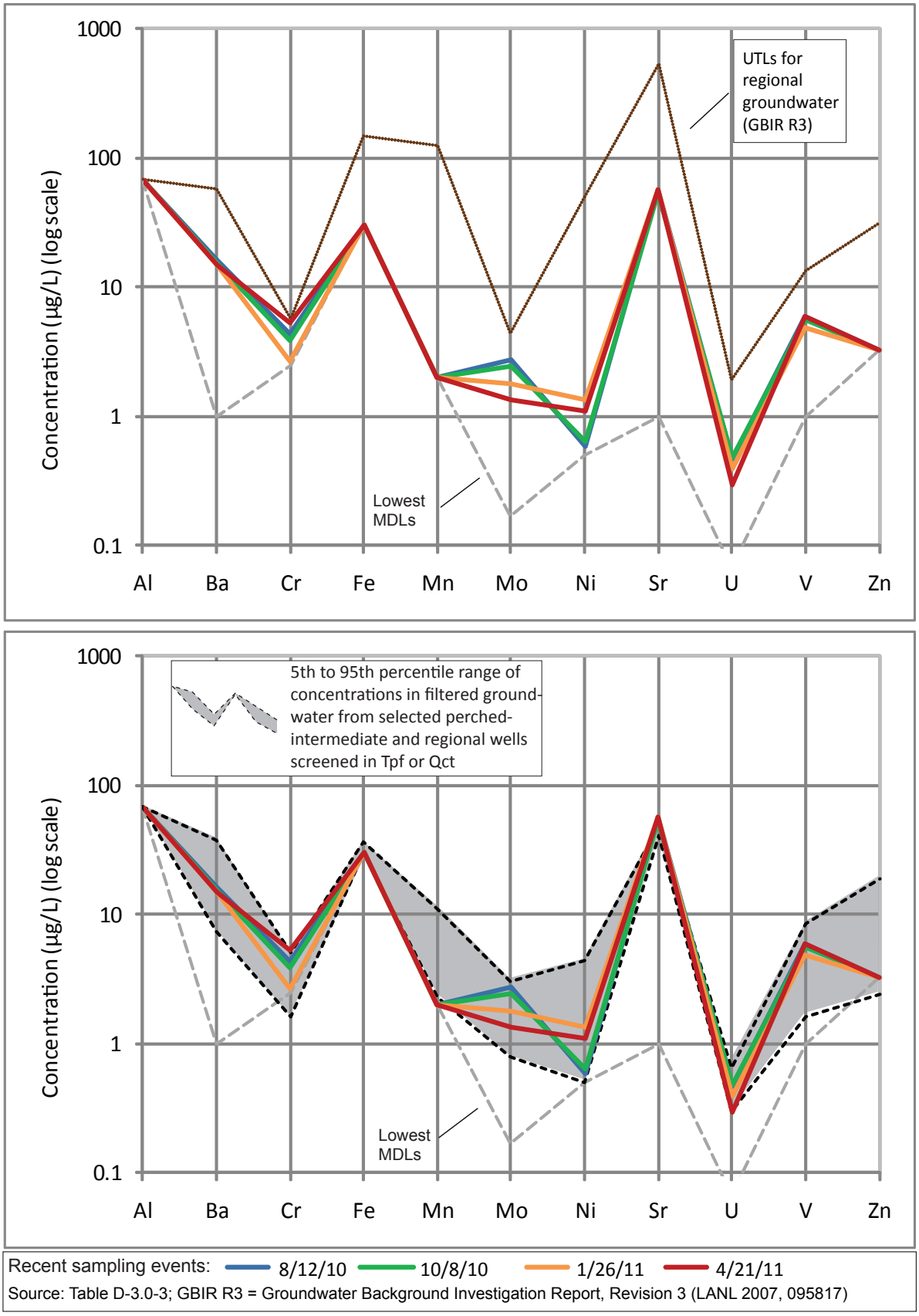
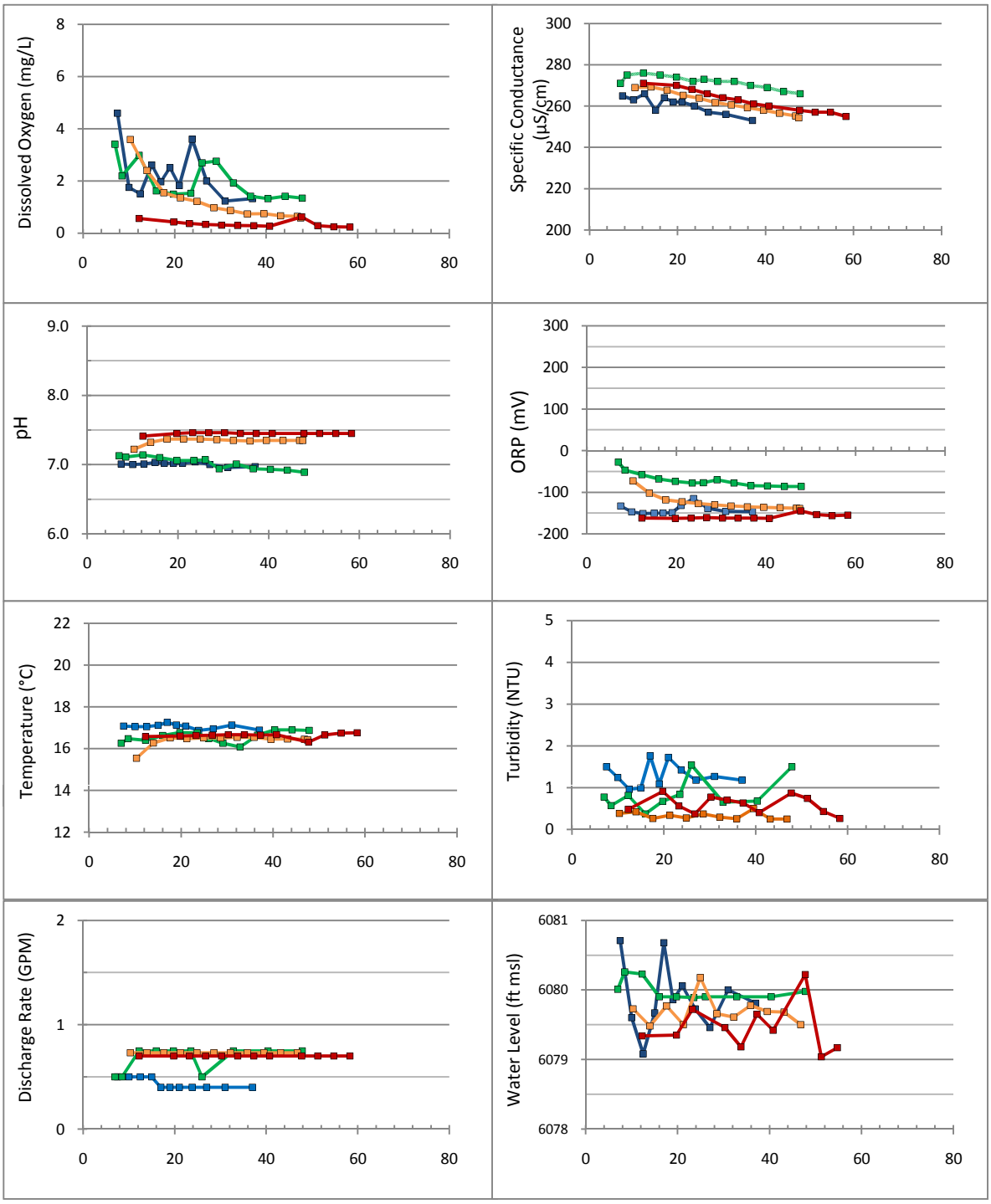


Figure D2-R39-3. Concentrations of trace metals in filtered groundwater from well R-39 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-40i, port depth 650 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

28-Jul-10 20-Oct-10 21-Jan-11 25-Apr-11

Figure D2-R40i-1. Time-series plots of field parameters monitored during purging of R-40i

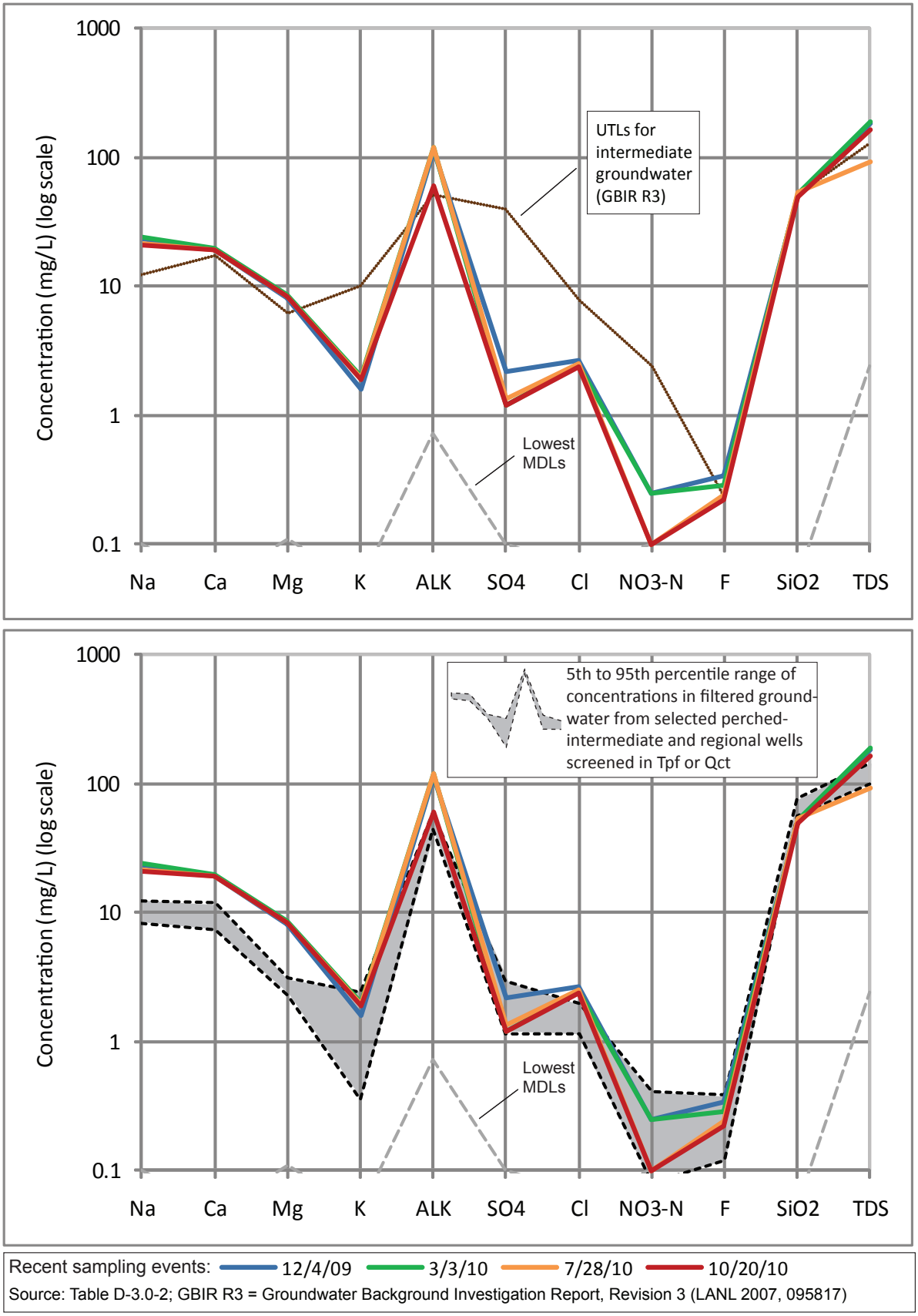
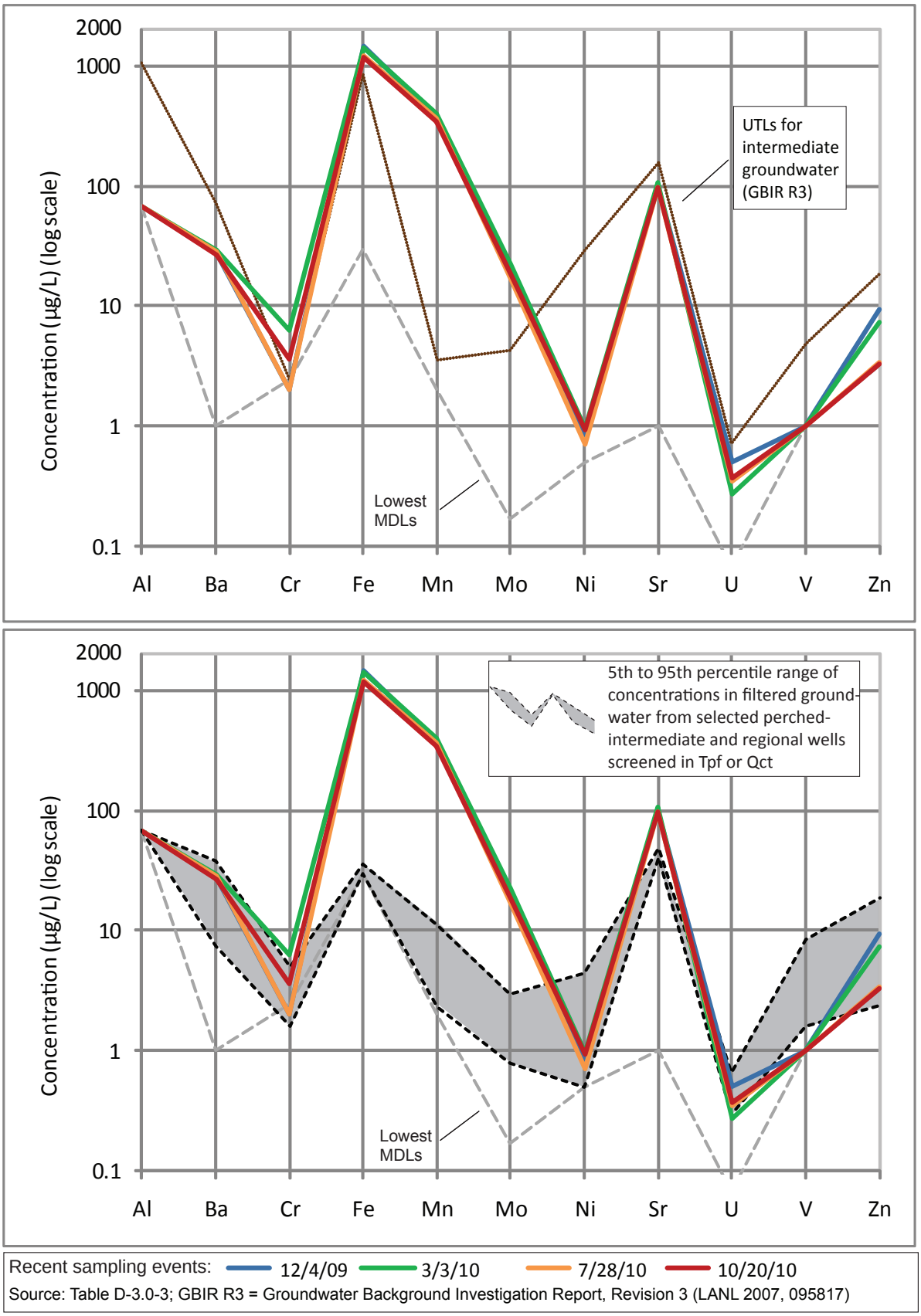


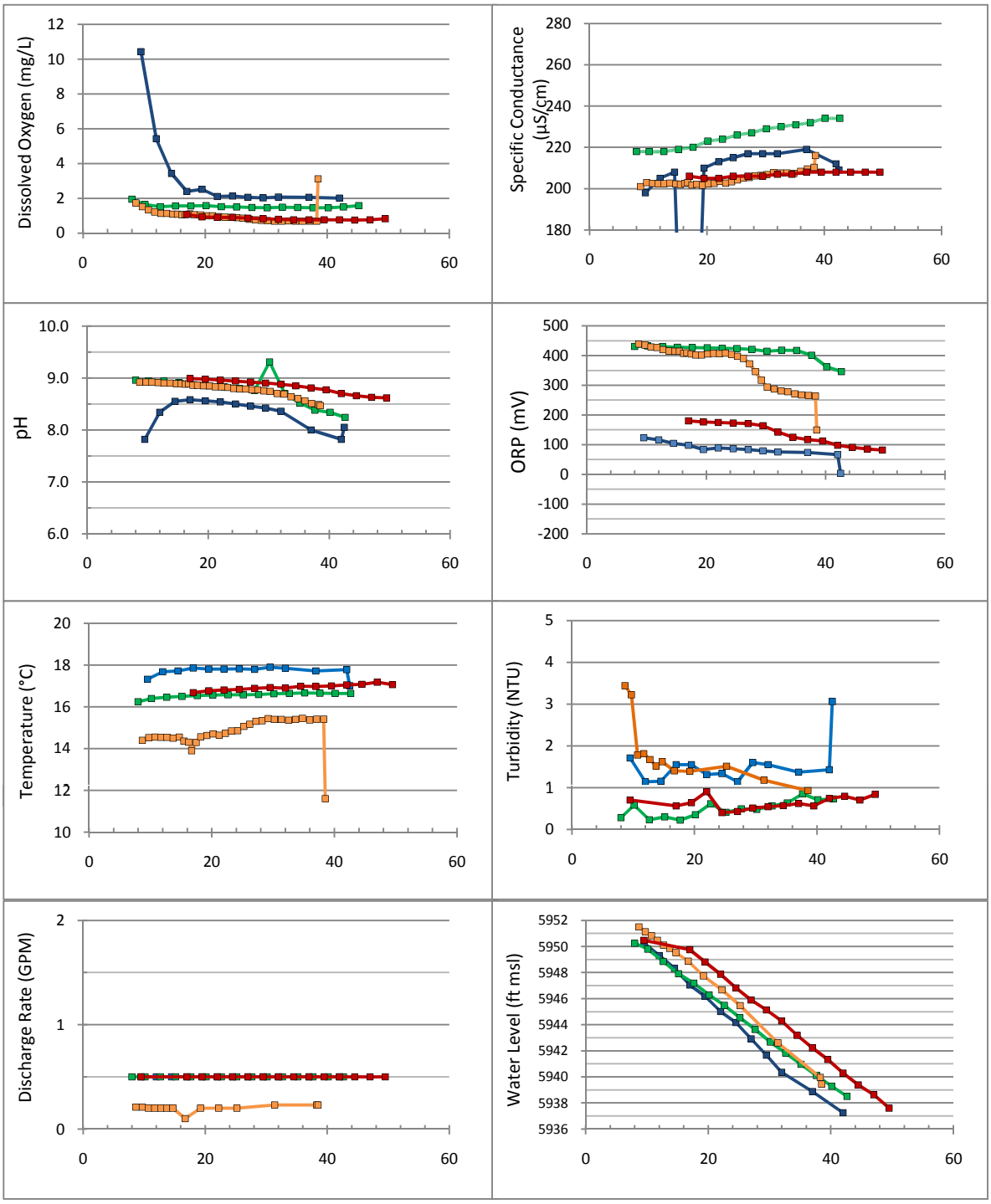
Figure D2-R40i-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-40i for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).



Source: Table D-3.0-3; GBIR R3 = Groundwater Background Investigation Report, Revision 3 (LANL 2007, 095817)

Figure D2-R40i-3. Concentrations of trace metals in filtered groundwater from well R-40i for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-40 screen 1 (port P1A), port depth 752 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

27-Jul-10 19-Oct-10 21-Jan-11 5-May-11

Figure D2-R40-1. Time-series plots of field parameters monitored during purging of R-40 screen 1 (port P1A)

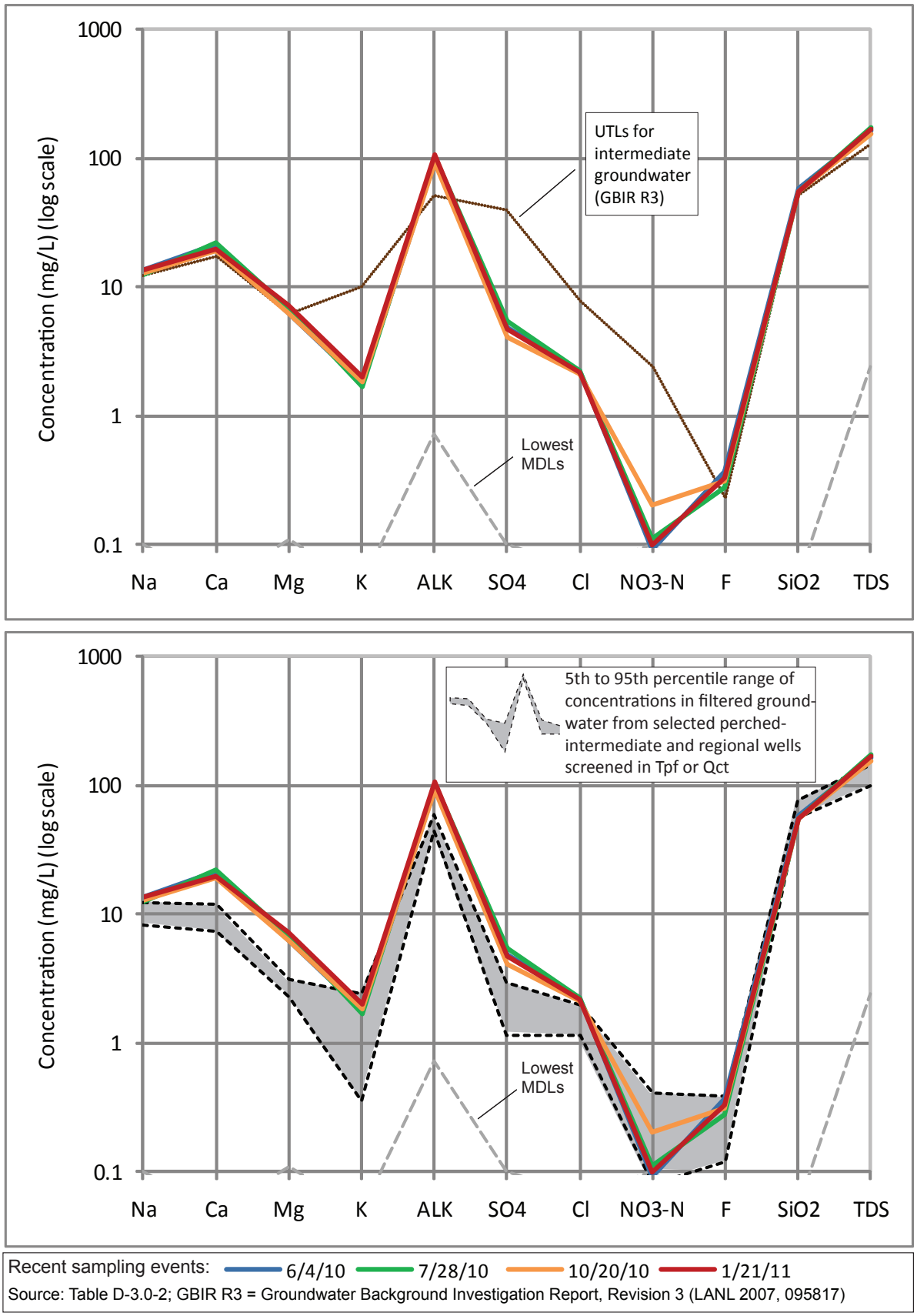


Figure D2-R40-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-40 screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

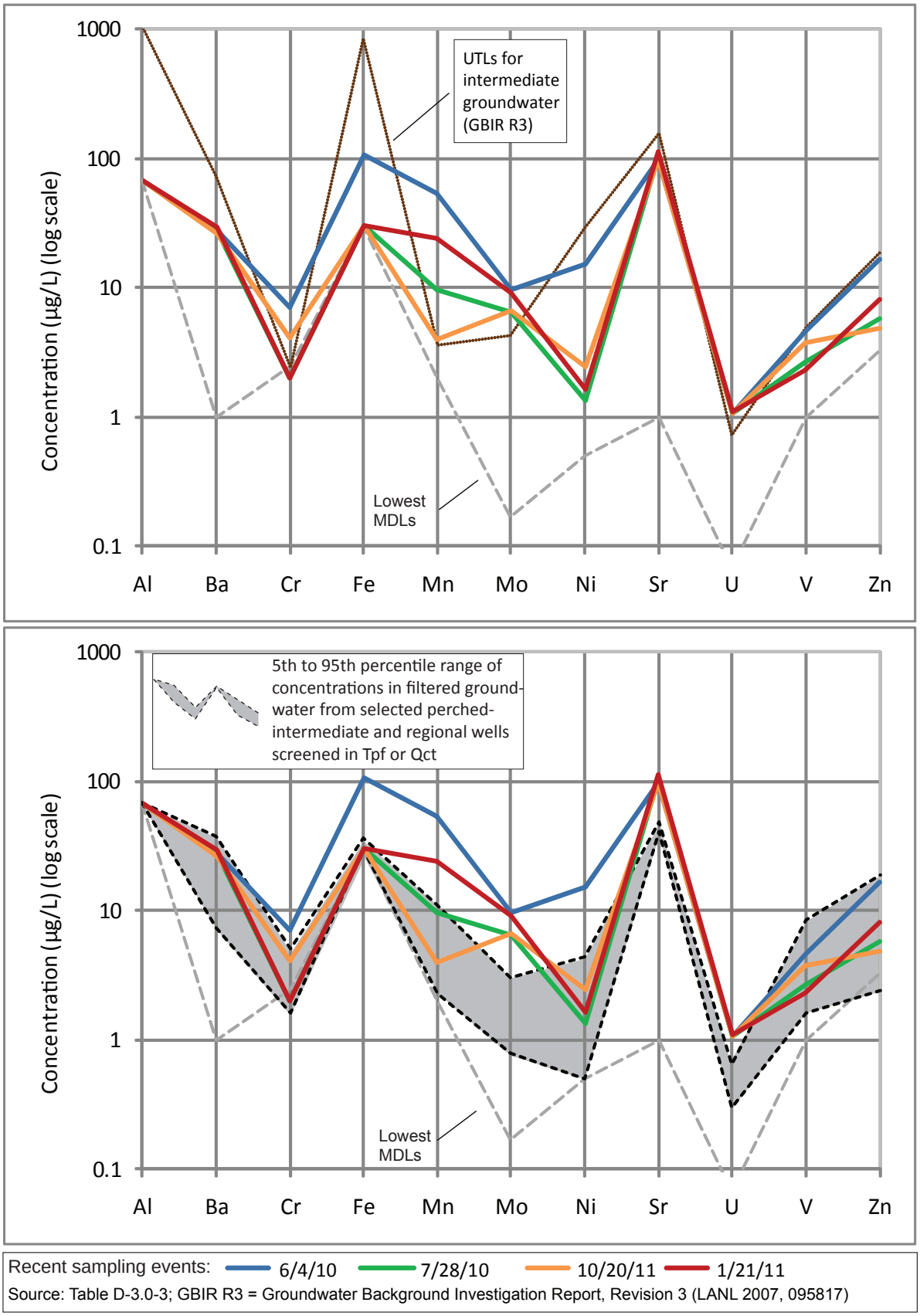


Figure D2-R40-3. Concentrations of trace metals in filtered groundwater from well R-40 screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

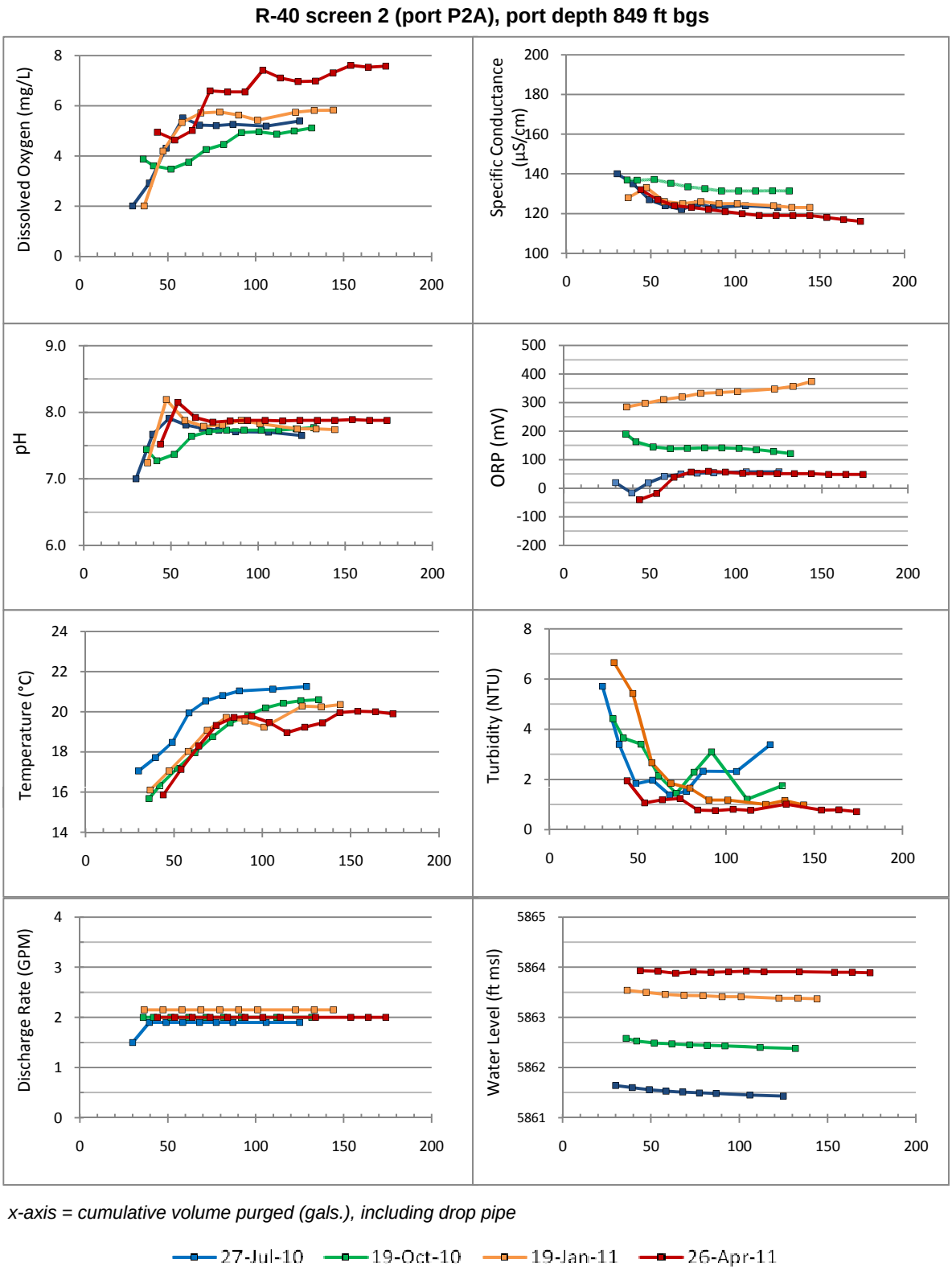


Figure D2-R40-4. **Time-series plots of field parameters monitored during purging of R-40 screen 2 (port P2A)**

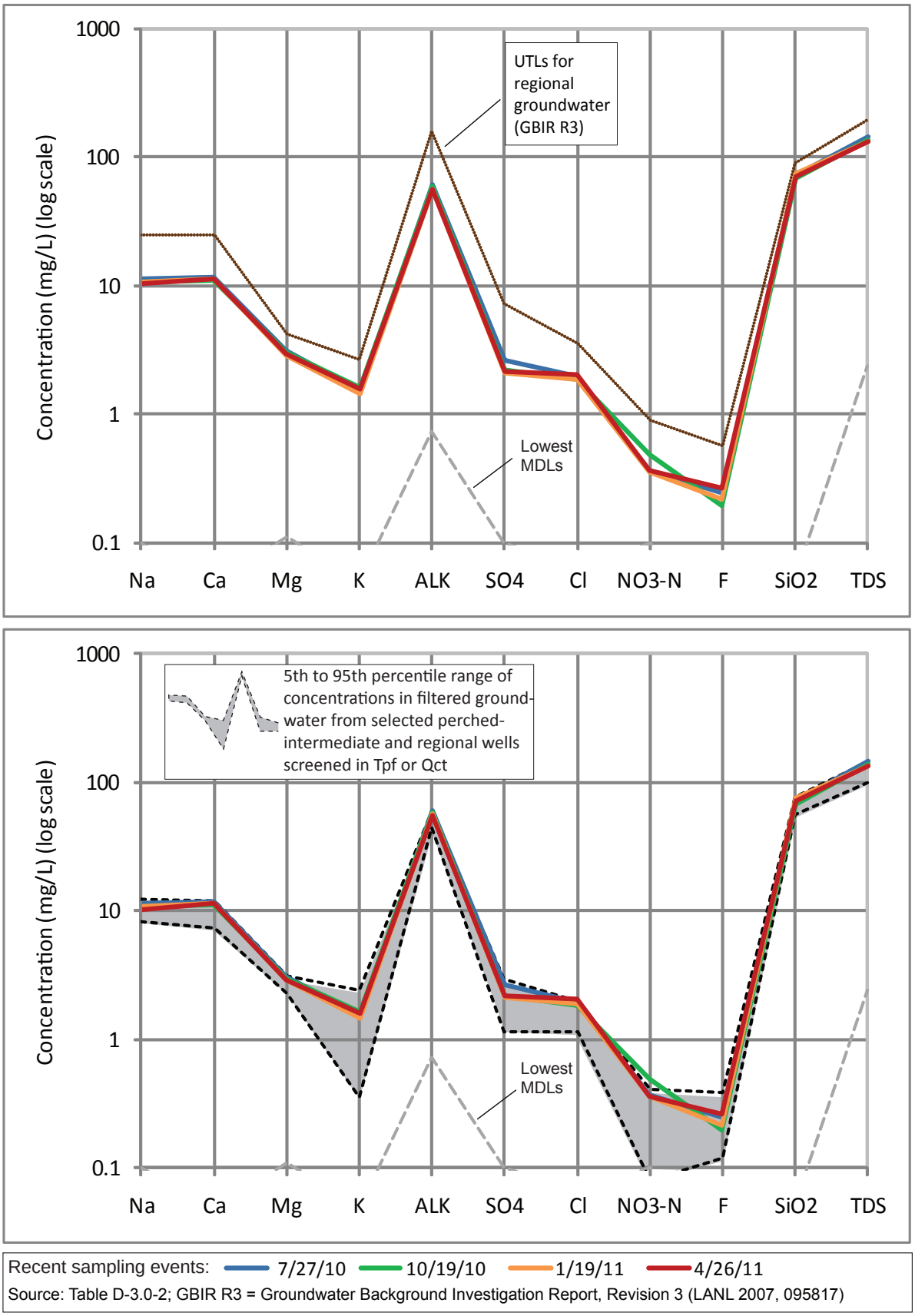


Figure D2-R40-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-40 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

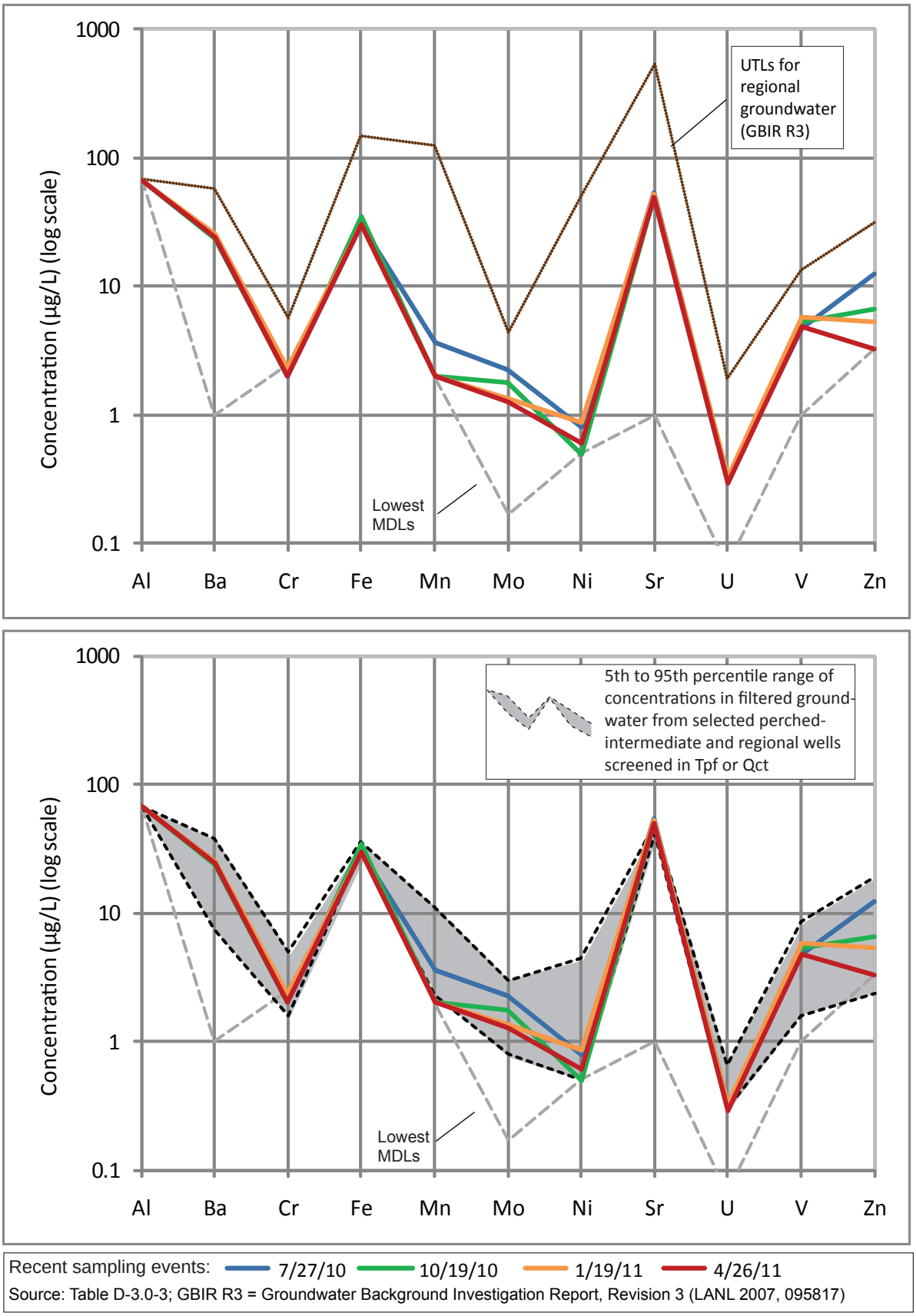
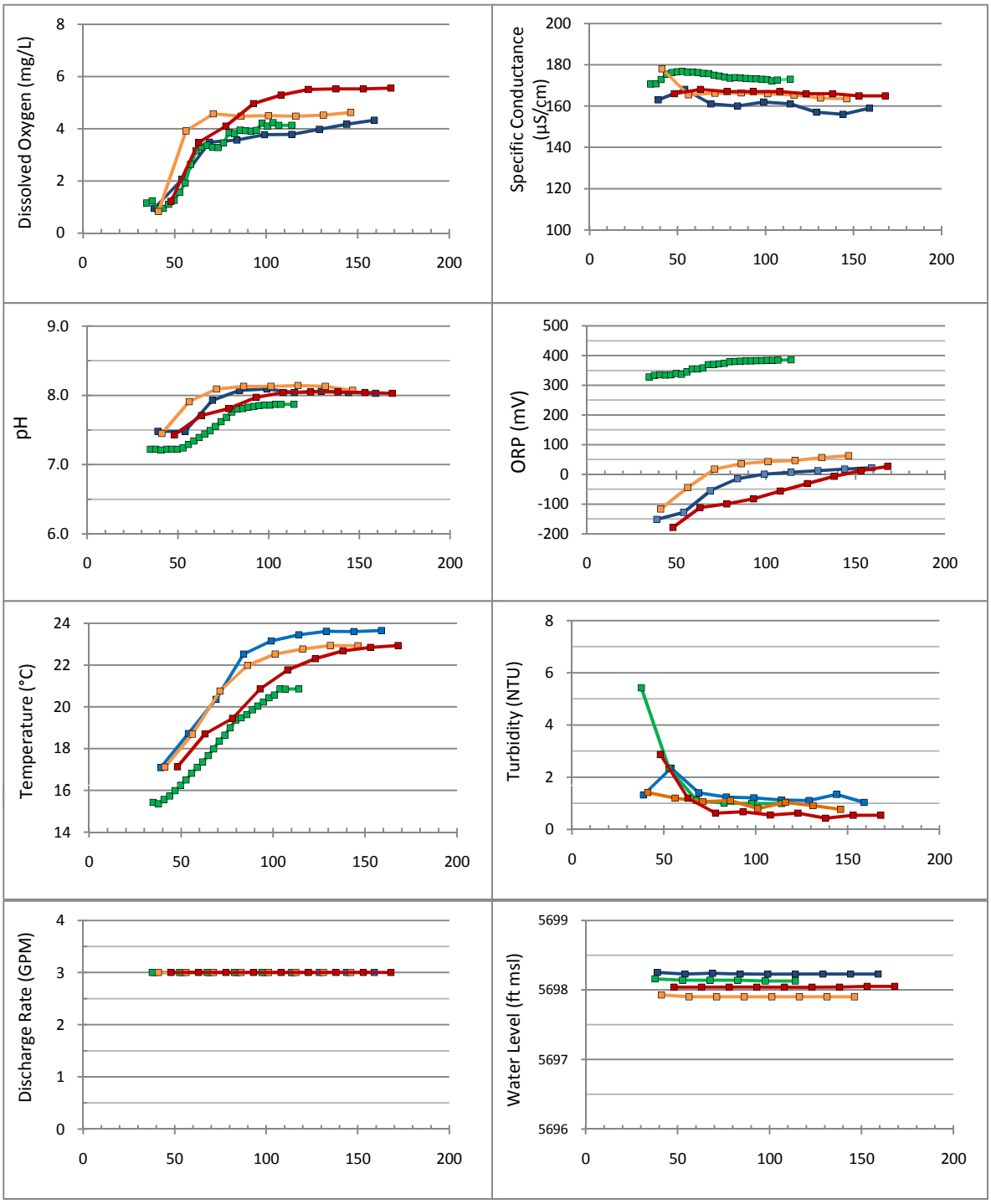


Figure D2-R40-6. Concentrations of trace metals in filtered groundwater from well R-40 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-41 screen 2 (port P2A), port depth 965 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

9-Aug-10 8-Oct-10 12-Jan-11 21-Apr-11

Figure D2-R41-1. Time-series plots of field parameters monitored during purging of R-41 screen 2 (port P2A)

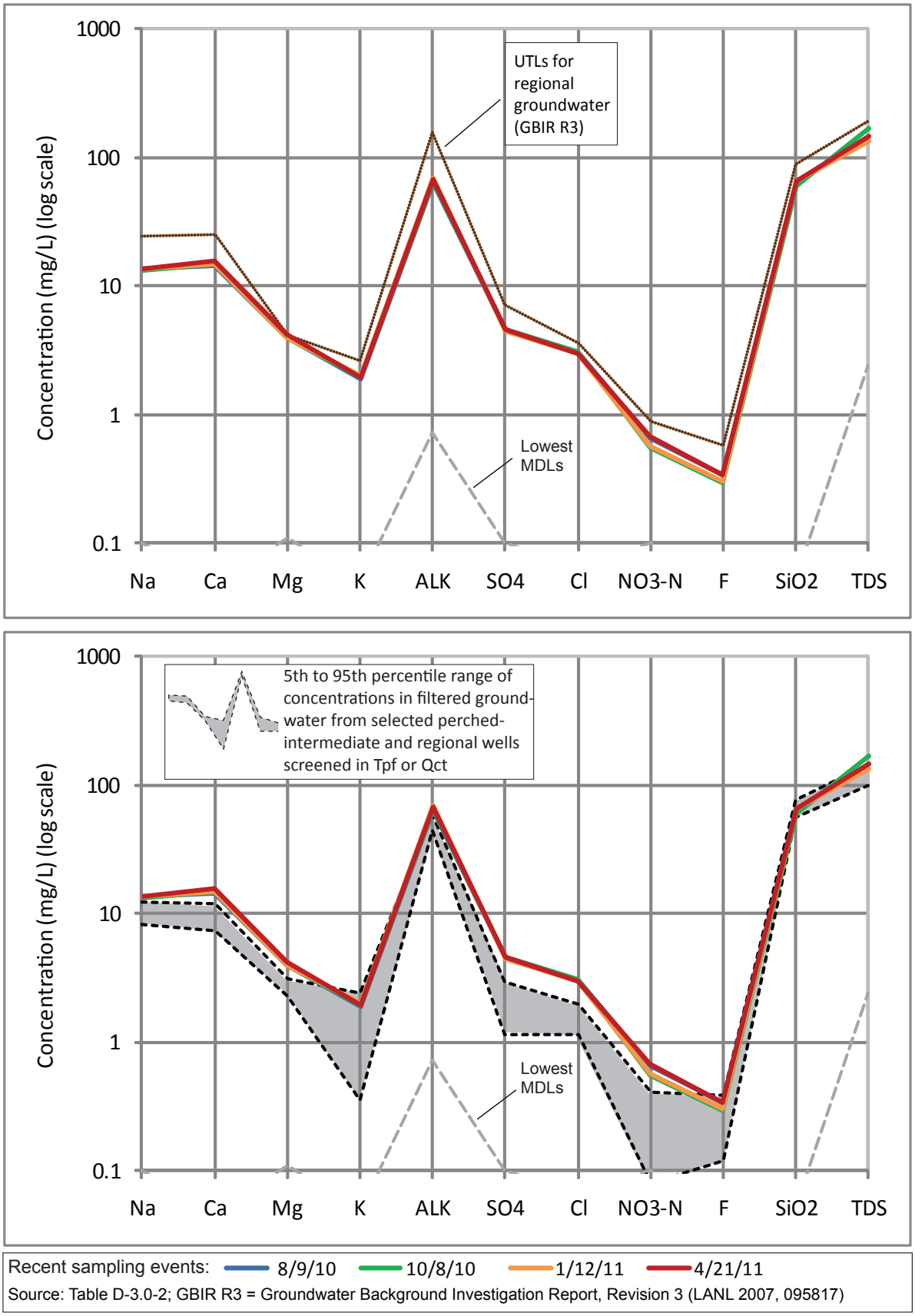


Figure D2-R41-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-41 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

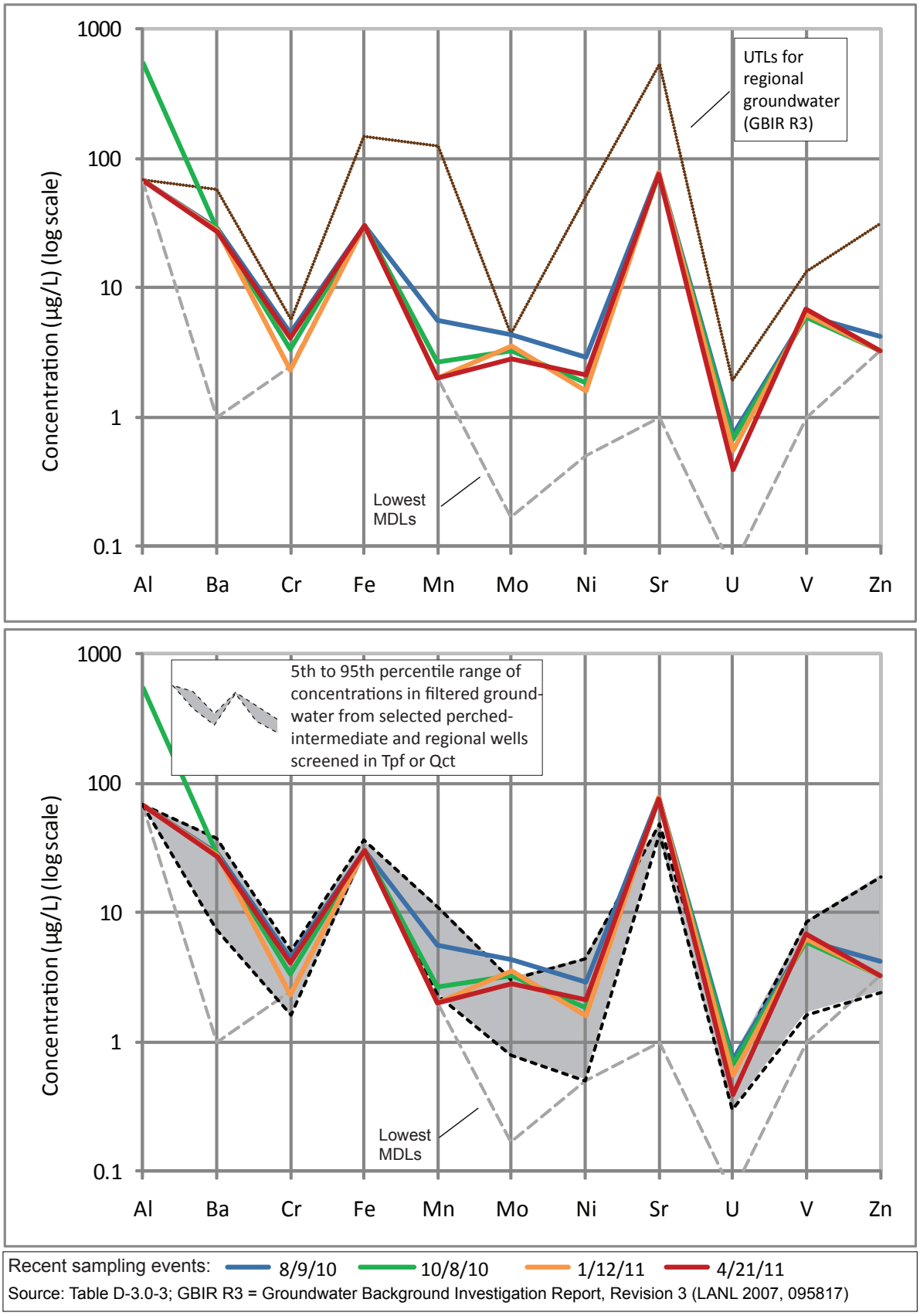
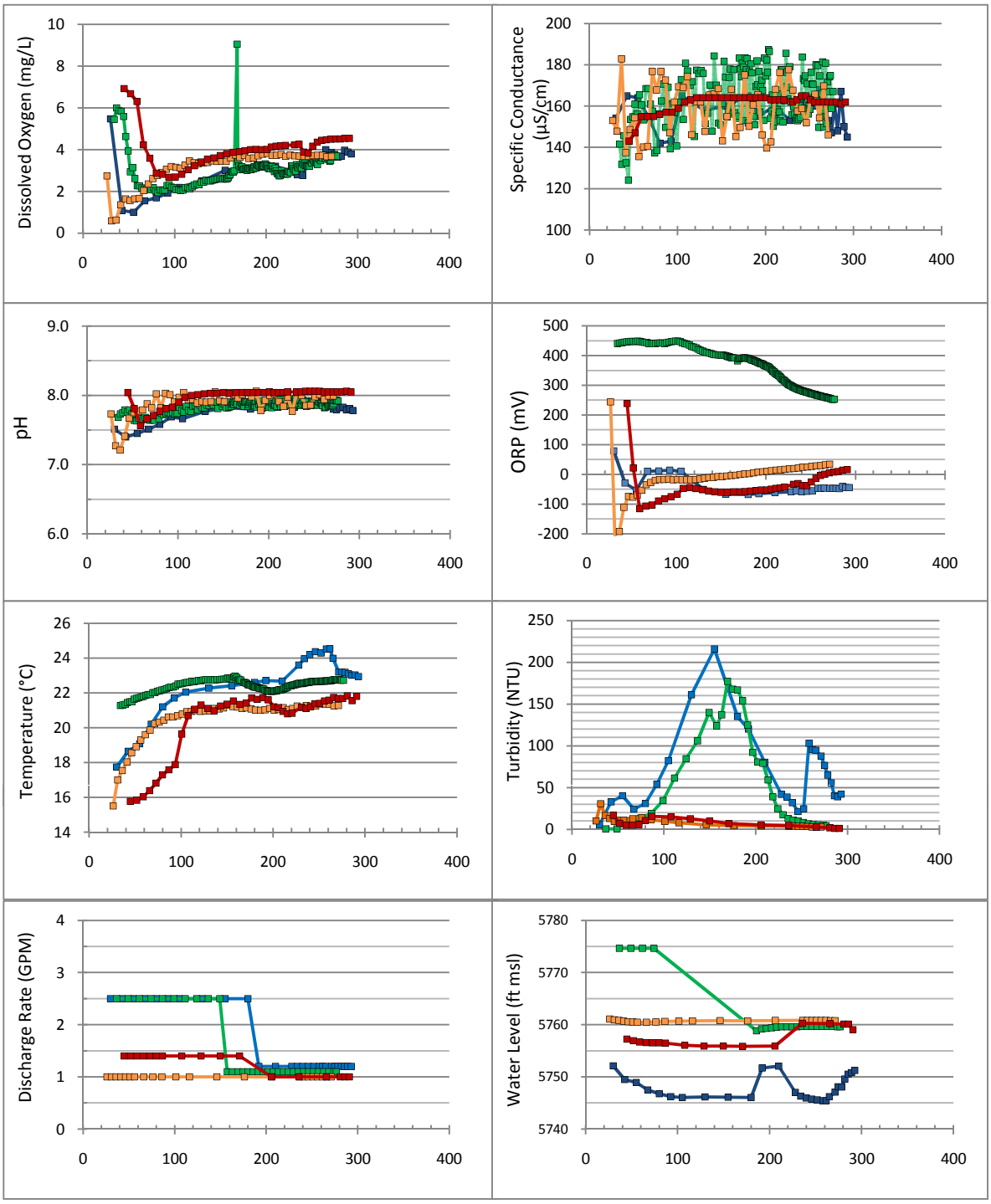


Figure D2-R41-3. Concentrations of trace metals in filtered groundwater from well R-41 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-49 screen 1 (port P1A), port depth 845 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

29-Jul-10 7-Oct-10 19-Jan-11 2-May-11

Figure D2-R49-1. Time-series plots of field parameters monitored during purging of R-49 screen 1 (port P1A)

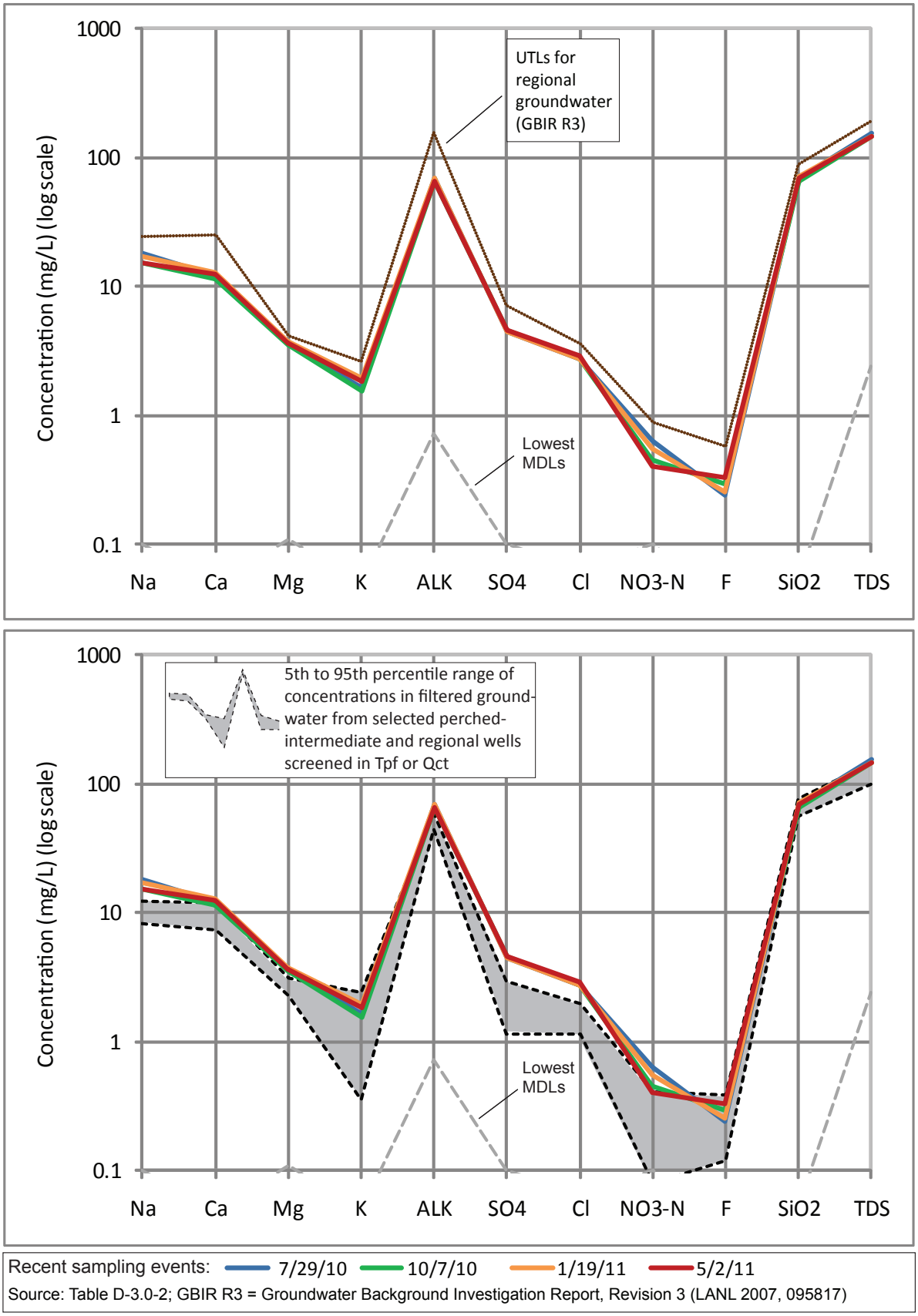


Figure D2-R49-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-49 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

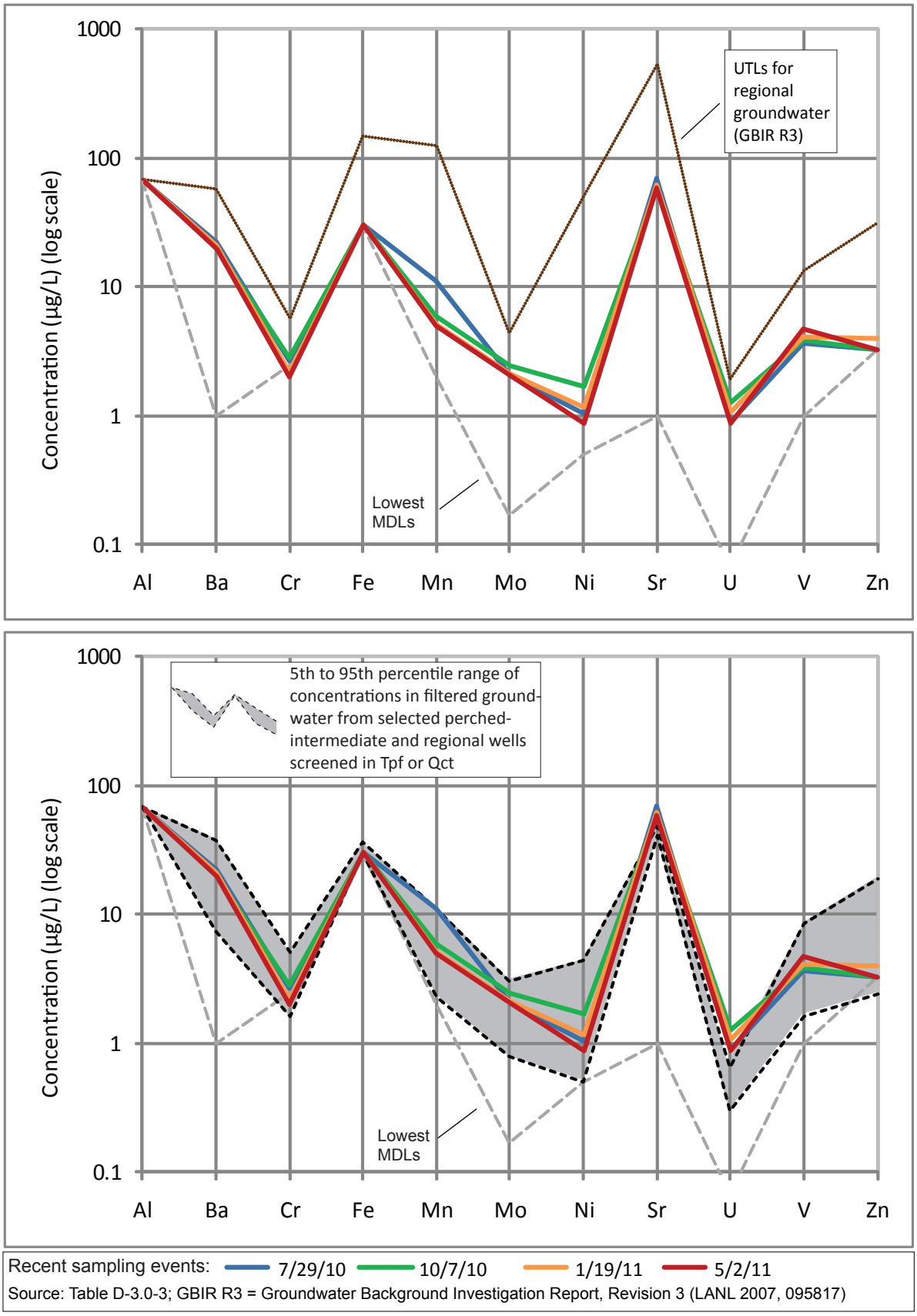
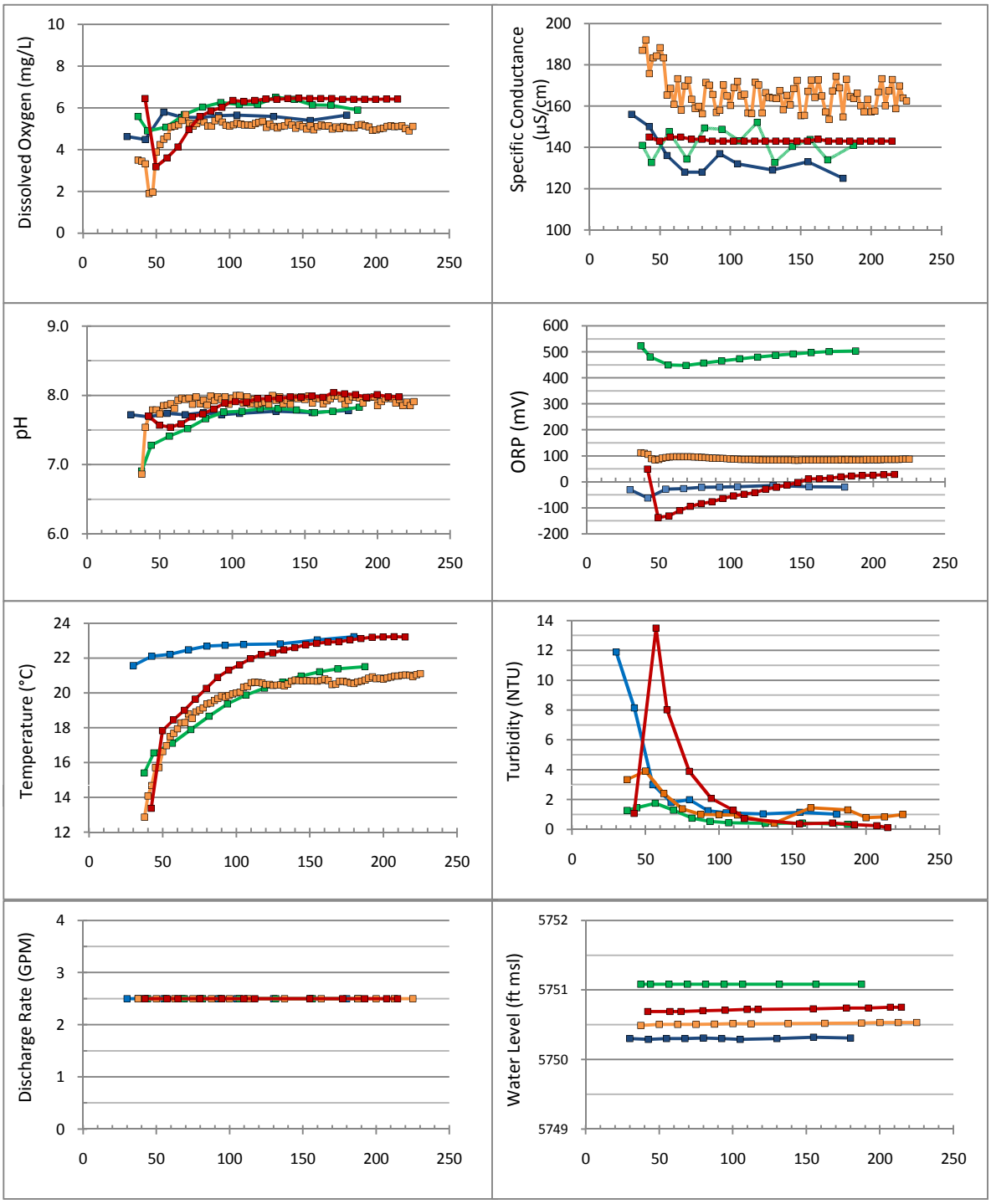


Figure D2-R49-3. Concentrations of trace metals in filtered groundwater from well R-49 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-49 screen 2 (port P2A), port depth 906 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

29-Jul-10 7-Oct-10 26-Jan-11 29-Apr-11

Figure D2-R49-4. Time-series plots of field parameters monitored during purging of R-49 screen 2 (port P2A)

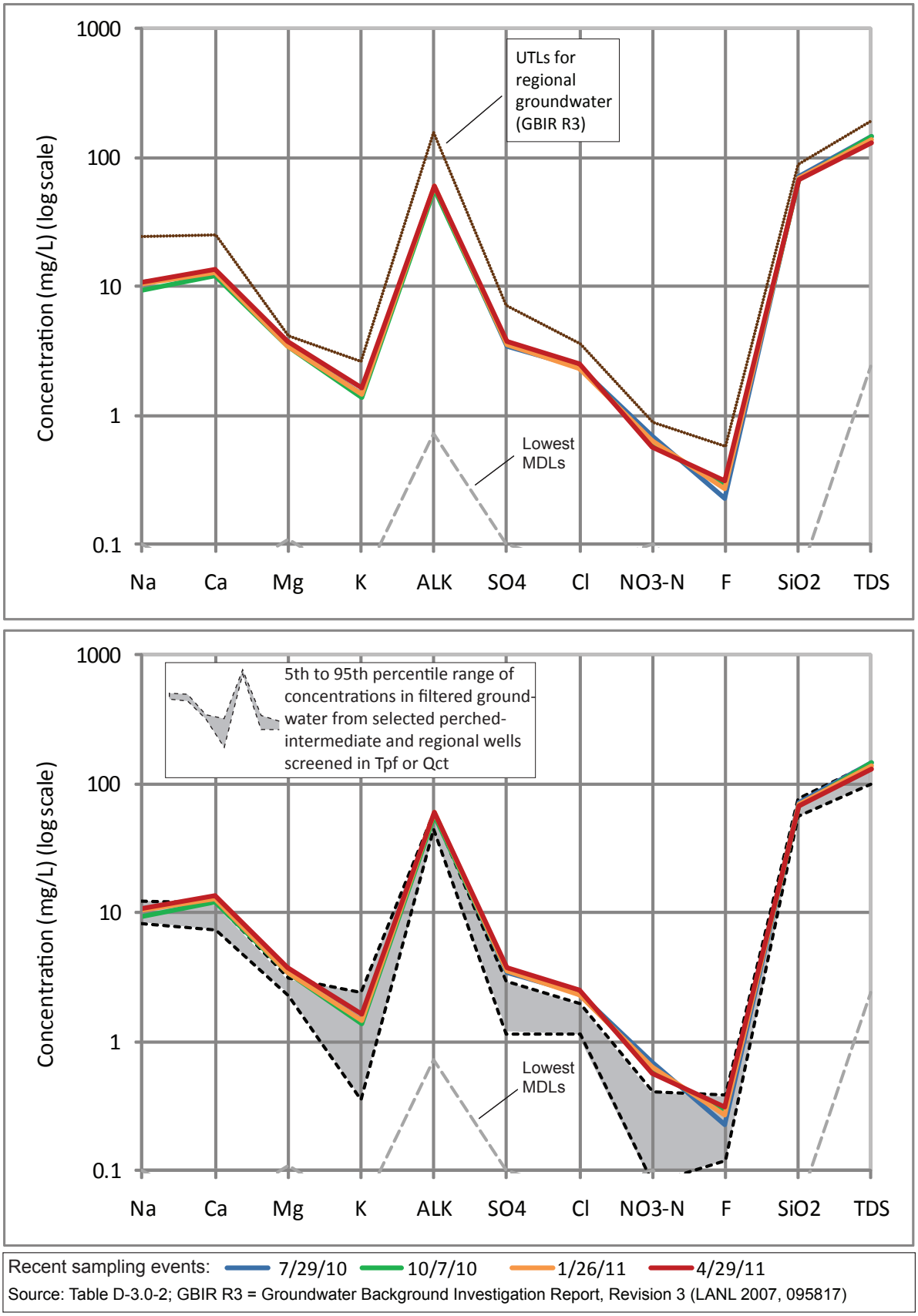


Figure D2-R49-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-49 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

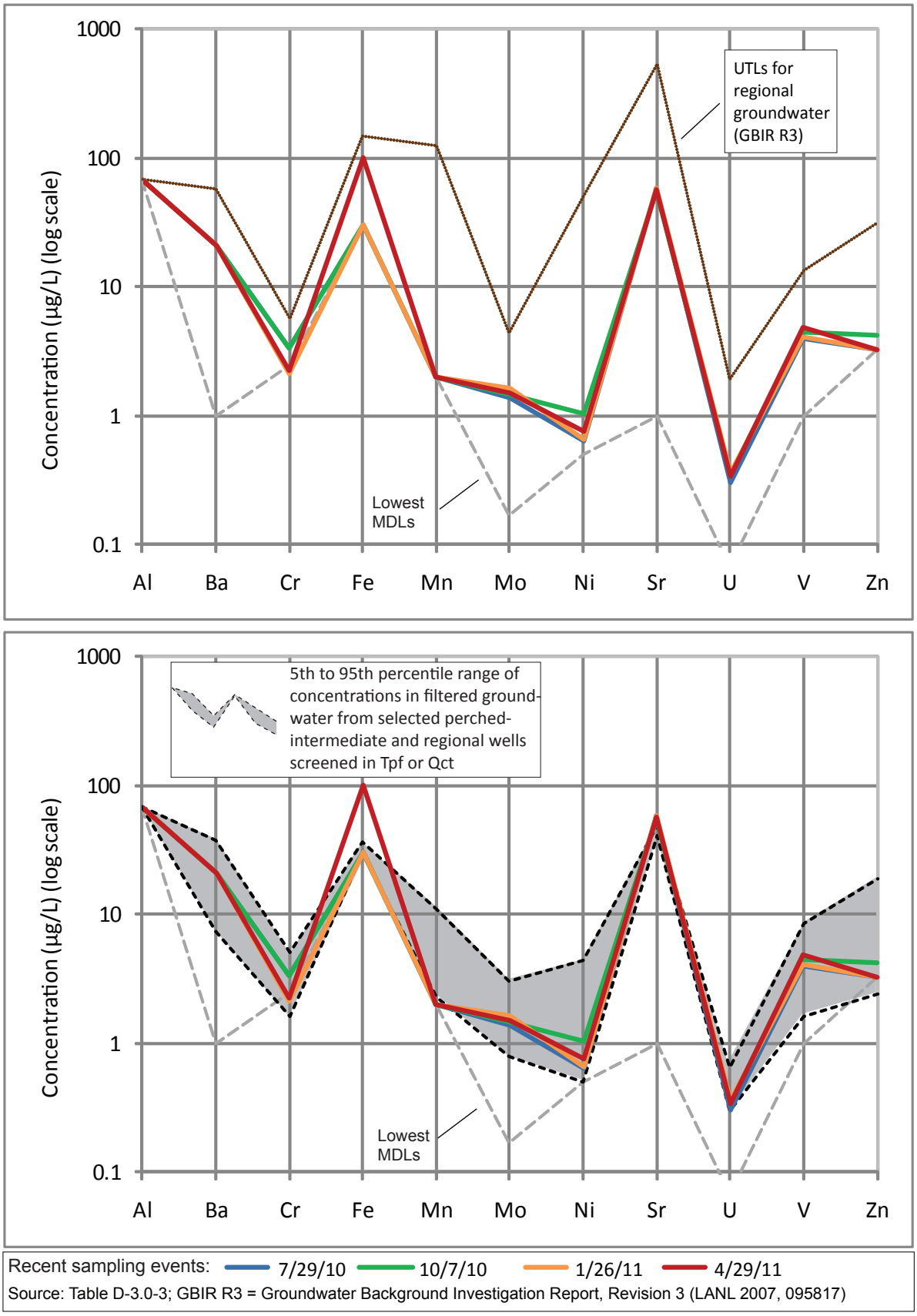
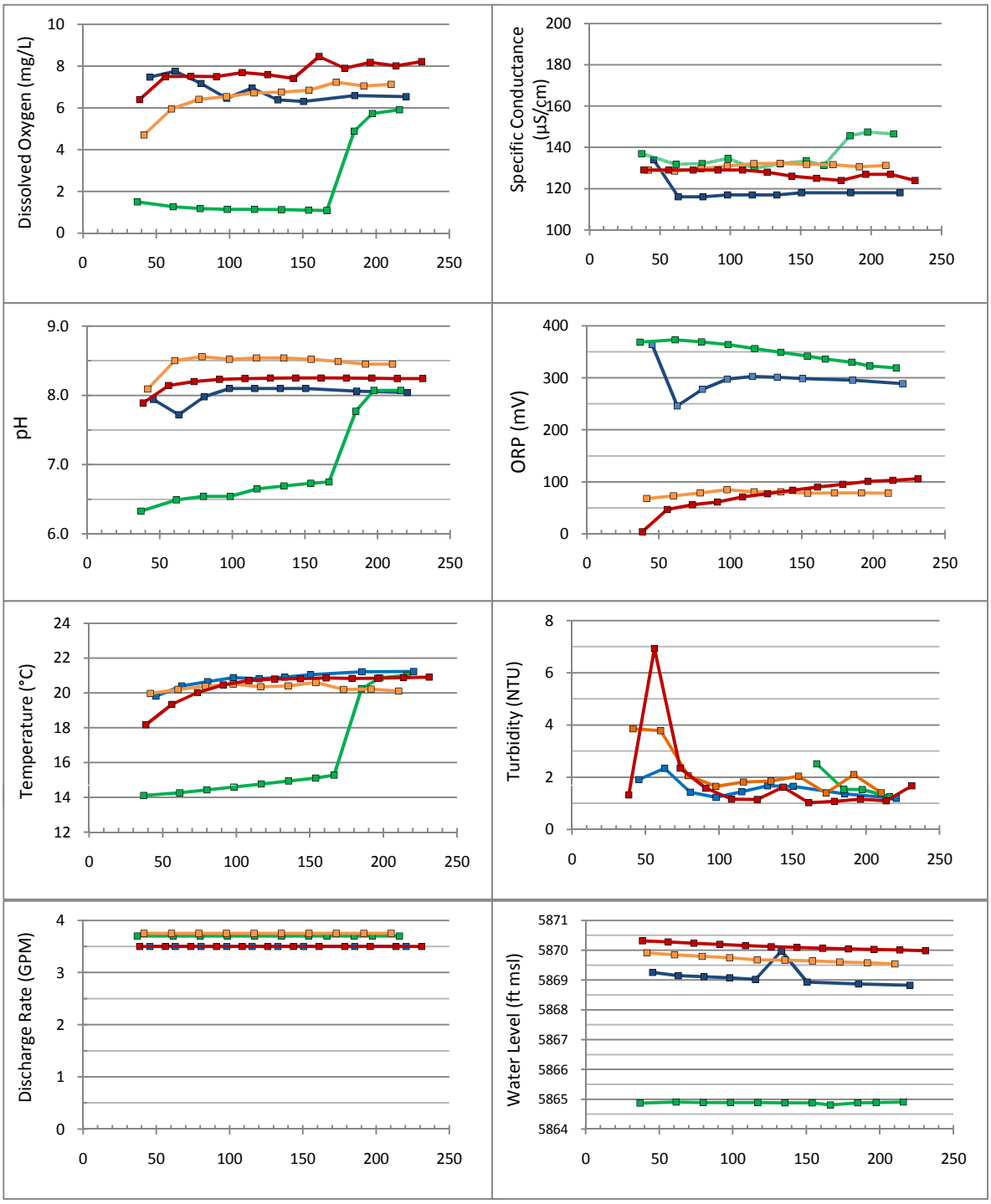


Figure D2-R49-6. Concentrations of trace metals in filtered groundwater from well R-49 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-51 screen 1 (port P1A), port depth 915 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

26-Jul-10 19-Oct-10 11-Jan-11 9-May-11

Figure D2-R51-1. Time-series plots of field parameters monitored during purging of R-51 screen 1 (port P1A)

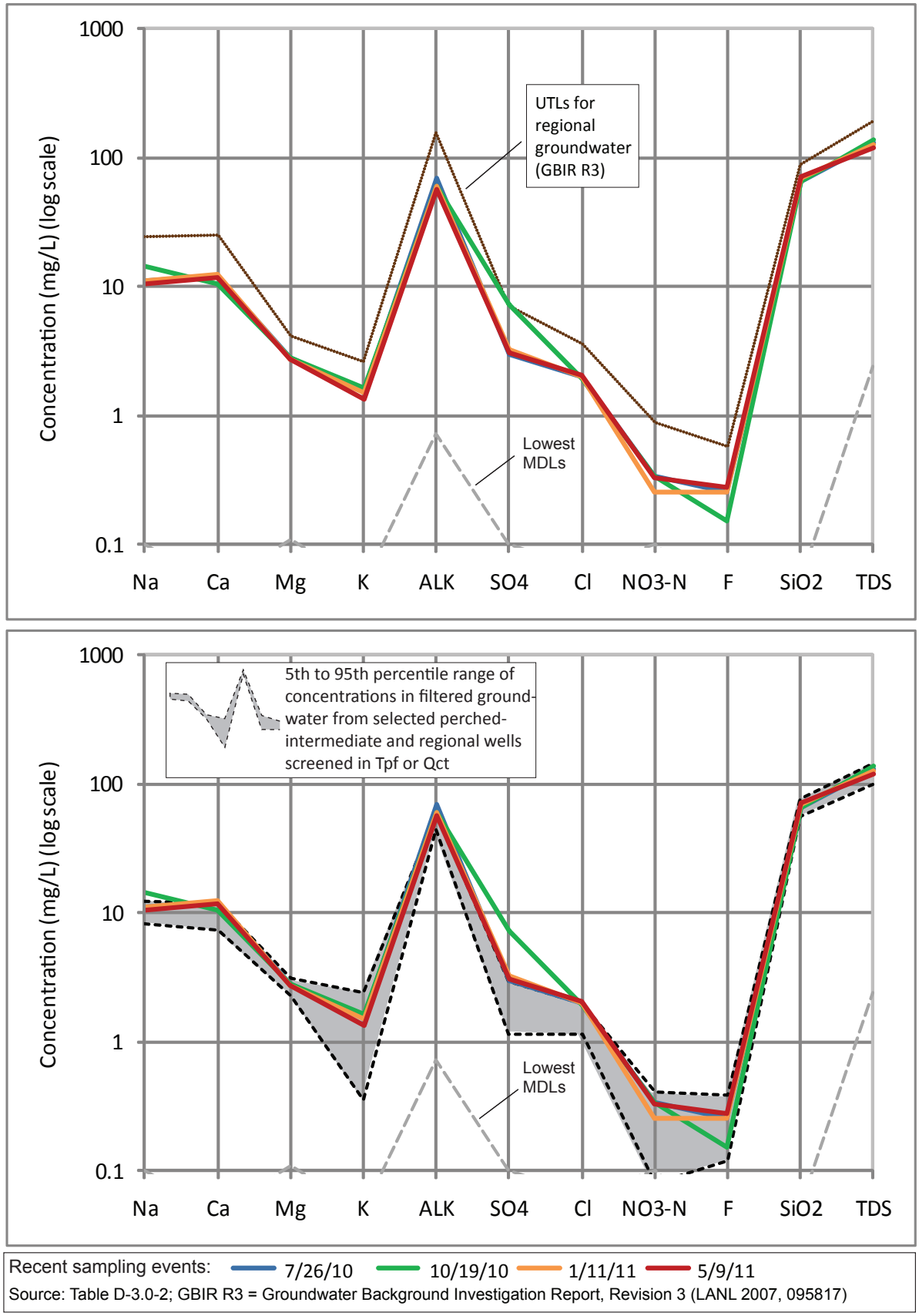


Figure D2-R51-3. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-51 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

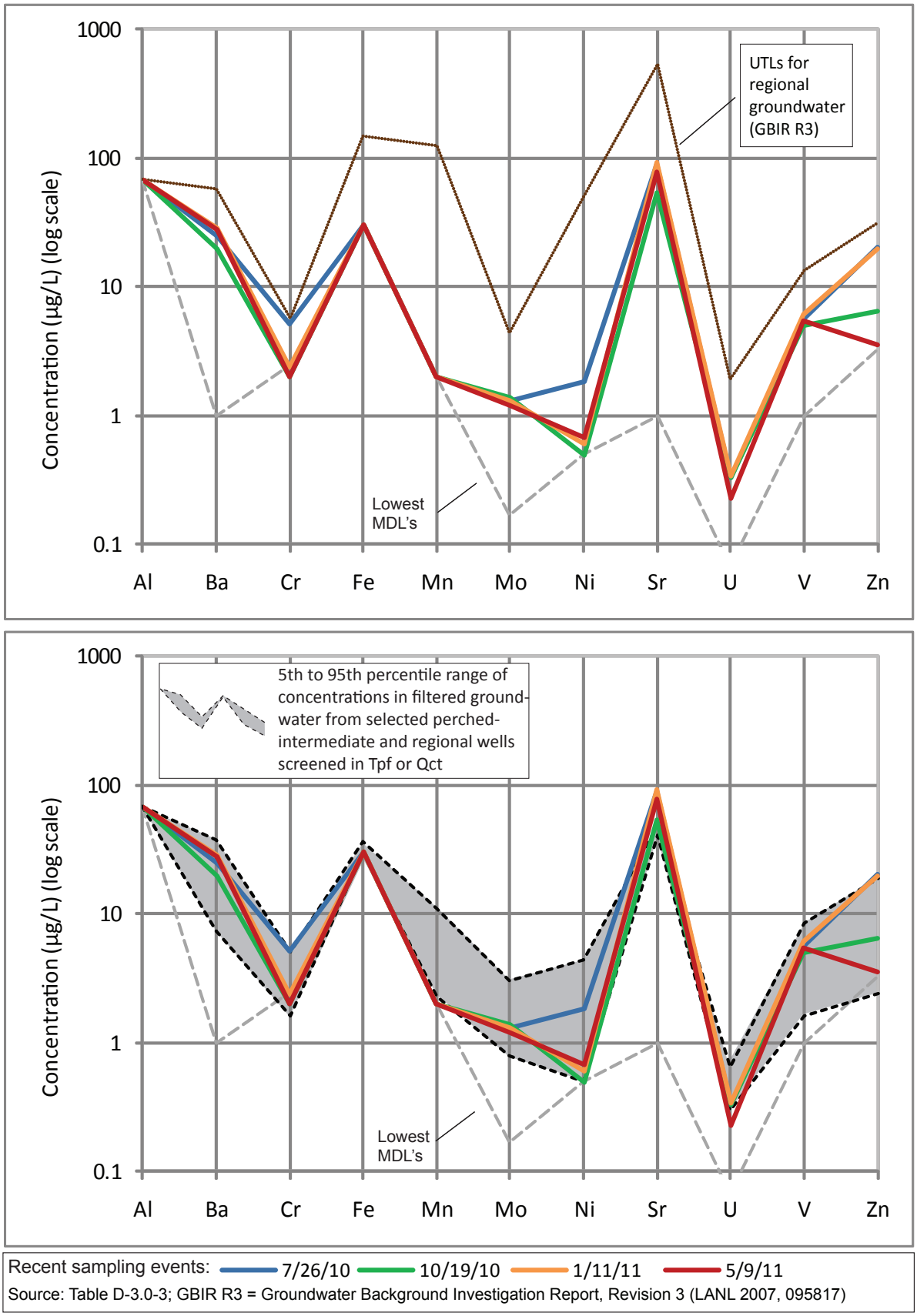
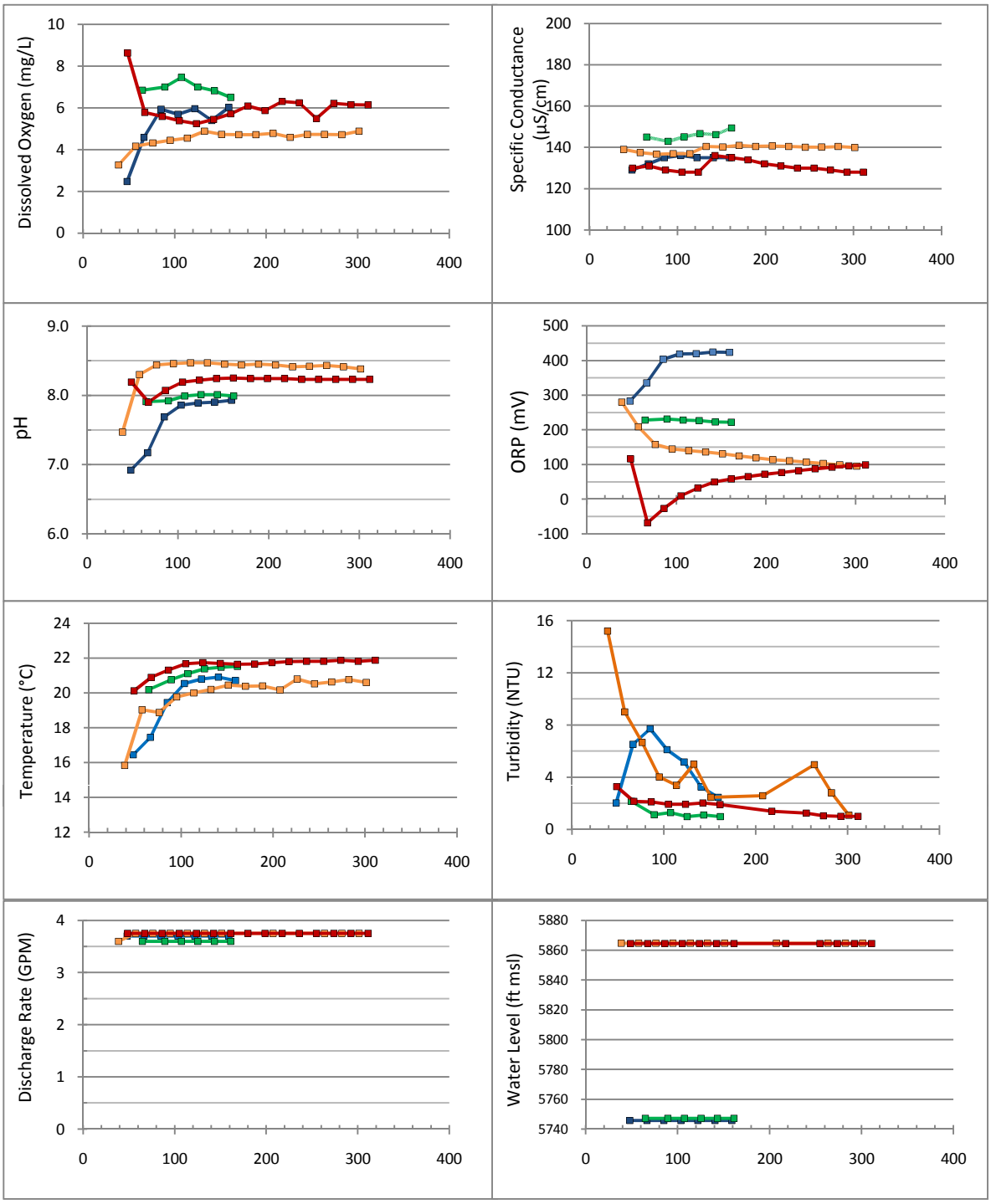


Figure D2-R51-3. Concentrations of trace metals in filtered groundwater from well R-51 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-51 screen 2 (port P2A), port depth 1031 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

26-Jul-10 19-Oct-10 11-Jan-11 9-May-11

Figure D2-R51-4. Time-series plots of field parameters monitored during purging of R-51 screen 2 (port P2A)

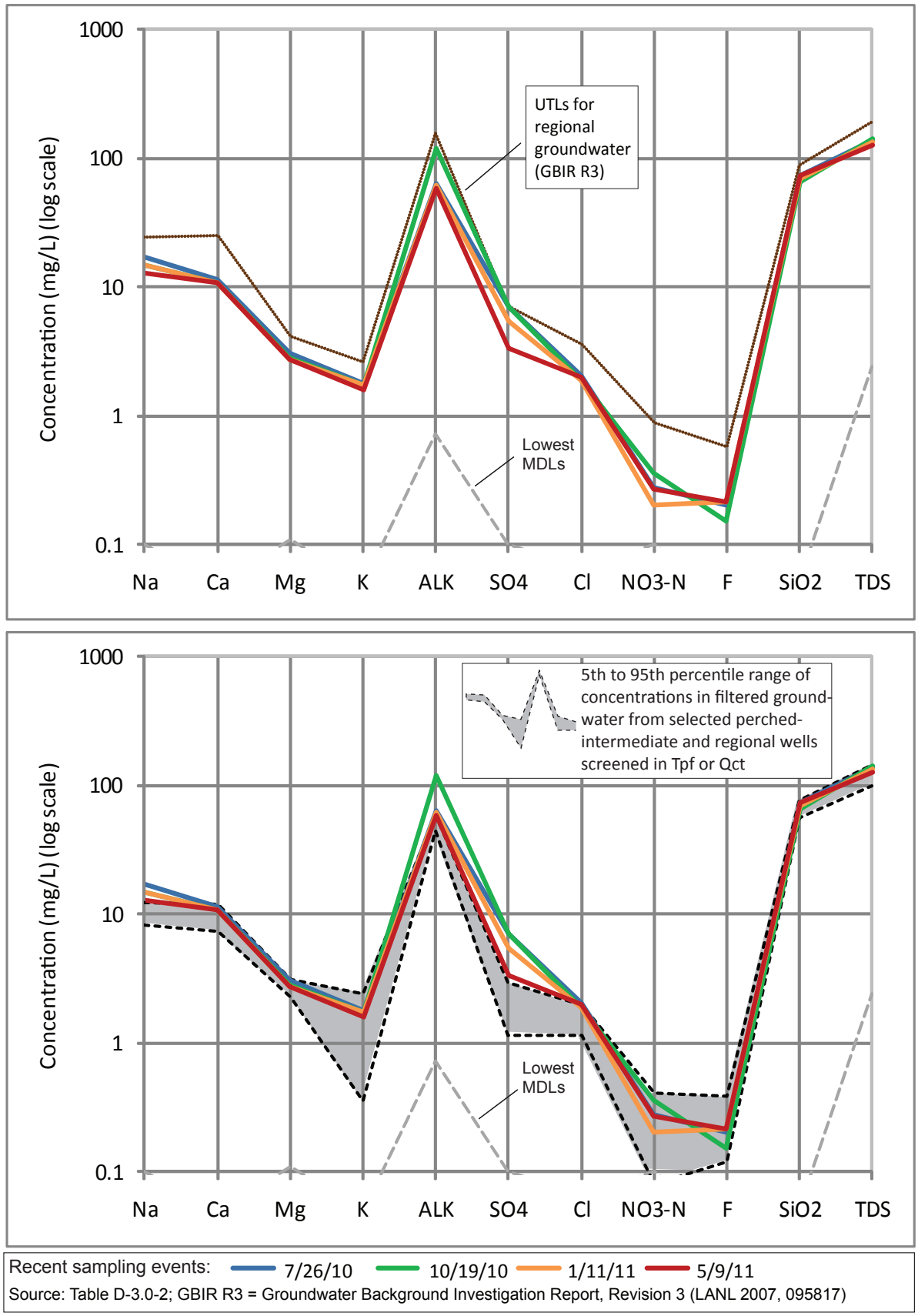


Figure D2-R51-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-51 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

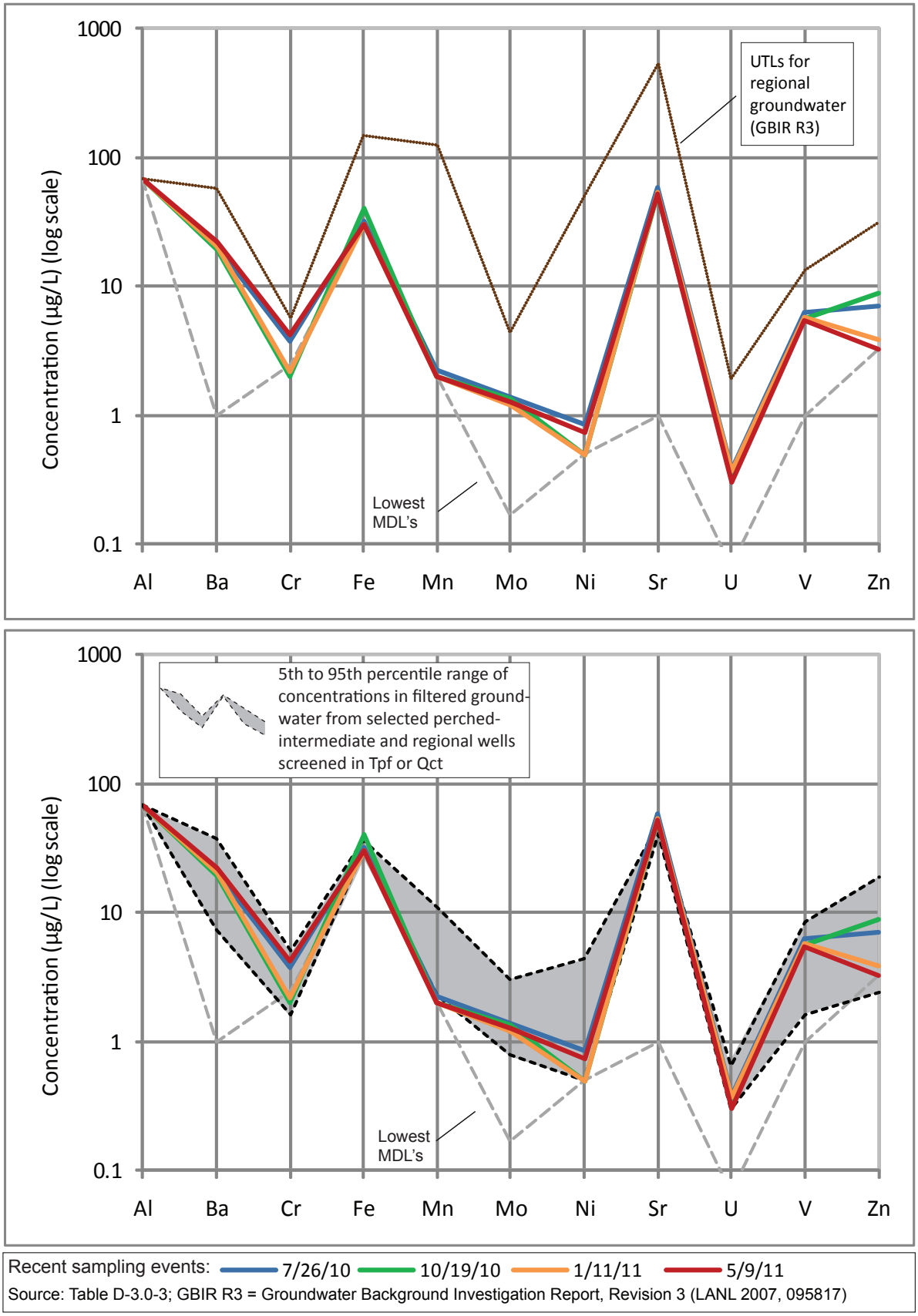
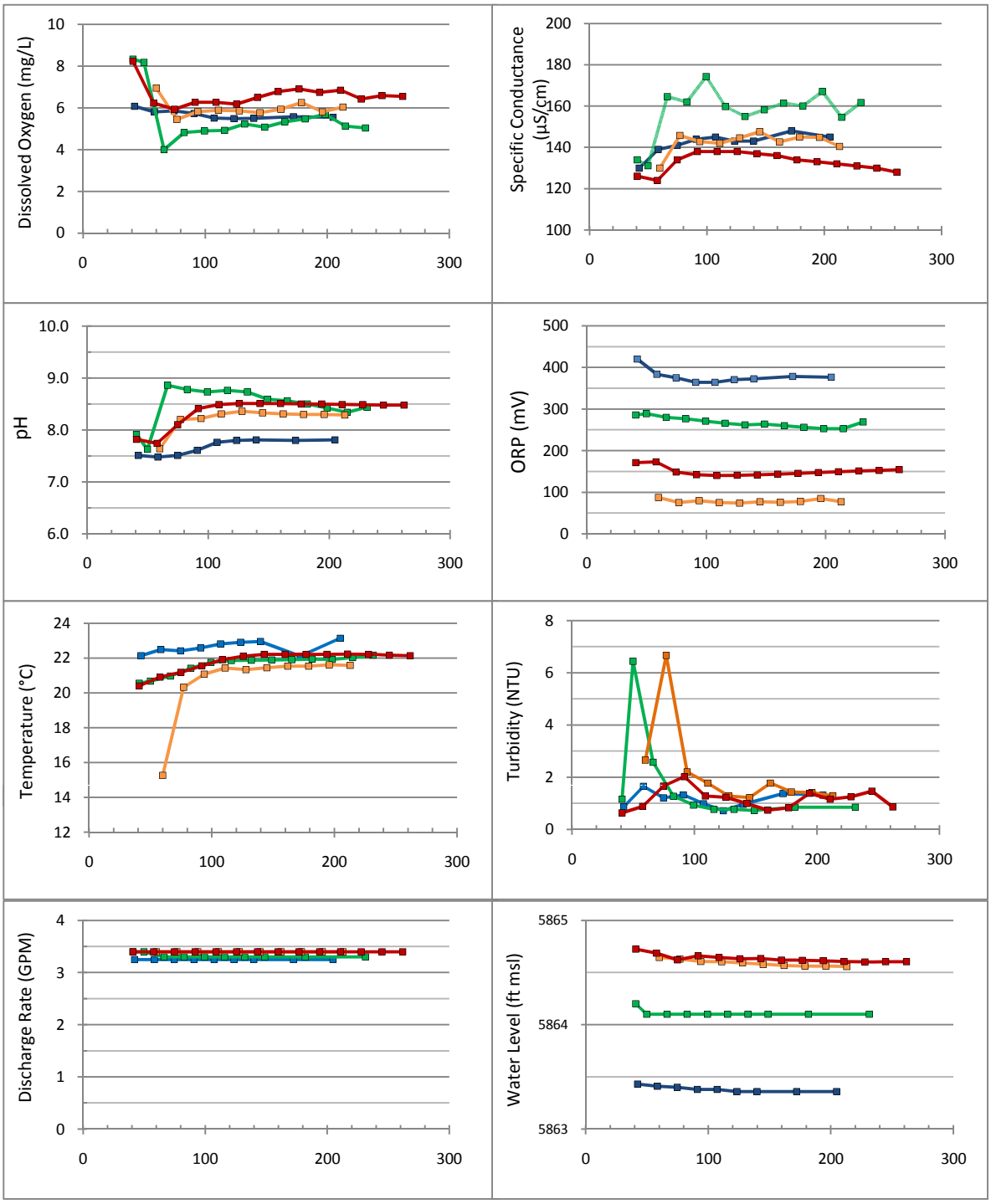


Figure D2-R51-6. Concentrations of trace metals in filtered groundwater from well R-51 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-52 screen 1 (port P1A), port depth 1035 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

5-Aug-10 12-Oct-10 13-Jan-11 4-May-11

Figure D2-R52-1. Time-series plots of field parameters monitored during purging of R-52 screen 1 (port P1A)

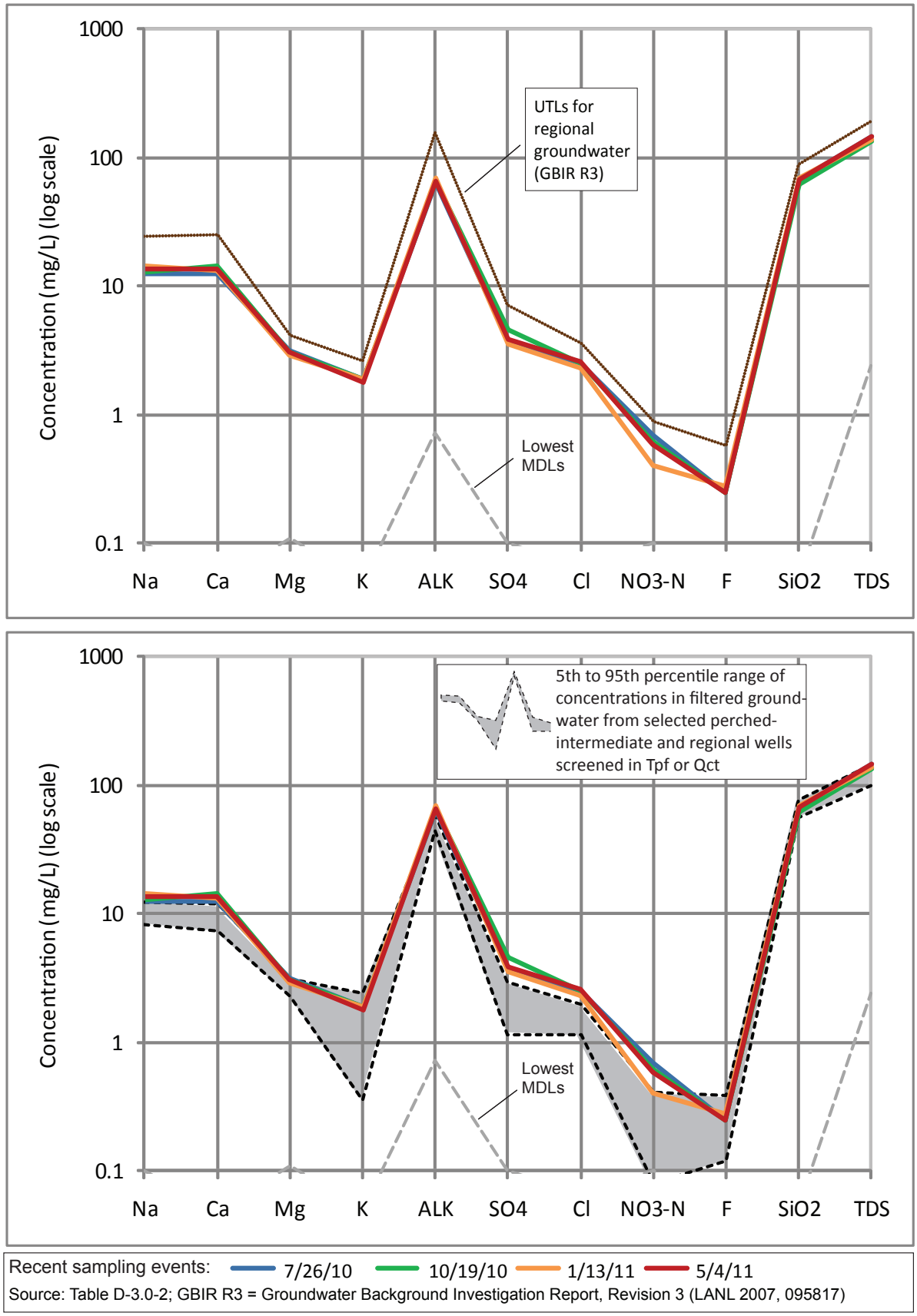


Figure D2-R52-3. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-52 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

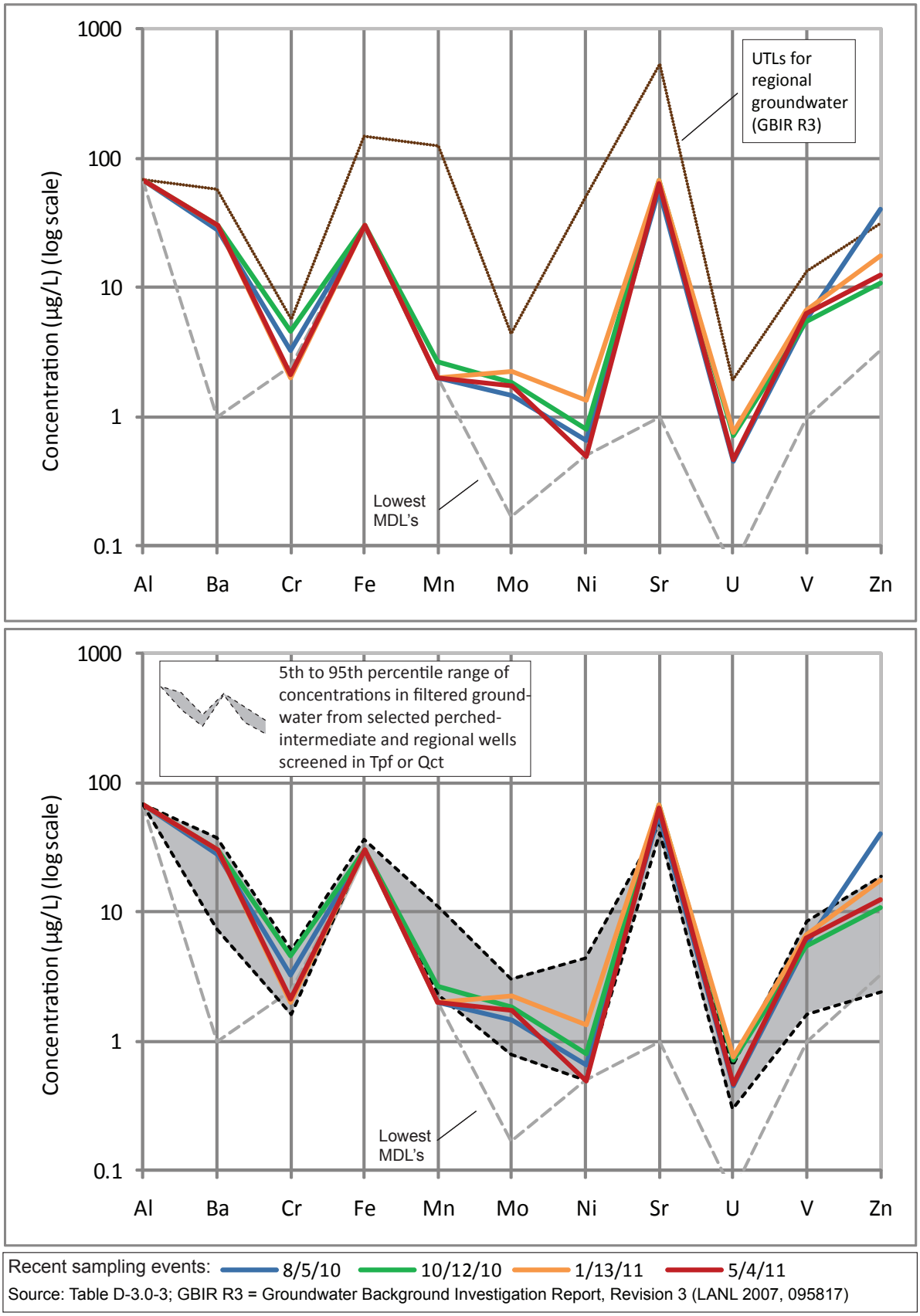
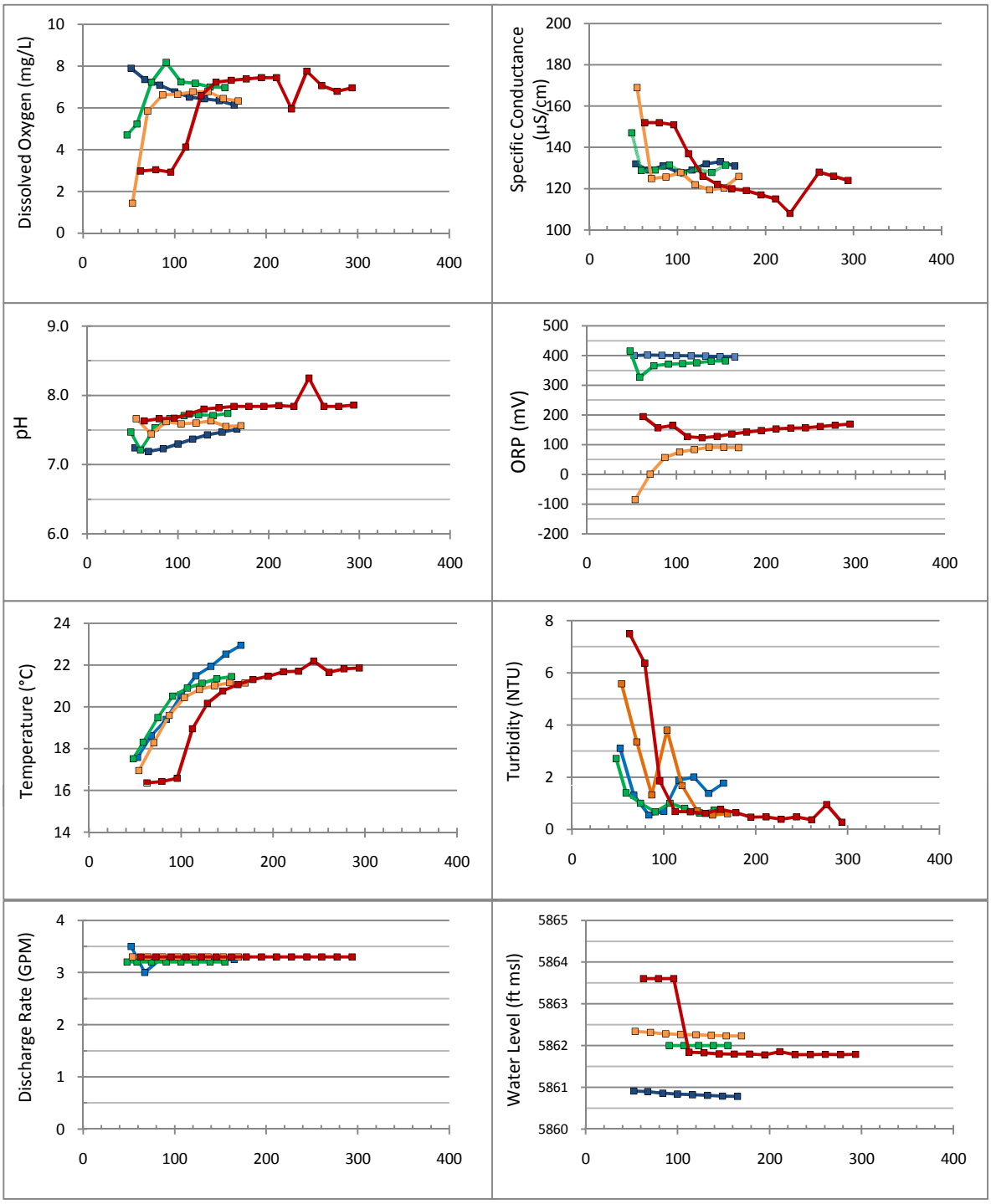


Figure D2-R52-3. Concentrations of trace metals in filtered groundwater from well R-52 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-52 screen 2 (port P2A), port depth 1107 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

5-Aug-10 12-Oct-10 13-Jan-11 4-May-11

Figure D2-R52-4. Time-series plots of field parameters monitored during purging of R-52 screen 2 (port P2A)

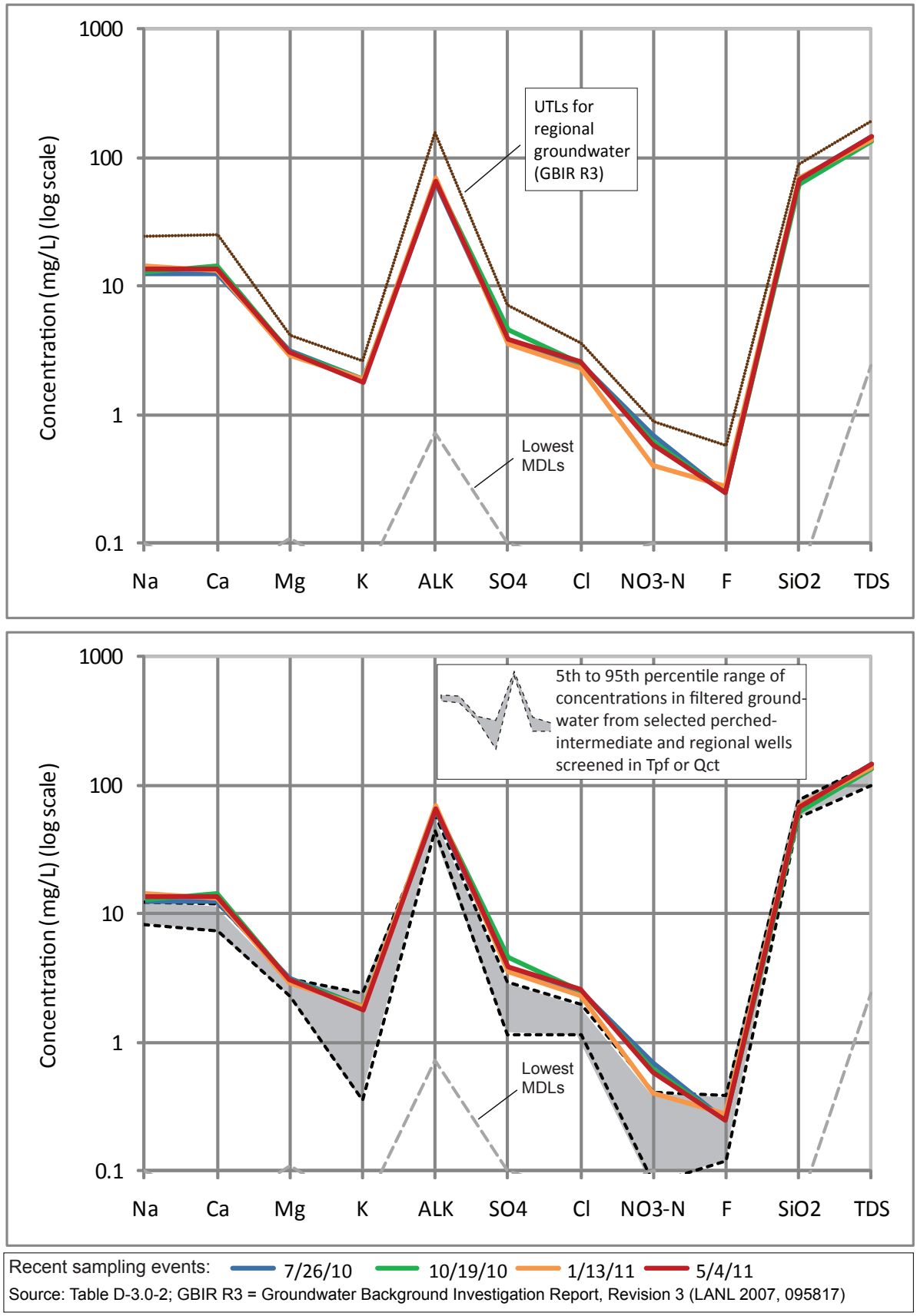


Figure D2-R52-3. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-52 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

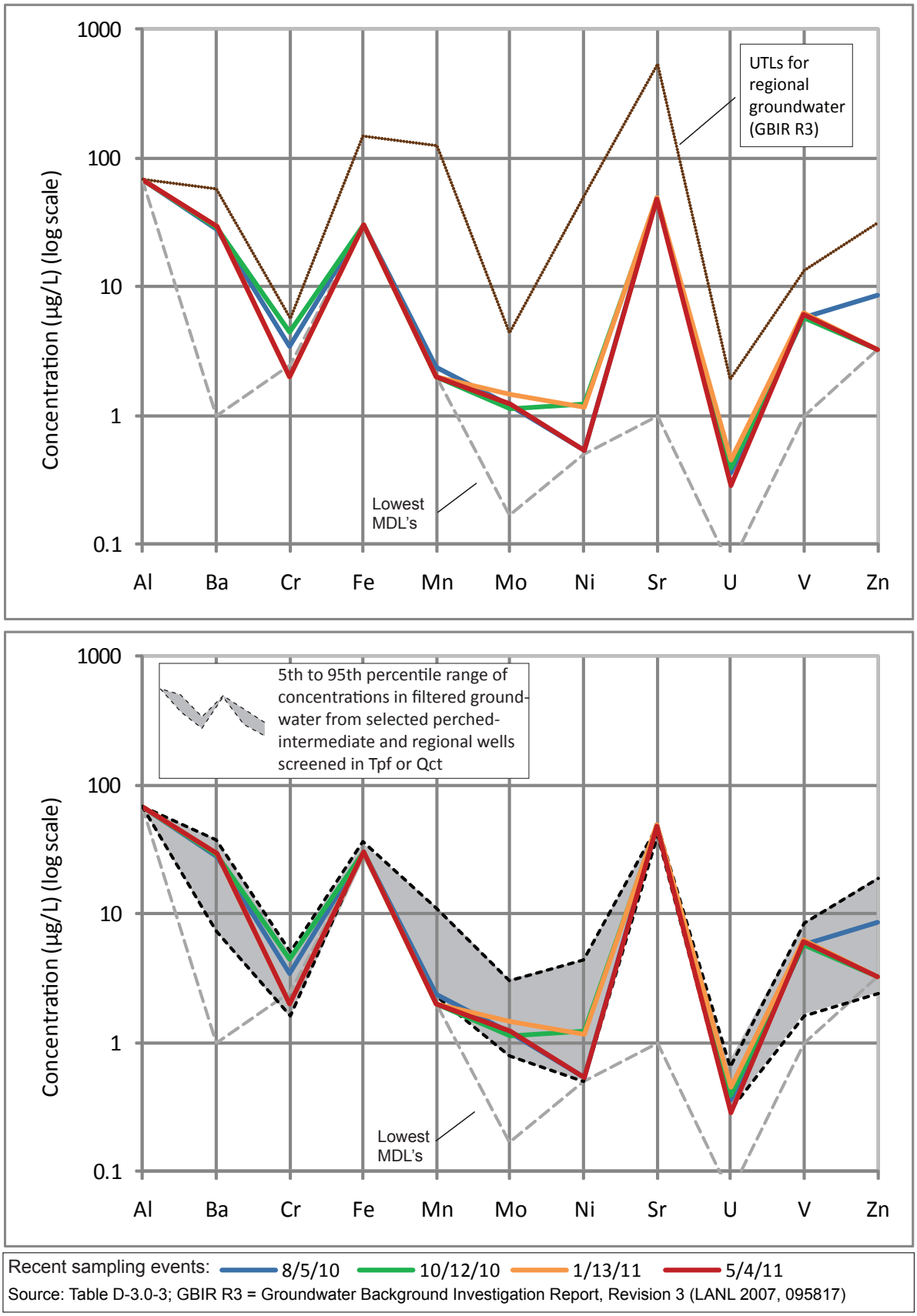
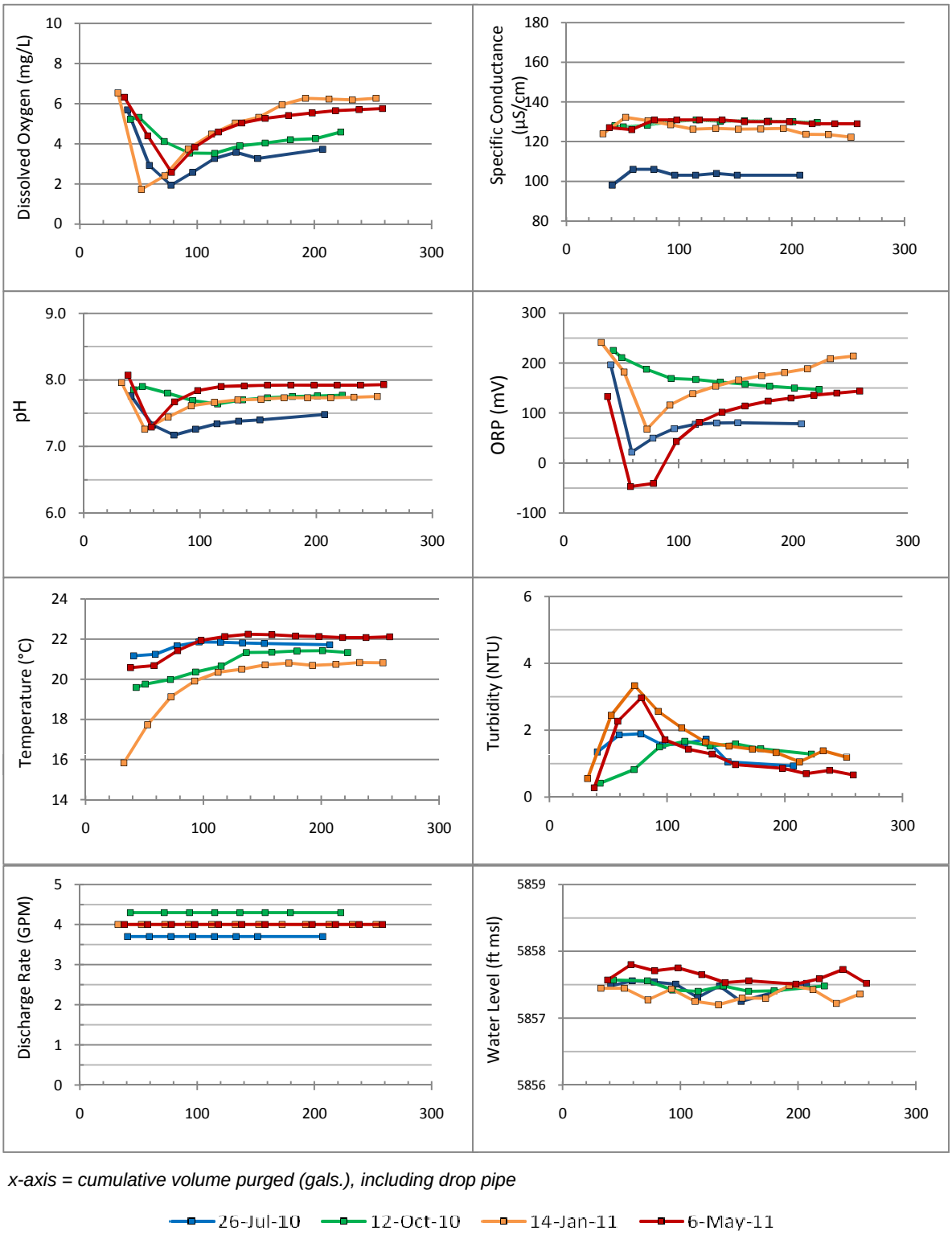


Figure D2-R52-6. Concentrations of trace metals in filtered groundwater from well R-52 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-53 screen 1 (port P1A), port depth 849 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

26-Jul-10 12-Oct-10 14-Jan-11 6-May-11

Figure D2-R53-1. Time-series plots of field parameters monitored during purging of R-53 screen 1 (port P1A)

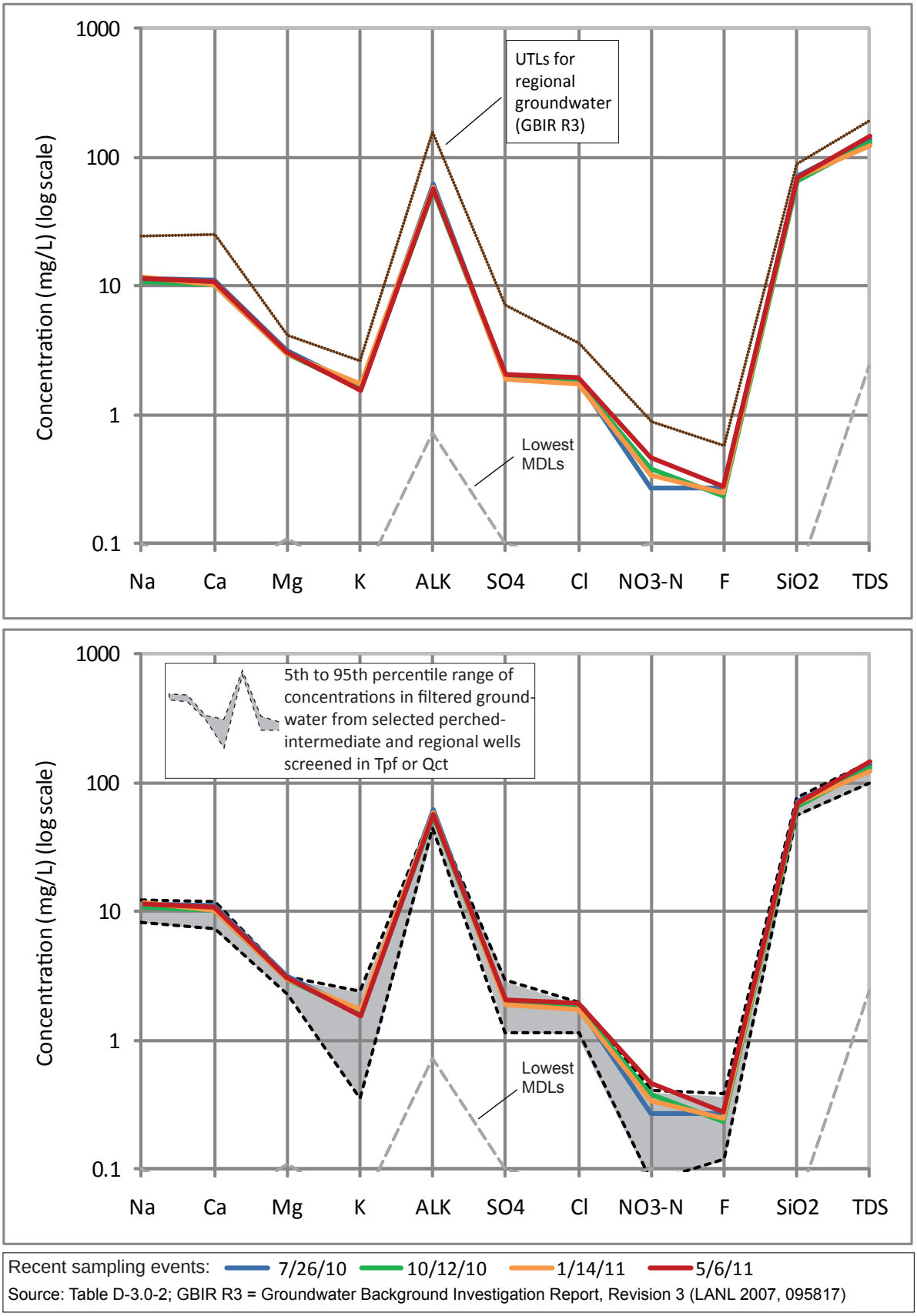


Figure D2-R53-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-53 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

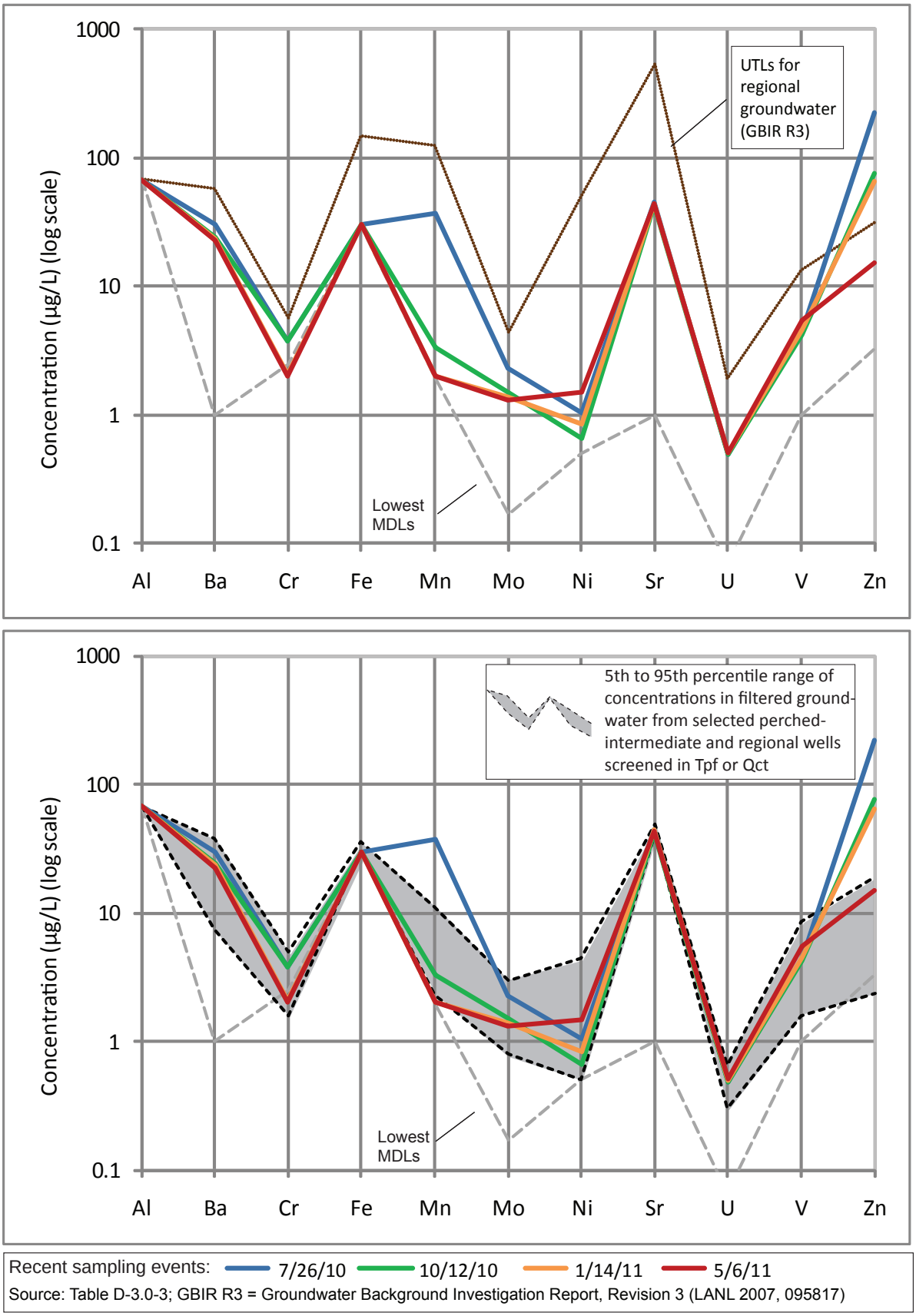


Figure D2-R53-3. Concentrations of trace metals in filtered groundwater from well R-53 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-53 screen 2 (port P2A), port depth 960 ft bgs

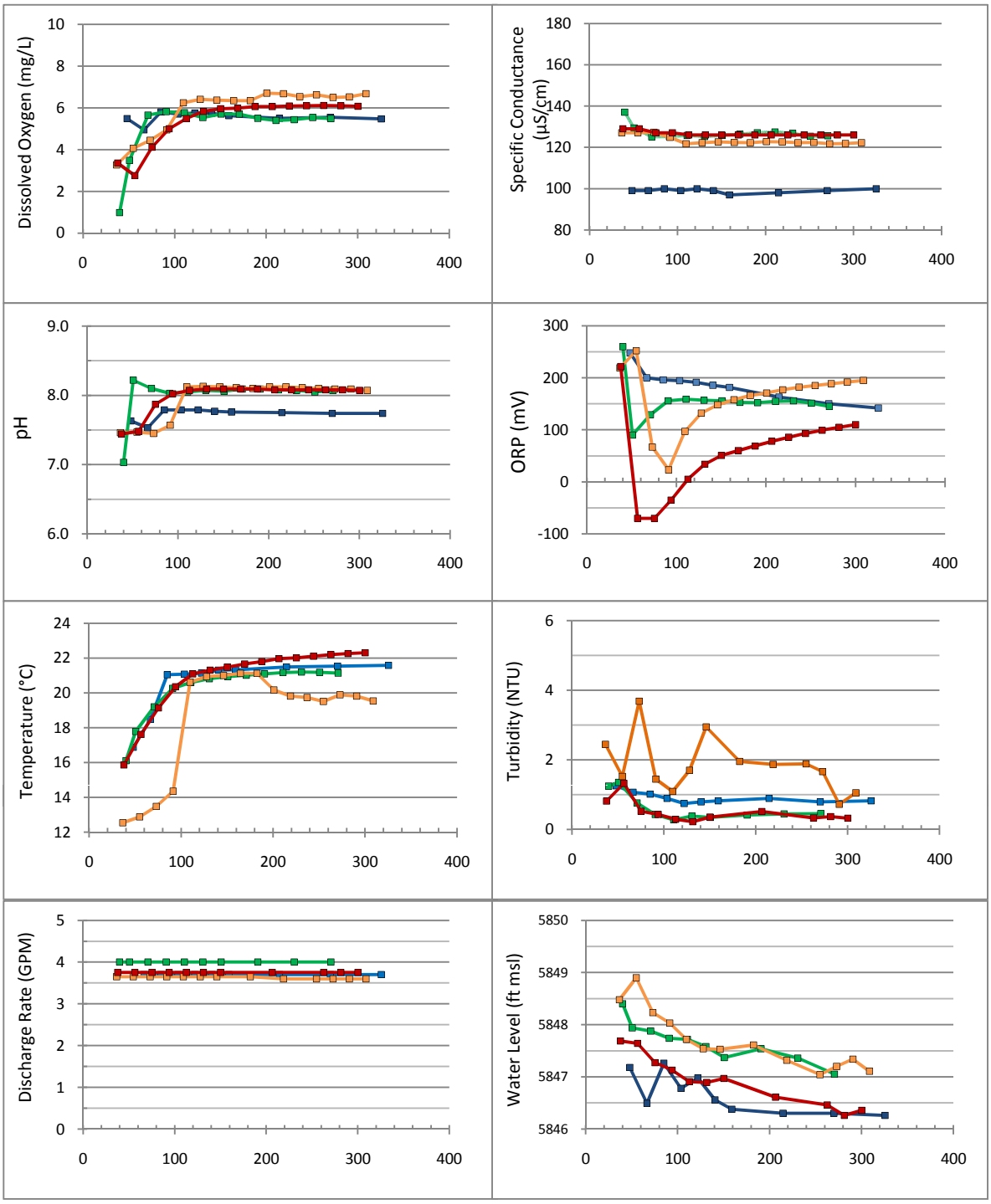
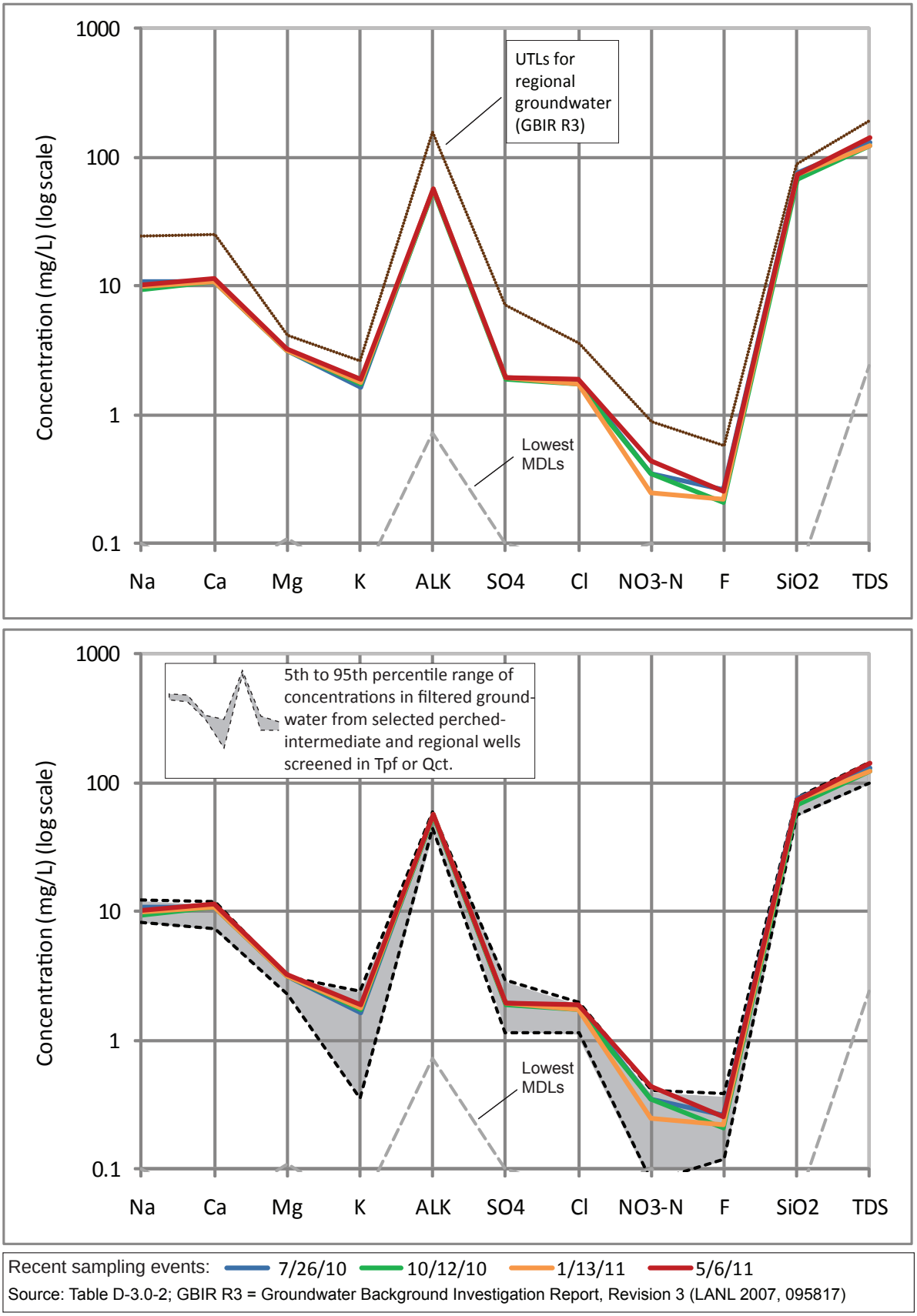


Figure D2-R53-4. **Time-series plots of field parameters monitored during purging of R-53 screen 2 (port P2A)**



Recent sampling events: 7/26/10 10/12/10 1/13/11 5/6/11

Source: Table D-3.0-2; GBIR R3 = Groundwater Background Investigation Report, Revision 3 (LANL 2007, 095817)

Figure D2-R53-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-53 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

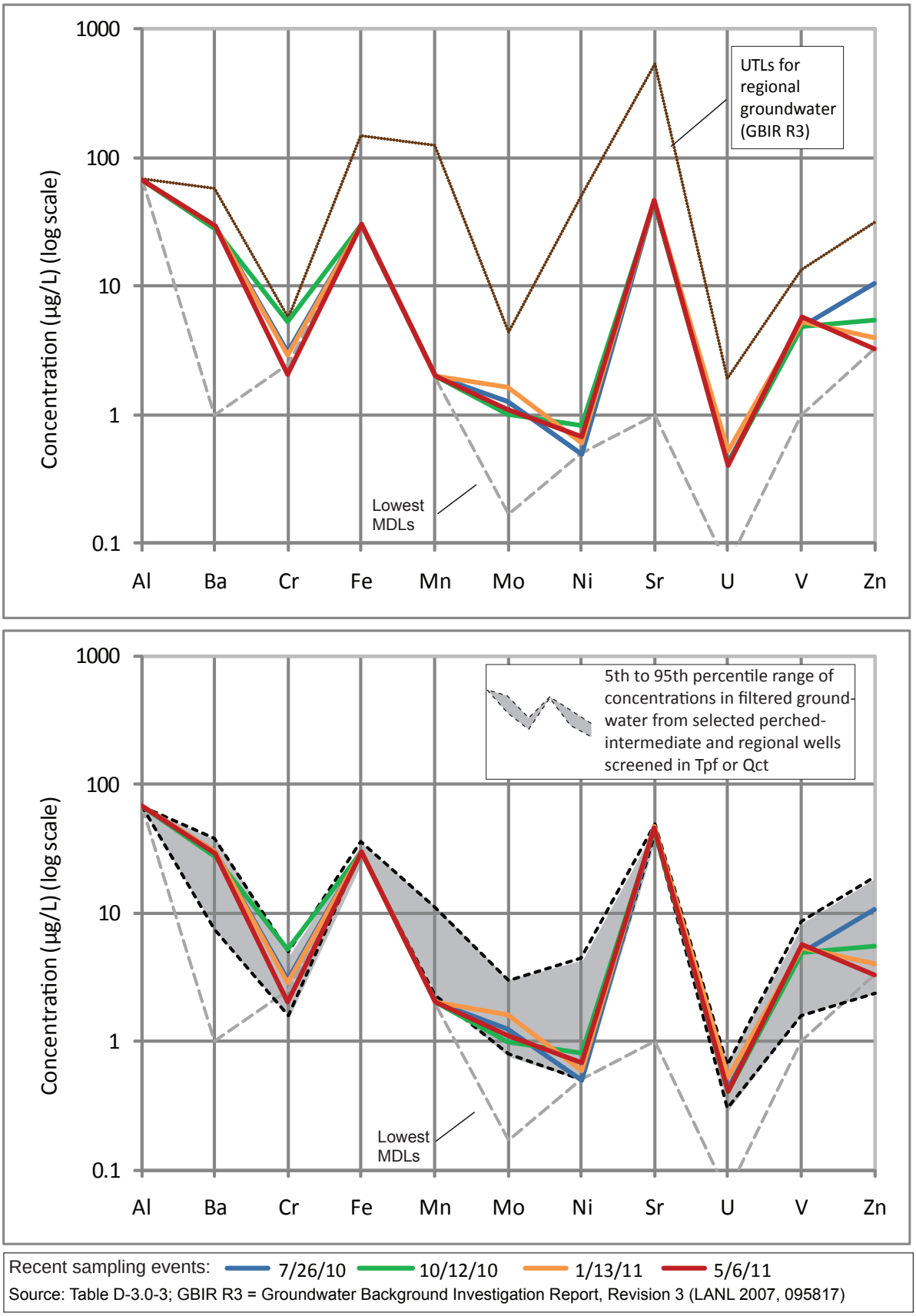
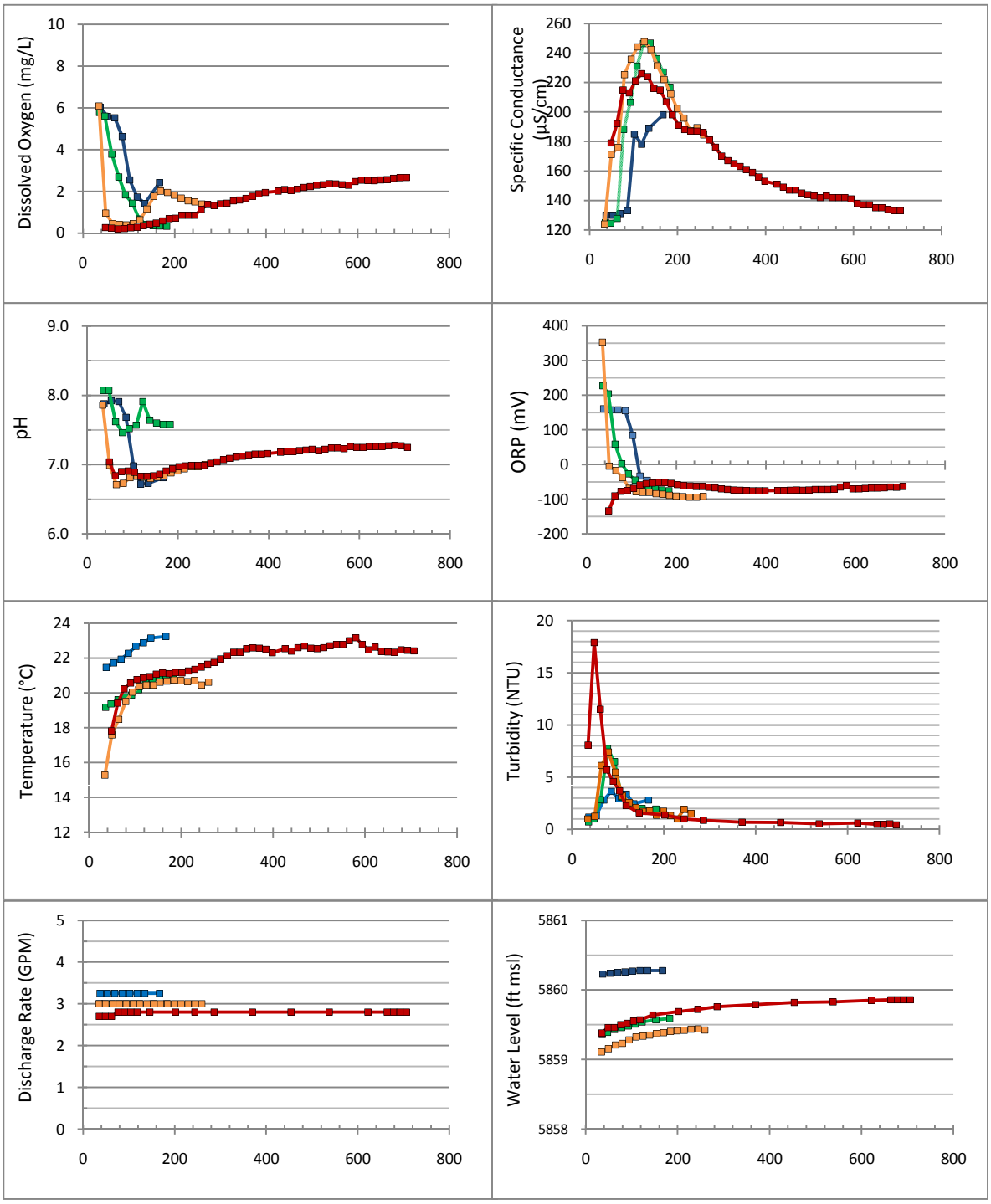


Figure D2-R53-6. Concentrations of trace metals in filtered groundwater from well R-53 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-54 screen 1 (port P1A), port depth 830 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

27-Jul-10 13-Oct-10 14-Jan-11 4-May-11

Figure D2-R54-1. Time-series plots of field parameters monitored during purging of R-54 screen 1 (port P1A)

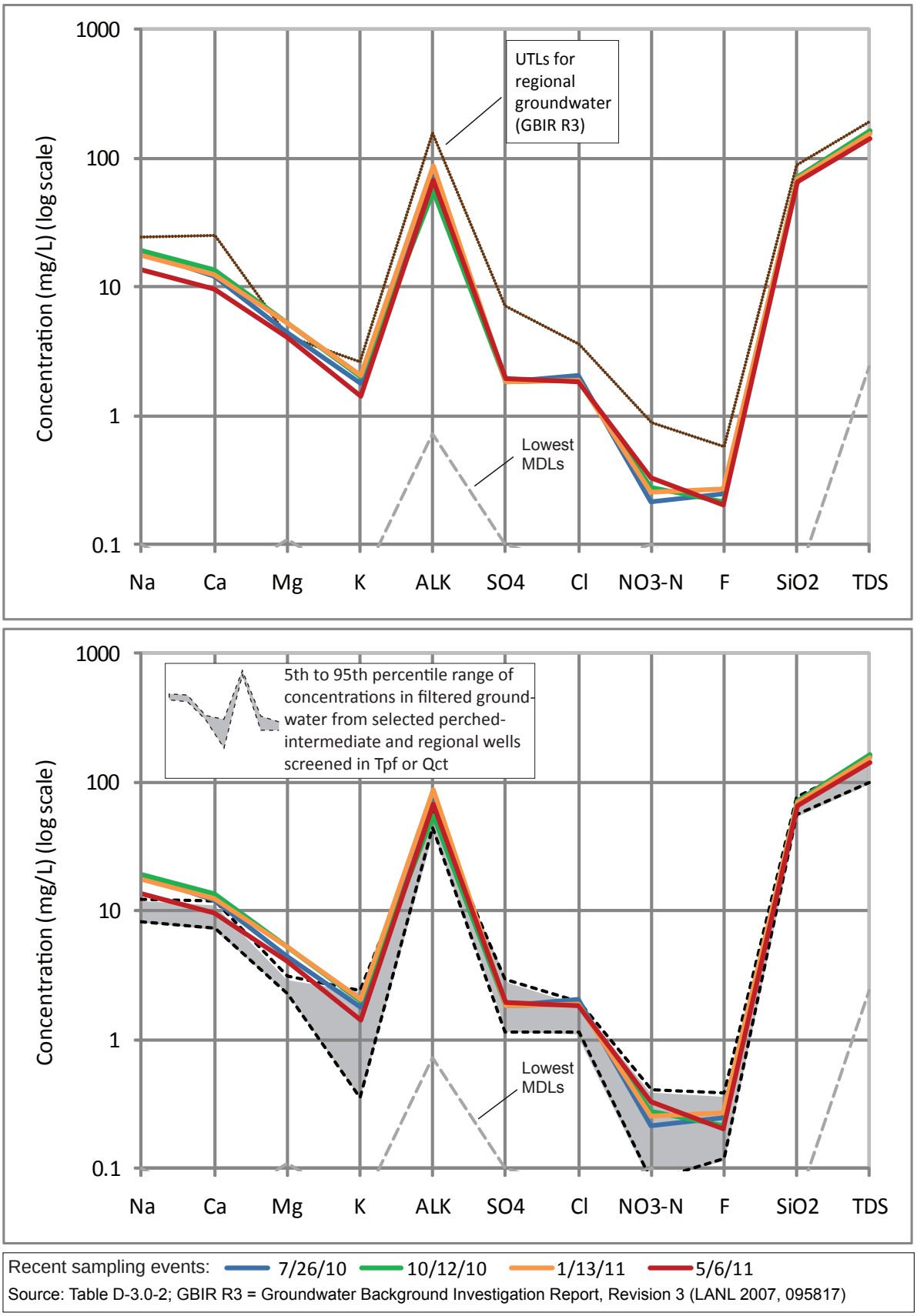


Figure D2-R54-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-54 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

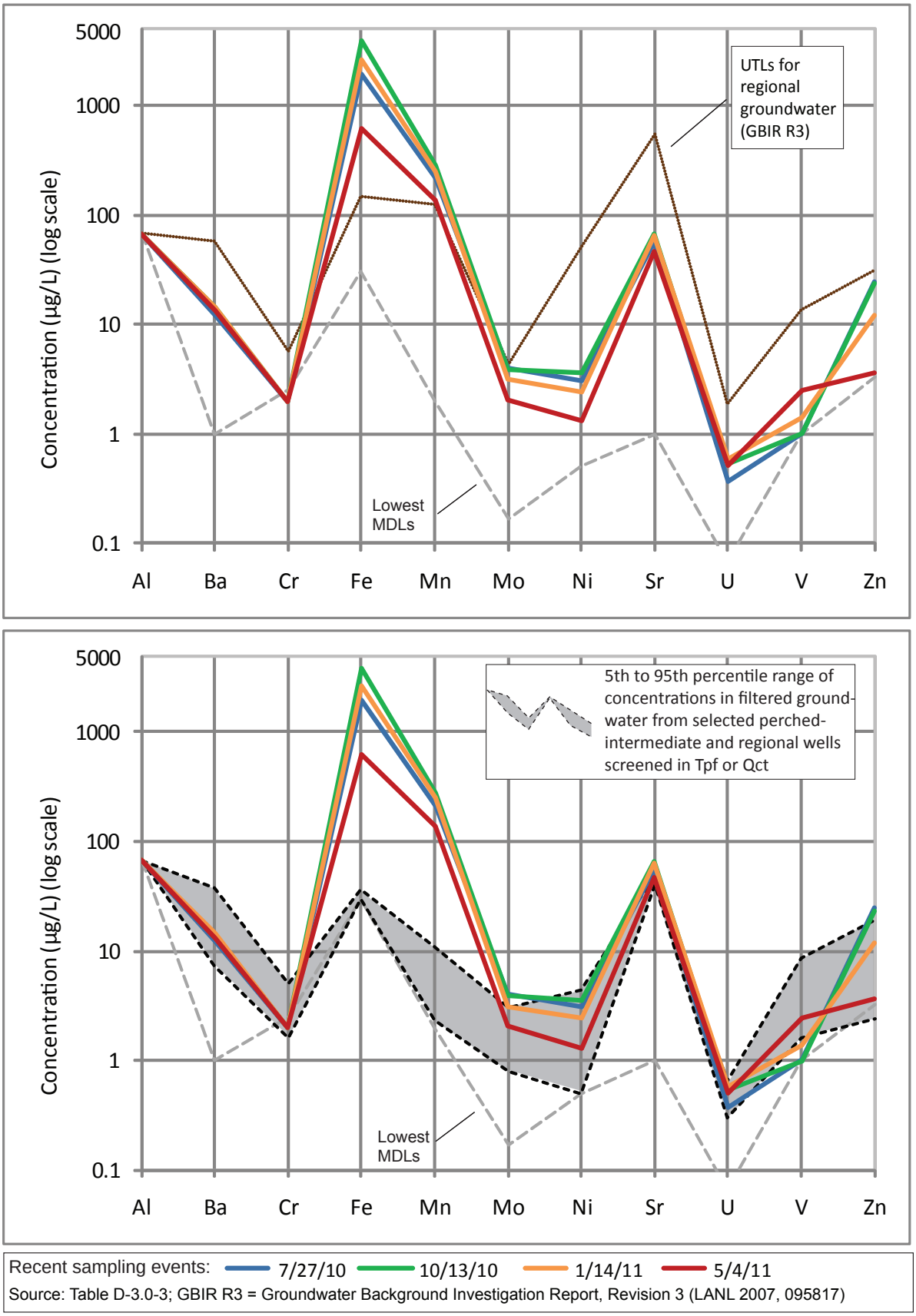
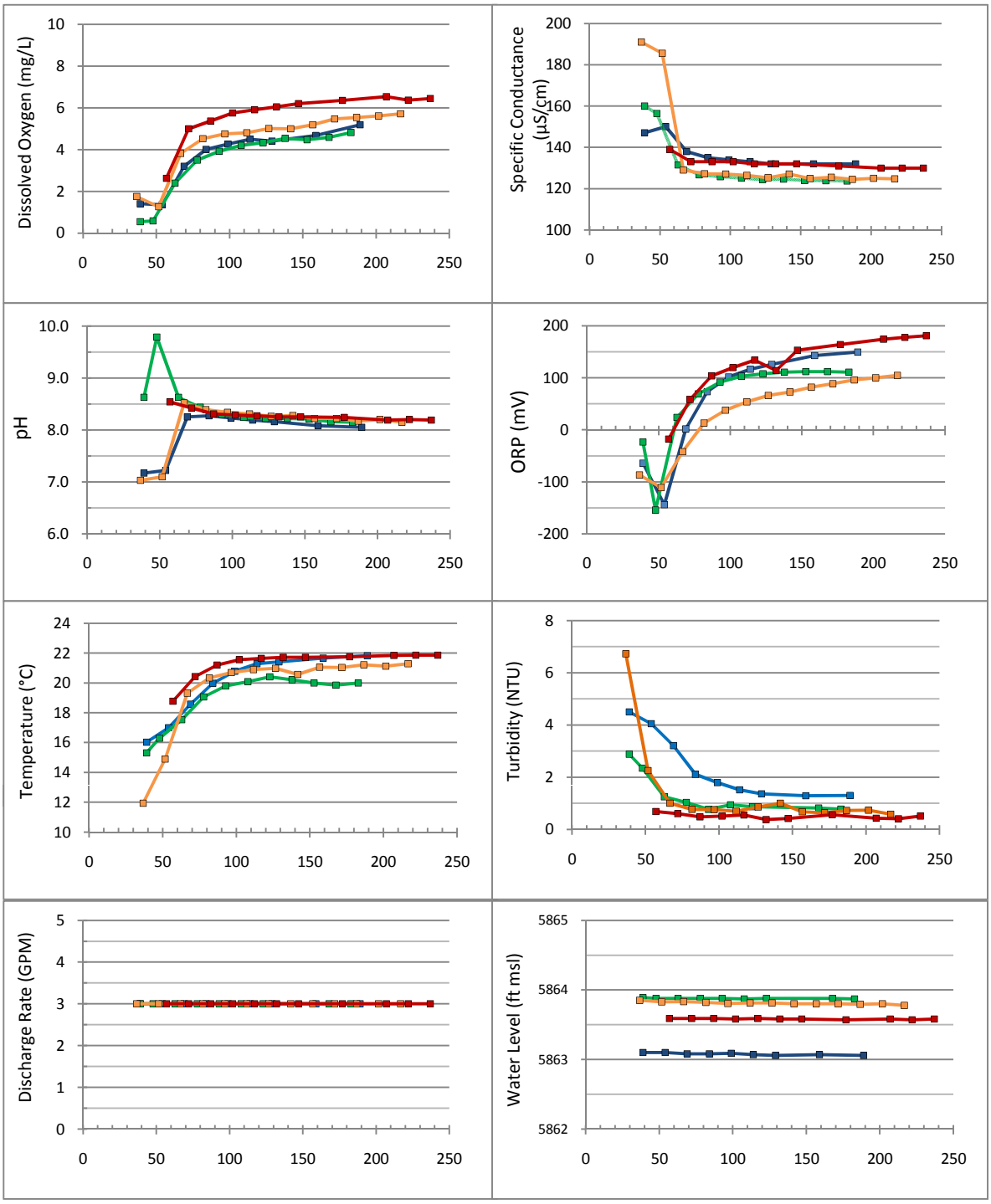


Figure D2-R54-3. Concentrations of trace metals in filtered groundwater from well R-54 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows"background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-54 screen 2 (port P2A), port depth 915 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

27-Jul-10 13-Oct-10 12-Jan-11 5-May-11

Figure D2-R54-4. Time-series plots of field parameters monitored during purging of R-54 screen 2 (port P2A)

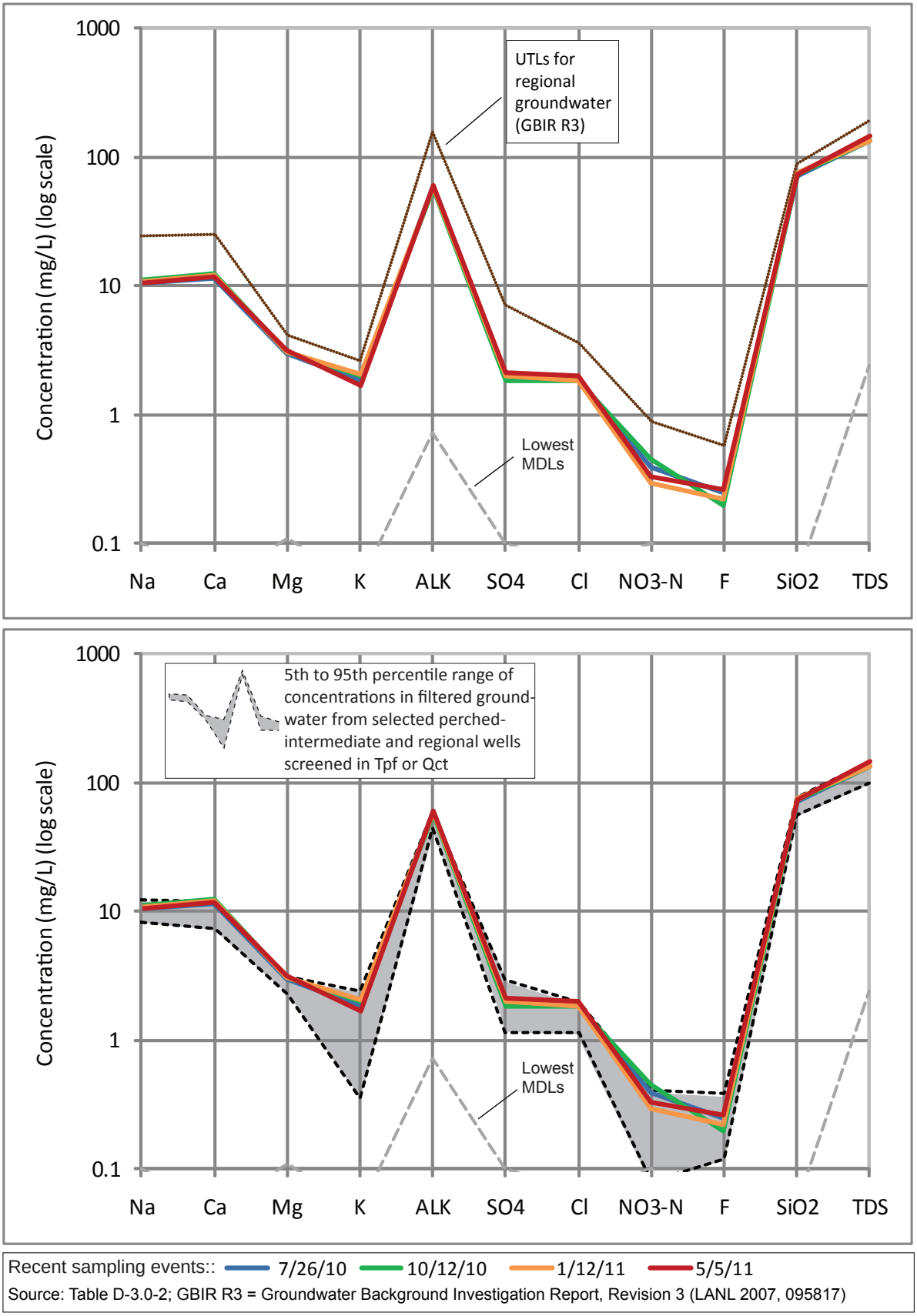


Figure D2-R54-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-54 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

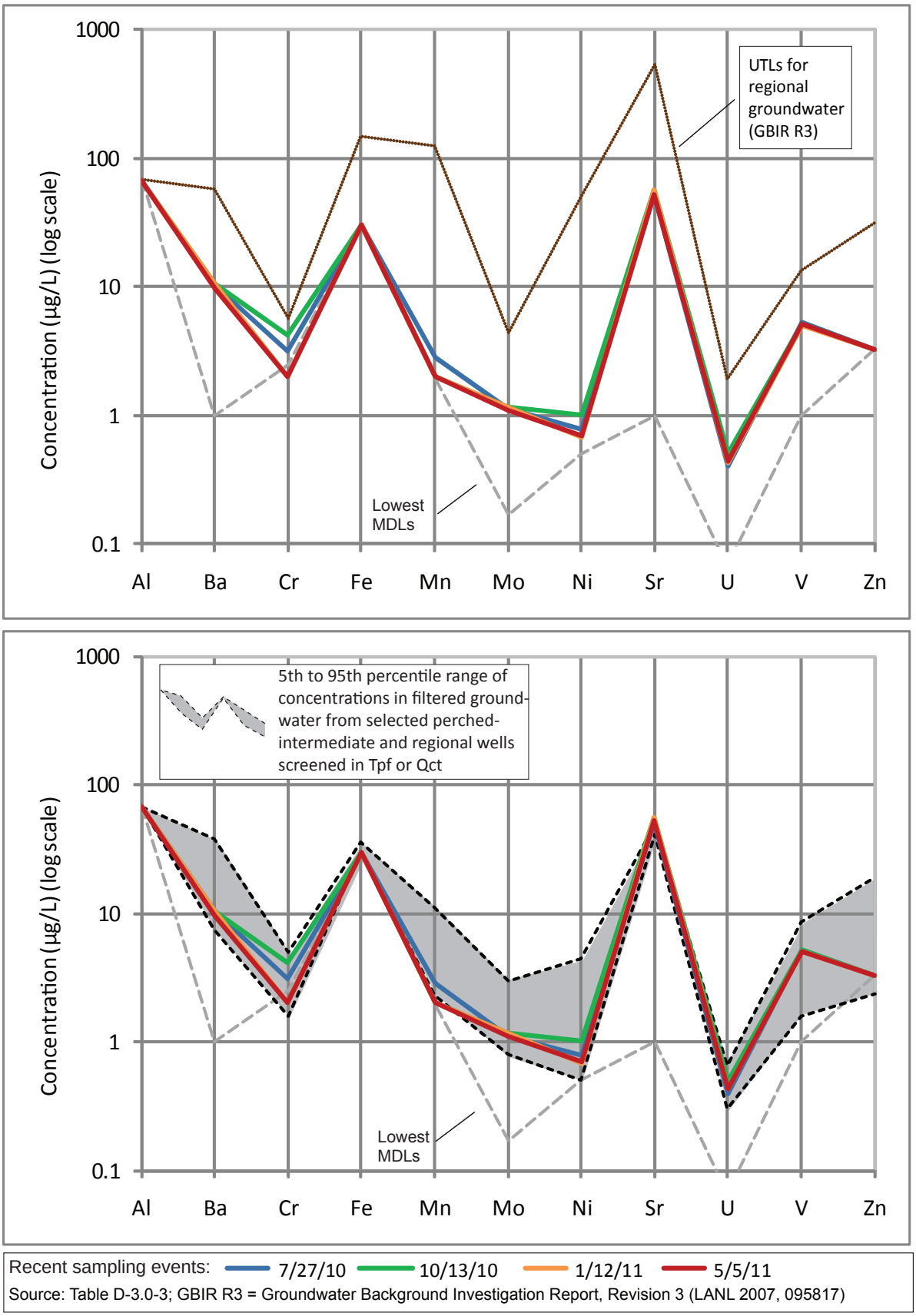
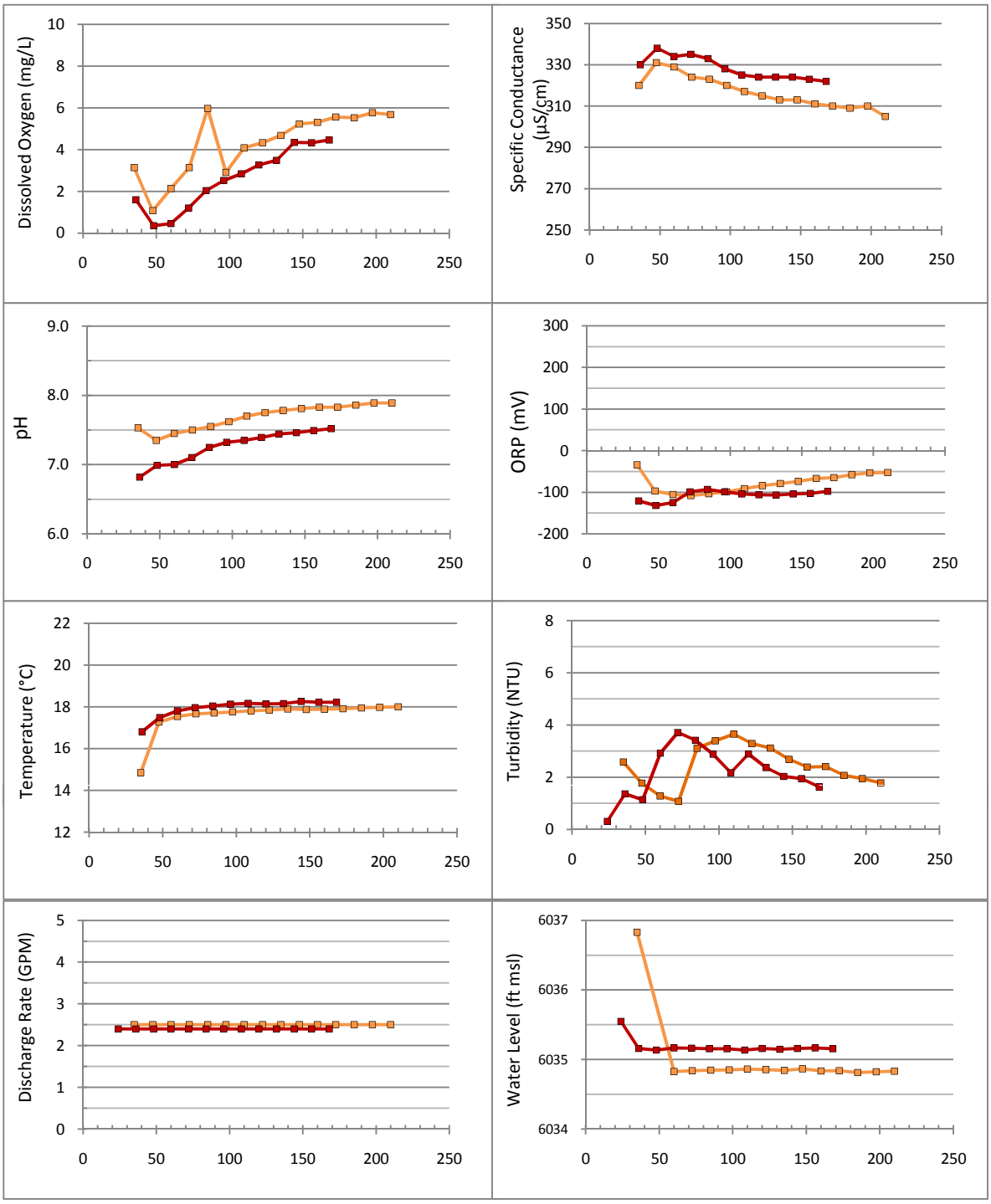


Figure D2-R54-6. Concentrations of trace metals in filtered groundwater from well R-54 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-55i (single screen), port depth 510 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

23-Mar-11 10-May-11

Figure D2-R55i-1. Time-series plots of field parameters monitored during purging of R-55i (single screen)

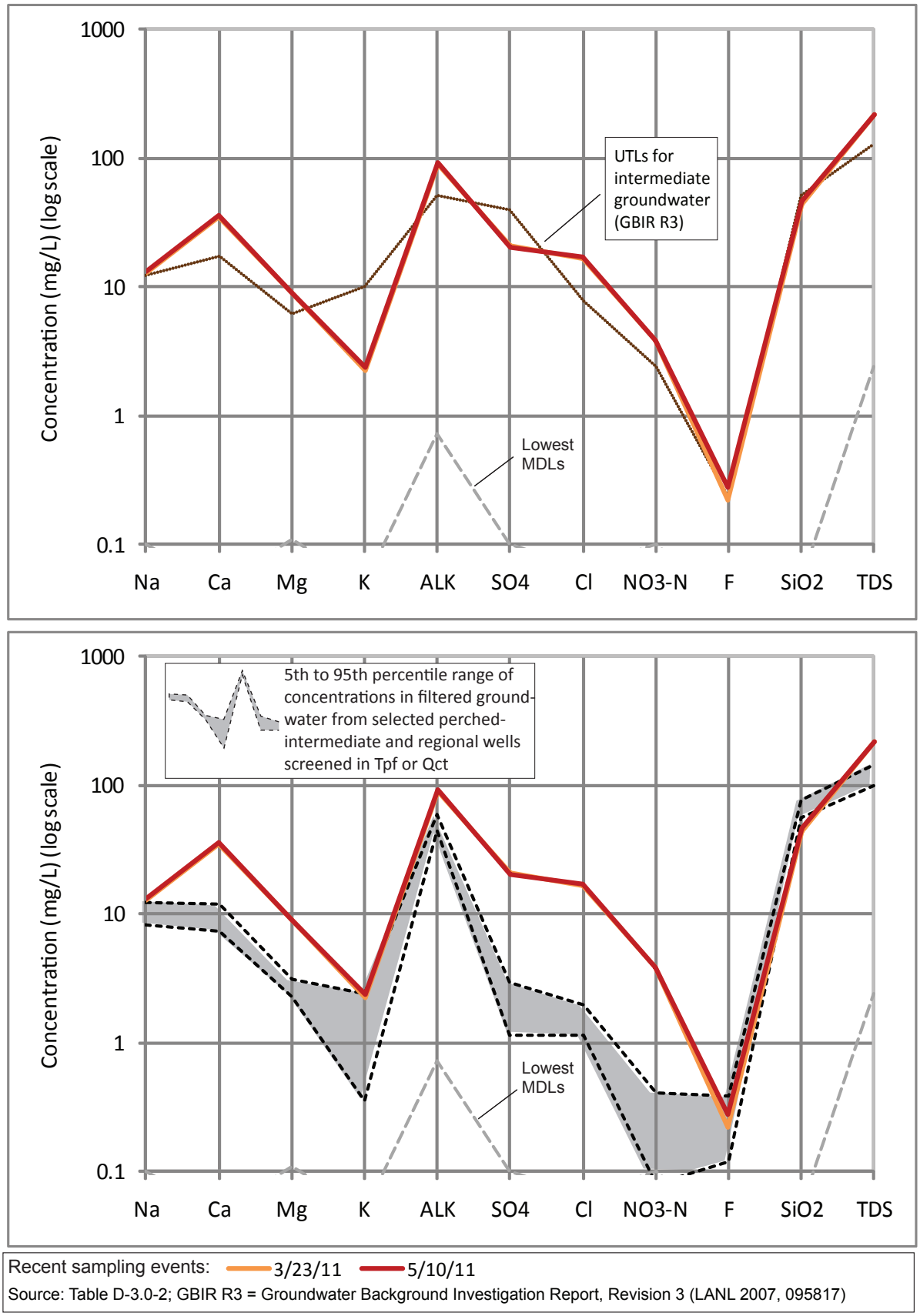


Figure D2-R-55i-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-55i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

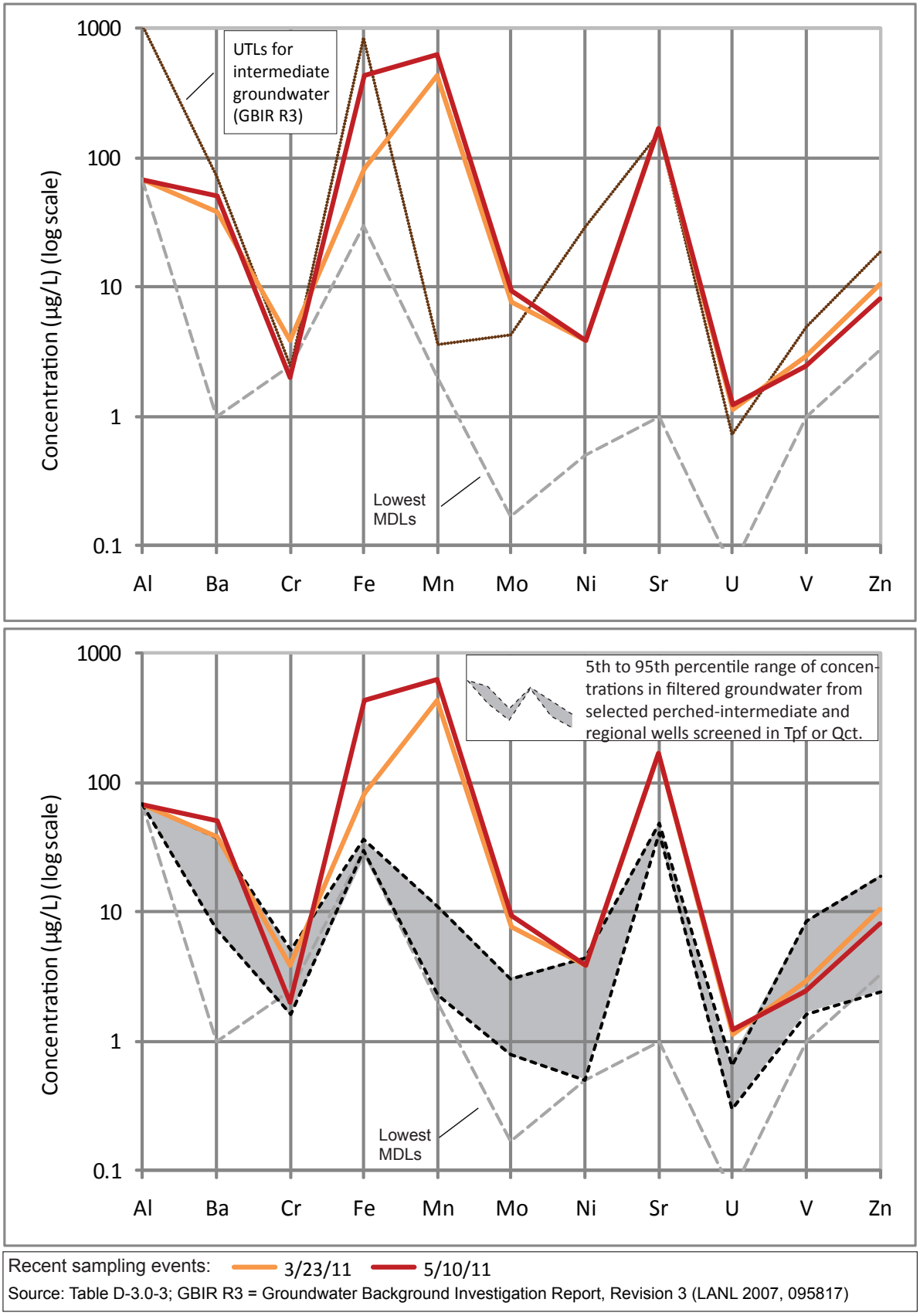
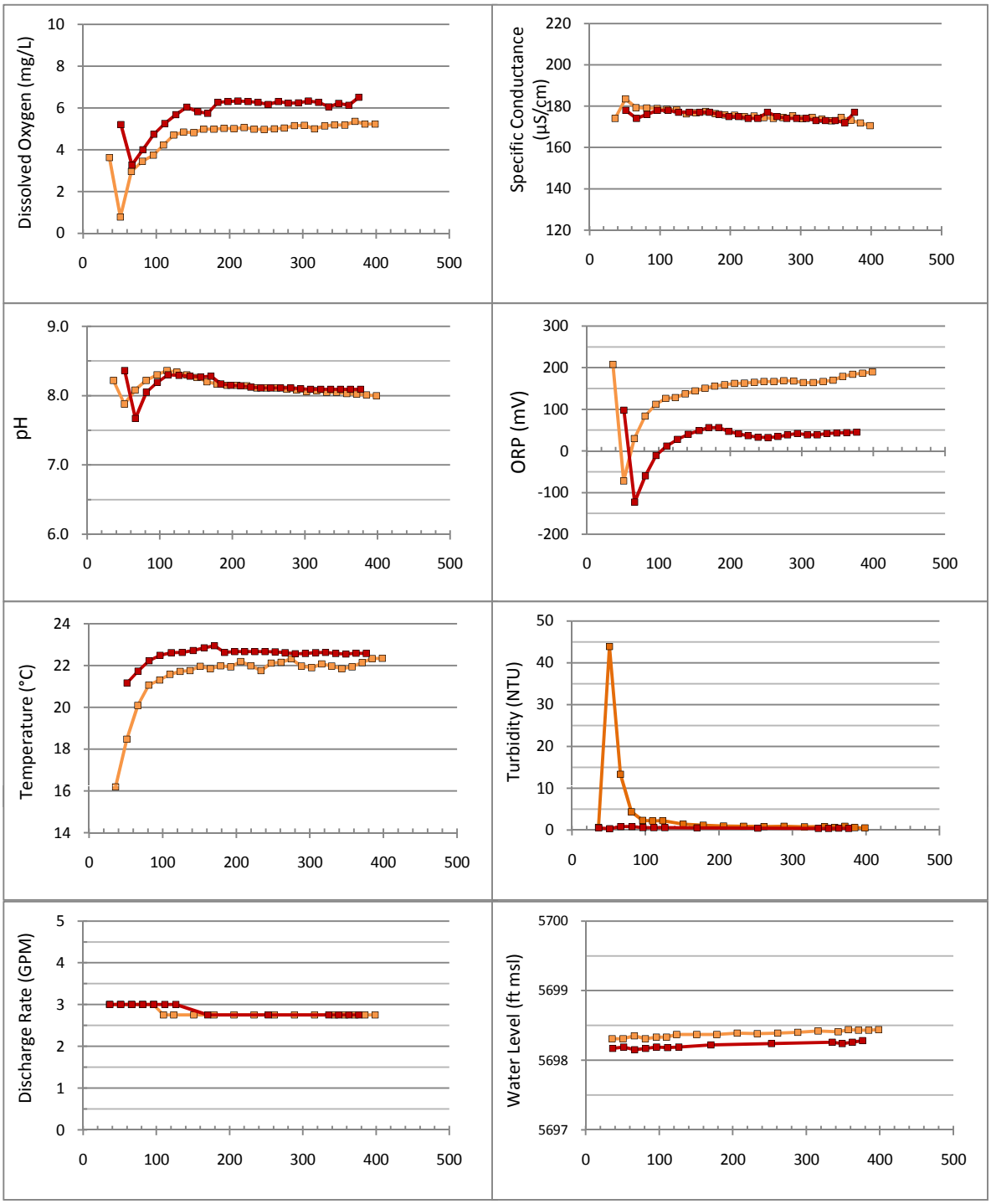


Figure D2-R55i-3. Concentrations of trace metals in filtered groundwater from well R-55i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-55 screen 1 (port P1A), port depth 860 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

7-Feb-11 28-Apr-11

Figure D2-R55-1. Time-series plots of field parameters monitored during purging of R-55 screen 1 (port P1A)

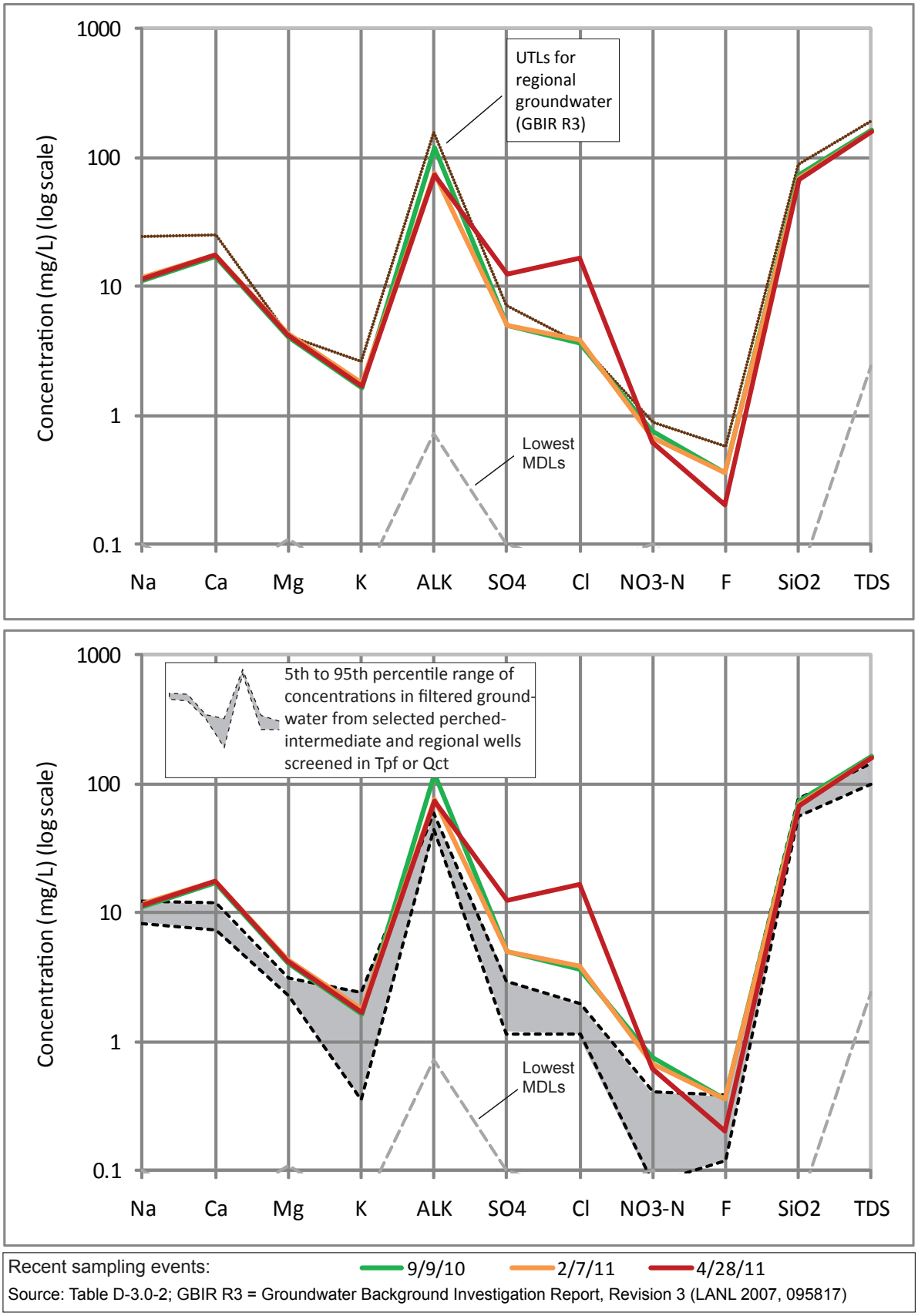
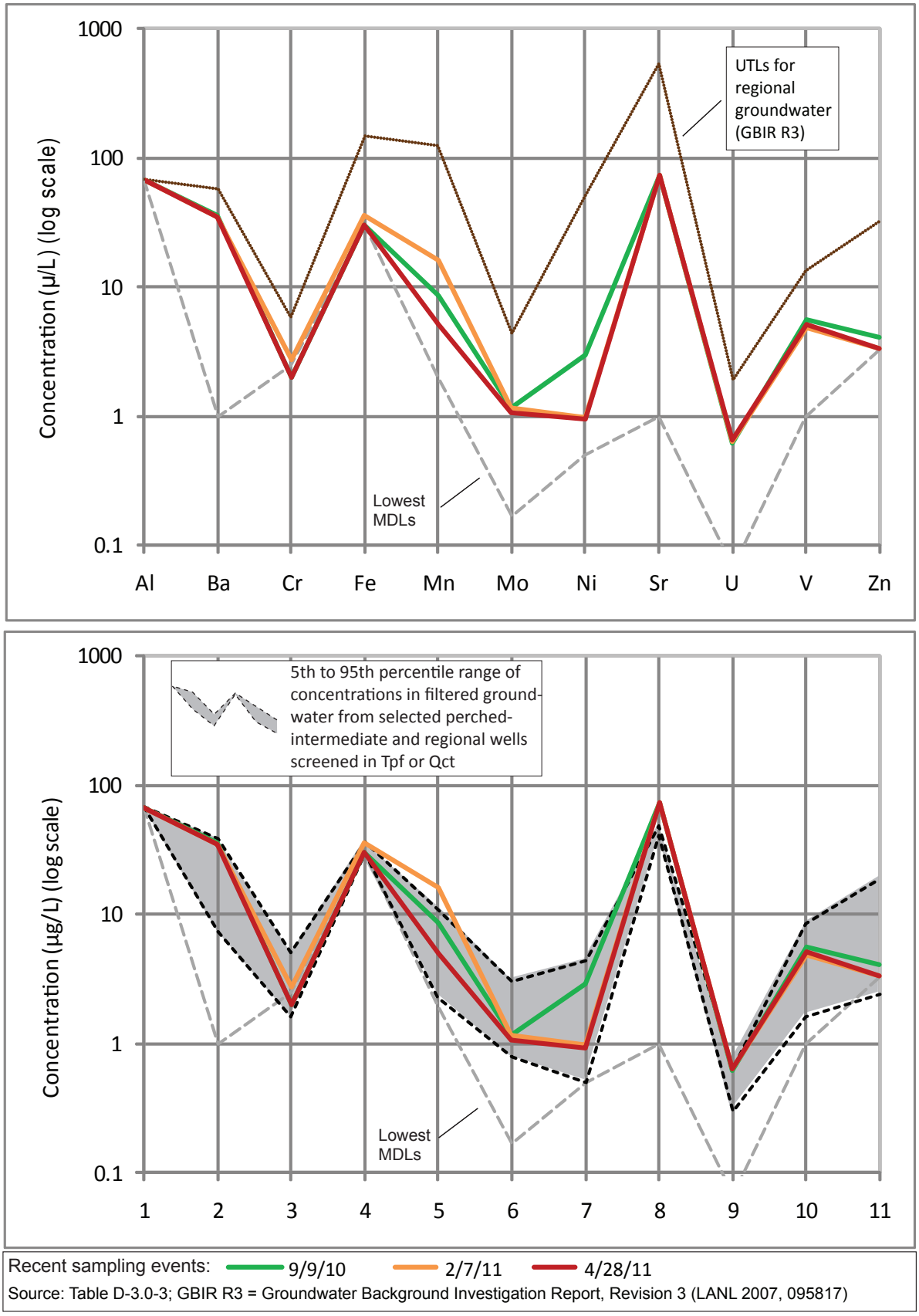


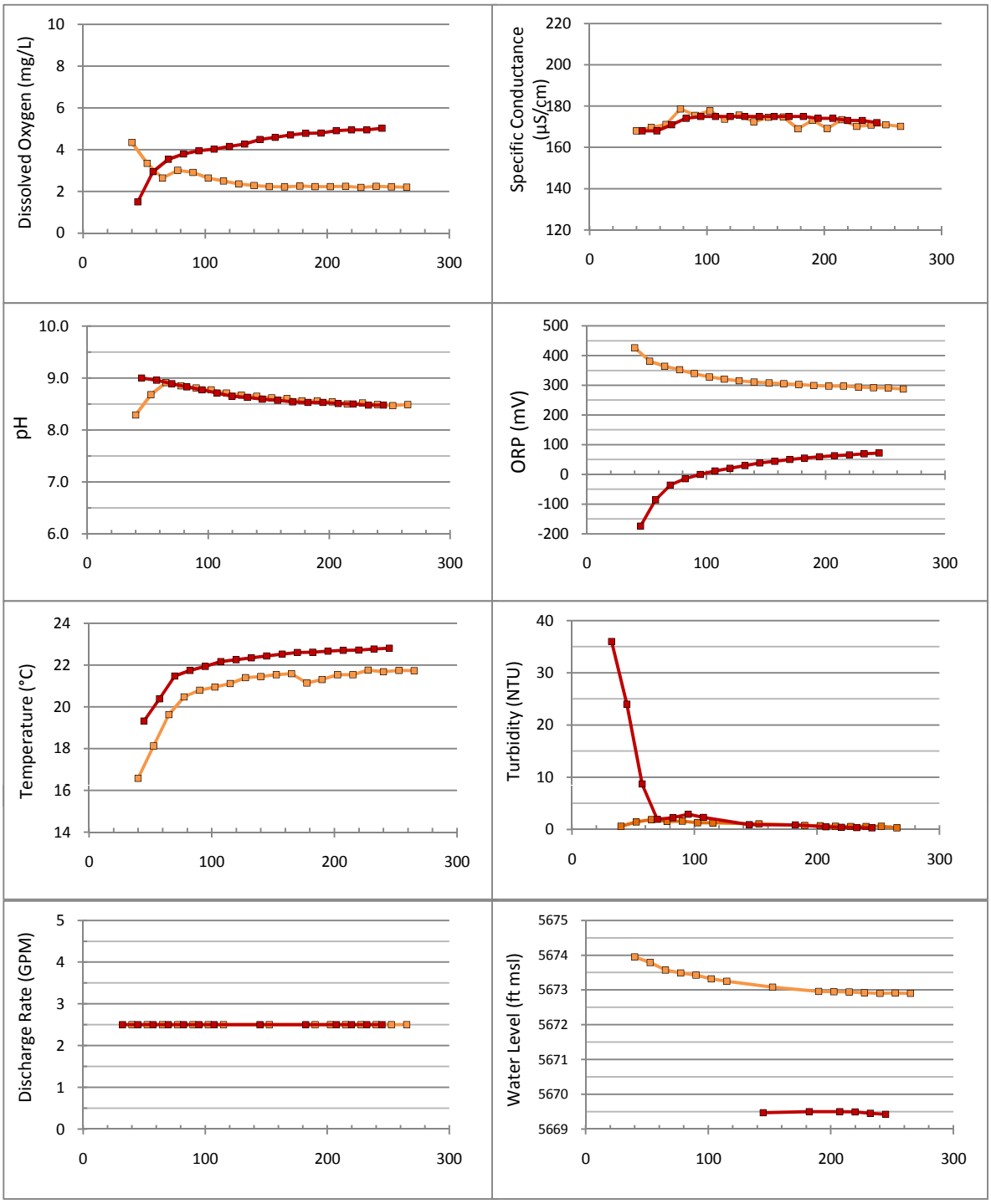
Figure D2-R55-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-55 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).



Source: Table D-3.0-3; GBIR R3 = Groundwater Background Investigation Report, Revision 3 (LANL 2007, 095817)

Figure D2-R55-3. Concentrations of trace metals in filtered groundwater from well R-55 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-55 screen 2 (port P2A), port depth 994 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

2-Feb-11 28-Apr-11

Figure D2-R55-4. Time-series plots of field parameters monitored during purging of R-55 screen 2 (port P2A)

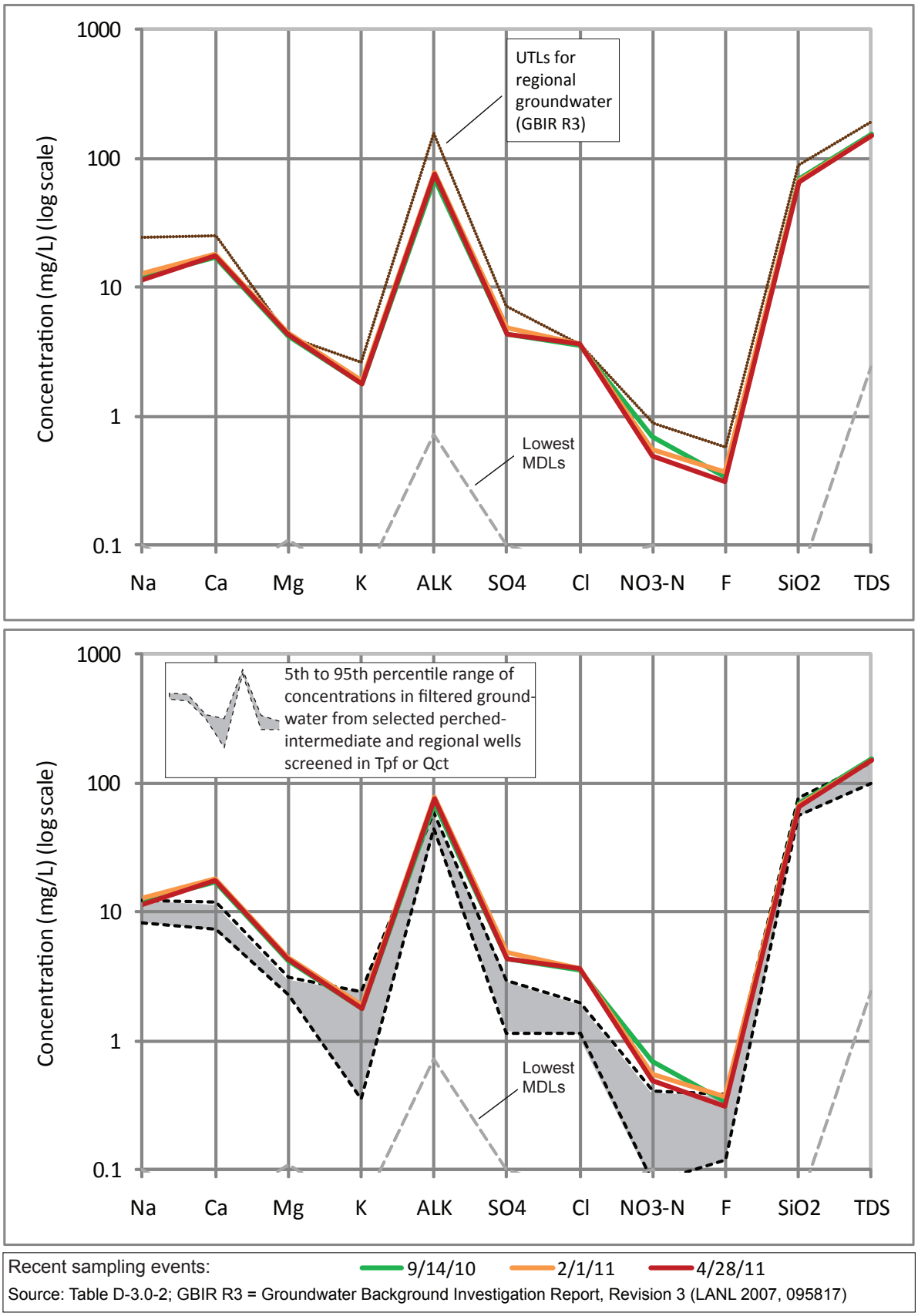


Figure D2-R55-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-55 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

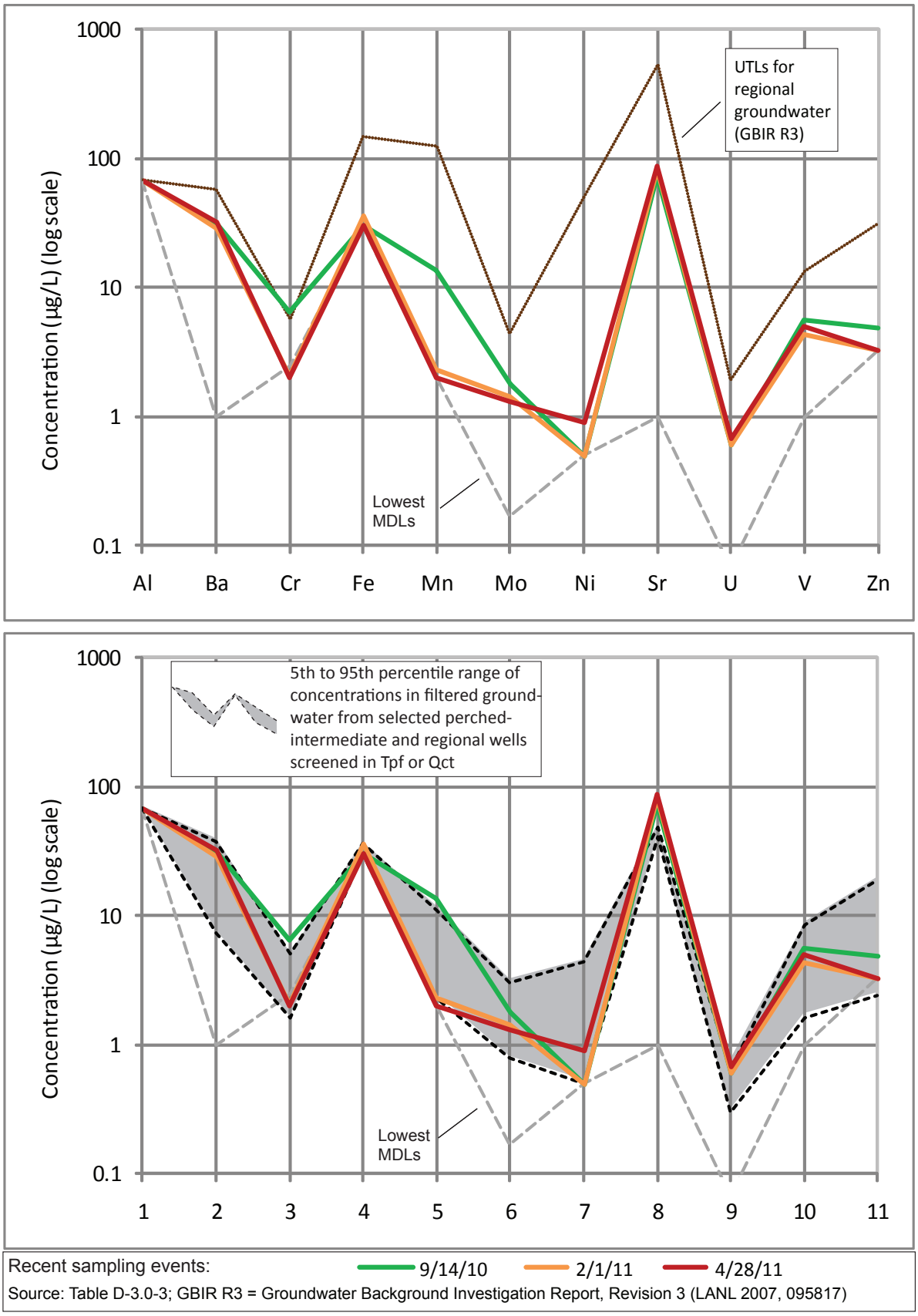
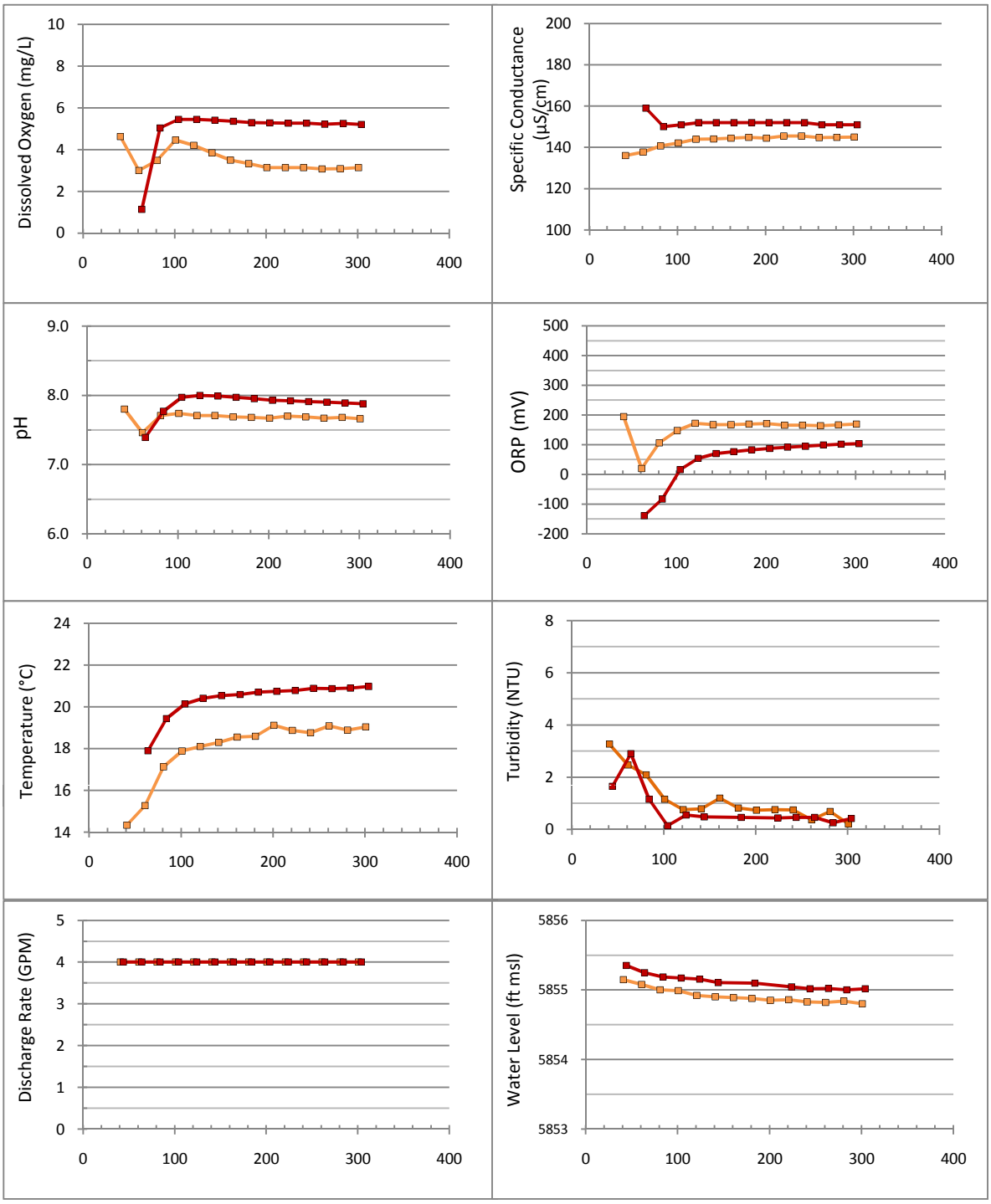


Figure D2-R55-6. Concentrations of trace metals in filtered groundwater from well R-55 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-56 screen 1 (port P1A), port depth 945 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

3-Feb-11 10-May-11

Figure D2-R56-1. Time-series plots of field parameters monitored during purging of R-56 screen 1 (port P1A)

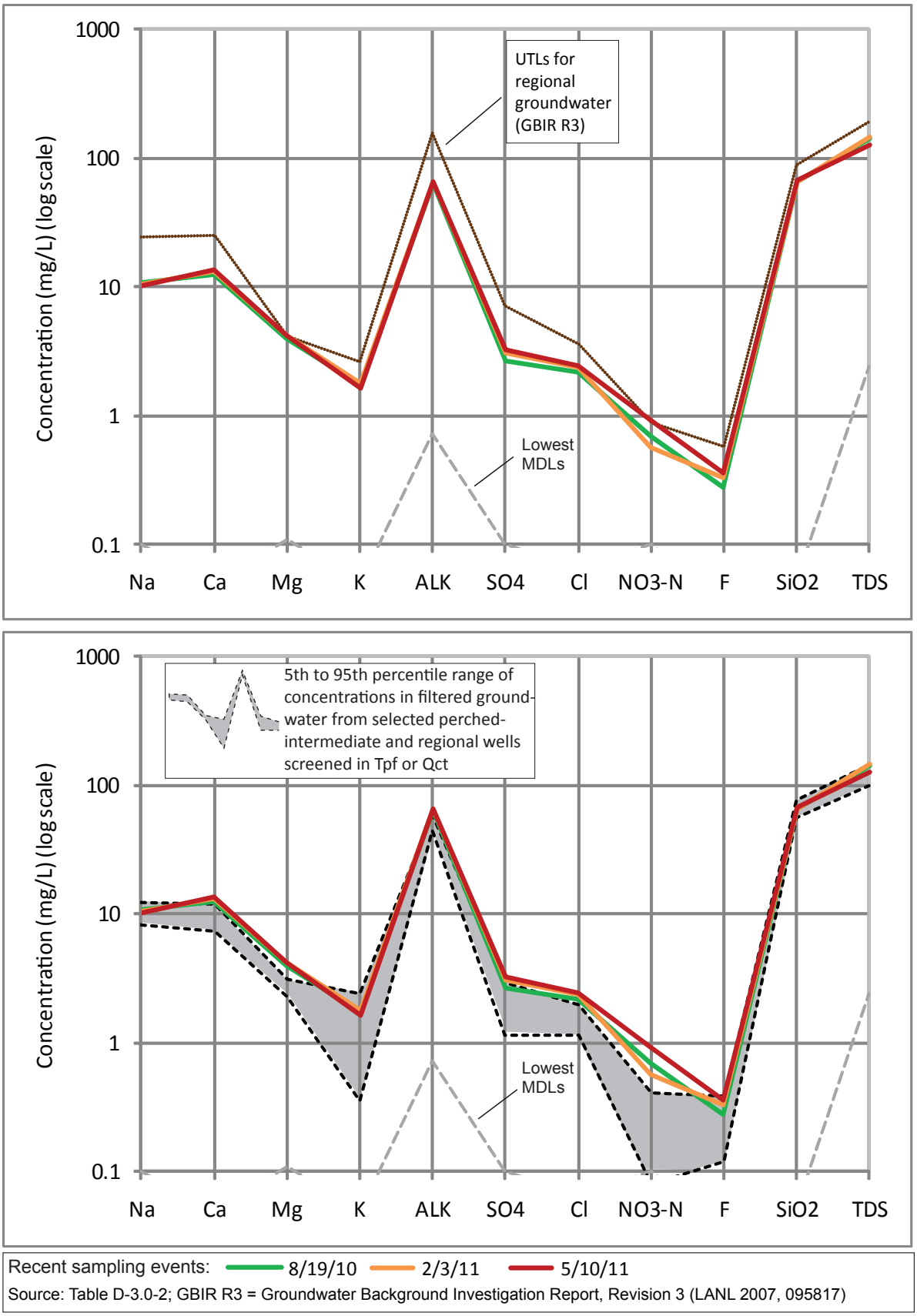


Figure D2-R56-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-56 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

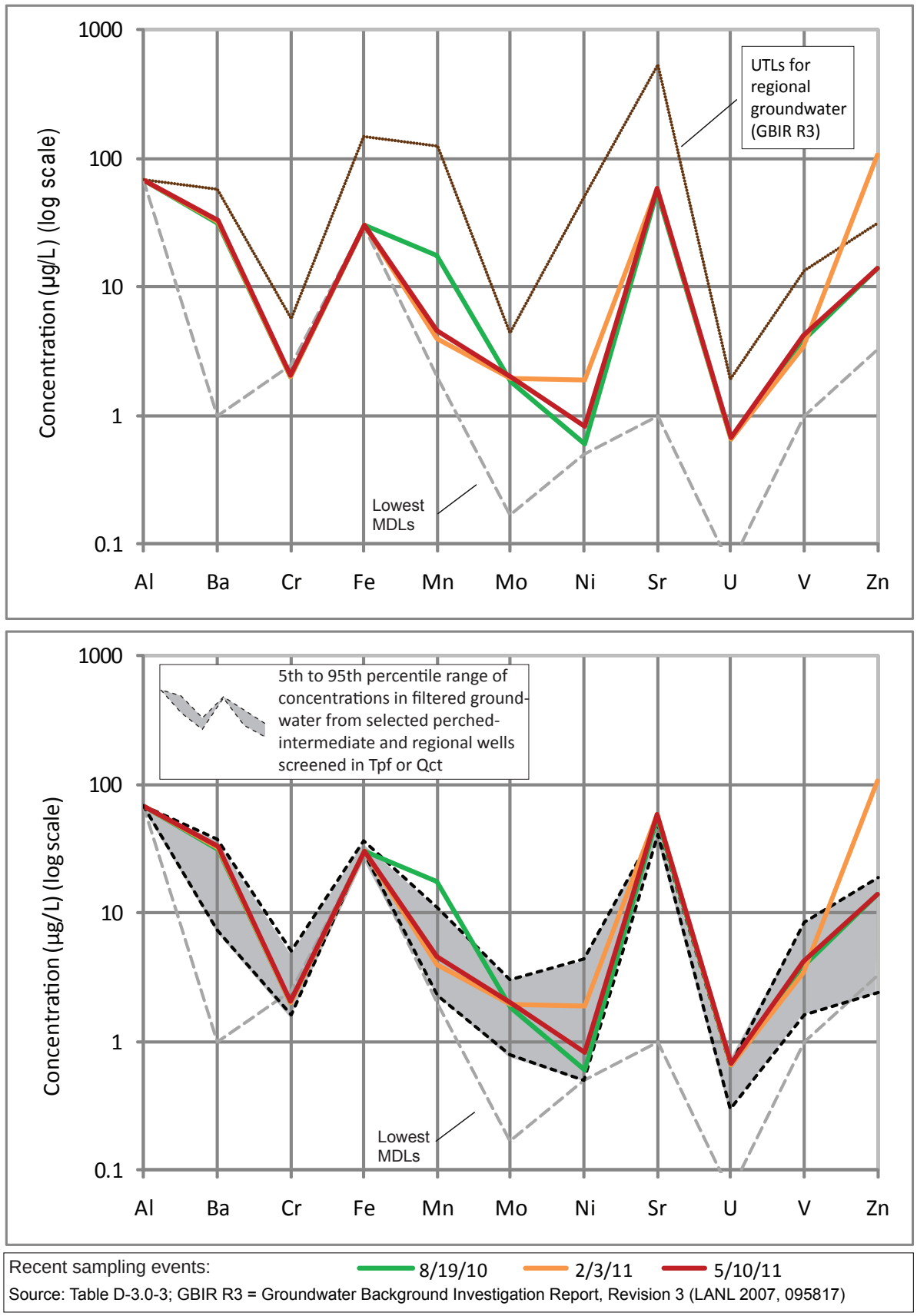
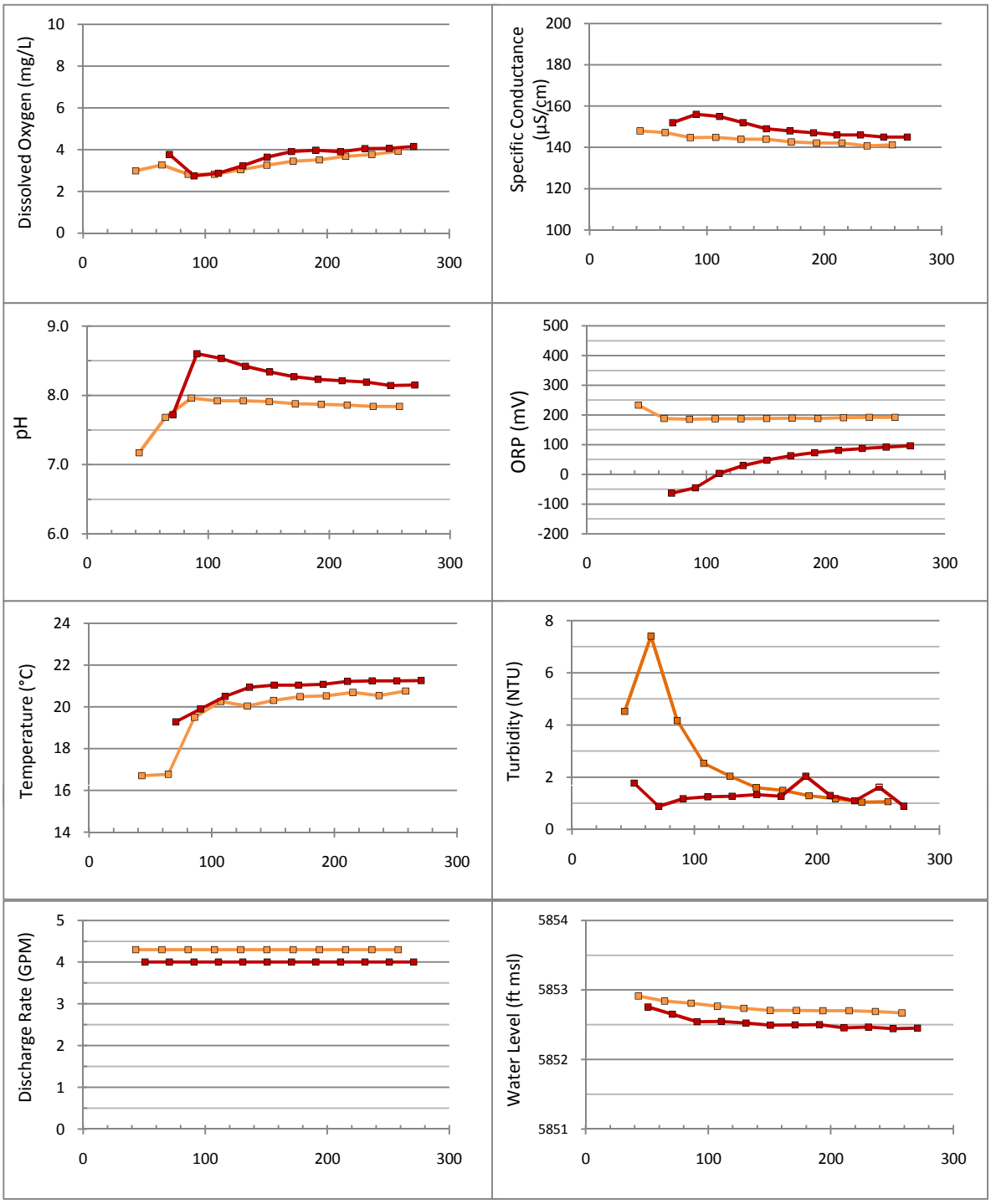


Figure D2-R56-3. Concentrations of trace metals in filtered groundwater from well R-56 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-56 screen 2 (port P2A), port depth 1047 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

7-Feb-11 10-May-11

Figure D2-R56-4. Time-series plots of field parameters monitored during purging of R-56 screen 2 (port P2A)

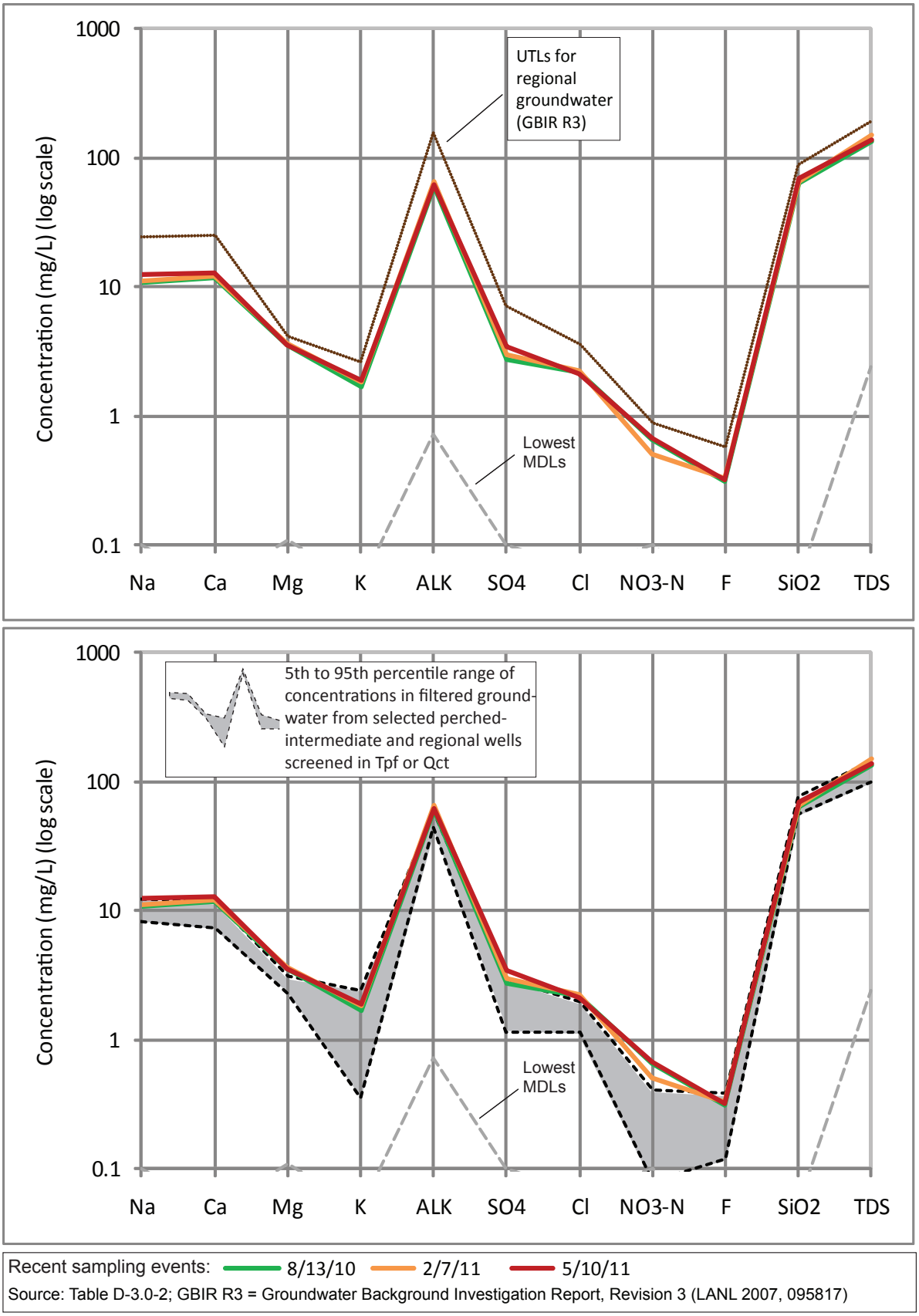


Figure D2-R56-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-56 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011,201564).

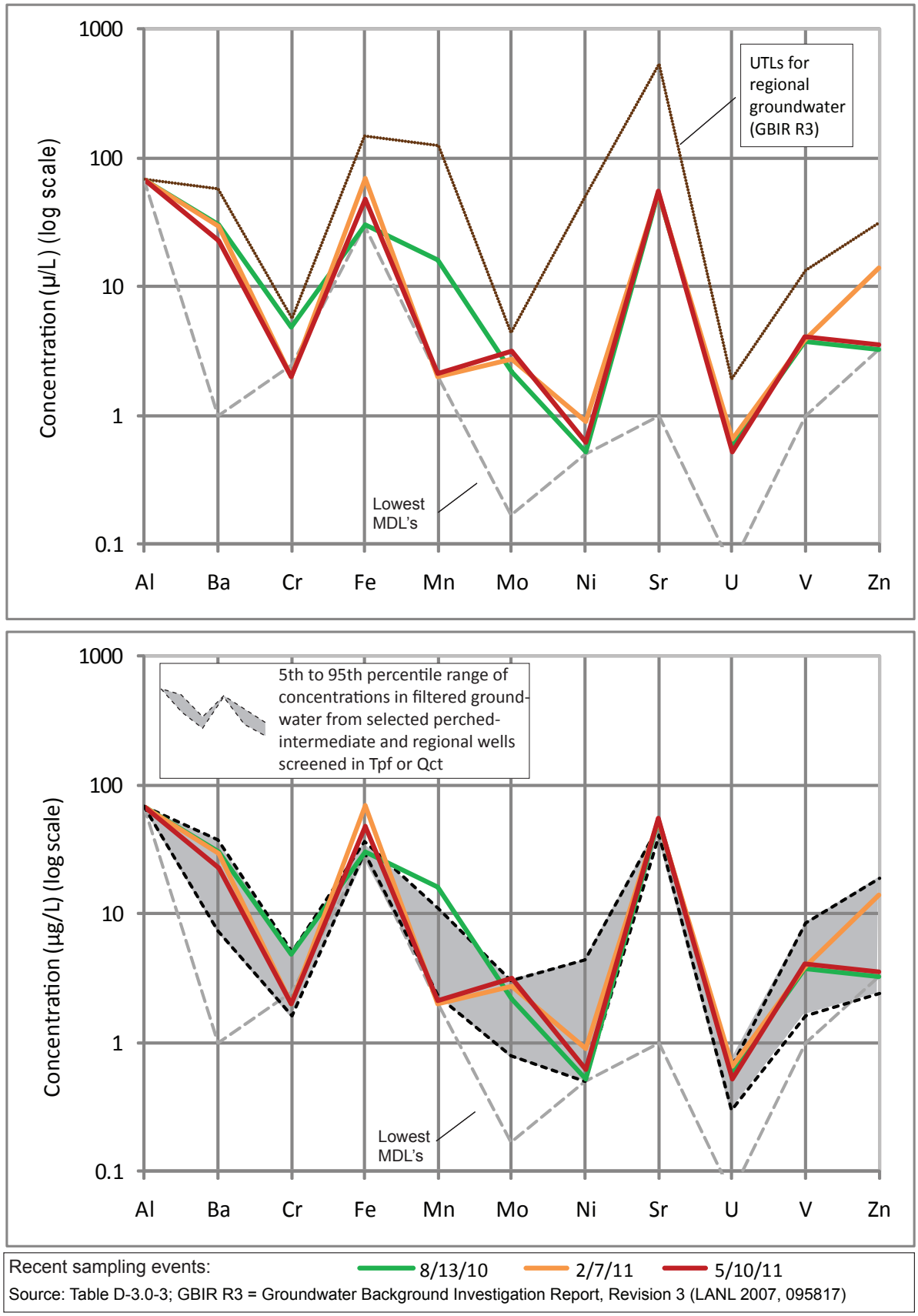
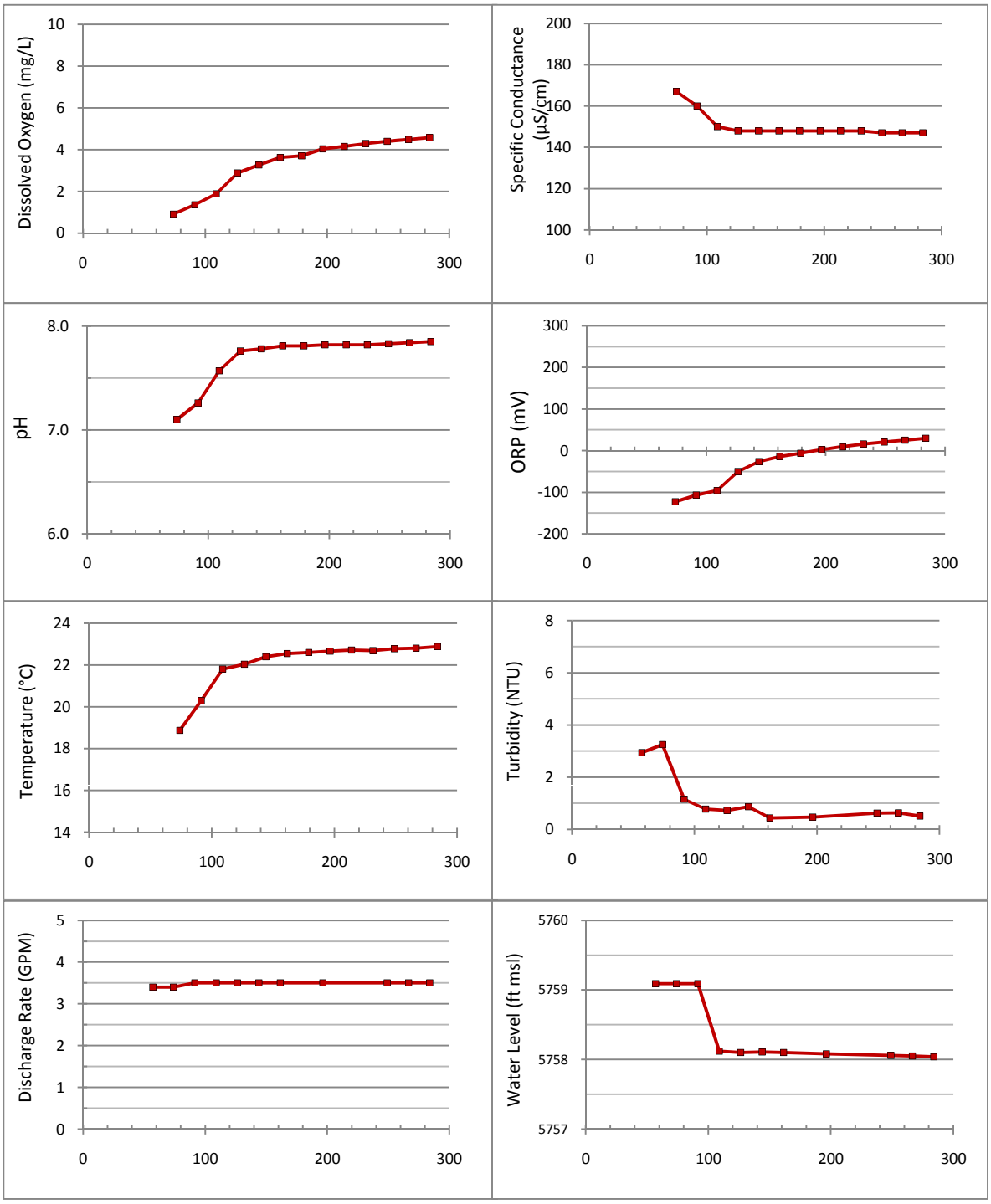


Figure D2-R56-6. Concentrations of trace metals in filtered groundwater from well R-56 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-57 screen 1 (port P1A), port depth 910 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

9-May-11

Figure D2-R57-1. Time-series plots of field parameters monitored during purging of R-57 screen 1 (port P1A)

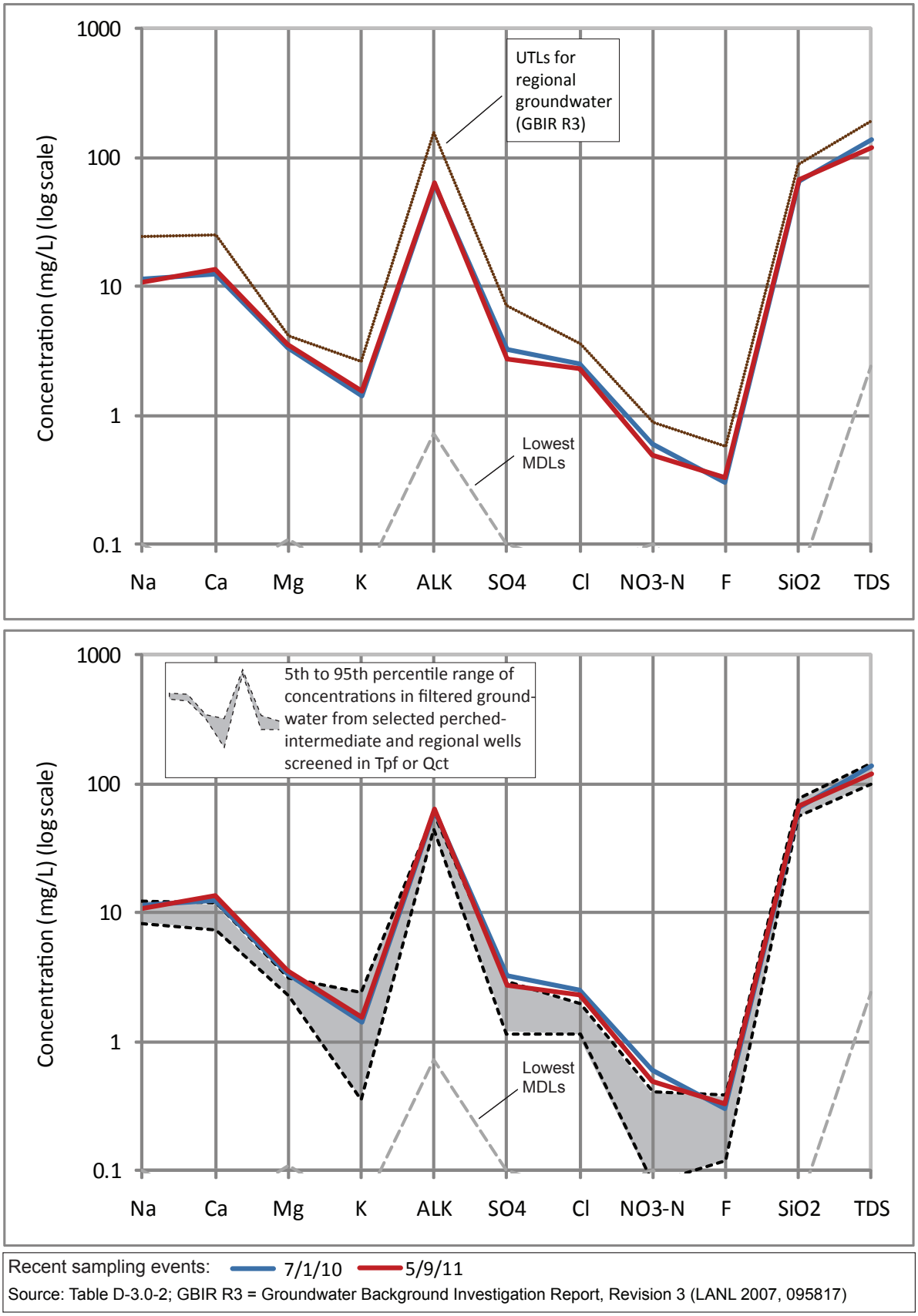


Figure D2-R57-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-57 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

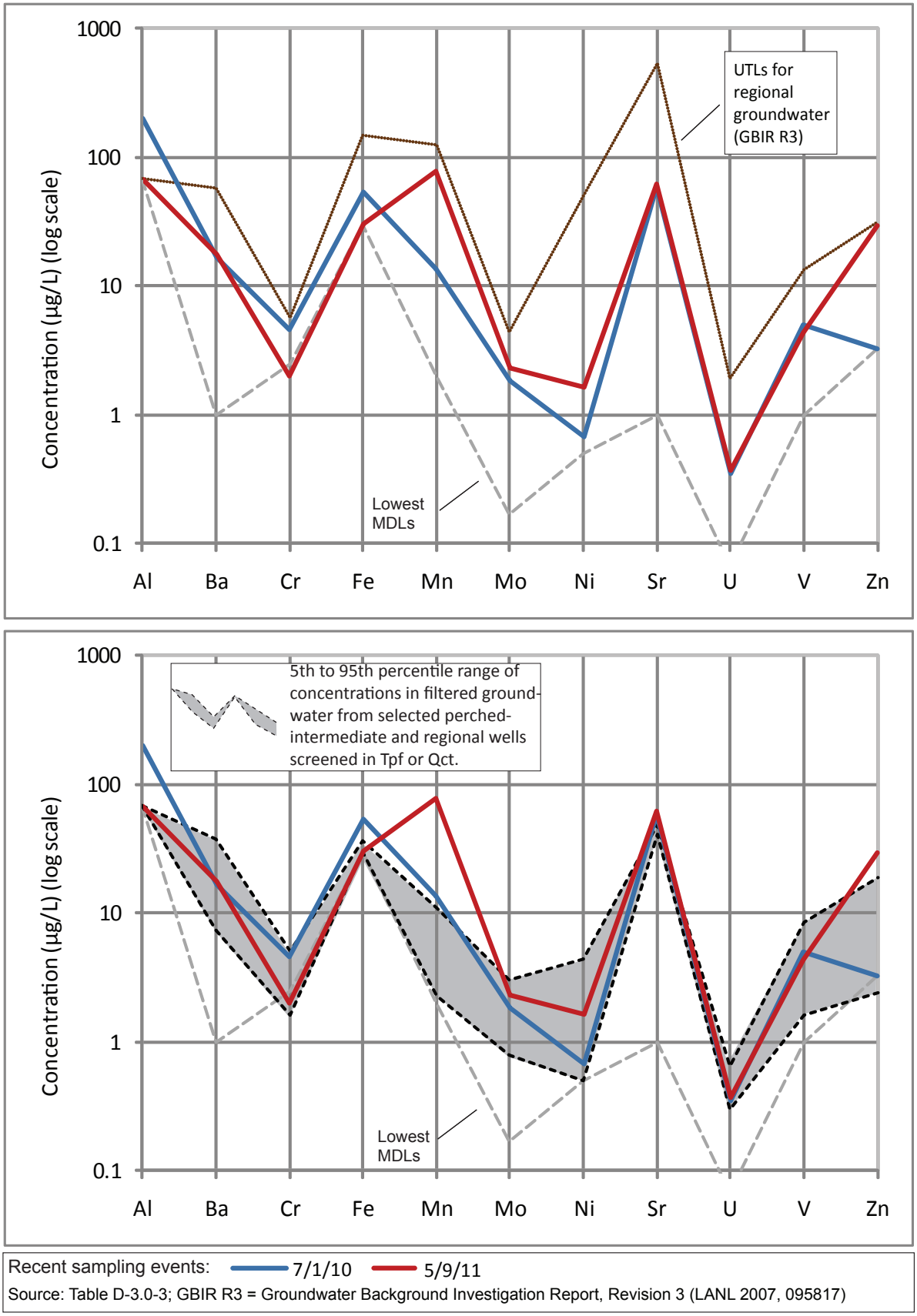
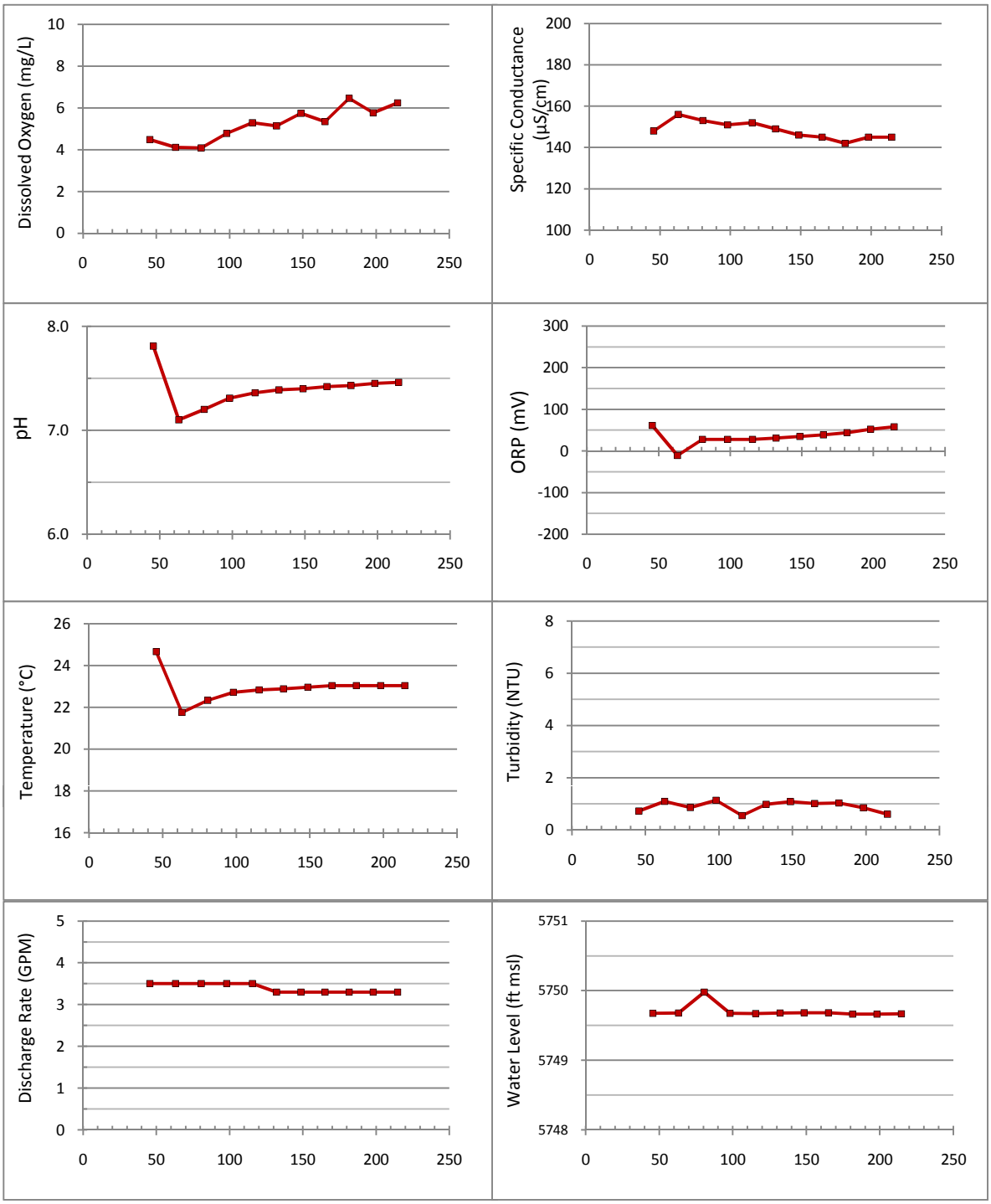


Figure D2-R57-3. Concentrations of trace metals in filtered groundwater from well R-57 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-57 screen 2 (port P2A), port depth 972 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

9-May-11

Figure D2-R57-4. Time-series plots of field parameters monitored during purging of R-57 screen 2 (port P2A)

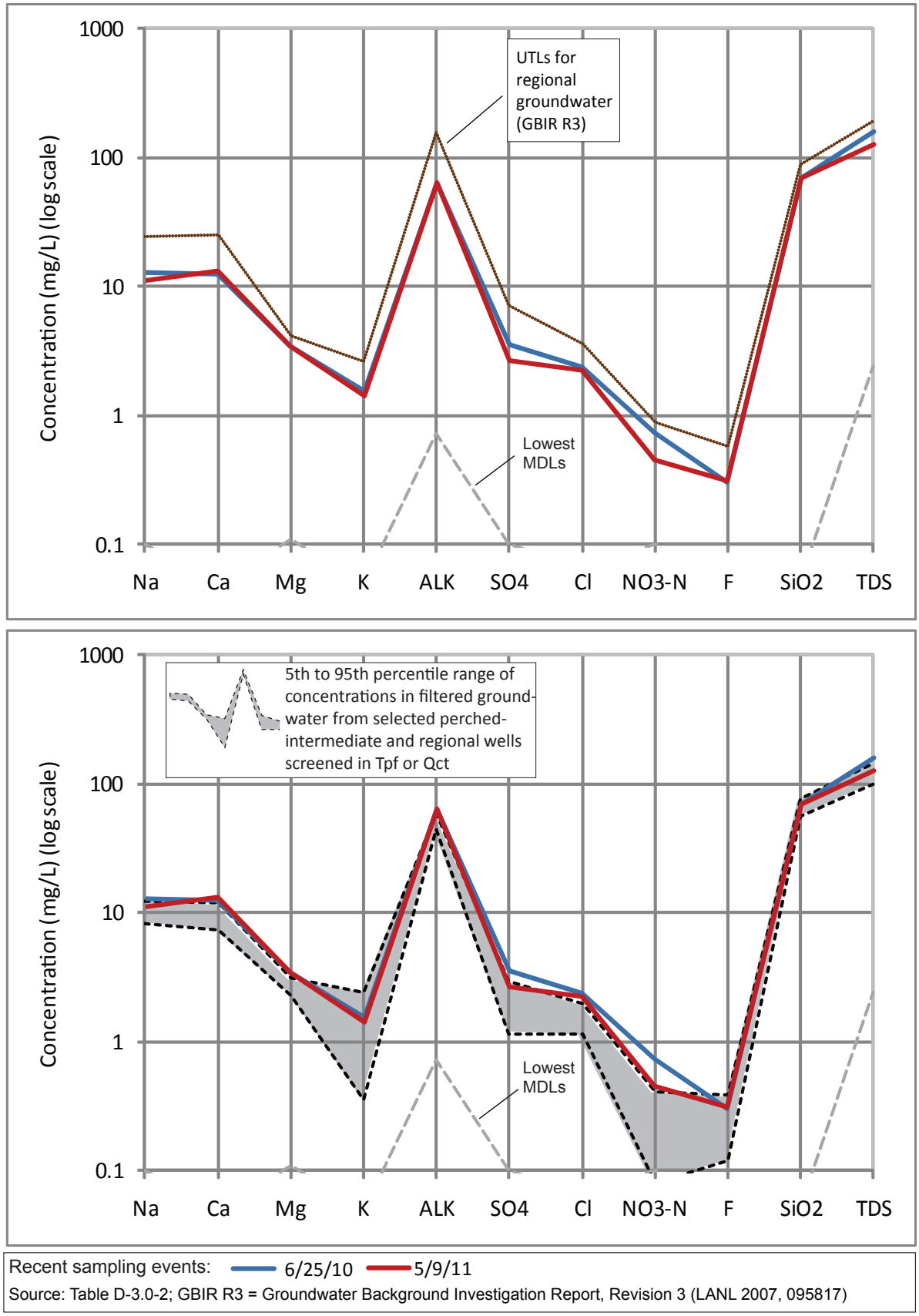


Figure D2-R57-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-57 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

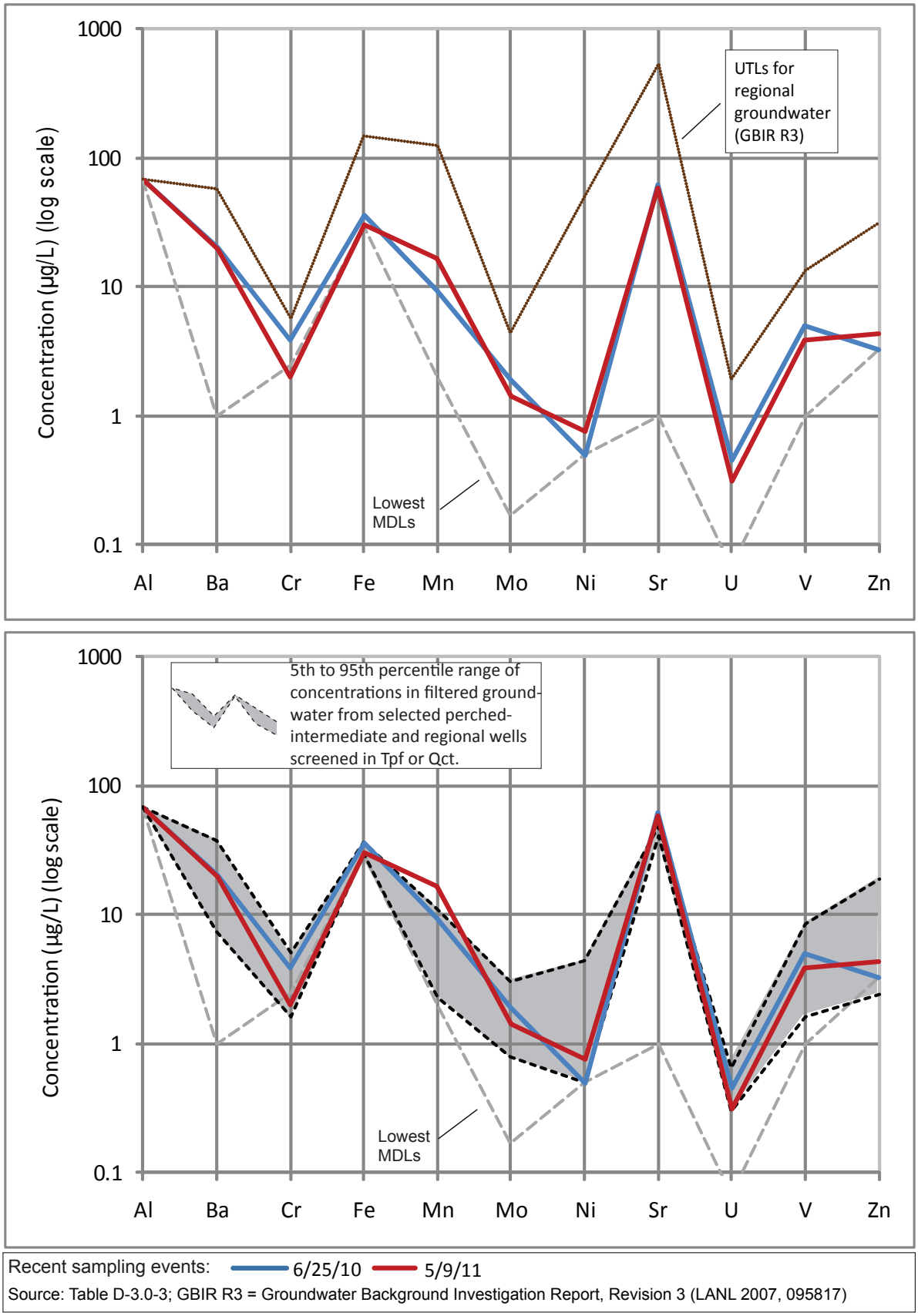


Figure D2-R57-6. Concentrations of trace metals in filtered groundwater from well R-57 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

Appendix E

Technical Area 54 Geology and
Material Disposal Area L Regional Aquifer Hydrology

E-1.0 INTRODUCTION

This appendix discusses the sitewide geology and hydrology of Technical Area 54 (TA-54) at Los Alamos National Laboratory (LANL or the Laboratory). Section E-2.0 discusses the site geology, including the stratigraphy of TA-54 (section E-2.1), seismic hazards (section E-2.2), and cliff retreat (section E-2.3). Section E-3.0 discusses the regional aquifer hydrology of the area. It includes information on the regional aquifer monitoring wells near Material Disposal Area (MDA) L (section E-3.1), summarizes hydrogeologic information collected at monitoring wells (section E-3.2), presents interpretations of regional aquifer water-table maps (section E-3.3), and presents interpretations of the regional aquifer monitoring network (section 3.4).

E-2.0 GEOLOGY

The sitewide geology for TA-54 is discussed in this appendix. More site-specific descriptions of geology are presented in the approved investigation work plans for MDAs G and L (LANL 2004, 087624; LANL 2004, 087833; LANL 2006, 094673). Upper vadose-zone geology in the vicinity of the MDAs was characterized through borehole logging discussed in various investigation reports (LANL 2005, 090513; LANL 2006, 091888; LANL 2007, 096409). Additional information about vadose-zone and regional-aquifer geology around TA-54 was collected during the installation of deep wells to monitor perched-intermediate and regional groundwater. These groundwater-monitoring wells included R-20, R-21, R-22, R-23, R-23i, R-32, R-37, R-38, R-39, R-40, R-40i, R-41, R-49, R-51, R-52, R-53, R-54, R-55, R-55i, R-56, and R-57. Collectively, the investigations described above confirm that the sitewide geology for TA-54 is consistent with the regional geology described by Broxton and Vaniman (1995, 049726, pp. 8–19).

E-2.1 Stratigraphy of TA-54

The stratigraphy in the vicinity of TA-54 includes ignimbrites of the Tshirege and Otowi Members of the Quaternary Bandelier Tuff (including interbedded sedimentary deposits of the Cerro Toledo Formation); volcanic and sedimentary deposits of the Pliocene Cerros del Rio volcanic series; fanglomerate, riverine, and lacustrine deposits of the Pliocene Puye Formation; Jemez-derived fanglomerate and pumice-rich alluvial fan deposits of Miocene age; and riverine deposits of the Miocene Chamita Formation. The distribution and thickness of geologic units vary from west to east across the TA-54 site. Figure E-2.1-1 shows the locations of intermediate and regional monitoring wells in the vicinity of TA-54 and the locations of geologic cross-sections for the site. Figures E-2.1-2 through E-2.1-8 are geologic cross-sections for TA-54 based on a geologic framework model that incorporates geologic controls from wells, boreholes, and outcrops at the site.

Bandelier Tuff

The Bandelier Tuff has two members, each consisting of a basal pumice fall overlain by a petrologically related succession of ash-flow tuffs (Bailey et al. 1969, 021498). The lower Bandelier Tuff includes the Otowi Member and its basal pumice fall deposit, the Guaje Pumice Bed. The upper Bandelier Tuff is made up of the Tshirege Member and its basal pumice fall, the Tsankawi Pumice Bed. The Cerro Toledo Formation is a volcaniclastic deposit of sediment and tephra between the Otowi and Tshirege Members.

The following description of Bandelier Tuff uses the term *welding* to distinguish between tuff that is less compacted (or noncompacted) and porous (nonwelded) as opposed to tuff that is more compacted, dense (welded), and less porous. In the field, the degree of welding in tuff is quantified by the degree of flattening of pumice fragments (a higher degree of flattening and elongation equals a higher degree of

welding). Petrographically, welded tuff shows adhesion (welding) of pumice and ash, but nonwelded tuff does not. The term *devitrified* is applied to tuff whose volcanic glass has crystallized to a fine-grained mineral assemblage of alkali feldspar and silica polymorphs (quartz, cristobalite, and tridymite).

Tshirege Member (Qbt)

The Tshirege Member of the Bandelier Tuff is a compound cooling unit that resulted from several successive ash-flow deposits separated by periods of inactivity that allowed for partial cooling before subsequent tuffs within the member were deposited (Smith and Bailey 1966, 021584; Broxton and Reneau 1995, 049726). Because of the episodic depositional history of the tuff, physical properties such as density, porosity, degree of welding, fracture content, and mineralogy vary both vertically and laterally within the member. These variations in tuff properties are used to subdivide the Tshirege Member into mappable units that reflect localized emplacement temperature, thickness, gas content, and composition of the tuff deposits (Broxton and Reneau 1995, 049726). The Tshirege Member thins eastward across TA-54 where the deposits overlapped a paleotopographic highland formed by older Cerros del Rio volcanic centers (Broxton and Reneau 1995, 049726, pp. 8–19; Broxton and Reneau 1996, 055429). The Tshirege Member is 235 ft (72 m) thick in the west near MDA H and 128 ft (39 m) thick in the east near MDA G.

Tshirege Member Unit 2 (Qbt 2)

Unit 2 of the Tshirege Member of the Bandelier Tuff forms the caprock of Mesita del Buey and is the host unit for most disposal pits and shafts at TA-54. The thickness of unit 2 varies from 36 to 65 ft (11 to 19.8 m). Where exposed, unit 2 forms a medium brown, vertical cliff that stands out in marked contrast to the slope-forming, lighter colored tuffs below. It is a moderately welded ash-flow tuff composed of crystal-rich, devitrified pumice fragments in a matrix of ash, shards, and phenocrysts (primarily sanidine and quartz). Vapor-phase crystallization of flattened shards and pumices is extensive in this unit.

Unit 2 is extensively fractured as a result of contraction during postdepositional cooling. High-angle cooling-joint fractures are visible on mesa edges and on the walls of pits. In general, the fractures dissipate at the bottom of unit 2. On average, fractures in unit 2 are nearly vertical. At MDA G, Purtymun et al. (1978, 005728) measured an average fracture spacing of 3 to 5.6 ft (0.9 to 1.7 m), and Purtymun and Kennedy (1971, 004798) cite a maximum aperture of 2 in. (51 mm). Reneau and Vaniman (1998, 063135) mapped the walls of Pit 39 at MDA G and measured average fracture spacing of 3.2 to 4.2 ft (1.0 to 1.3 m) and average apertures of 0.12 to 0.21 in. (3.1 to 5.3 mm) (with a maximum of 3.9 in. [10 cm]). The fractures are often filled with clays, calcite, and fine detritus to a depth of about 10 ft (3 m); smectites are the dominant clay minerals present. Smectites are known for their tendency to swell when water is present and for their ability to strongly bind certain elements, properties that have implications for the transport of metals and radionuclides in fractures. Opal and calcite may be found throughout the fractured length, usually associated with the presence of tree and plant roots (live and decomposed); the presence of both the minerals and the roots indicates moisture at depth in fractures (Reneau and Vaniman 1998, 063135).

The base of unit 2 is marked by a series of thin (less than 3.9-in.- [10-cm-] thick) discontinuous, stratified, crystal-rich and fines-depleted sandy surge deposits. Cross beds and planar bedding structures are often observed in these deposits.

Tshirege Member Unit 1v (Qbt 1v)

Tshirege Member unit 1v is a light-colored vapor-phase-altered cooling unit underlying unit 2. This unit forms generally sloping outcrops, which contrast with the near-vertical cliffs of unit 2. Unit 1v is further subdivided into units 1v(u) and 1v(c).

Unit 1v(u). The uppermost portion of unit 1v is devitrified and vapor-phase-altered ash-fall and ash-flow tuff; it is designated unit 1v(u), where *u* signifies upper. This unit thins eastward across TA-54, ranging in thickness from 100 ft (30 m) near MDA H to 25 ft (8 m) on the east side of MDA G. Unit 1v(u) is nonwelded at its base and becomes partly welded in its interior. Only the more prominent cooling fractures originating in unit 2 continue into the more welded upper section of unit 1v(u), but these die out in the lower, less consolidated section. More typically, fractures in unit 2 do not extend into unit 1v(u).

Unit 1v(c). Beneath unit 1v(u) is unit 1v(c), where *c* stands for colonnade, named for the columnar jointing visible in cliffs formed by this unit. Unit 1v(c) is an orange-brown nonwelded, devitrified ash-flow tuff at its base and top; it becomes slightly more welded in its interior. Unit 1v(c) varies in thickness from 6 to 15 ft (1.8 to 3 m) at TA-54. The basal contact of unit 1 v(c) is marked by a rapid vertical change (within 0.7 ft [0.2 m]) from devitrified (crystallized) matrix in unit 1 v(c) to vitric (glassy) matrix in the underlying unit 1g. In many outcrops, the transition from devitrified to vitric rock matrix forms a prominent erosional recess termed the *vapor-phase notch*; at other locations this transition is marked by a prominent bench. No depositional break is associated with the vapor-phase notch, indicating that this mineralogic transition developed within the interior of the cooling ash-flow sheet after the tuffs were deposited.

Tshirege Member Unit 1g (Qbt 1g)

Unit 1g is a white to tan vitric, pumiceous, nonwelded ash-flow tuff. This unit thins eastward across TA-54, ranging in thickness from 100 ft (30 m) near MDA H to 50 ft (16 m) on the east side of MDA G. Few fractures are observed in the outcrops of this unit where exposed in nearby areas, and the weathered cliff faces have a distinctive Swiss-cheese appearance because of the softness of the tuff. The uppermost 5 to 20 ft (1.5 to 6.1 m) of unit 1g are discolored by oxidation, possibly by development of ferric oxyhydroxides. This portion of unit 1g is resistant to erosion, helping to preserve the vapor-phase notch in the outcrops. A pumice-poor surge deposit forms the base of unit 1g locally.

Tsankawi Pumice Bed (Qbtt)

The Tsankawi Pumice Bed is the basal fall deposit of the Tshirege Member of the Bandelier Tuff. It is a stratified, fines-depleted deposit of gravel-sized vitric pumice and quartz and sanidine crystals. The maximum thickness of the Tsankawi Pumice Bed is 2 ft (0.6 m). Despite being thin, this pumice-fall unit was uniformly deposited throughout the area and is expected to be laterally continuous.

Pueblo Canyon Member, Cerro Toledo Formation (Qct)

Sedimentary deposits of the Cerro Toledo Formation are commonly referred to as the Cerro Toledo interval in other Laboratory reports (e.g., Broxton and Reneau 1995, 049726). However, these deposits were recently incorporated into the newly revised Cerro Toledo Formation, consisting of extrusive volcanic domes, lava flows, tephras, and sedimentary rocks that record landscape evolution in the time interval between the Tshirege and Otowi Members of the Bandelier Tuff (Gardner et al. 2010, 204421). The newly defined Pueblo Canyon Member of the Cerro Toledo Formation is stratigraphically equivalent to the deposits identified as the Cerro Toledo interval in previous reports. At TA-54, the Cerro Toledo Formation represents channelized fluvial deposits that consist of thin beds of tuffaceous sandstone,

siltstone, and ash and pumice falls. It also includes localized dacitic gravel- and cobble-rich fluvial deposits eroded from Tschicoma Formation exposed in the eastern Jemez Mountains. This unit reaches a maximum thickness of 55 ft (17 m) at well R-56, but because it fills channels eroded into the top of the Otowi Member, its thickness is variable and these deposits are absent in many areas of TA-54.

Otowi Member (Qbo)

The Otowi Member lacks the welding and crystallization zonation found in the Tshirege Member, and it is treated as a single, relatively homogeneous lithologic unit. The Otowi Member is a white to tan, pumiceous, nonwelded ash-flow tuff. The unit is characterized by fully inflated vitric pumices whose supporting tubular structures have not collapsed as a result of welding. The pumices are supported by a matrix of poorly sorted ash, glass shards, broken pumice fragments, phenocrysts (primarily sanidine and quartz), perlite clasts, and volcanic lithics. Otowi ash-flow tuffs thin eastward against a paleotopographic high formed by Cerros del Rio volcanics near White Rock. These tuffs are continuous under TA-54, but unit thicknesses decrease eastwards, ranging between 250 ft (76 m) near MDA H to 45 ft (14 m) on the east side of MDA G.

Guaje Pumice Bed (Qbog)

The Guaje Pumice Bed (Qbog) is the basal fall deposit of the Otowi Member. It is a stratified, fines-depleted deposit of gravel-sized vitric pumice and quartz and sanidine crystals. Borehole data indicate that the thickness of this unit at TA-54 ranges between 5 ft (1.5 m) and 19 ft (5.8 m). This pumice-fall unit was deposited throughout the area and is expected to be laterally continuous. It is potentially important for vadose zone flow and transport because higher moisture content and zones of saturation occur within this unit at other areas of the Laboratory beneath wet canyons (e.g., Los Alamos Canyon). Site investigations in the vicinity of TA-54 indicate that saturated conditions occur in the Guaje Pumice Bed only at well R-51 (Figure E-2.1-3).

Cerros del Rio Volcanic Series (Tb4, Tvt2b)

Basaltic rocks of the Cerros del Rio volcanic field crop out primarily in White Rock Canyon and east of the Rio Grande in the Caja del Rio (Griggs and Hem 1964, 092516; Smith et al. 1970, 009752; Kelley 1978, 011659; Sawyer et al. 2007, 106130). The northwest part of the volcanic field extends beneath the Pajarito Plateau where it is covered by thick deposits of Bandelier Tuff (Dransfield and Gardner 1985, 006612; Broxton and Reneau 1996, 055429). Cerros del Rio volcanic rocks interfinger with the upper Puye Formation west of the Rio Grande and unconformably overlie the Tesuque Formation east of the river. Discontinuous thin beds of fine-grained cemented sandstone and siltstone (possible paleosols or eolian deposits) and coarse-grained volcanic colluvium occur at the top of the Cerros del Rio volcanics. Sediments directly beneath or between individual lava flows show varying degrees of cementation and mineralogic alteration because of thermal contact metamorphism.

At TA-54, the Cerros del Rio volcanic series is a thick sequence of stacked lava flows that are separated by interflow breccias, cinder or scoria zones, volcaniclastic and riverine sediments, phreatomagmatic deposits, and lake-bed deposits. The lava flows generally have massive interiors made up of dense, variably fractured impermeable rock. Cuttings samples of lavas and related deposits were analyzed by x-ray fluorescence for major and trace elements to aid in the correlation of lavas from borehole to borehole. The lava flows range in composition from basalt to dacite, with the more silicic rock types (dacites) occurring at the base of the volcanic pile (oldest units) and less evolved flows (tholeiites and alkali basalts) at the top (youngest units) (Figure E-2.1-9). The more mafic portions of the Cerros del Rio volcanic series (compositions ranging from basalt through trachyandesite in Figure E-2.1-9) are labeled

Tb4 on the geologic cross-sections (Figures E-2.1-2 to E-2.1-8). Dacite lavas form a compositionally distinct volcanic feature near the east end of TA-54 and are labeled Tvt2b on the cross-sections (Figures E-2.1-2, E-2.1-7, and E-2.1-8).

The dacite lavas at the east end of TA-54 were likely erupted from a small dome and flow complex. Dacite flows of similar age occur at other locations beneath the Pajarito Plateau (Samuels et al. 2007, 204422) and at Tetilla Peak and Montoso Arroyo in the Caja del Rio (Sawyer et al. 2007, 106130). These dacite lavas are similar in composition to Tschicoma lavas exposed in the Jemez Mountain volcanic field (JMVF), but they are slightly younger and lack the coarse-grained, abundant phenocrysts that characterize the Tschicoma Formation. The dacite lavas of the Pajarito Plateau closely overlap the age and distribution of mafic lavas of the Cerros del Rio volcanic field (CdRVF), but their compositions are more evolved than the basalts that make up most of the volcanic field. Thus, dacites of the Pajarito Plateau differ in significant ways from dominant rock types found in both JMVF and CdRVF, and they probably reflect a transitional style of magmatism that developed in the region between these adjacent, concurrently active volcanic fields (Samuels et al. 2007, 204422). Because of their temporal and spatial overlap, they are included in the Cerros del Rio volcanic series in this report.

The Cerros del Rio volcanic series thickens eastward, ranging from about 300 ft (91 m) near MDA H to about 775 ft (236 m) near the east end of MDA G. The thickest deposits generally coincide with a south-southwest-draining paleovalley that is defined by structure contours at the base of the unit (Figure E-2.1-10). An isolated occurrence of anomalously thick (983 ft [300 m]) Cerros del Rio volcanic deposits occurs at well R-22; this anomalous occurrence is discussed below.

The Cerros del Rio volcanic series was erupted primarily between 2.8 and 2.3 million years ago (Ma) (WoldeGabriel et al. 1996, 054427; WoldeGabriel et al. 2001, 092523; Sawyer et al. 2007, 106130). Overlapping $^{40}Ar/^{39}Ar$ ages of 2.40±0.09 and 2.50±0.33 were obtained for dacite and overlying tholeiite lavas, respectively, at well R-22.

Rapid lateral facies variations of the volcanic rocks and their intercalated deposits are common in this unit. These variations reflect dynamic landscape processes associated with the rapid growth of overlapping volcanoes and eruption of lava flows onto a basin floor that included the ancestral Rio Grande floodplain and the western alluvial slope of the Española basin. The thickest volcanic deposits overlie Totavi Lentil (Tpt) riverine deposits in the vicinity of MDA G and to the east. The presence of phreatomagmatic deposits within the volcanic sequence indicates that erupting magmas frequently interacted explosively with the ancestral Rio Grande and its saturated flood plain sediments. Lavas flowing into low-lying areas periodically blocked the ancestral Rio Grande, causing lake sediment (lacustrine) deposits to form behind temporary lava dams. Riverine deposits intercalated within the volcanic sequence mark the changing course of the ancestral Rio Grande in response to the continuously evolving basin-floor topography. These intercalated riverine deposits are associated with temporary river channels, and the deposits are probably not laterally continuous.

The presence of volcanic vents in the vicinity of TA-54 is inferred from the presence of thick cinder and phreatomagmatic deposits that commonly accumulate near their source vents as well as subdued exposures of an eroded cinder cone south of R-23 in TA-36. Cinder deposits more than 50 ft (16 m) thick occur in wells R-20, R-21, R-22, R-34, R-39, R-41, R-49, R-53, R-54, R-55, and R-56. These cinder deposits range in composition from basalt to dacite, indicating multiple vents are in the vicinity. Thick (>25 ft [>7.6 m]) basaltic phreatomagmatic deposits occur in wells R-38, R-41, R-49, R-55, and R-57, suggesting maar volcanoes are located near the east end of MDA G. Additionally, the top of Cerros del Rio volcanics form a broad paleotopographic high area east and north of TA-54 (Figures E-2.1-2, E-2.1-3, E-2.1-6, and E-2.1-11). This paleotopographic high likely represents a constructional highland formed by coalescing volcanic vents, including the dacite dome and flow complex (Tvt2b) that was buried by

subsequent basaltic lavas (Tb4) near the east end of MDA G (Figures E-2.1-2, E-2.1-7, E-2.1-8, and E-2.1-11).

Well R-22 may have intersected a volcanic vent conduit of unknown morphology that fed the upper tholeiitic lavas at the east end of TA-54. All other wells at the east end of TA-54 (e.g., R-23, R-39, R-41, R-55, R-49, and R-57) show a consistent volcanic stratigraphy in which basaltic lavas (tholeiite and alkali basalt) overlie more evolved lava types (trachyandesite and dacite). Well R-22 is the only location where tholeiites are found beneath dacite lavas. The lowermost tholeiites at R-22 occur 213 ft (65 m) deeper than the base of the volcanic pile (dacite lava) and 785 ft (239 m) deeper than tholeiites at R-57, located only 215 ft (66 m) to the west. It is possible that the deep tholeiites at R-22 represent older lavas filling a deep, narrow paleocanyon, but such a canyon would have been cut into poorly consolidated riverine sediments that were unlikely to support such a steep-walled feature. Moreover, other closely spaced boreholes in the vicinity do not intersect any igneous lithologies this deep, as would be expected if there were a lava-filled canyon with lateral extent. The alternative interpretation is that R-22 was drilled through an obliquely oriented vent conduit related to the upper tholeiitic lavas. Chemical compositions of the shallow and deep tholeiites at R-22 are similar; these similarities permit, but do not prove, a relationship between the two. Because other lines of evidence suggest volcanic vents occur in the area (see discussion above), cross-sections through well R-22 show the interpretation that well R-22 intersected a volcanic conduit that feeds the upper tholeiite lava flows (Figures E-2.1-2 and E-2.1-8).

The Cerros del Rio volcanic series is largely in the vadose zone at TA-54. However, the base of these volcanic deposits extends more than 150 ft beneath the regional water table in the vicinity of MDA G where lavas pooled in a south-southwest-draining paleovalley (Figures E-2.1-2, E-2.1-10, and E-2.1-12). Under unsaturated and saturated conditions, groundwater flow in lava interiors is impacted by fractures, with properties of groundwater flow and contaminant transport (direction, magnitude, etc.) influenced by fracture aperture, fracture density, fracture orientation, fracture connectivity, and fracture-filling materials. Groundwater flow and contaminant transport are also impacted by porous flow through interflow zones made up of highly permeable breccias, cinder and scoria deposits, and sedimentary deposits. The nonfractured volcanic rocks and clay-filled fractured zones are expected to have low saturated permeability. Zones with significant connected and open fractures, interflow zones, and possible lava tubes are expected to have higher saturated permeability and low matrix porosity, a combination of properties that can lead to fast travel times.

Puye Formation (Tpf and Tpt)

The Pliocene Puye Formation is subdivided into three interfingering facies: fanglomerate, lacustrine beds, and Totavi Lentil riverine deposits. Fanglomerate and Totavi riverine deposits are the dominant facies of the Puye Formation at TA-54. Lacustrine beds are relatively minor components of the Puye Formation at TA-54, and they (along with other intercalated sedimentary deposits) are included in the Cerros del Rio volcanic series where they are interbedded with thick lava flows. Fanglomerate and lacustrine beds are labeled Tpf and the Totavi Lentil is labeled Tpt on the geologic cross-sections (Figures E-2.1-2 through E-2.1-8).

The fanglomerate facies of the Puye Formation was deposited as broad, coalescing alluvial fans shed eastward from the JMVF into the western Española basin (Griggs and Hem 1964, 092516; Bailey at el. 1969, 021498). The sources for these alluvial-fan deposits were large overlapping dacite to low-silica rhyolite dome complexes of the Tschicoma Formation that formed the eastern part of the Jemez Mountains between about 3 and 5 Ma (Broxton et al. 2007, 106121). The fanglomerates are a heterogeneous assemblage of clast- to matrix-supported conglomerates, with associated gravels and lithic sandstones. The coarsest parts of the deposits contain subangular to subrounded boulders and

cobbles of lava and tuff in a poorly sorted matrix of ash, silts, and sands. Debris flow deposits are common throughout the unit. Thin ash- and pumice-fall deposits of dacitic to rhyolitic composition are interbedded with the conglomerates and gravels. At TA-54, the fanglomerate facies thins eastward; it is >263 ft (>80 m) thick at well R-52 and is absent on the east side of MDA G.

During the early Pliocene, before the development of the Cerros del Rio volcanic field, the distal parts of Puye alluvial fans merged with ancestral Rio Grande axial river sediments (Totavi Lentil) that were being deposited over a basin floor that was at least 3 to 6 km wide. As a result, fanglomerate and riverine deposits are interbedded in the vicinity of MDA G and eastwards. The early Pliocene Totavi riverine deposits consist of poorly consolidated conglomerate containing well-rounded cobbles and gravels of Precambrian quartzite, granite, and pegmatite with subrounded to subangular cobbles and boulders of silicic to intermediate and rarer basaltic volcanic rocks. Precambrian clasts commonly make up >80% of the clasts in the deposits. These deposits also contain subordinate subangular to subrounded clasts of intermediate volcanic rocks derived from the JMVF in some horizons. Loose, well-sorted, fine to coarse quartz and microcline sands occur as lenses within the conglomerate. The Totavi deposits are up to 203 ft (62 m) thick and formed deposits primarily beneath MDA G and to the east. The ancestral Rio Grande flowed north to south so it is expected that Totavi deposits contain stacked channel sands and gravels with the same orientation and with length-to-width dimensions on the order of 0.5 to 3 km and 50 m, respectively. This may cause large-scale anisotropy of flow and transport properties within the unit, with preferential flow along permeable channel deposits. Totavi deposits west of MDA G are much thinner (<40 ft [12 m]), or they are highly mixed with Puye fanglomerate; the deposits in this area probably represent an area of overlap between the western alluvial slope and the basin floor.

During the late Pliocene, the eastern Jemez Mountains remained structurally high and continued to supply sediment to Puye alluvial fans in the western Española basin. However, the onset of Cerros del Rio volcanism had three major effects on the Puye depositional patterns: (1) concurrent sedimentation and volcanism led to interfingering of Puye and Cerros del Rio deposits, (2) growth of a constructional volcanic highlands on the basin floor provided an eastern source of volcaniclastic sediments for the Puye Formation and blocked the eastern migration of alluvial fans from the Jemez Mountains, and (3) Totavi Lentil deposition became more restricted in areal distribution, and areas of deposition frequently shifted in response to damming and diversion of the Rio Grande by lava flows.

Miocene Jemez Alluvial Fan Deposits (Tjfp)

Unnamed Miocene Jemez alluvial fan deposits generally include a lower fanglomerate and an upper subunit of pumiceous sands and gravels at the Laboratory (Broxton and Vaniman 2005, 090038). Only the upper pumiceous subunit was encountered in boreholes at TA-54. The pumiceous sediments are 115 ft (35 m) thick at well R-20 and pinch out eastward, probably in the vicinity of MDA L.

Although their deposits are not as coarse, these Miocene rocks share similarities with the overlying Pliocene Puye Formation in that they are interpreted as alluvial fans shed eastward from the JMVF into the western Española basin (Broxton and Vaniman 2005, 090038). However, there appears to be a significant unconformity that represents a 2-million-year hiatus in deposition between these two alluvial-fan sequences. A poorly developed, oxidized paleosol occurs at the top of the Miocene sediments at core hole SCI-2, located 1.4 mi (2.3 km) north of TA-54, but the lateral extent and continuity of this paleosol is not known because of limited data. Formation microimager geophysical logs collected at R-20 indicate that bedding in the upper pumiceous sediments dips towards the south-southwest, possibly indicating postdepositional tilting of the Miocene units before the Puye Formation was deposited.

The Miocene sediments in the vicinity of TA-54 consist of well-bedded horizons of light-colored reworked pumiceous sands and subordinate gravels of rhyolite and dacite. Deposits typically contain up to 30% subangular to rounded vitric rhyolite pumice admixed with 70% to 90% ash and lithic sands. Some intervals contain as much as 90% subangular to angular pumice that represent primary fall deposits or reworked deposits that underwent minimal transport. Pumice clasts are characterized by sparse phenocrysts that include quartz, sanidine, plagioclase, biotite, and pyroxene. Seven pumice samples collected from boreholes across the Pajarito Plateau yielded $^{40}Ar/^{39}Ar$ feldspar ages ranging between 6.44 ± 0.46 Ma and 7.50 ± 0.30 Ma. The ages overlap the 6.01 ± 0.05 to 7.1 ± 0.2 Ma ages reported for the Bearhead Rhyolite in outcrops southwest of the Pajarito Plateau (Justet and Spell 2001, 093391). Microprobe analyses of glass and whole rock analyses of pumices closely match the chemistry of the Bearhead Rhyolite.

These pumiceous deposits are entirely within the regional aquifer and should have relatively high permeability where they occur beneath the western part of TA-54. Individual beds are made up of relatively uniform, well-sorted lithologies. Heterogeneity in this unit is primarily associated with bedding. The south-southwest dip of these deposits may cause some preferential groundwater flow towards the east-southeast along the strike of bedding. However, beneath TA-54, these beds are too deep in the regional aquifer for preferential flow to be a concern and these beds are thin to absent beneath much of the site.

Chamita Formation (Tcar)

The Miocene Chamita Formation of the Santa Fe Group is made up of basin-floor axial river deposits consisting of the Hernandez and Vallito Members. The Hernandez Member represents ancestral Rio Chama deposits, and the Vallito Member represents ancestral Rio Grande deposits. These south-flowing river systems merged in the vicinity of Buckman Mesa (Koning et al. 2007, 106122), and the separate members are grouped at the formation level in the vicinity of TA-54. The Chamita Formation is >1285 ft (391 m) thick at well PM-2 and >559 ft (170 m) thick at well R-16. Most water-supply wells on the Pajarito Plateau are completed in this formation. The Chamita Formation ranges in age between 6 and 13 Ma. The upper part of the formation overlaps in age with Miocene Jemez alluvial fan deposits, and it is likely that alluvial fan and axial river sediments interfinger along the western margin of the basin floor. The Chamita Formation is overlain by Miocene pumiceous alluvial fan deposits at well R-20 and by riverine deposits of the Totavi Lentil at well R-57.

The Chamita Formation consists of fine- to coarse-grained quartz sands and silty sands with minor microcline and felsic to intermediate volcanics, fine- to coarse-grained volcanic lithic sands, and sandy and silty gravels dominated by well-rounded felsic to intermediate volcanics and 1% to 3% Precambrian quartzite. Some gravel deposits also contain subangular to subrounded intermediate volcanic clasts that probably represent input of sediment from tributary streams draining the Miocene JMVF. These stratified deposits are variably cemented by calcite with poorly to noncemented sands and gravels intercalated with cemented sandstones.

The Chamita Formation is entirely within the regional aquifer at TA-54. These rocks should have relatively good permeability characteristics because they contain relatively abundant, sorted coarse-grained channel fills. Intercalated silt-rich sands and gravels are likely to be less transmissive than clean channel sands and gravels, providing vertical stratification and hydraulic compartmentalization. Because of their accumulation as axial deposits in a north-to-south-flowing river, these sediments probably contain north-to-south-oriented stacked channel sands and gravels with long length to width dimensions similar to the Totavi Lentil. This characteristic may cause large-scale anisotropy of flow and transport properties of the aquifer medium with preferential north-to-south orientation.

Basaltic lava flows are intercalated within the Chamita Formation at wells PM-2 and R-22. These basalts are deep within the regional aquifer and show varying degrees of alteration of groundmass minerals and phenocrysts, with fractures that appear to be at least partly sealed by smectite. Alteration minerals typically include smectite; calcite may also occur. At well PM-2, upper and lower basalt flows are 52 ft (16 m) and 94 ft (29 m) thick, respectively. At well R-22, the basalt sequence is 68 ft (21 m) thick. The basalt at R-22 yielded a $^{40}Ar/^{39}Ar$ age of 8.97±0.11 Ma. The basalts at PM-2 occur at greater depths than the R-22 basalt. Assuming they are correlative, these basalts appear to have a westward component of dip. In age and composition, these lavas appear to be related to those near the top of the regional aquifer at R-9 and R-12, to the north, suggesting that there may also be a southern component of dip with net dip of these lavas to the southwest.

E-2.2 Seismic Hazards

A seismic hazard evaluation was conducted at several sites around the Laboratory to estimate ground motion from possible earthquakes (tectonics) (Wong et al. 1995, 070097). The objective was to determine the seismic hazard criteria for designing new nuclear facilities. The evaluation led to the conclusion that within 100 yr an earthquake with a magnitude of 6 or greater is considered likely to occur in the Pajarito fault system.

While TA-54 was not included in the study, its geology is similar to two of the sites evaluated at TA-18 and TA-46. Results of the study were applied in the safety analysis report for MDA G, which includes the Laboratory's radioactive waste disposal facility (Benchmark Environmental Corporation 1995, 063300). Such an earthquake was determined not to pose a hazard to waste buried below the surface at MDA G.

Small-scale faults have been documented in the disposal pits and in cliff outcrops at MDA G (Reneau et al. 1998, 063497; Schultz and Kelley 2009, 111231). However, these faults have small displacements (less than 1 ft [30 cm] of offset on Tshirege subunits), they lack lateral continuity (they cannot be traced across mesas or to other canyon exposures), they do not show movement in Holocene time, and they do not have clear connections to other major regional faults. Therefore, these small faults are not considered a seismic hazard to MDA G or neighboring facilities. Based on the data from published geologic studies at and around TA-54, aerial reconnaissance of the area within a 5-mi radius of MDA G, an analysis of aerial photographs, and field reconnaissance of lineaments and contact elevations, Schultz and Kelley (2009, 111231) concluded that no faults with Holocene displacement are present at MDA G.

E-2.3 Cliff Retreat

The MDAs at TA-54 are located on Mesita del Buey next to Pajarito Canyon and Cañada del Buey, and cliff retreat is a primary process by which the canyon walls erode. Siting of disposal pits at MDA G included a 50-ft setback from the mesa edges to avoid the possibility of exposure of waste by cliff retreat (Purtymun and Kennedy 1971, 004798; Rogers 1977, 005707). Geomorphic studies at DP and Pajarito Mesas indicate that mass wasting and cliff retreat on the Pajarito Plateau occur by detachment of fracture-bounded blocks in relatively small rockfalls along shallow canyons, similar to those bordering Mesita del Buey at MDA G (Broxton and Eller 1995, 058207; Reneau and Raymond 1995, 054709). Larger-scale mass wasting involving landsliding along canyon walls only occurs where canyons are deeper, including Los Alamos Canyon next to DP Mesa and Pajarito Canyon next to Pajarito Mesa. Using various lines of evidence, including the size of fracture-bounded blocks and long-term evolution of the canyons and assuming a 10,000-yr period of interest, the studies at DP and Pajarito Mesas supported the use of a 50-ft setback from mesa edges for shallow canyons like those that exist next to MDA G (Broxton and Eller 1995, 058207; Reneau and Raymond 1995, 054709). Larger setbacks were recommended next to deeper canyons where larger-scale mass wasting occurs.

E-3.0 HYDROLOGY

The regional aquifer beneath the Pajarito Plateau occurs at depths between 1200 ft (366 m) along the western edge of the Pajarito Plateau and about 600 ft (183 m) along the eastern edge. Beneath MDA H, the regional water-table elevation is approximately 5865 ft above mean sea level (amsl) or approximately 935 ft (280 m) below the ground surface.

As with the conditions observed elsewhere beneath the Pajarito Plateau, the regional aquifer beneath MDA L is a complex heterogeneous system that includes deep, predominantly confined and shallow, predominantly unconfined zones. No lithologic observations demonstrate the existence of clearly defined aquitards or confining layers that provide hydraulic separation between the deep and shallow zones of the regional aquifer. However, the vertical hydraulic stratification of the regional aquifer has been observed at numerous aquifer locations where there are deep and shallow monitoring well screens. The vertical hydraulic stratification is indicated by (1) pronounced vertical differences in hydraulic heads and (2) a lack of vertical propagation of pumping drawdown caused by pumping tests and municipal water supply pumping. The vertical stratification of the regional aquifer is also demonstrated by the PM-2 spinner test (LANL 2009, 106939, Appendix J). The vertical hydraulic separation is most likely caused by pronounced vertical aquifer anisotropy; that is, the lateral permeability is substantially higher than the vertical permeability. The anisotropy is probably caused by the depositional layering of the hydrostratigraphic units. Based on the existing observations, the degree of hydraulic communication between these zones is (1) relatively poor and (2) spatially variable depending on local hydrogeologic conditions and hydrostratigraphy. The poor hydraulic communication between the two zones does not preclude the possibility that some contaminant migration may occur between the shallow and deep zones. Between the two zones, the hydraulic gradient has a downward vertical component because of water-supply pumping in the deep zone, creating the possibility that downward contaminant flow may occur along “hydraulic windows,” although these flows have not been directly observed.

E-3.1 Regional Aquifer Wells Near MDA L

Information about the hydrogeological properties of the regional aquifer can be obtained by analyzing the ambient water-level transients and pumping drawdowns observed at the monitoring wells near MDA L. The aquifer properties are important to evaluate groundwater flow and contaminant transport in the regional aquifer. The hydrogeological conditions at the monitoring wells are important to take into account in evaluating monitoring-well capabilities for characterizing regional groundwater flow and to detect potential contaminants originating from MDA L. Drawdown data are collected during the pumping tests (up to 24 h long) conducted at each of the monitoring wells. Drawdown data are also obtained as a result of the water-supply pumping at the municipal wells on the Pajarito Plateau; the transient analysis of water-supply pumping effects is computationally intensive but allows for a cost-effective estimation of the effective large-scale properties of the aquifer (Harp and Vesselinov 2010, 111220). The analysis of the water-table drawdowns caused by water-supply pumping also allows for the evaluation of the impact of the water-supply pumping on the regional groundwater flow directions. This is important because MDA L is located near two of the water-supply wells on the Pajarito Plateau: PM-4 and PM-2 (Figure E-2.1-1).

Hydrogeologic information obtained from the intermediate and regional monitoring wells next to MDA L (R-40, R-40i, R-20, R-54, R-53, R-56, R-38, R-21, and R-32) is summarized below and in Tables E-3.1-1 through E-3.1-4. Most of the information about the monitoring wells is obtained from the respective well completion reports.

R-40 and R-40i

The combination R-40 and R-40i constitutes a multiple well completion that includes screens 1 and 2 in well R-40, and R-41i, a 3-in. slotted schedule 80 polyvinyl chloride well installed in the annulus outside the R-40 well casing (LANL 2009, 106432). R-40 screen 1 is completed in a perched zone in Cerros del Rio basalt, and screen 2 is completed in the regional aquifer in the Puye Formation. Screen 1 is 33.5 ft long (751.6 to 785.1 ft bgs) and the water level is approximately 763 ft bgs; 5955 ft amsl. Screen 2 is 20.8 ft long (849.2 to 870 ft bgs), and the water level is approximately 853 ft bgs; because of transients, the water level varies between approximately 5864 ft and 5866 ft amsl. The top of the screen 2 lies within a transition zone separating overlying basalt-rich sediments from underlying basalt-free sediments, with the bottom of the screen extending into the basalt-free sediments. Well R-40i is set in an upper perched zone within Cerros del Rio basalt and consists of 19.3-ft slotted pipe (649.7 ft to 669 ft bgs). At the time of well completion, the water level for screen R-40i was 9.4 ft above the top of the screen at 640.3 ft bgs; 6077.7 ft amsl.

The difference in the water levels in screen 1 and 2 is approximately 93 ft. The vertical gradient between the two screens is close to unity, suggesting that there is a zone of unsaturated groundwater conditions between the screens. The difference in the water levels in screen 1 and R-40i is approximately 121 ft. Again, the vertical gradient between the two screens is close to unity, suggesting a zone of unsaturated groundwater conditions occurs between the screens. None of the pumping tests affected water levels in any of the other R-40/R-40i well screens or at nearby monitoring well R-20. The three screens at R-40 are within hydraulically distinct zones of saturation.

During the aquifer pump test, groundwater flow into R-40 screen 1 was on the order of just 12 gallons per day (gpd). This suggests extremely low permeability of the screened interval (less than 0.1 ft/d). More recently, sampling of this screen has been problematic because of rapid drawdown and slow recovery.

The water-level data in R-40 screen 2 indicate a barometric efficiency of 100% (Table E-3.1-4). Hydraulic conductivity is estimated to be 4.4 ft/d.

Transients in the water-level data demonstrate screen 2 responds to water-supply pumping at PM-2 and PM-4 (Table E-3.1-2).

The water levels in screen R-40i responded to atmospheric pressure changes with a barometric efficiency of 33% and an average lag time of 5 h. Hydraulic conductivity is estimated to be 118 ft/d. At a distance from the well, effective average hydraulic conductivity is approximately 22 ft/d. Late drawdown and recovery data showed boundary effects potentially due to the limited lateral extent of the perched zone.

R-20

R-20 was drilled in 2002 and originally had three regional aquifer screens (LANL 2003, 079600). Screen 1 is within in cinder deposits located below the Cerros del Rio lavas; the screen length is 7.6 ft from 5782 ft to 5789 ft amsl. Screen 2 is within Miocene Jemez pumiceous alluvial fan deposits; the screen length is 7.6 ft from 5540 ft to 5547 ft amsl. Screen 3 has been abandoned, as described below. Screen 3 was sited within Chamita Formation sediments; the screen length was 7.7 ft from 5358 ft to 5366 ft amsl. Hydraulic conductivity of the screens was estimated using single-hole pumping tests. The apparent hydraulic conductivity of all the screens was evaluated to be about 1 ft/d.

Screen 1 is placed about 77 ft beneath the regional water table. The screened saturated zones appears to be either unconfined or under partly confined conditions. The deeper two screens appear to be confined. The vertical component of the hydraulic gradient between screens 1 and 2 is on the order of 0.2

(Table E-3.1-3). The vertical component of the hydraulic gradient between screens 1 and 3 is on the order of 0.1. It is important to note that even though screen 3 is substantially impacted by water-supply pumping, the vertical component of the hydraulic gradient is higher between screens 1 and 2 than between screens 1 and 3. This suggests that spatial and temporal distribution of the vertical component of the hydraulic gradient in the regional aquifer is not only controlled by water-supply pumping but also by (1) hydrogeological processes occurring in the shallower section of the regional aquifer (e.g., aquifer recharge); and (2) vertical distribution of aquifer properties (hydrostratigraphy, heterogeneities).

Screen 1 has a high barometric efficiency of around 100%, demonstrating a lack of response to barometric pressure fluctuations (Table E-3.1-4). Screen 2, on the other hand, has a barometric efficiency less than 100% (about 80%), suggesting unconfined or partially confined conditions because of a pneumatic connection of the screen with the atmosphere. Screen 3 pressures are strongly impacted by water supply pumping at the nearby pumping wells (e.g., PM-2, PM-4); this did not allow for estimation of the barometric efficiency. It is very unusual for the upper saturated zone to be less influenced than the deeper saturated zone by atmospheric pressure fluctuations; most of the wells on the Pajarito Plateau have increasing or no change in the barometric efficiency with depth (e.g., R-49, R-50, R-53, and R-55). Wells with decreasing barometric efficiency with depth in the TA-54 area are R-51, R-20, R-54, and R-32. The cause for the anomalous behavior is unclear. It suggests the hydrostratigraphic units in the lower screens are pneumatically connected with the atmosphere through a pathway that is not strictly vertical and bypasses the upper well screens. For example, hydrostratigraphic units screened by the deep screens might be pneumatically connected with the atmosphere to the northeast of the wells; it is also possible that the propagation of the atmospheric pressures into the subsurface is related to Pajarito Canyon and aquifer heterogeneity (R-51, R-20, R-54, and R-32 are located along the canyon bottom).

R-20 was rehabilitated in 2007, and screen 3 was plugged and abandoned (LANL 2008, 100473). Screens 1 and 2 are redeveloped. The specific capacity of screen 1 substantially improved as a result of the redevelopment; from 0.01 to 0.02 gpm/ft. The specific capacity of screen 2 did not improve; the low specific capacity (0.01 gpm/ft) of screen 2 is a result of low permeability of the screened aquifer sediments. The hydraulic conductivity of screens 1 and 2 are about 2 and 1 ft/d, respectively, postdevelopment.

Transients in the water-level data demonstrate that all R-20 screens are impacted by water-supply pumping at PM-2 and PM-4. Screen 3 drawdowns from water-supply pumping were on the order of 20 ft. Screen 1 and 2 drawdowns are much smaller, on the order of 0.5 ft and 2 ft, respectively. The water-level transients also allowed the estimation of the effective large-scale properties of the regional aquifer between the water-supply wells and R-20 (Table E-3.1-2).

R-54

Well R-54 screen 1 is set within sands and gravels in basaltic sediments that underlie Cerros del Rio lavas (Tb4), and screen 2 is set within the upper portion of the Puye Formation dacitic gravels (LANL 2010, 109828). Screen 1 is 10 ft long, extending from 830 ft to 840 ft bgs, and screen 2 is 10 ft long, extending from 915 ft to 925 ft bgs. Most of the interval between the well screens, from 845 ft to 900 ft, is clay-rich, including a 10-ft interval of particularly tight clay and silt from 860 ft to 870 ft. It is expected that these fine-grained sediments served as an aquitard separating the two screened zones.

During well completion, the composite water level for both screens was 815.47 ft bgs (5864.53 ft amsl). When packers isolated the screens, the water level in screen 1 declined 1.59 ft (5862.94 ft amsl), and the head in screen 2 rose 0.18 ft to a depth of 815.29 ft bgs (5864.71 ft amsl). Thus, the water levels showed an upward vertical component of the hydraulic gradient across the tight clay-rich materials between 845 ft

and 900 ft (head difference of -1.77 ft over vertical distance of 75 ft). This result is unusual and opposite of most observations on the Pajarito Plateau. The vertical component of the hydraulic gradient at R-54 is on the order of −0.03 (Table E-3.1-3). The upward vertical gradient is observed only when no intensive water-supply pumping occurs, and the water levels in the deep screen have recovered. During periods of intensive water-supply pumping at PM-4, the water-levels in the deeper R-54 screen decline and the vertical component of the hydraulic gradient becomes downward. This type of behavior is expected if PM-2 is pumped in the future.

The upper aquifer is considered to be unconfined and 27.94 ft thick, extending from the measured water level of approximately 817 ft (5862.8 amsl) to the top of the clay-rich sediments at 845 ft. The observed water level in screen 1 almost coincides with the contact between the screened sediments and the overlying lavas (Tb4). Based on the hydrostratigraphy observed during well drilling, the lower aquifer is considered confined and of unknown saturated thickness, extending from the bottom of the clay-rich zone at 900 ft to an unknown depth beneath screen 2.

Screen 1 has a high barometric efficiency, perhaps near 100% (Table E-3.1-4). The pressure data for screen 2, on the other hand, suggest a barometric efficiency less than 100% (about 85%). This demonstrates that the lower screen is not confined, as expected based on hydrostratigraphy observed during well drilling, but pneumatically connected to the atmosphere. It is very unusual that the upper saturated zone is isolated from barometric pressure fluctuations, while the deeper zone appears to be pneumatically connected with the atmosphere.

Pumping of either zone does not induce drawdown in the other. Tight, clay-rich materials dominate the sediments between the well screens, effectively hydraulically isolating the screen zones.

Analysis of the screen 1 pumping tests suggests a transmissivity of 1010 gpd/ft and a hydraulic conductivity of 4.8 ft/d. Screen 1 produces 0.77 gpm for 405 min with 1.66 ft of drawdown for a specific capacity of 0.46 gpm/ft. Pumping screen 1 was difficult because of air entrainment in the groundwater.

Analysis of the screen 2 pumping tests suggests an area-wide hydraulic conductivity of 57.5 ft/d for the 10-ft-thick screened interval and a slightly greater conductivity immediately adjacent to the borehole of 84.1 ft/d. Screen 2 produces 18.6 gpm for 1440 min with 5.6 ft of drawdown for a specific capacity of 3.3 gpm/ft.

Transients in the R-54 water-level data show responses to water-supply pumping at PM-4 (Table E-3.1-2). During the trial pumping at PM-2 in late May 2010, screen 2 showed a daily response of about 1 ft to the pumping; screen 1 showed no response. R-54 screen 2 responded to pumping at R-56 screen 2 (the wells are 1793 ft apart).

R-53

Both screens in R-53 lie within sands and gravels of the Puye Formation that are intermixed with Totavi riverine sediments (LANL 2010, 110516). Screen 1 is 10 ft long, from 849.2 ft to 859.2 ft bgs, and screen 2 is 20.5 ft long and is positioned about 100 ft beneath screen 1, from 959.7 ft to 980.2 ft bgs.

During well completion, the composite water level was 831.75 ft bgs (5855.25 ft amsl). When packers isolated the screen zones, the water level in screen 1 rose 2.90 ft to a depth of 828.85 ft bgs (5858.15 ft amsl), and the water level in screen 2 declined 6.25 ft to a depth of 838.00 ft bgs (5849.00 ft amsl). Thus, the water levels showed a large head difference of 9.15 ft over a vertical distance of about 100 ft, indicating highly resistive sediments separate the two screen zones. The vertical component of the hydraulic gradient at R-53 is on the order of 0.09 (Table E-3.1-3). The observed water

level in screen 1 is slightly below (approximately 2 ft) the contact between the screened sediments and the overlying lavas (Tb4). Screen 1 is about 80% barometrically efficient, and screen 2 is about 100% barometrically efficient (Table E-3.1-4).

Pumping screen 1 at more than 10 gpm for 1440 min has no discernable effect on water levels in screen 2 and likewise had no effect on water levels in nearby wells R-21, R-32, and R-38. Pumping screen 2 at more than 20 gpm has no discernable effect on screen 1 as well as on R-32 (2265 ft away) or R-38 (937 ft away). However, 0.5 ft of drawdown is observed in R-21 at a distance of 1384 ft.

Screen 1 produced 10.5 gpm for 1440 min with 7.20 ft of drawdown for a specific capacity of 1.46 gpm/ft. Analysis of the screen 1 pumping tests showed an average hydraulic conductivity value of 25.7 ft/d.

Screen 2 produced 20.2 gpm for 1440 min with 38.7 ft of drawdown for a specific capacity of about 0.52 gpm/ft. Analysis of the screen 2 pumping tests suggests a near-well transmissivity for the 20.5-ft-thick screened interval averaging 1100 gpd/ft. The corresponding average hydraulic conductivity is 7.2 ft/d. Subsequent slope increases on the data graphs yielded an average transmissivity value of 470 gpd/ft—approximately half the previous result. The computed 2:1 ratio in transmissivity is symptomatic of an aquifer with limited lateral extent (for example, bounded by a vertical planar boundary such as a fault or pinch out of a permeable hydrostratigraphic facies). Alternatively, this result could indicate a lateral reduction in hydraulic conductivity near the well. The late drawdown data from screen 2 showed near stabilization associated with leakage, partial penetration effects (vertical growth of the cone of depression) or a large lateral increase in transmissivity.

Aerated groundwater was produced from both screens 1 and 2 during the pumping tests. The origin of the gases in the screened hydrostratigraphic units is unclear: the gases may have been naturally occurring in the aquifer, or air may have been injected in the formation during drilling.

Transients in the R-53 water-level data demonstrate that screen 1 does not respond to pumping at municipal supply wells, but screen 2 responds to water-supply pumping at PM-4 (Table E-3.1-2). Response to water-supply well PM-2 pumping is also expected, but PM-2 has not been actively used for water supply since R-53 was installed. R-53 screens 1 and 2 responded to pumping at R-56 screens 1 and 2, respectively (the wells are 906 ft apart).

R-56

Both R-56 screens are placed within sands and gravels of the Puye Formation (LANL 2010, 111512). Screen 1 is 20.6 ft long, extending from 945.0 ft to 965.6 ft bgs. Screen 2 is 20.5 ft long and is positioned about 76 ft beneath screen 1, extending from 1041.4 ft to 1067.1 ft bgs. The composite water level during well completion was 924.04 ft bgs (5856.84 ft amsl). When packers isolated the screen zones, the water level in screen 1 rose 2.19 ft (921.85 ft bgs; 5859.03 ft amsl), and the water level in screen 2 declined 1.81 ft (925.85 ft bgs; 5855.03 ft amsl). The head difference is 4.0 ft over a vertical distance of about 76 ft; the vertical component of the hydraulic gradient is approximately 0.05 (Table E-3.1-3).

The observed water level in screen 1 is located within the overlying Cerros del Rio lavas (Tb4). Therefore, at this well location, the regional water table is within the overlying Cerros del Rio lavas. Based on the hydrogeologic data for the nearby monitoring wells, the regional water table appears to be within sediments at R-54 and R-52 and within the lavas at R-38, R-21, and R-32 (Table E-3.1-2 and Figures E-2.1-5 and E-2.1-6).

Pumping screen 1 at 5.6 gpm for 1440 min produces approximately 5.5 ft of drawdown at the pumped screen, but no apparent drawdown is observed in the lower screen as well as in any of the other nearby

monitoring wells, except at R-53 screen 1, which is located 906 ft north-northwest of R-56. The pumping drawdown at R-53 screen 1 is about 0.1 ft. The fairly quick response between the two wells suggests locally confined conditions in the area between R-56 screen 1 and R-53 screen 1. Hydraulic conductivity at R-56 screen 1 is estimated to be 6.6 ft/d. The late drawdown data showed steady flattening over time, with a very flat slope after a couple of hours of pumping. This drawdown behavior could indicate (1) three-dimensional flow (partial penetration well) effects, (2) increased aquifer transmissivity away from the well, or (3) leakage or slow drainage from the unconfined zone in the Cerros del Rio basalt.

Pumping screen 2 at 15.0 gpm for 1440 min produces approximately 12.5 ft of drawdown at the pumped screen but no apparent drawdown in the upper screen. However, the pumping caused drawdowns of 1.1 ft in R-21 (783 ft south), 0.5 ft in R-53 screen 2 (906 ft north-northwest), and 0.08 ft in R-54 screen 2 (1793 ft northwest). The fairly quick responses in the nearby monitoring wells again suggest locally confined aquifer conditions. There was no discernable drawdown effect at any of the other monitored locations. Average hydraulic conductivity at R-56 screen 2 is estimated to be 13.3 ft/d. The late drawdown data suggest a boundary effect with a corresponding hydraulic conductivity of 7.1 ft/d. This may be an indication of an actual lateral reduction in aquifer conductivity or the presence of an aquifer boundary such as a fault or pinch out. The computed 2:1 ratio in conductivity is symptomatic of an aquifer with limited lateral extent (for example, bounded by a vertical planar boundary such as a fault or pinch out of a permeable hydrostratigraphic facies). The late drawdown data show steady flattening over time, with a very flat slope after a couple of hours of pumping. This could indicate (1) three-dimensional flow (partial penetration well) effects, or (2) aquifer leakage.

The lack of responses during pumping tests and the head difference between the two R-56 screens suggest that highly resistive sediments separate the two screens. The Puye Formation is overlain by lava flows of the Cerros del Rio lava at a depth of 945 ft (the top of screen 1). It is suspected that the lava flows (because of their low permeability) might act as an aquitard, confining the screen 1 aquifer zone. This observation is supported by analysis of the pumping test data. Based on existing data, the aquifer is expected to be phreatic (under water-table conditions) within the Cerros del Rio lavas, and confined within Puye sediments. The regional water table is located within the Cerros del Rio lavas; the potentiometric surface associated with confined hydraulic heads within the underlying sediments is also located within the Cerros del Rio lavas. Screen 1 is about 20 ft below the regional water table. Because of the apparent low permeability of the basalts, screen 1 was set in the sediments below the basalts as the best location to monitor the top of the regional aquifer at R-56. The pumping-test data suggest the pumping of screen 1 potentially drains groundwater from the overlying basalts.

R-56 screens 1 and 2 have a high barometric efficiency close to 100% (Table E-3.1-4), demonstrating a lack of response to barometric pressure fluctuations in the aquifer; this observation suggests confined aquifer conditions.

Transients in the R-56 water-level data demonstrate that screen 1 does not respond to pumping at municipal supply wells, but screen 2 does respond to water-supply pumping at PM-4 (Table E-3.1-2). Response to PM-2 pumping also is expected, but PM-2 has not been actively used for water supply since R-56 was completed.

R-38

R-38 is completed in the regional aquifer just below Cerros del Rio lavas within the Puye Formation (LANL 2009, 105298). It is a single-screen completion with 10 ft of screen between 821.2 and 831.2 ft bgs. The interval from 820 ft to 834 ft bgs is made up of gravels, cobbles, and boulders derived from local Cerros del Rio volcanics. The water level prior to aquifer testing was 809.85 ft bgs (5860 ft

amsl). The Puye Formation from 836 ft to 841 ft is a stratified siltstone that may act as an aquitard. The observed water level at the well is within the overlying Cerros del Rio lavas (Tb4).

Water-level data from R-38 showed a barometric efficiency of about 55% with an average effective total lag time of about 24 h (Table E-3.1-4). The barometric efficiency suggests that the screened zone is unconfined and in pneumatic connection with the atmosphere.

None of the water-level drawdown or recovery graphs showed the common flattening observed in most pumping tests on the Pajarito Plateau. The data showed three distinct slopes on drawdown and recovery graphs.

The apparent hydraulic conductivity is a minimum of 17 ft/d (based on early-time pumping test data) but is more likely 37 ft/d (based on middle-time pumping test data). The late-time data showed a doubling of the drawdown and recovery slopes, a potential sign of an aquifer with limited lateral extent (for example, bounded by a vertical planar boundary such as a fault or pinch out of a permeable hydrostratigraphic facies). The steeper slope may also indicate a generalized reduction in transmissivity some distance from the well. If there is a boundary, calculations show possible distances from the pumped well ranging from about 450 ft to 710 ft for assumed storage coefficient values of 5×10^{-4} to 2×10^{-4}, respectively.

R-21 water levels showed no discernable response to the R-38 pumping test. However, a water-level response was observed in R-21 from the water injection associated with filter pack placement during R-38 construction. The lack of a pumping test response and the observation of an injection response could not be simulated using consistent aquifer coefficients. There is no obvious explanation for these contradictory responses.

R-21

R-21 is a single screen monitoring well; the screen length is 18 ft from 5750 ft to 5767 ft amsl (Kleinfelder 2003, 090047). The screen is placed within Puye Formation just below massive Cerros del Rio lavas. Hydraulic conductivity is estimated to be about 1 ft/d. The top of the screen is about 85 ft below the regional water table. Therefore, the regional water table is located within the overlying Cerros del Rio lavas (Tb4); because of the substantial submergence of the screen, the elevation of the regional water table is expected to be higher than the observed water level. Water-level data from R-21 show a barometric efficiency of about 100% (Table E-3.1-4), supporting a conceptual model that the screen is potentially confined.

Transients in the water-level data demonstrate that R-21 is impacted by the water-supply pumping at PM-2 and PM-4. The water-level transients also allowed for the estimation of the effective large-scale properties of the regional aquifer between the water-supply wells and R-21 (Table E-3.1-2). R-21 responded to pumping at R-56 screen 2 (wells are 783 ft apart).

R-32

The uppermost screen of R-32 (screen 1) is completed in interflow river gravels intercalated within Cerros del Rio lavas (LANL 2003, 079602). In the original well configuration, screens 2 and 3 were completed in the sediments of the Puye Formation. Screens 2 and 3 had similar hydraulic heads. The screen 1 water level does not respond to pumping at any supply well, while the water levels at screens 2 and 3 showed well-defined responses to PM-2 and PM-4 (Table E-3.1-2) (McLin 2005, 090073; McLin 2006, 092218). These observations indicate that the groundwater at screen 1 is not in direct communication with the groundwater at former screens 2 and 3.

In 2007, R-32 was converted into a single-screen well by plugging screens 2 and 3. The water level observed in the well was about 6 ft lower than the water level observed in screen 1 before the well conversion. The new data are considered to more representative of water table conditions at this location. Water-level data collected during a single-screen pumping test conducted at R-32 demonstrated late time reduction of the pumping drawdown. This drawdown behavior may be because of the various hydrogeologic factors: (1) phreatic aquifer conditions, (2) leaky aquifer conditions (e.g., leakage or slow drainage from the unconfined zone in the Cerros del Rio basalt), (3) three-dimensional flow (partial penetration well) effects, or (4) combinations of the above. The development during well conversion increased the apparent hydraulic conductivity of the screen and potentially improved the hydraulic connection of the screen with the aquifer. The hydraulic conductivity of screen 1 when drilled and after conversion is estimated to be 2 and 10 ft/d, respectively.

The water level in screen 1 is within the Cerros del Rio lavas about 70 ft above the screened interval. Because of substantial submergence of the screen, the elevation of regional water table is expected to be higher than the observed water level. Based on existing data, the aquifer is expected to be phreatic (under water-table conditions) within the Cerros del Rio lavas, and is confined within the Puye Formation. The regional water table is located within the Cerros del Rio lavas and the potentiometric surface associated with confined hydraulic heads in the former two lower screens within the underlying Puye Formation is also located within the Cerros del Rio basalts. The vertical component of the hydraulic gradient at R-32 is on the order of 0.02 (about 2 ft head difference over 100 ft separation distance; Table E-3.1-3). Because of the relatively low permeability of the Cerros del Rio basalts, screen 1 was placed as close as possible to the regional water table in riverine sediments between lava flows. The pumping-test drawdown data suggest that the pumping of R-32 potentially drains groundwater from the overlaying basalts.

Screens 1 and former screen 3 have a high barometric efficiency, perhaps near 100%, and appear to be pneumatically disconnected from the atmosphere (Table E-3.1-4). However, the pressure data for former screen 2, suggest a barometric efficiency less than 100% (about 80%). This suggests the middle screen is not confined and is pneumatically connected to the atmosphere. It is very unusual that the upper saturated zone is less influenced than the deeper saturated zone by atmospheric pressure fluctuations; most of the wells on the Pajarito Plateau have increasing or no change in the barometric efficiency with depth (e.g., R-49, R-50, R-53, R-55). Wells with decreasing barometric efficiency with depth in the TA-54 area are R-51, R-20, R-54, and R-32. The cause for the anomalous behavior is unclear. It suggests that the hydrostratigraphic units in the lower screens are pneumatically connected with the atmosphere through a pathway that is not strictly vertical and bypasses the upper well screens. For example, hydrostratigraphic units screened by the deep screens might be pneumatically connected with the atmosphere to the northeast of the wells; it is also possible the propagation of the atmospheric pressures into the subsurface is related to Pajarito Canyon and aquifer heterogeneity (R-51, R-20, R-54, and R-32 are located along the canyon bottom).

The water-level transients observed at R-32 screens 2 and 3 allowed for the estimation of the effective large-scale properties of the regional aquifer between the water supply wells and R-32 (Table E-3.1-2).

E-3.2 Summary of Hydrogeological Information Collected at the Intermediate and Regional Monitoring Wells

Table E-3.1-1 presents information about the regional monitoring wells near MDA L related to estimated hydraulic based on conducted pumping tests during well development, hydrodynamic conditions at the screens (unconfined, partially confined, or confined), and the submergence of the uppermost screen below the regional water table.

Table E-3.1-2 summarizes the information regarding the water-level transients observed in the regional monitoring wells near TA-54 and whether these transients are related to the water-supply pumping. When a sufficient amount of data are available, the water-level transients are analyzed to evaluate the large-scale aquifer properties (transmissivity and specific storage; Table E-3.1-2). For many of the newer regional wells in the TA-54 monitoring network, the period of record for pumping rates and water levels is insufficient to analyze the transients. Hydraulic properties could not be estimated base on PM-2 pumping for water-level transients at R-40, R-54, R-53, R-56, R-38, R-21, and R-32 because PM-2 was not actively used for water supply during the period of water-level observation. PM-2 has not been actively used since most of the new regional monitoring wells were completed. However, Los Alamos County plans to bring the well back on line in the fall of 2011 and potentially replace it with a new well near the current location of PM-2.

Table E-3.1-3 summarizes the estimated vertical component of the hydraulic gradient at the monitoring wells with more than one screen near TA-54. The highest values for the vertical component of the hydraulic gradient are observed at R-20, R-49, R-57, and R-22. R-20 is located close to PM-2, and its water levels have been strongly impacted by the water-supply pumping (Table E-3.1-2); therefore, the high value is probably caused by the water-supply pumping. However, R-49, R-57, and R-22 are all located farther to the east of MDA L. In this case, the high values for the vertical component of the hydraulic gradient are probably caused by either three-dimensional groundwater flow effects or stronger vertical stratification (hydraulic separation) in the upper section of the regional aquifer. In either case, the groundwater flow may be impacted by the spatial extent of the Cerros del Rio lavas and/or the Totavi Lentil sediments within the regional aquifer. At R-54, the water levels show an *upward* vertical component of the hydraulic gradient (Table E-3.1-3). This result is unusual and contrary to most observations on the Pajarito Plateau. The upward vertical gradient is observed only when there is no intensive water-supply pumping and the water levels in the deep screen have recovered. During periods of intensive water-supply pumping at PM-4, the water-levels in the deeper R-54 screen decline, and the vertical component of the hydraulic gradient becomes downward. This behavior also is expected from pumping at PM-2.

Table E-3.1-4 presents information regarding barometric efficiency of the monitoring well screens near MDA L based on a comparison of the hourly water-level data with the barometric pressure changes. Screens with barometric efficiency less than 100% are not confined. The table also discusses the potential impacts of Earth tide effects on the regional water levels. Screens impacted by Earth tide effects are expected to be confined.

In the vicinity of MDA L, the shallow portion of the regional aquifer is located within the Puye Formation sediments and Cerros del Rio lavas. The deep portion of the regional aquifer is predominantly under confined conditions, and it is stressed by Pajarito Plateau water supply pumping. The intensive pumping causes small water-level fluctuations in the shallow phreatic (unconfined) zone. Groundwater flow and contaminant transport directions in this zone are expected to generally follow the hydraulic gradients along the regional water table.

The measured water levels at the regional monitoring wells around MDA L represent unconfined, partially confined, or confined hydrogeologic conditions (Table E-3.1-1). This finding suggests that the upper well screens and the regional water table are potentially hydraulically connected, and they are good monitoring locations.

E-3.3 Regional Aquifer Water-Table Maps

Groundwater flow directions and fluxes that control contaminant transport in the aquifer are generally dictated by the shape of the regional water table (Freeze and Cherry 1979, 088742, Chapter 5;

Vesselinov 2004, 090040). The general shape of the regional water table beneath the Laboratory is predominantly controlled by the areas of regional recharge to the west (the flanks of Sierra de los Valles and the Pajarito fault zone) and discharge to the east (the Rio Grande and the White Rock Canyon Springs). The structure of the regional phreatic flow is also expected to be impacted by (1) local infiltration zones (e.g., beneath wet canyons), (2) heterogeneity and anisotropy in the aquifer properties, and (3) discharge zones (water-supply wells and springs).

Information about the elevation of the regional water table is provided by existing data from monitoring wells (water levels) and selected springs (for example, the White Rock Canyon Springs; discharge elevations of the springs are applied as an estimate of the local elevation of the regional water table). Well data are predominantly applied to map the elevation of the regional water table; spring discharge elevations are used in the vicinity of White Rock Canyon to provide additional constraints on the water-table elevation.

Water-table elevations under the Pajarito Plateau vary in time because of transient effects that include pumping of the water-supply wells and large- and small-scale variability in aquifer recharge. In general, water-level maps are representative of specific periods of time. The interpretation of water-level data not representative of the same time period is a source of uncertainty in the mapping process. Differences in the depths of screen placements and local hydrogeologic conditions also complicate the interpretation of the water-level data. In addition, up to a month (depending on the local hydrogeological conditions) is required for the water levels in the recently drilled wells to equilibrate after they are disturbed by drilling, development, and pump testing.

The process of water-table contouring is theoretically constrained by conformity rules (Freeze and Cherry, 1972, 088742): (1) the contour lines should be perpendicular to the flow paths; (2) the length and the width of the flownet cells formed by the contour lines between two adjacent flow paths should have the same ratios. These rules are theoretically valid only for the case of two-dimensional (lateral) groundwater flow in a uniform, isotropic aquifer with no recharge/discharge sources within flownet cells. Deviations from the conformity rules are caused by three-dimensional flow effects, aquifer heterogeneity and anisotropy as well as recharge/discharge sources within flownet cells. Here, the regional water table maps are contoured by attempting to satisfy four goals simultaneously: (1) to match the water-level data at the monitoring wells; (2) to account for issues of data representativeness (confined vesus unconfined hydrodynamic conditions at the screens, submergence of the screen below the regional water table, water-level transients, etc.); (3) to preserve flownet conformity; and (4) to account for conceptual models of groundwater flow in the regional aquifer. Because of the existing uncertainties in the data and knowledge about the site, a series of alternative conceptual-model assumptions pertaining to the regional groundwater flow have been evaluated. The actual contouring is performed using a combination of manual and automated techniques; the automated contouring is performed using the minimum curvature method.

A Laboratory-wide water-table map based on monthly averaged regional-aquifer water-level data from February 2011 is presented in Figure E-3.3-1. The maps incorporate the water-level data from the recently drilled monitoring wells near MDA L. The process of development of the water-table map follows the methodology outlined in the 2011 General Facility Information Report (LANL 2010, 109084). The water-level contour map in Figure E-3.3-1 is overall consistent with the maps previously presented in various reports (LANL 2005, 091139; LANL 2006, 093570; LANL 2006, 093196; LANL 2007, 095364; LANL 2008, 101932; LANL 2009, 105632; LANL 2009, 106589; LANL 2011, 201568).

The hydrogeological properties and thickness of Cerros del Rio lavas below the water table is expected to affect flow directions beneath TA-54. The distribution of hydrostratigraphic units at the regional water table and the estimated thickness of the Cerros del Rio lavas beneath the regional water table are presented in Figure E-2.1-12. The thickness of the lavas is evaluated using the February 2010 version of the water-table map (LANL 2010, 109084) and an updated version of the 2009 geologic framework model

(Cole et al. 2010, 106101), based on the new geologic data collected at the recently drilled wells at TA-54. The February 2010 version of the water-table map is somewhat similar to the map presented in Figure E-3.3-1; the new water-table map is updated and incorporates the water-level data from the recently drilled monitoring wells.

The effective saturated hydraulic permeability of the Cerros del Rio lavas depends on the permeabilities of (1) the intact lava matrix, (2) fractures separating lava blocks and their fracture-lining minerals, and (3) interbedded sediments between lava flows. Permeabilities of these lavas are also a function of the spatial distribution and interconnection of the fractures and interbedded sediments. The permeability of the intact lava matrix is expected to be quite low. However, high permeability fractures and interbedded sediments can lead to relatively high local groundwater flow velocities and preferential flows though the phreatic zone. Depending on the hydrogeological properties and spatial connection between the fractures and interbedded sediments, the groundwater volume flowing through the fractures is expected to be relatively low. As a result, the effective saturated hydraulic permeability of the Cerros del Rio lavas is also expected to be relatively low. Although total groundwater flux through the phreatic system may be lower than to other parts of the plateau, focusing flow into fractures or interbedded sediments may lead to higher groundwater transport velocities than would be encountered where the phreatic system is found in sediments (such as the Puye Formation). The low effective permeability of the Cerros del Rio lavas is supported by the observed steep gradients in the areas where these rocks occur at the top of the regional aquifer (Figure E-3.3-1). The hydraulic gradient along the regional water-table beneath MDA G is 0.02 m/m; it is among the highest hydraulic gradients observed beneath the Laboratory (Figure E-3.3-1).

The structure of the regional aquifer flow near MDA L is represented in greater detail by two water-table (piezometric) maps in Figures E-3.3-2 and E-3.3-3. Both maps are based on monthly averaged regional-aquifer water-level data from February 2011; water-level contours in Figures E-3.3-1 and E-3.3-2 are equivalent. The contours in Figures E-3.3-1 and E-3.3-2 are based on the water levels from the upper most screens in the regional aquifer; the maps represent the general structure of the groundwater flow along the regional water table (applied water-level data is presented in Figure E-3.3-2). The water-level contour map in Figure E-3.3-3 incorporates information from the deeper screens in the regional aquifer at the monitoring wells with more than one screen (applied water-level data is presented in Figure E-3.3-3). Figure E-3.3-3 attempts to represent the structure of the groundwater flow about 100 ft (the average distance between the shallow and deep screens in the regional wells; Table E-3.1-1) below the regional water table based on the available information.

The water-level contour maps in Figures E-3.3-2 and E-3.3-3 are somewhat similar; a comparison of the contours is presented in Figure E-3.3-4. The general directions and hydraulic gradients of the groundwater flow in the shallow and deep sections of the regional aquifer appear to be similar as well. The major differences are in the area near R-54 and R-53. The deep screens of the monitoring wells near MDA L are responding the water-supply pumping (R-20, R-54, R-53, R-56, R-21, R-32; Table E-3.1-2; R-21 screen is located substantially below the regional water table; Table E-3.1-1). The shallow screens of R-54, R-53, and R-56 are not responding to water-supply pumping; it is not known what the impact is of the water-supply pumping on the water table near R-20 because the shallowest R-20 screen is substantially below the regional water table (Table E-3.1-1). Therefore, the differences in the water levels contours (Figure E-3.3-4) are expected to be predominantly caused by the water-supply pumping; it is feasible that the differences are also influenced by aquifer heterogeneity and regional aquifer recharge. It is important to emphasize that well PM-2 has not actively been used for water supply since the summer of 2007, and the observed pumping fluctuations in the water levels are due to pumping of PM-4 only. It is expected that PM-2 will start pumping again in the fall of 2011. Based on the existing hydrogeological data, PM-2 has a larger impact than PM-4 on the deep water levels in the regional aquifer. Therefore, future PM-2 pumping will further impact the structure of the deep regional aquifer flow beneath TA-54.

The northeastward direction of the groundwater flow beneath and to the west-northwest of MDA L (Figures E-3.3-2 and E-3.3-3) may indicate a complex three-dimensional structure of the groundwater flow that is potentially influenced by (1) hydrostratigraphy, (2) aquifer recharge, and/or (3) water-supply pumping in the deep sections of the regional aquifer. For example, it is plausible that the shape of regional water table beneath and to the northwest of MDA L is influenced by the water-supply pumping in PM-4 and PM-2. The presence of the low permeable Cerros del Rio lavas (Tb4) below the regional water table in the area to the southeast of MDA L (beneath MDA G) may act as a hydrogeologic barrier that diverts flow northeastward (Figures E-3.2-2 and E-3.2-3). The impact of this hydrogeologic barrier on the groundwater flow may have been observed during the pumping tests conducted in R-53, R-56, and R-38; the drawdowns during the pumping tests at these wells were impacted by boundary effects (section E-3.1; Table E-3.1-1). The distribution of hydrostratigraphic units at the regional water table and the estimated thickness of the Cerros del Rio lavas beneath the regional water table are presented in Figure E-2.1-12. The relatively lower water levels and flat hydraulic gradients in the area north of R-38 may be also affected by flow-through highly permeable Puye Formation sediments (as indicated by the pumping test results from wells R-28, R-11, R-13, R-44, and R-45). The northeastward direction of the groundwater flow beneath and to the northwest of MDA L may be also influenced by enhanced recharge of the regional aquifer potentially occurs to the west and southwest of MDA L along Pajarito Canyon, Cañon de Valle, and Water Canyon. The three-dimensional structure of the groundwater flow may also be influenced by the general trends of (1) decreased thickness of the Puye Formation at the top of the regional aquifer and (2) decreased depth of the Santa Fe Group sediments below the regional water table in the area north of R-38 (LANL 2009, 106939, Figure O-4.0-1).

E-3.4 Regional Aquifer Monitoring Network

The regional monitoring-well network around MDA L is designed to provide reliable detection of potential contaminants reaching the regional aquifer in an area of considerable hydrogeologic complexity. The wells are located both upgradient and downgradient. The monitoring network includes single-screen (R-38, R-21, and R-32) and two-screen (R-20, R-54, R-53, and R-56) wells. In the two-screen wells, the upper screen is placed as close to the water table as possible to monitor the first arrival of contaminants in the aquifer, and the lower screen is placed in deep permeable aquifer sediments to monitor the primary groundwater pathways downgradient of the facility. All the monitoring wells located downgradient of MDA L are screened in sections of the regional aquifer that appear to be the best locations for monitoring potential contaminants.

Hydrogeologic data also suggest the screened regional-aquifer zones at the regional monitoring wells near MDA L are either unconfined or partially confined (Table E-3.1-1): for example, R-20 screen 1, R-54 screen 1, R-53 screen 1, and R-32 screen 1. This suggests that the upper well screens and the regional water table are potentially hydraulically connected. The barometric pressure responses of the monitoring screens (barometric efficiency less than 100%) demonstrate a connection between the screens and the vadose zone (i.e., the screens are not confined; Table E-3.1-4): for example, R-20 screen 2, R-54 screen 2, R-53 screen 1, and R-32 screen 2. The cross-well hydraulic responses between R-56, R-54, R-53, and R-21 during the performed pumping tests (section E-3.1) demonstrate that the well screens are in good hydraulic communication with the aquifer and are expected to provide early detection of potential contaminants originating from MDA L.

E-4.0 REFERENCES

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

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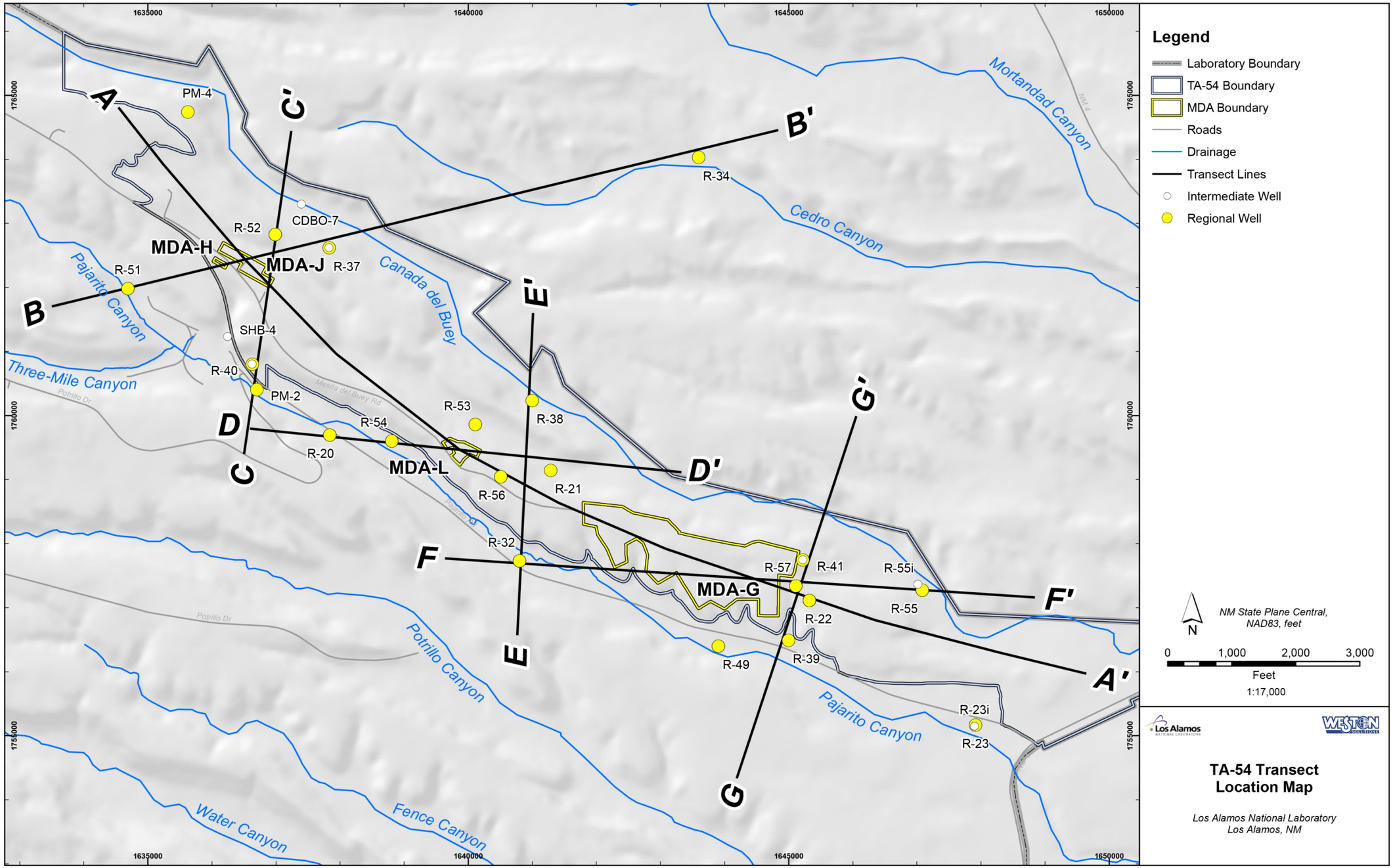
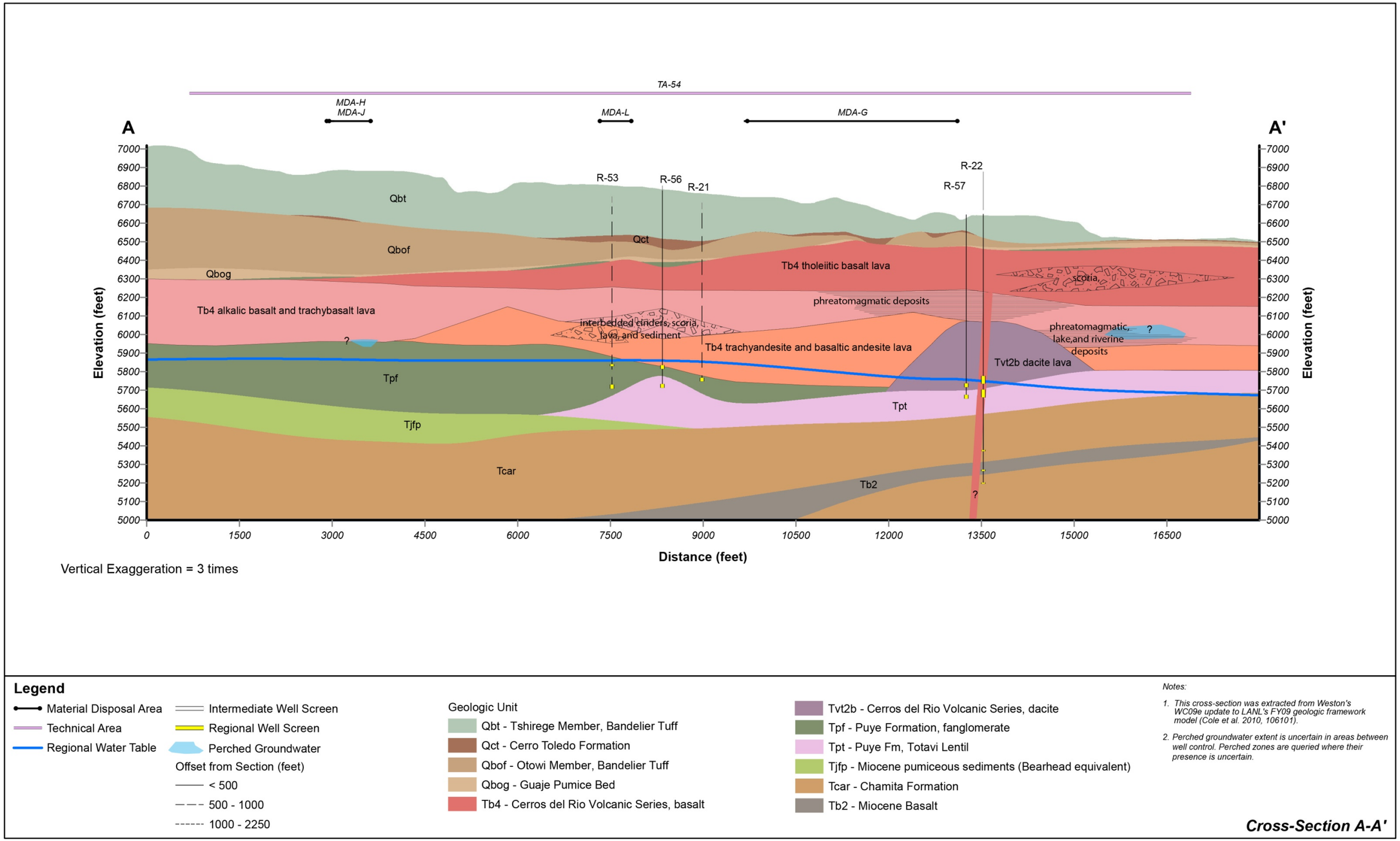
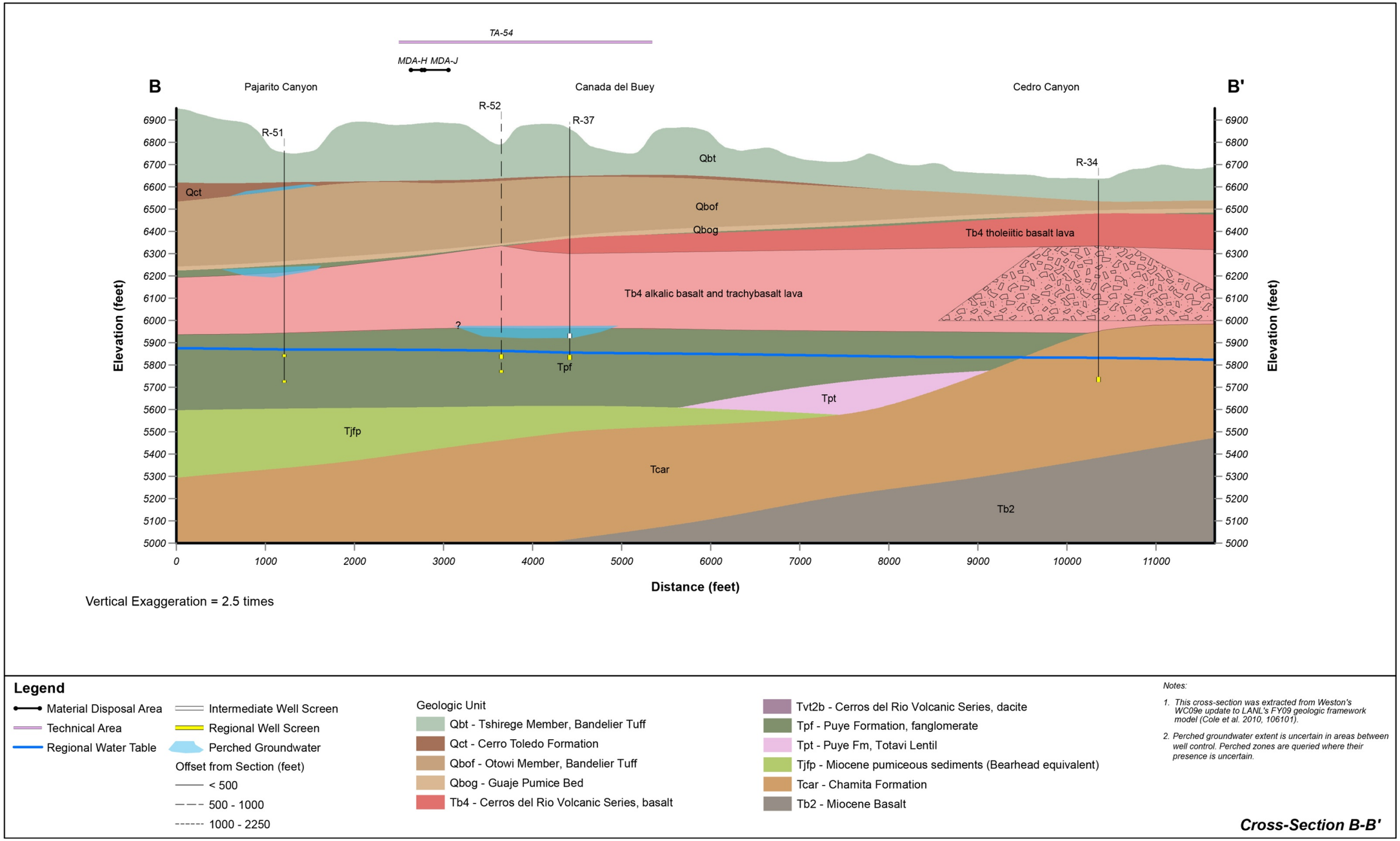


Figure E-2.1-1 **Location of regional and intermediate wells in the vicinity of TA-54 and the lines of section for geologic cross-sections shown in Figures E-2.1-2 through E-2.1-8**



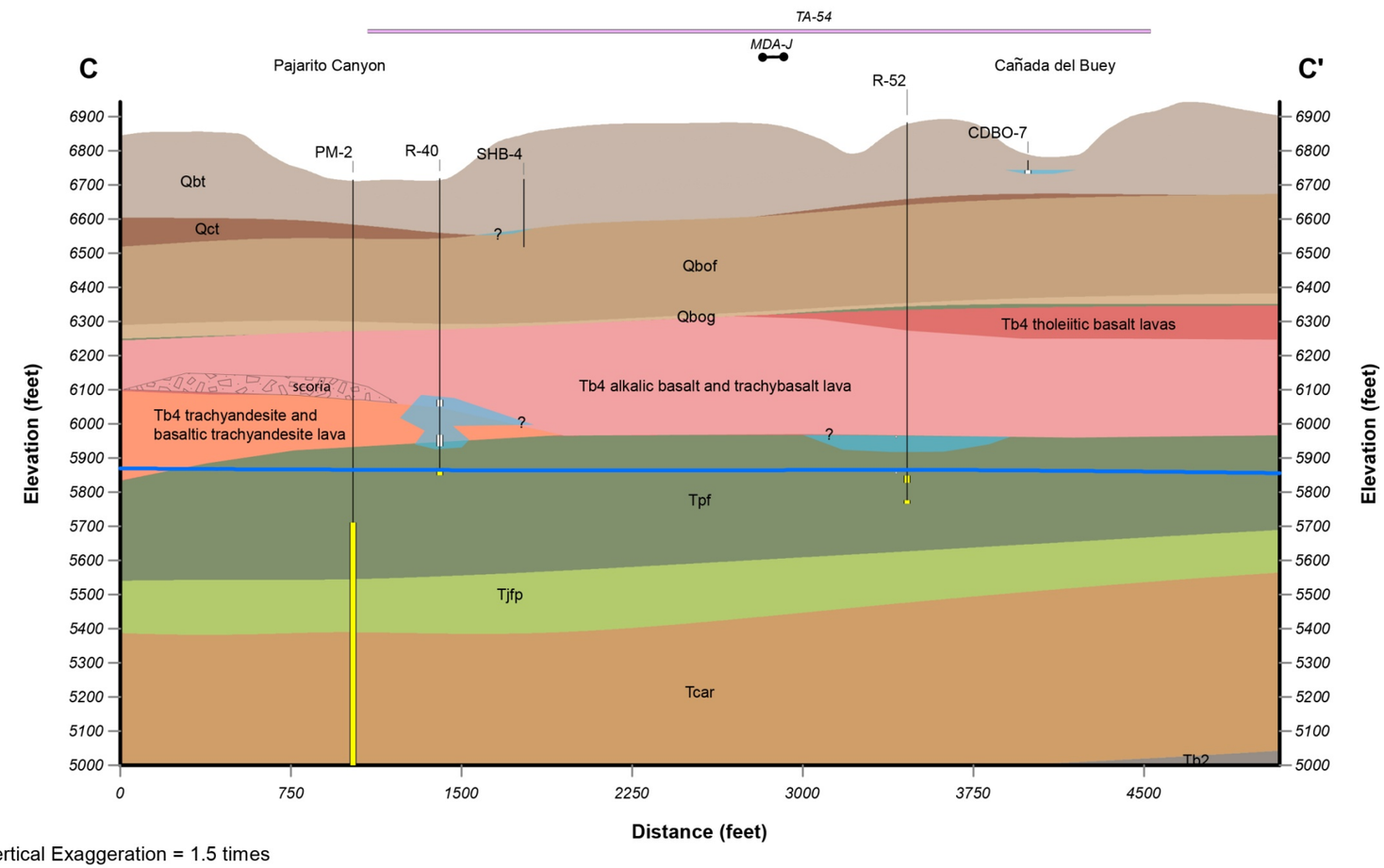
Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-2 Northwest to southeast geologic cross-section A-A' along the axis of Mesita del Buey



Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-3 Southwest to northeast geologic cross-section B-B' through MDA H



Vertical Exaggeration = 1.5 times

Legend

- Material Disposal Area
- Technical Area
- Regional Water Table
- Intermediate Well Screen
- Regional Well Screen
- Perched Groundwater

Offset from Section (feet)

- < 500
- 500 - 1000
- 1000 - 2500

Geologic Unit

- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Volcanic Series, tholeiitic
- Tb4 - Cerros del Rio Volcanic Series, alkalic basalt and trachybasalt
- Tb4 - Cerros del Rio Volcanic Series, trachyandesite and basaltic trachyandesite
- Tvt2b - Cerros del Rio Volcanic Series, dacite
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt

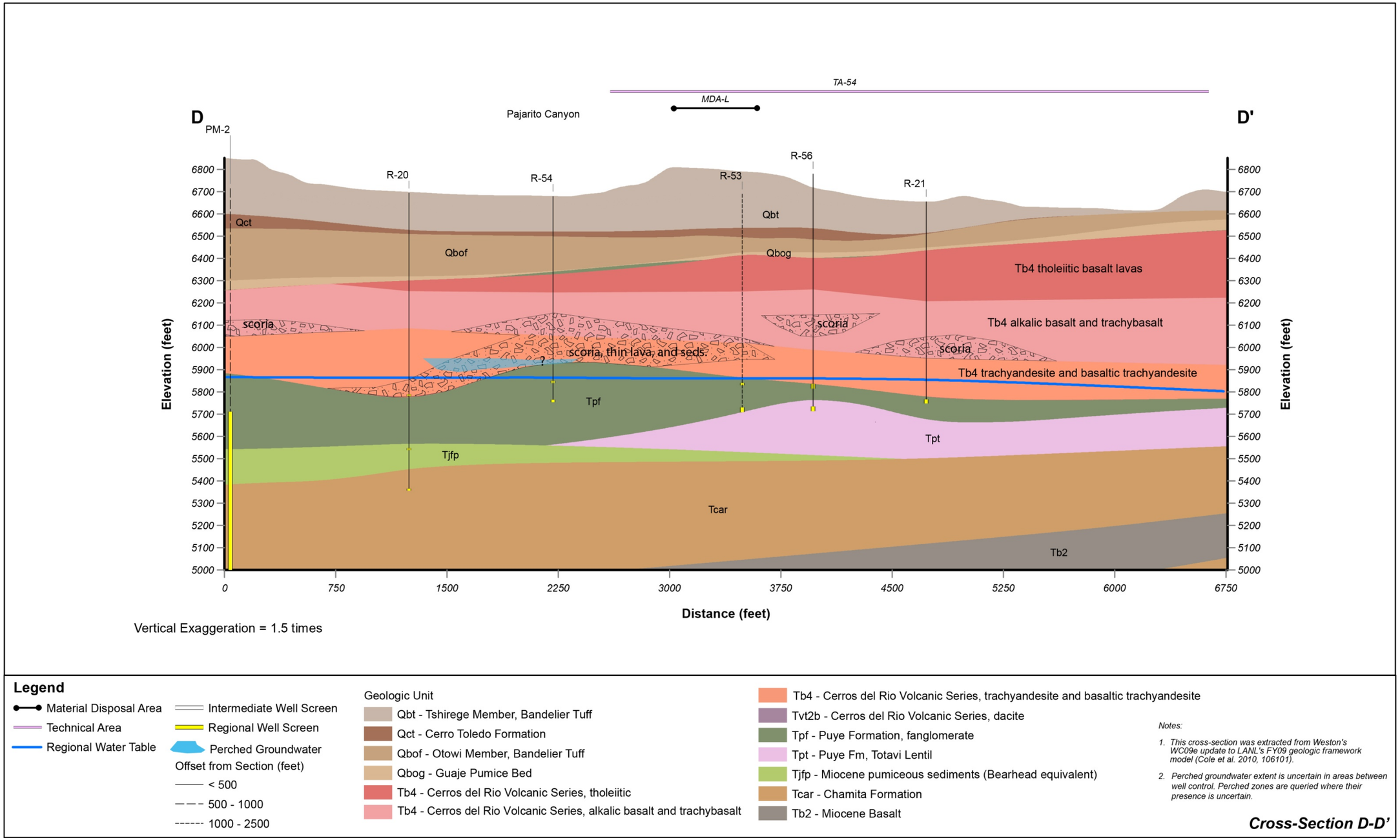
Notes:

1. *This cross-section was extracted from Weston's WC09e update to LANL's FY09 geologic framework model (Cole et al. 2010, 106101).*
2. *Perched groundwater extent is uncertain in areas between well control. Perched zones are queried where their presence is uncertain.*

Cross-Section C-C'

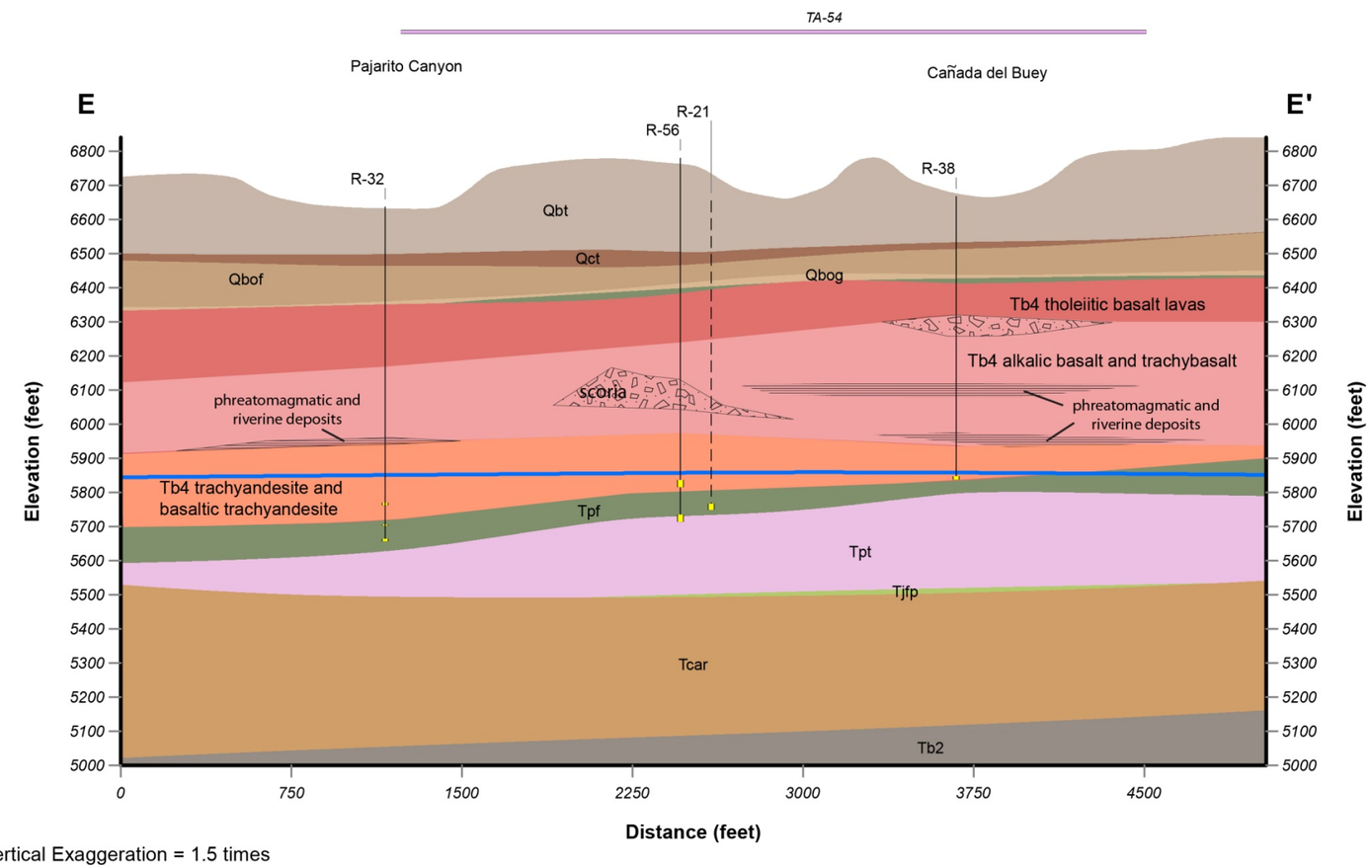
Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-4 South to north geologic cross-section C-C' near MDA H



Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-5 West to east geologic cross-section D-D' through MDA L



Legend

- Material Disposal Area
- Technical Area
- Regional Water Table
- Intermediate Well Screen
- Regional Well Screen
- Perched Groundwater

Offset from Section (feet)

- < 500
- 500 - 1000
- 1000 - 2500

Geologic Unit

- Qbt - Tshirege Member, Bandelier Tuff
- Qct - Cerro Toledo Formation
- Qbof - Otowi Member, Bandelier Tuff
- Qbog - Guaje Pumice Bed
- Tb4 - Cerros del Rio Volcanic Series, tholeiitic
- Tb4 - Cerros del Rio Volcanic Series, alkalic basalt and trachybasalt
- Tb4 - Cerros del Rio Volcanic Series, trachyandesite and basaltic trachyandesite
- Tvt2b - Cerros del Rio Volcanic Series, dacite
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tjfp - Miocene pumiceous sediments (Bearhead equivalent)
- Tcar - Chamita Formation
- Tb2 - Miocene Basalt

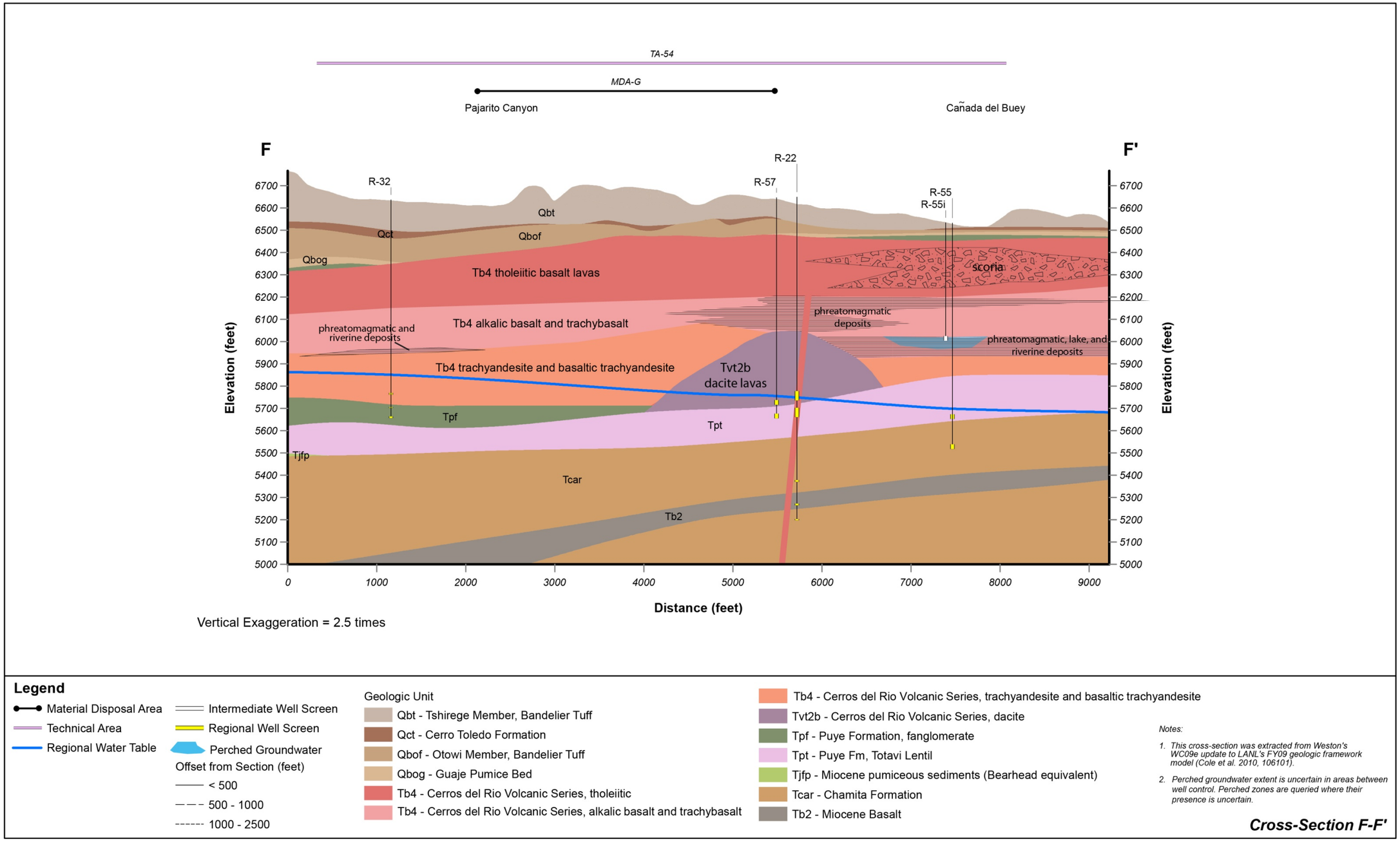
Notes:

1. *This cross-section was extracted from Weston's WC09e update to LANL's FY09 geologic framework model (Cole et al. 2010, 106101).*
2. *Perched groundwater extent is uncertain in areas between well control. Perched zones are queried where their presence is uncertain.*

Cross-Section E-E'

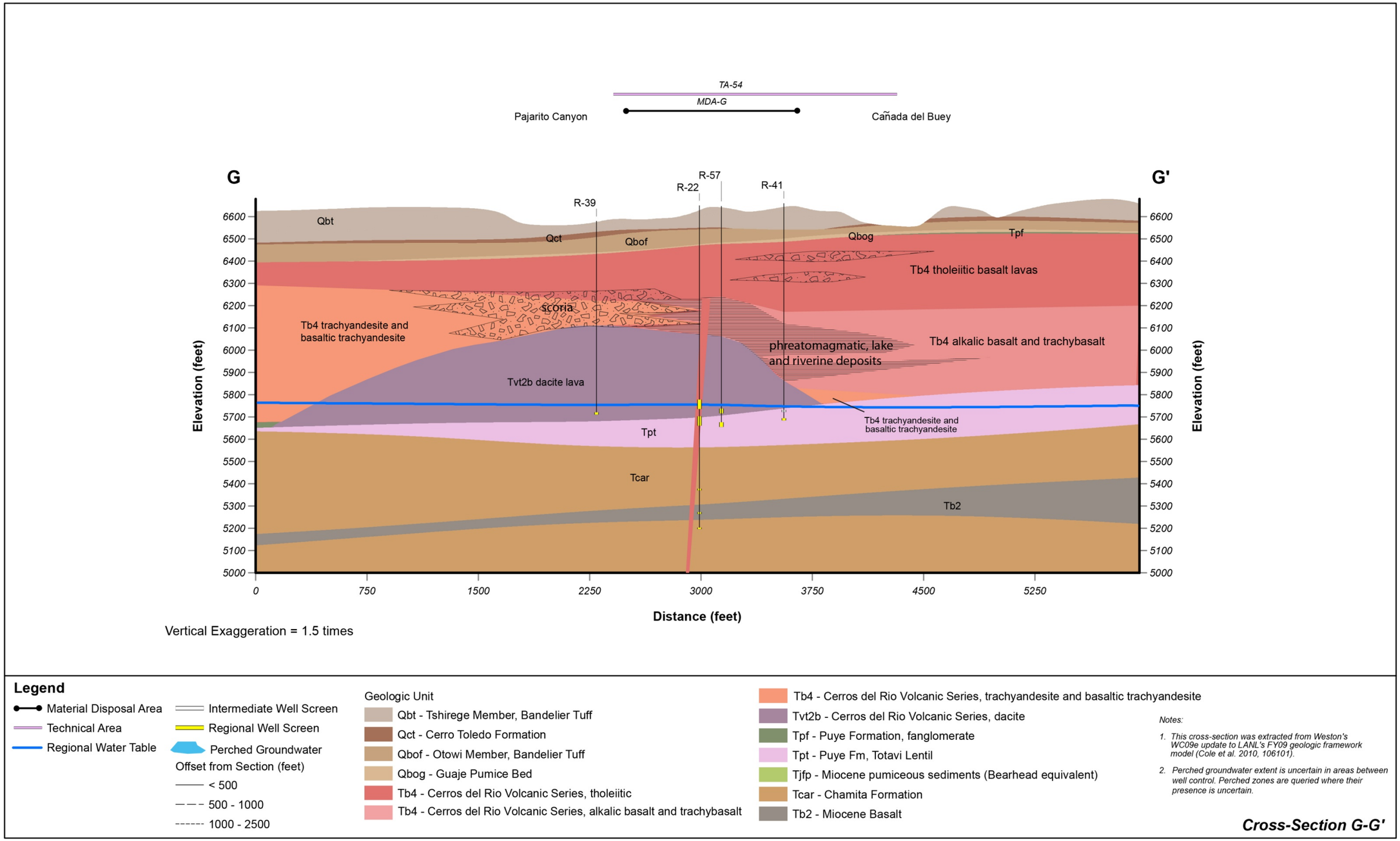
Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-6 South to north geologic cross-section E-E' through the area between MDAs G and L



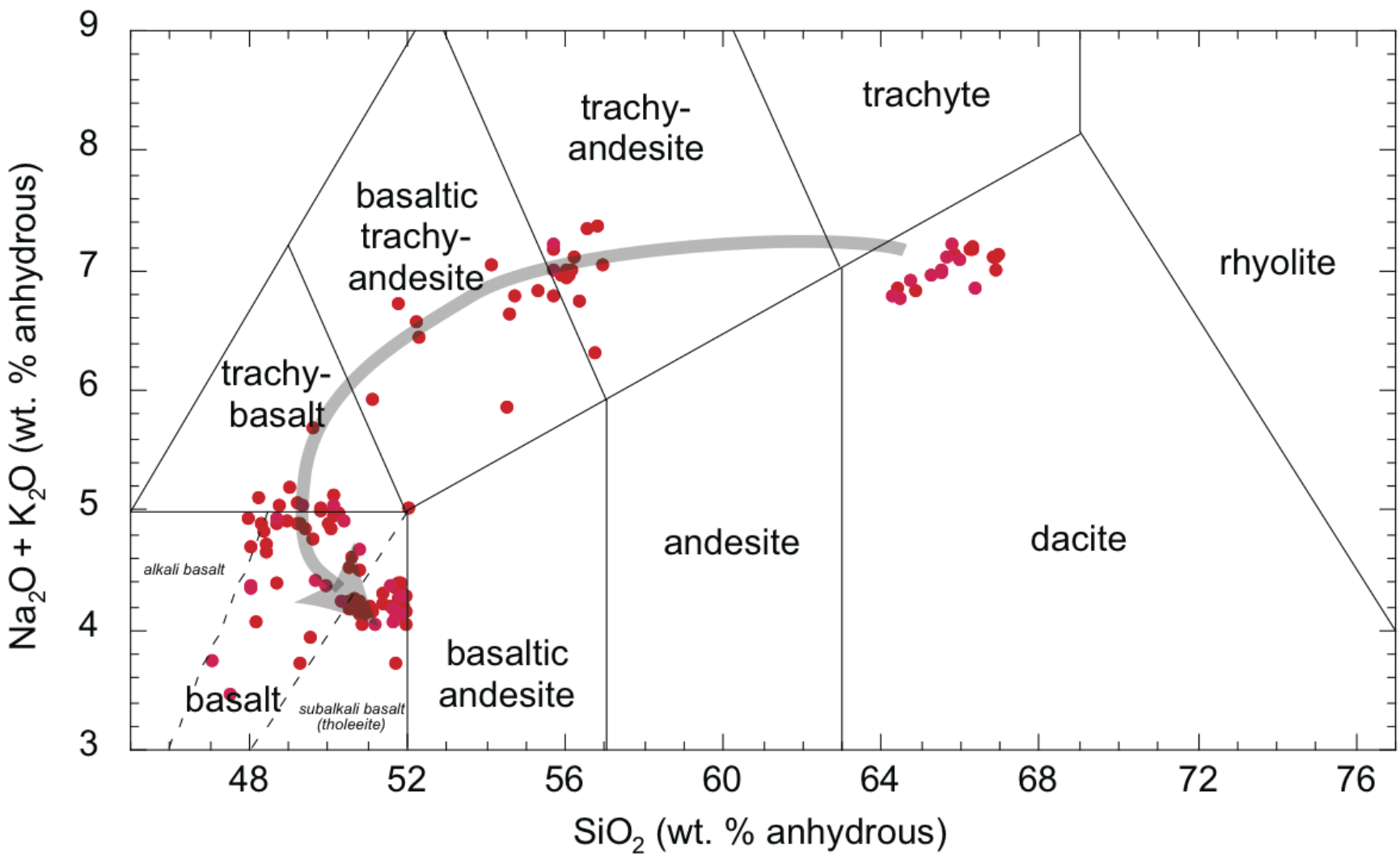
Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-7 West to east geologic cross-section F-F' through MDA G



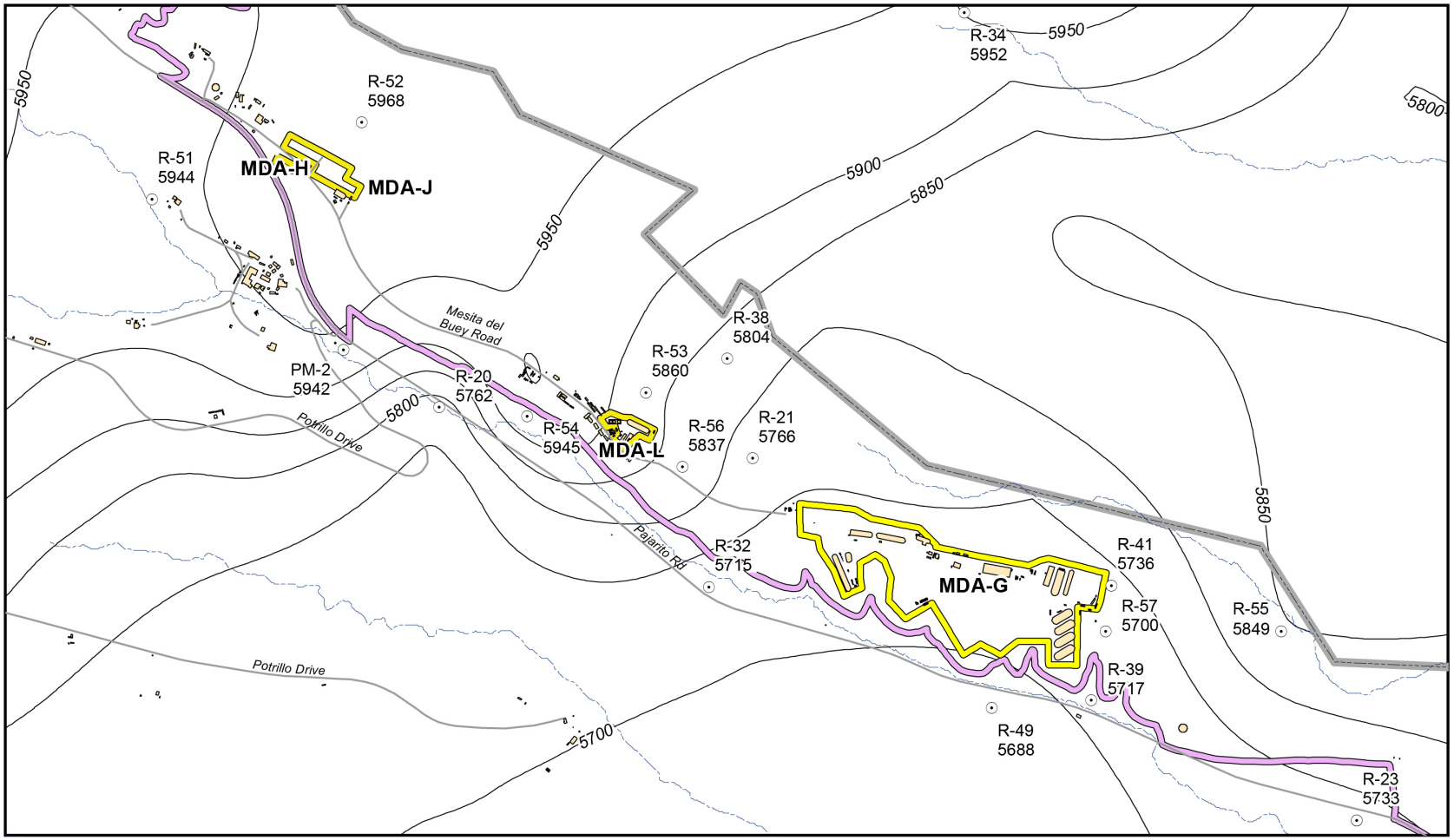
Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-8 Southwest to northeast geologic cross-section G-G' through MDA G



Notes: Gray arrow shows the eruption sequence from oldest to youngest rocks. Rocks with basalt through trachyandesite compositions are designated Tb4 in the discussion and cross-sections; dacite compositions are designated as Tvt2b.

Figure E-2.1-9 Alkali-silica diagram showing chemical classification of Cerros del Rio volcanic rocks in the vicinity of TA-54



Legend

- Laboratory Boundary
- TA Boundary
- WC09d_vflts_buffer
- MDA Boundary
- Structures
- Roads
- Drainage
- Regional Well ID
- Contact Elevation (ft MSL)
- Modeled Structural Contour

0 1,000 2,000
Feet

N W E S

Figure E-2.1-10 Structure contour map for the base of Cerros del Rio volcanic rocks in the vicinity of TA-54

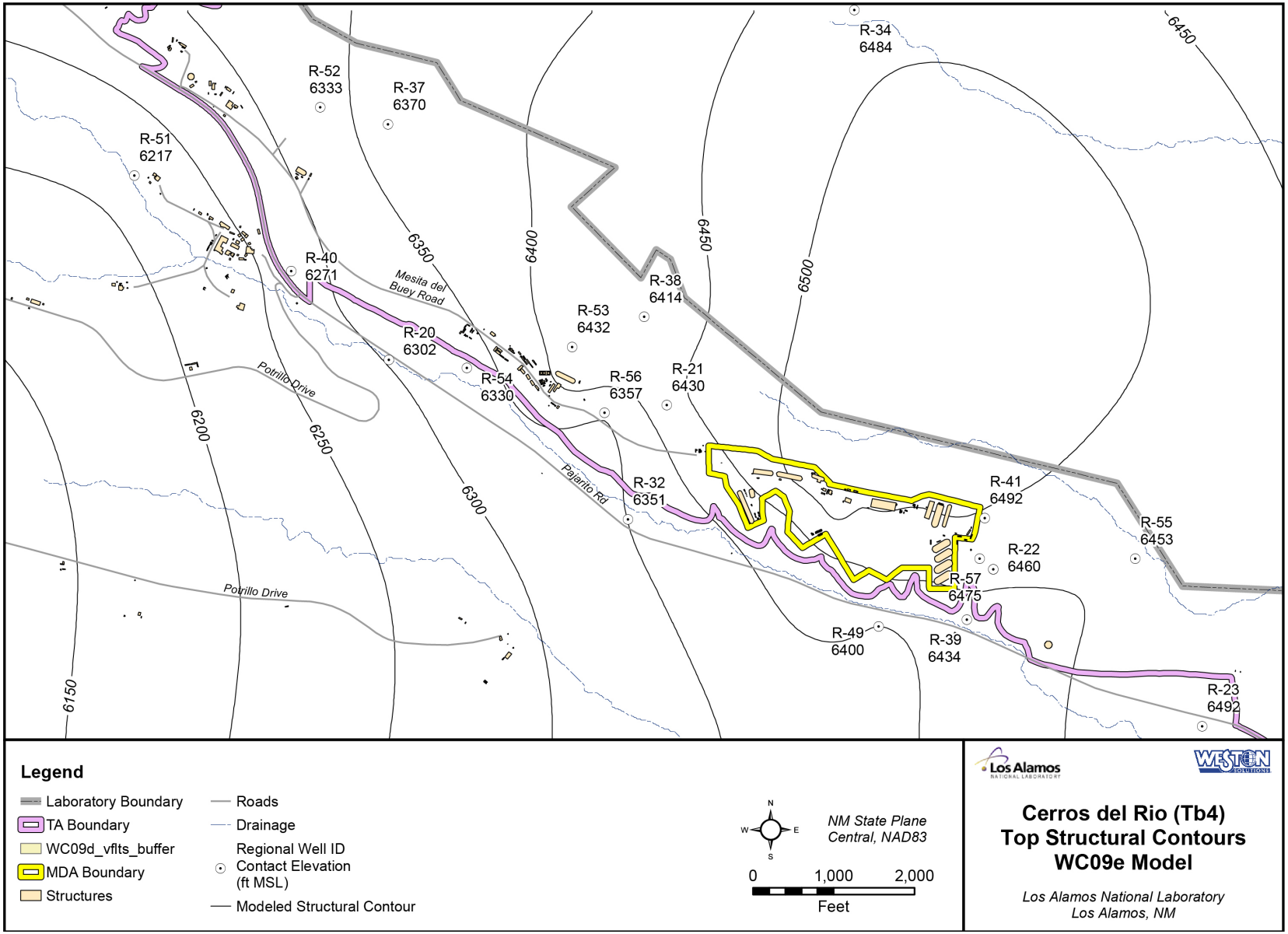
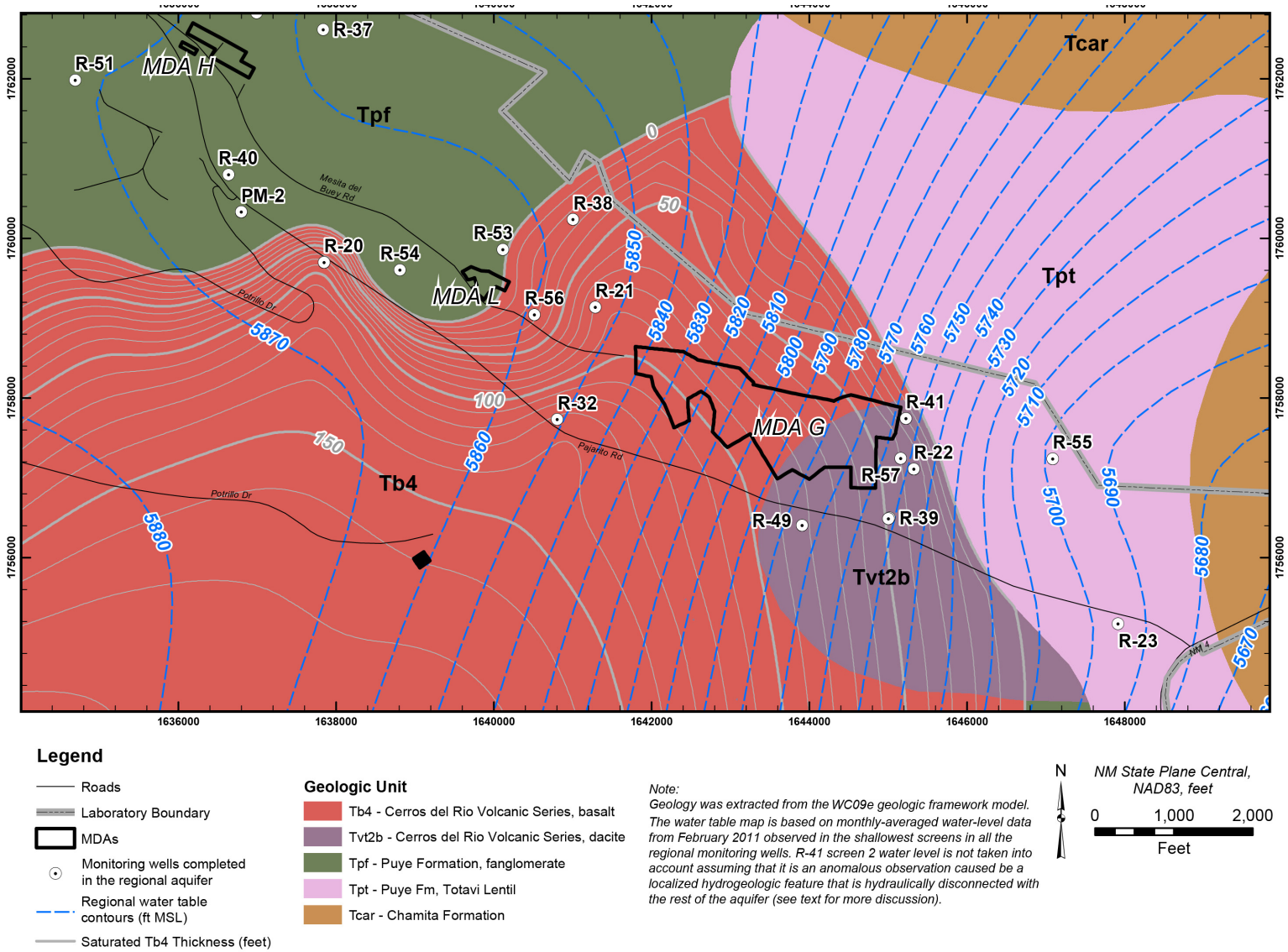


Figure E-2.1-11 Structure contour map for the top of Cerros del Rio volcanic rocks in the vicinity of TA-54



Legend

- Roads
- Laboratory Boundary
- MDAs
- Monitoring wells completed in the regional aquifer
- Regional water table contours (ft MSL)
- Saturated Tb4 Thickness (feet)

Geologic Unit

- Tb4 - Cerros del Rio Volcanic Series, basalt
- Tvt2b - Cerros del Rio Volcanic Series, dacite
- Tpf - Puye Formation, fanglomerate
- Tpt - Puye Fm, Totavi Lentil
- Tcar - Chamita Formation

Note:
Geology was extracted from the WC09e geologic framework model. The water table map is based on monthly-averaged water-level data from February 2011 observed in the shallowest screens in all the regional monitoring wells. R-41 screen 2 water level is not taken into account assuming that it is an anomalous observation caused be a localized hydrogeologic feature that is hydraulically disconnected with the rest of the aquifer (see text for more discussion).

N

NM State Plane Central, NAD83, feet

0 1,000 2,000
Feet

Note: Groundwater-level contour map is based on average data representative for September 2010.

Figure E-2.1-12 Hydrostratigraphy at the regional water table and estimated thickness of Cerros del Rio lavas beneath the regional water table (gray contours)

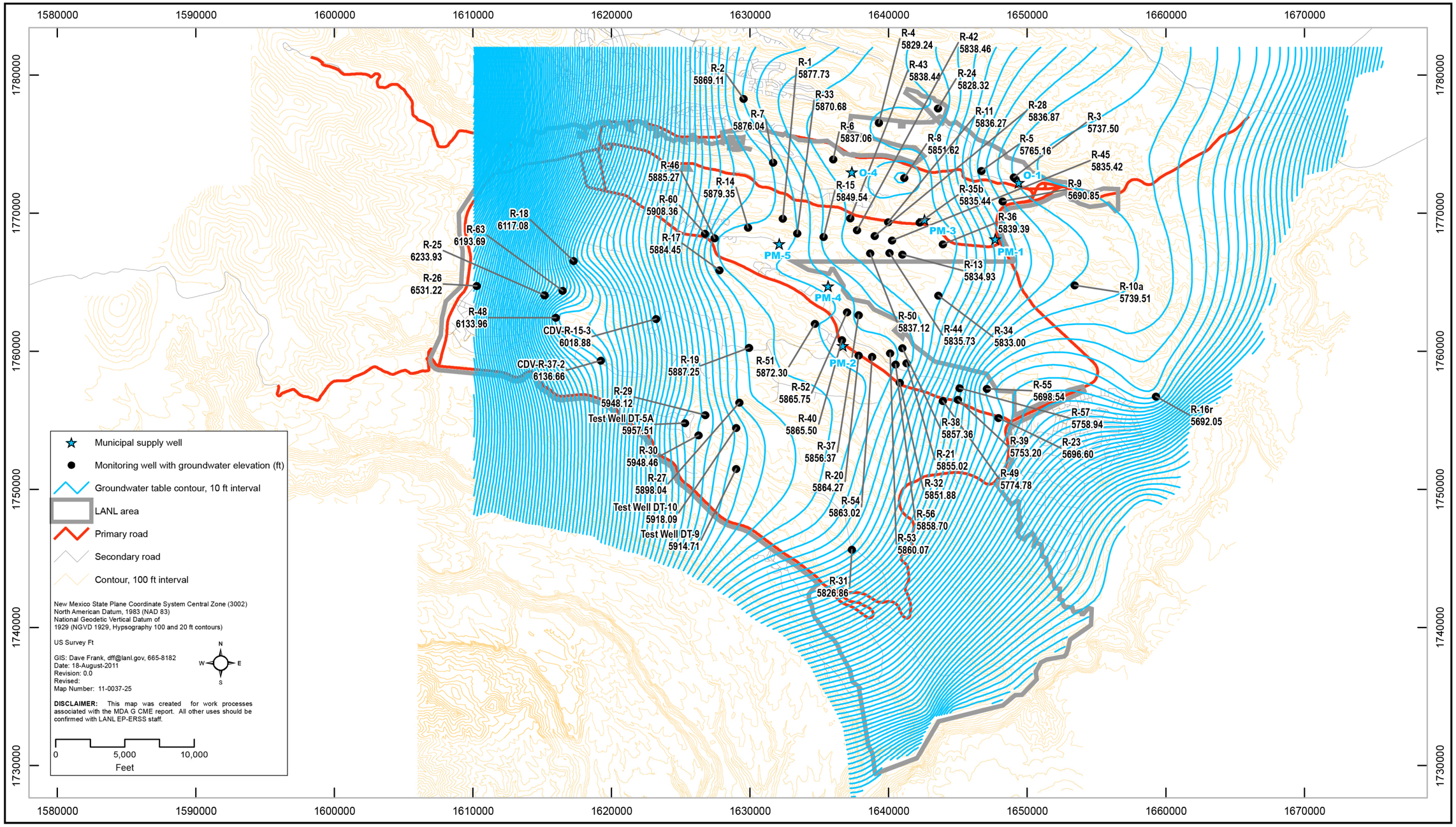
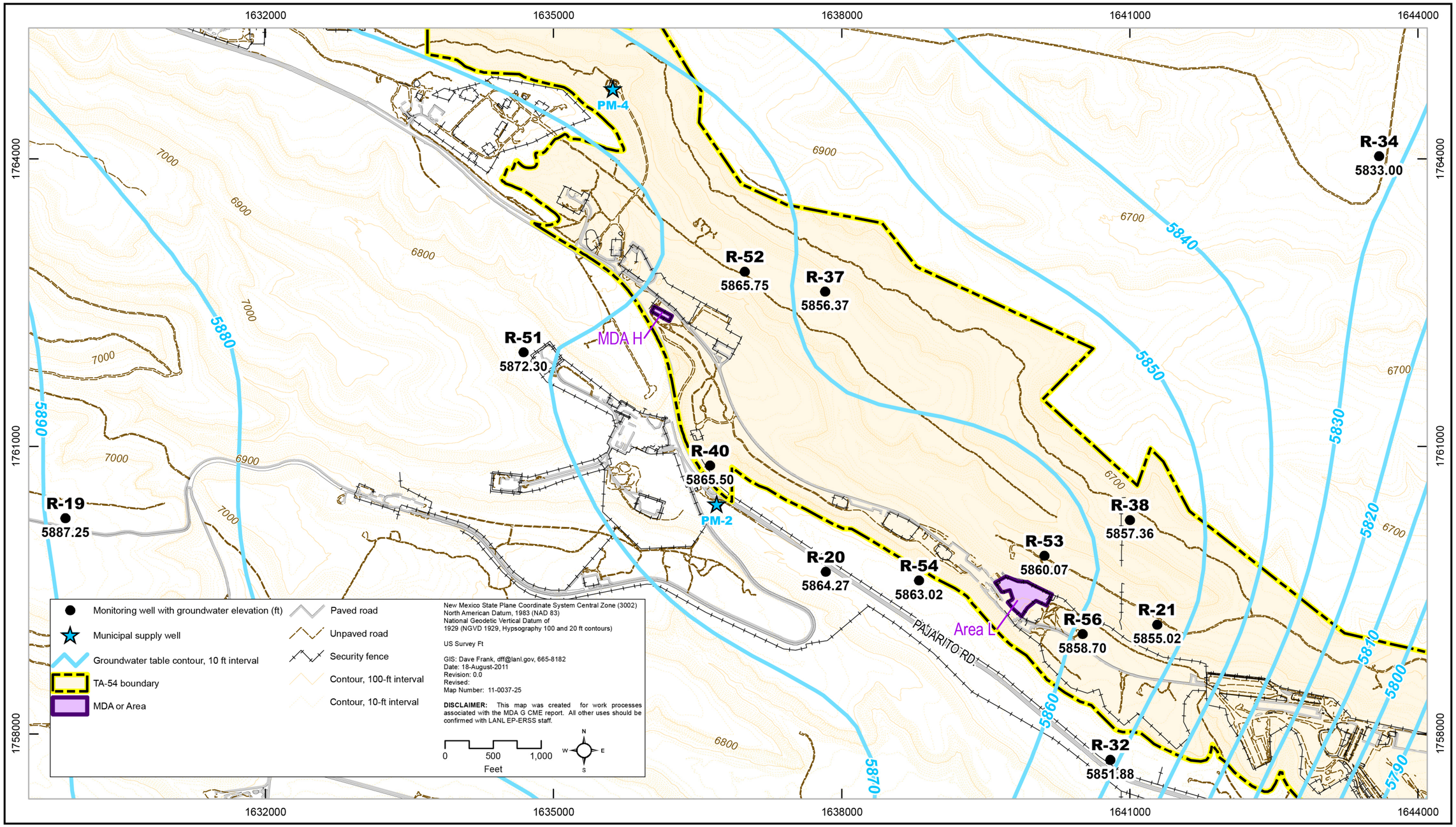
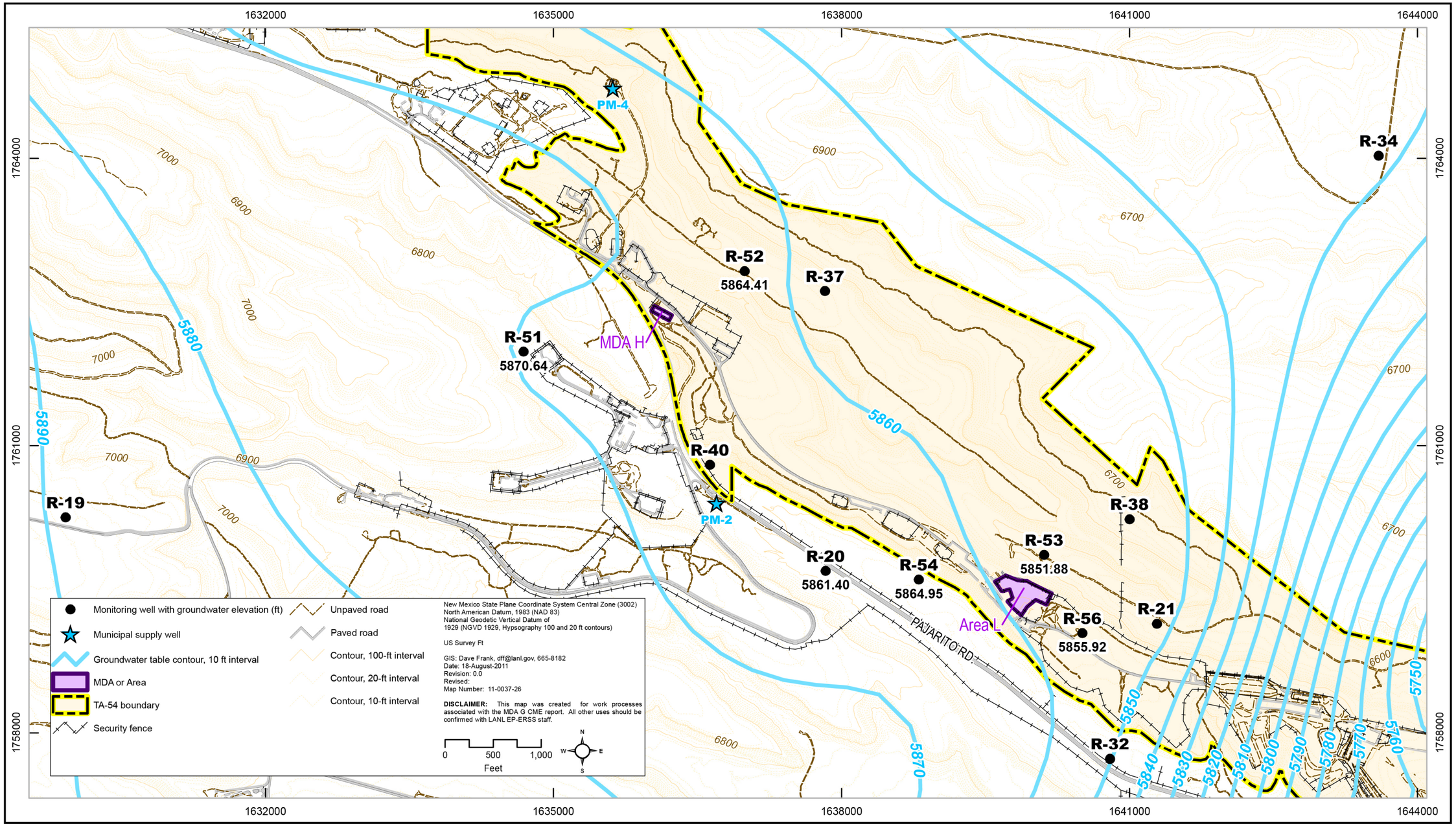


Figure E-3.3-1 Laboratory-scale regional water-table map based on February 2011 water levels



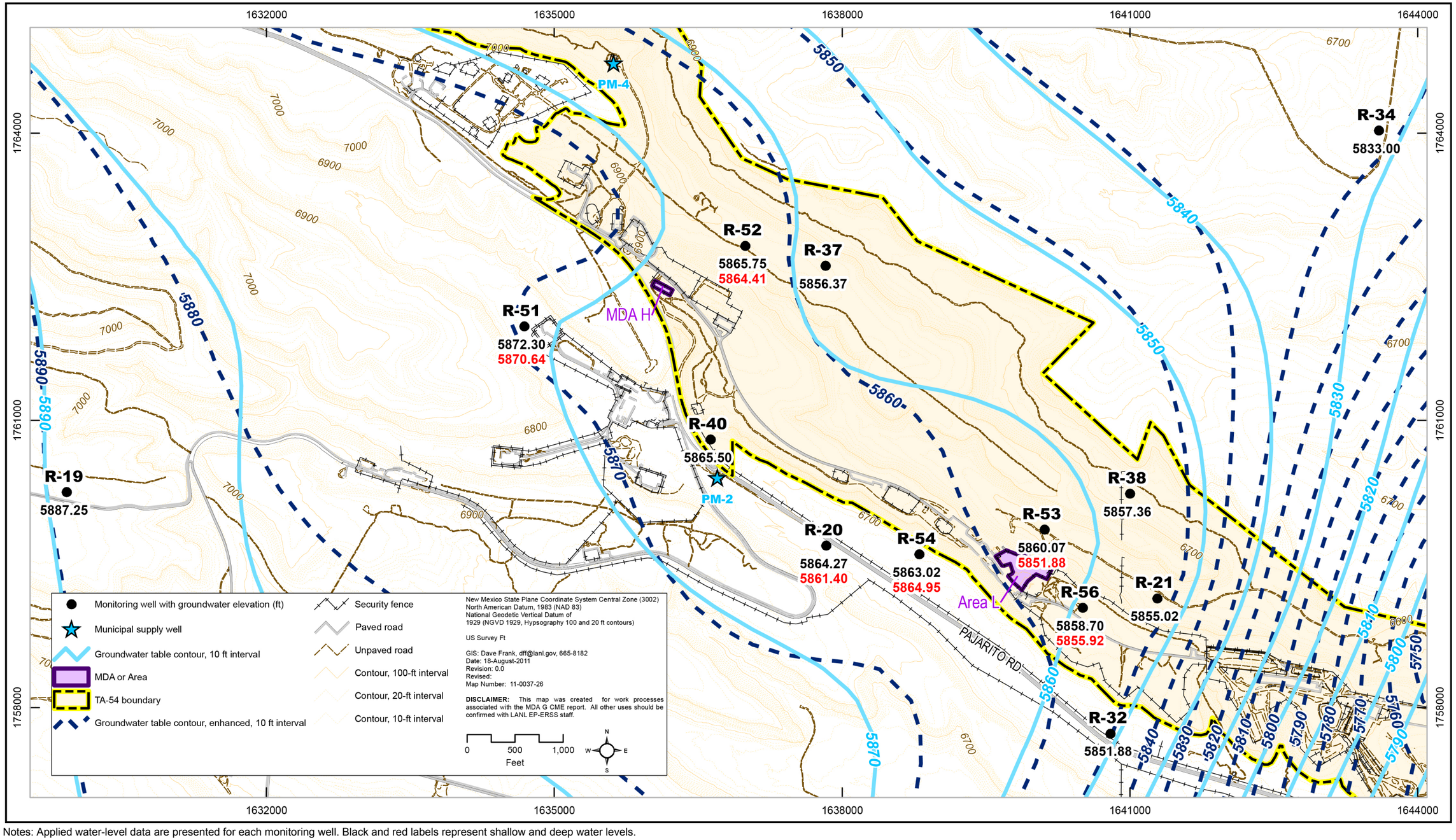
Note: Applied water-level data are presented for each monitoring well. Water-level contours in Figures E-3.3-1 and E-3.3-2 are equivalent.

Figure E-3.3-2 Water-level contour map representative of the regional water-table near MDA L; the map is based on February 2011 water levels measured in the shallowest screens in the monitoring wells



Note: Applied water-level data are presented for each monitoring well.

Figure E-3.3-3 Water-level contour map representative of the groundwater flow in the deeper section of the regional aquifer (about 100 ft below the regional water table) near MDA L; the map is based on February 2011 water levels measured in the deep screens of the regional monitoring wells (average distance between the shallow and deep screens in the wells is about 100 ft)



Notes: Applied water-level data are presented for each monitoring well. Black and red labels represent shallow and deep water levels.

Figure E-3.3-4 Comparison of the water-level contour maps presented in Figures E-3.3-2 and E-3.3-3; the light and dark blue contours represent the shallow and deep sections of the aquifer, respectively

Table E-3.1-1
Hydrogeologic Characteristics of the Regional Monitoring Wells in the Area Near MDA L

Well Screen	k (ft/d)	Unit	Submergence below the Water Table	Hydrodynamic Conditions	Comments
R-40 #2	4	Tpf mixed with Tpt	-4	Unconfined	Well screen straddles the regional water table; hydraulic connection between the regional aquifer and the overlying perched zone (screened at R-40 screen 1 and R-40i) is not known.
R-20 #1	1	Cinder deposits below Tb4	~77	Unconfined or partly confined	Observed water level is slightly below (~5–10 ft) the contact between the screened cinder deposits and the overlying Tb4; Because of substantial submergence of the screen, the elevation of regional water table is expected to be higher than the observed water level; regional water table might be located within the overlying Tb4 or close to the contact between cinders and lavas.
R-20 #2	1	Tjfp	317	Confined	None
R-20 #3	1	Tcar	407	Confined	Plugged and abandoned
R-54 #1	5	Tpf	13	Unconfined or partly confined	Observed water level is almost coinciding with the contact between the screened sediments and the overlying lavas (Tb4).
R-54 #2	58	Tpf	~100	Unconfined or partly confined	None
R-53 #1	26	Tpf mixed with Tpt	20	Unconfined or partly confined	Pumping test complicated because of gases in the aquifer Observed water level is slightly below (~2 ft) the contact between the screened sediments and the overlying lavas (Tb4).
R-53 #2	7	Tpf mixed with Tpt	~120	Unconfined or partly confined	Drawdown equilibration at late pumping times; boundary effects
R-56 #1	7	Tpf	23	Unconfined or partly confined	Observed water level is within the overlying lavas (Tb4); the regional water table is located within the overlying Tb4 and its elevation is expected to be slightly higher than the observed water level; drawdown equilibration at late pumping times; boundary effects.
R-56 #2	7	Tpf	120	Confined	Drawdown equilibration at late pumping times; boundary effects
R-38	37	Tpf	11	Unconfined	Observed water level is within the overlying lavas (Tb4). Regional water table is located within the overlying lavas (Tb4) and its elevation is expected to be slightly higher than the observed water level. No drawdown equilibration at late pumping times; boundary effects.

Table E-3.1-1 (continued)

Well Screen	k (ft/d)	Unit	Submergence below the Water Table	Hydrodynamic Conditions	Comments
R-21	1	Tpf	85	Confined	Observed water level is within the overlying lavas (Tb4) Because of substantial submergence of the screen, the elevation of regional water table is expected to be higher than the observed water level;
R-32 #1	10	River gravels (Tpt) within Tb4	70	Unconfined or partly confined	Regional water table is located within the overlying lavas (Tb4) Because of substantial submergence of the screen, the elevation of regional water table is expected to be higher than the observed water level.
R-32 #2	ND	Tpf	135	Confined	Plugged and abandoned
R-32 #3	0.5	Tpf	200	Confined	Plugged and abandoned

Note: Wells are ordered from west to east, approximately following the general groundwater flow directions of the regional aquifer.

Table E-3.1-2
Estimates of Effective Aquifer Hydraulic Properties in the Area Near MDA L Based on Analysis of the Water-Level Transients Observed at the Monitoring Wells Caused by Water-Supply Pumping at PM-2 and PM-4

Well Screen	PM-2		PM-4		Comment
	Transmissivity (m^2/d)	Specific Storage (-)	Transmissivity (m^2/d)	Specific Storage (-)	
R-40 #2	ND[a]	ND	4.4E+02	8.2E-03	Responses to PM-2 (~2 ft) and PM-4 (~0.75 ft based on the existing data)
R-37 #2	ND	ND	2.3E+02	9.1E-02	Response to PM-2 and PM-4 (~2 ft based on the existing data)
R-20 #1	4.2E+03	3.9E-02	8.5E+03	1.5E-02	Responses to PM-2 and PM-4 only
R-20 #2	1.9E+03	6.2E-03	3.2E+03	8.9E-04	Responses to PM-2 and PM-4 only
R-20 #3	4.5E+02	9.1E-04	7.9E+02	2.2E-05	Responses to PM-2 and PM-4 only
R-54 #1	—[b]	—	—	—	No apparent or very small water-supply pumping response (more data are needed)
R-54 #2	ND	ND	1.7E+02	7.8E-03	Responses to PM-2 and PM-4 (~2.5 ft based on the existing data); Responses to PM-2 also expected
R-53 #1	—	—	—	—	No apparent or very small water-supply pumping response (more data are needed)
R-53 #2	ND	ND	7.2E+02	5.0E-03	Responses to PM-4 (~2 ft based on the existing data); Responses to PM-2 also expected
R-56 #1	—	—	—	—	No apparent or very small water-supply pumping response (more data are needed)
R-56 #2	ND	ND	3.9E+02	9.1E-03	Responses to PM-4 (~1 ft based on the existing data); Responses to PM-2 also expected
R-38	—	—	—	—	No apparent water-supply pumping response
R-21	1.7E+03	2.9E-02	1.1E+03	9.3E-03	Responses to PM-2 and PM-4 only
R-32 #1	—	—	—	—	No apparent water-supply pumping response
R-32 #2	3.1E+03	6.0E-03	3.8E+03	2.5E-03	Responses to PM-2 and PM-4 only
R-32 #3	3.1E+03	2.9E-03	4.0E+03	1.5E-03	Responses to PM-2 and PM-4 only

Note: Wells are ordered from west to east, approximately following the general groundwater flow direction of the regional aquifer.

[a] ND = Not determined because PM-2 was not actively used for water supply during the period of observation.

[b] — = Not determined because there is no apparent water-level response to water-supply pumping during the period of observation.

Table E-3.1-3
Vertical Component of the Hydraulic Gradient at the Monitoring Wells Near TA-54

Well	Value
R-51	0.02
R-52	0.03
R-20	0.2
R-54	−0.03
R-53	0.09
R-56	0.05
R-32	0.02
R-49	0.4
R-57	0.2
R-22	0.2
R-55	0.03

Notes: Wells are ordered from west to east, approximately following the general groundwater flow directions of the regional aquifer. The vertical distance between the screens does not account for the extent of the filter pack.

Table E-3.1-4
Barometric Efficiency of the Monitoring Well Screens Near MDA L Based on Hourly Water-Level Data

Well	Screen	Barometric Efficiency (%)	Time Lag (h)	Earth-Tide Response
R-40	R-40 #2	100	2	N
R-37	R-37 #2	100	1	N
R-20	R-20 #1	100	2	N
R-20	R-20 #2	80	24	Y
R-20	R-20 #3	—*	—	—
R-54	R-54 #1	100	1	N
R-54	R-54 #2	85	24	Y
R-53	R-53 #1	80	3	Y
R-53	R-53 #2	100	16	Y
R-56	R-56 #1	100	1	Possible
R-56	R-56 #2	100	4	Y
R-38	R-38 #1	55	24	Possible
R-21	R-21 #1	100	1	Possible
R-32	R-32 #1	100	2	Y
R-32	R-32 #2	80	5	Y
R-32	R-32 #3	100	16	Y

Note: Wells are ordered from west to east, approximately following the general groundwater flow directions of the regional aquifer.

*— = Response to PM-2 and PM-4 pumping inhibits evaluation.

Appendix F

Supporting Information for
Cost Estimates for Material Disposal Area L

F-1.0 INTRODUCTION

This appendix provides the basis for the cost estimates, summary cost information, assumptions, estimate details, and material and labor pricing data used in developing the cost estimates for corrective measures evaluation (CME) alternatives for Material Disposal Area (MDA) L at Technical Area 54 (TA-54) at Los Alamos National Laboratory (the Laboratory) (section 8 of the CME report). The estimates are intended to be consistent with U.S. Environmental Protection Agency (EPA) guidance on developing and documenting costs estimated during feasibility studies (EPA 2000, 071540). Cost estimates are expected to be within the accepted standard accuracy range of +50% to –30% established by EPA for remedial alternative estimates at the alternatives screening stage (EPA 2000, 071540, p. 2-4).

Five corrective measures alternatives were retained and have been brought forward for cost estimating purposes. These are in addition to the no-action alternative.

F-1.1 Compliance Order on Consent Requirements

The Compliance Order on Consent (Consent Order) requires the following: capital costs shall include, without limitation, construction and installation costs; equipment costs; land development costs; and indirect costs, including engineering costs, legal fees, permitting fees, startup and shakedown costs, and contingency allowances. Operations and maintenance (O&M) costs shall include, without limitation, operating labor and materials costs, maintenance labor and materials costs, replacement costs, utilities, monitoring and reporting costs, administrative costs, indirect costs, and contingency allowances. All costs shall be calculated based on their net present value (PV).

As presented in guidance documents, confusion often exists with the terms “direct” and “indirect” costs. Therefore, in this report the term “capital” costs includes planning, design, construction, management-related activities, and both labor and professional services for installing the remedial alternative. Recurring operations, maintenance, and monitoring costs, including regular annual costs and periodic costs, are separated out from capital costs. Periodic costs include 5-yr reviews, equipment replacement, and major repairs.

F-2.0 METHOD

The cost estimates have been developed based on a bottom-up approach using WINEST cost estimating software. The assumptions used in the calculations are discussed in section F-3.0. The construction pricing is based on the 2010 RS Means Database for equipment and materials and the current Davis Bacon Wage Rates for construction in Los Alamos. RS Means is a comprehensive database of industry averages for materials, labor, and equipment. Line items contain descriptions of appropriate materials, labor, and equipment to successfully perform particular tasks.

An example line item follows for installation of a fence:

> Fence, chain link industrial, aluminized steel, 6-gauge wire, 2-1/2-in. posts @ 10-ft on center, 8-ft high, includes excavation, in concrete, excludes barbed wire

For this line item, RS Means has taken an industry average of the cost of materials for a particular task, including aluminized 6-gauge steel wire; 2-1/2-in.-diameter, 8-ft-long posts; and concrete, not including barbed wire. This average includes the labor cost to string the aluminized wire, excavate post holes, set

the posts, and mix and place concrete and also includes any equipment costs for performing the excavation.

A labor factor was used to increase the project cost on labor because of the remote location of the site or for additional rigor for a site. The basic estimating units generally reflect a normal standard for construction costs. Many special work situations and job conditions may require additional material or labor work hours. The quantities used here are for estimating purposes only and vary slightly from quantities stated within the waste inventory, section 2.3. The actual design and operations costs will vary from these estimates when the corrective measure implementation (CMI) is completed.

F-2.1 Capital Costs

Capital costs include both direct and indirect costs. The capital costs consist of construction and installation costs; equipment costs; land development costs; distributables; and indirect costs, including engineering design costs, legal fees, permitting fees, professional management startup and shakedown costs, and contingency allowances. Detailed estimates of capital costs in calendar year 2010 dollars are provided below and in section 8 tables of the CME report.

The distributable costs include Field Non-Manual, which is calculated as 20% of direct capital labor hours, Craft Distributable–Labor, which is calculated as 25% of direct capital labor hours, and Craft Distributable–Materials which in this estimate include a $7 per direct job hour cost to account for the nonlabor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. For example,

> Site Fencing Labor Hours (465) + RCRA Cover Labor Hours (5540) + SVE Labor Hours (5933) = 11,938 hours * 20% = 2387 hr of Field Non-Manual.
>
> Site Fencing Labor Hours (465) + RCRA Cover Labor Hours (5540) + SVE Labor Hours (5933) = 11,938 hours * 25% = 2984 hr of Craft Distributable–Labor.
>
> Site Fencing Labor Hours (465) + RCRA Cover Labor Hours (5540) + SVE Labor Hours (5933) = 11,938 hours * 25% = 2,984 hr * $7/hr = $20,888 which is then burdened with applicable taxes including, NMGRT, G&A, Infrastructure, and AD Support Taxes for a Total Craft Distributable–Material Cost of $35,741.

The design costs were calculated as 16% of the total direct capital costs. For example,

> Site Fence Total ($162,835) + RCRA Cover Total ($1,885,806) + SVE Total ($1,169,387) + Distributable Total ($542,282) = $3,760,310 * 16% = $601,649 which is then burdened with applicable taxes including, NMGRT, G&A, Infrastructure, and AD Support Taxes for a Total Design Cost of $875,941.

The professional management costs were calculated as 26% of the total direct capital costs and design. For example,

> Site Fence Total ($162,835) + RCRA Cover Total ($1,885,806) + SVE Total ($1,169,387) + Distributable Total ($542,282) + Design Total ($875,941) = $4,636,251 * 26% = $1,205,425 which is then burdened with applicable taxes including, NMGRT, G&A, Infrastructure, and AD Support Taxes for a Total professional management cost of $2,641,242.

The contingency costs were calculated as 50% of the total direct capital costs plus design and professional management costs. For example,

> Total Direct Capital Costs ($3,760,310) + Design Costs ($875,941) + Professional Management Costs ($2,641,242) = $7,277,493 * 50% = $3,638,746.

F-2.2 Operations and Maintenance Costs

O&M costs include both direct and indirect costs. The O&M costs include operating labor and materials costs, maintenance labor and materials costs, replacement costs, utilities, monitoring and reporting costs, administrative costs, O&M associated indirect costs, and contingency allowances. Estimates of O&M costs in 2010 dollars are provided below and in section 8 tables of the CME report.

The professional management costs were calculated as 26% of the total direct O&M costs prior to PV analysis. The costs are then discounted based on the PV analysis discussed below in section F-2.3.

The contingency costs were calculated as 50% of the total direct O&M costs plus professional management costs. For example,

> Total Direct O&M Costs ($4,495,254) + Professional Management O&M Costs ($1,546,856) = $6,042,110 * 50% = $3,021,055.

F-2.3 PV Analysis

To compare one alternative's costs with other alternative's costs over different time periods, the costs were discounted to a 2010 PV, as recommended in "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (EPA 2000, 071540). PV costs for a technology are the sum of all capital costs and continuing costs. Presentation of capital and O&M costs as PV is consistent with the CME requirements contained in Section VII.D.4.b.v of the Consent Order. The principle is also embraced for federal programs. The Office of Management and Budget (OMB) circular A-94 states, "The standard criterion for deciding whether a government program can be justified on economic principles is net present value" (Office of Management and Budget 1992, 094804, p. 3). The OMB circular Appendix C (revised December 2009) recommends the use of a real discount rate of 0.9% for activities lasting 3 yr and 2.7% for activities lasting between 20 and 30 yr. These assumptions have been used in the calculation of the net PV for the alternatives within this CME.

Net PV was calculated according to the following formula:

$$PV_{total} = \sum_{t=1}^{t=n} \frac{1}{(1+i)^t} \cdot C_t$$

where PV_{total} = present single sum of money,
t = specific year,
n = final project year,
i = the discounted interest rate, and
C_t = cost in year t in base-year dollars.

The discount factor, the $1/(1+i)^t$ term from the PV equation, has been calculated for the interest rates listed above. The PV analyses are presented in the cost estimate tables in section 8 of the CME report.

F-2.4 General Assumptions

The estimates are based on an 8-h work day and 5-d work week. No overtime is included. On-site activities will be conducted under Hazardous Waste Operations and Emergency Response requirements. Safety levels are based on the Occupational Safety and Health Administration regulations in 29 Code of Federal Regulations Part 1910. Most activities are set to safety level D. All appropriate site-related plans (e.g., general safety plan, quality assurance plan, waste management plan, work plan, hoisting and rigging plan, and health and safety plan) will be prepared and submitted by the subcontractor. All plans will be reviewed and approved by the Laboratory as necessary so as not to adversely impact the project schedule.

Labor rates, waste disposal rates, and material pricing were based on 2010 RS Means rates.

The burdens included NMGRT applied to total costs at a defined recovery rate of 5.5%, G&A at 38%, infrastructure at 21.5%, and AD support at 29%.

The project was assumed to be a DOE on-site not DP project and escalation was not accounted for.

- Three years of SVE and rebound vapor monitoring are assumed for cost estimation purposes for Alternatives 2A, 2B, 3A, 3B, and 4. However, SVE operations will continue until shut down parameters are achieved as described in Appendix I. Attachment F-1 is the detailed cost assembly report for the estimates described below.

F-3.0 MDA L ALTERNATIVES

Five corrective measures alternatives, plus the no-action alternative, are described below.

F-3.1 Alternative 1: No Action

This alternative involves leaving the site as is. No costs are involved with this alternative.

F-3.2 Alternative 2A: Multilayer Cover, SVE, and Institutional Controls

This technology includes the following tasks:

- site preparation of the existing soil surface and installation of a multilayer cover (Resource Conservation and Recovery Act [RCRA] Subtitle C cover) over the shafts, pit, and impoundments
- SVE to remove volatile organic compounds (VOCs)
- vapor monitoring for 30 yr
- maintenance of the cover and institutional controls for 100 yr
- preparation of an annual long-term monitoring report for 100 yr

F-3.2.1 Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Area to be covered by the multilayer (RCRA) cover is 0.90 acres.
- Fencing around the site will total 1450 ft.

- Construction of the multilayer (RCRA) cover will consist of
  - site preparation of the existing soil surface and cover preparation, which includes 3 ft of operational cover above the waste material;
  - a 2-ft layer of compacted natural or amended soil with a maximum saturated hydraulic conductivity of 1×10^{-7} cm/s;
  - a 40-mil flexible geomembrane liner, such as high-density polyethylene (HDPE), to limit downward moisture movement;
  - a 1-ft drainage layer of sand having a minimum saturated hydraulic conductivity of 1×10^{-2} cm/s;
  - a 2-ft soil and vegetation layer graded at slopes between 3% and 5%; and
  - shoulder fill to meet grades and armoring of slopes with the assumption of 15-ft-wide riprap around the circumference of the cover.
- Time to complete construction will be 6 mo; irrigation will continue for 1 yr.
- Shoulder fill material and armoring material parametric unit costs are higher than other cover materials due to the increase in hand labor needed to place these on steeper slopes.
- No time-domain reflectometers (TDRs) will be installed because of the construction of a drainage collection system in the RCRA cover.
- Site maintenance, including visual inspection, removal of debris and large woody plants, and erosion control for the entire site, will continue for 100 yr.
- Site maintenance includes periodic revegetation of bare areas and mowing of the entire site every 5 yr.
- Four existing Flexible Liner Underground Technologies (FLUTe) monitoring boreholes will be removed.
- Five existing FLUTe monitoring boreholes will be converted to stainless-steel sampling systems.
- Operation of SVE will continue for 3 yr.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Three 10-in.-diameter extraction boreholes will be installed to a depth of 300 ft.
- Construction of each borehole will require 2 wk.
- SVE operations will involve three SVE units operating 30 d at each of the nine boreholes once per year for 3 yr.
- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples at 9 boreholes (45 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per year, at 19 ports (171 samples/yr).
- Yearly vapor monitoring will consist of 72 ports each sampled once per year (72 samples) for 27 yr.
- Indirect O&M cost for professional management is based on 26% of direct O&M costs. These costs will vary as O&M costs vary, such as when subsurface VOC vapor monitoring is complete at the end of the first 30 yr.

- Design costs are calculated using the percentage method, which calculates the design cost as a percentage of direct capital costs (16% of direct capital costs).
- Contingency is based on 50% total for both direct and indirect costs.

F-3.3 Alternative 2B: ET Cover, SVE, and Institutional Controls

This technology includes the following tasks:

- site preparation of the existing soil surface and installation of an evapotranspiration (ET) cover over the shafts, pit, and impoundments
- SVE to remove VOCs
- vapor monitoring for 30 yr
- maintenance of the cover and institutional controls for 100 yr
- preparation of an annual long-term monitoring report for 100 yr

F-3.3.1 Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Area to be covered by the ET cover is 0.90 acres.
- Fencing around the site will total 1450 ft.
- Construction of the ET cover will consist of
    - site preparation the existing soil surface and cover preparation, which includes 3 ft of operational cover above the waste material;
    - a 1-ft layer of angular cobbles with a minimum diameter of 4 to 6 in. to act as a biointrusion barrier;
    - a 0.5-ft layer of sand and gravel mixture to prevent the mixing of soil layers;
    - a 3.5-ft layer of natural or amended soil meeting the water storage capacity of a typical sandy loam;
    - a 1.5-ft layer of natural or amended soil and vegetation, with minimal slopes, to ensure a desired stand of vegetation is maintained; and
    - shoulder fill to meet grades and armoring of slopes with the assumption of 15-ft-wide riprap around the circumference of the cover.
- Time to complete construction will be 6 mo; irrigation will continue for 1 yr.
- Shoulder fill material and armoring material parametric unit costs are higher than other cover materials due to the increase in hand labor needed to place these on steeper slopes.
- TDRs will be installed for moisture monitoring.
- Site maintenance, including visual inspection, removal of debris and large woody plants, and erosion control for the entire site, will continue for 100 yr.
- Site maintenance includes periodic revegetation of bare areas and mowing of the entire site every 5 yr.

- Four existing FLUTe monitoring boreholes will be removed.
- Five existing FLUTe monitoring boreholes will be converted to stainless-steel sampling systems.
- Operation of SVE will continue for 3 yr.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Three 10-in.-diameter extraction boreholes will be installed to a depth of 300 ft.
- Construction of each borehole will require 2 wk.
- SVE operations: will involve three SVE units operating 30 d at each of the nine boreholes once per year for 3 yr.
- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples at 9 boreholes (45 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per year, at 19 ports (171 samples/yr).
- Yearly vapor monitoring will consist of 75 ports each sampled once per year (75 samples) for 27 yr.
- Indirect O&M cost for professional management is based on 26% of direct O&M costs. These costs will vary as O&M costs vary, such as when subsurface VOC vapor monitoring is complete at the end of the first 30 yr.
- Design costs are calculated using the percentage method (16% of direct capital costs).
- Contingency is based on 50% total of prior costs.

F-3.4 Alternative 3A: Multilayer Cover (shafts), Excavation (pit and impoundments), SVE, and Institutional Controls

This technology includes the following tasks:

- excavation of the waste in the pit and impoundments using standard excavation methods
- analysis and segregation of the waste
- site preparation and installation of a multilayer (RCRA) cover over the shafts
- SVE to remove VOCs
- vapor monitoring for 30 yr
- maintenance of the cover and institutional controls for 100 yr
- preparation of an annual long-term monitoring report for 100 yr

F-3.4.1 Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Excavation and disposal activities for the pit and impoundments will be complete within 1 yr.
- Excavation volume of 3250 yd^3 of materials is based on the profile shown in Figure F-3.4-1 and a length of 240 ft for Pit A, 80 ft for Impoundment B, 40 ft for Impoundment C, and 90 ft for Impoundment D (see Table F-3.4-1).

- Excavation volume of road access material is 7194 yd^3 based on a road 740 ft long, 35 ft wide, and 15 ft deep; all material is assumed to be clean and can be returned to the site.
- Any environmental media meeting the residential exposure standards will be replaced in the original excavation (estimated to be 31% of excavated material, which is 1008 yd^3).
- Disposal of approximately 2243 yd^3 of waste is estimated to account for 69% of excavated material costs.
- Area to be covered by the multilayer (RCRA) cover is 0.40 acres
- Fencing around the site will total 1450 ft.
- Construction of the multilayer (RCRA) cover will consist of
    - regrading the existing soil surface and cover preparation, which includes 3 ft of operational cover above the waste material;
    - a 2-ft layer of compacted natural or amended soil with a maximum saturated hydraulic conductivity of 1×10^{-7} cm/s;
    - a 40-mil flexible geomembrane liner, such as HDPE, to limit downward moisture movement;
    - a 1-ft drainage layer of sand having a minimum saturated hydraulic conductivity of 1×10^{-2} cm/s;
    - a 2-ft soil and vegetation layer graded at slopes between 3% and 5%; and
    - shoulder fill to meet grades and armoring of slopes with the assumption of 15-ft-wide riprap around the circumference of the cover.
- Time to complete construction of cover will be 6 mo; irrigation will continue for 1 yr.
- Shoulder fill material and armoring material parametric unit costs are higher than other cover materials due to the increase in hand labor needed to place these on steeper slopes.
- No TDRs will be installed due to the construction of a drainage collection system in the RCRA cover.
- Site maintenance, including visual inspection, removal of debris and large woody plants, and erosion control for the entire site, will continue for 100 yr.
- Site maintenance includes periodic revegetation of bare areas and mowing of the entire site every 5 yr.
- Four existing FLUTe monitoring boreholes will be removed.
- Five existing FLUTe monitoring boreholes will be converted to stainless-steel sampling systems.
- Operation of SVE will continue for 3 yr.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Three 10-in.-diameter extraction boreholes will be installed to a depth of 300 ft.
- Construction of each borehole will require 2 wk.
- SVE operations will involve three SVE units operating 30 d at each of the nine boreholes once per year for 3 yr.

- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples at 9 boreholes (45 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per year, at 19 ports (171 samples/yr).
- Yearly vapor monitoring will consist of 75 ports each sampled once per year (75 samples) for 27 yr.
- Indirect O&M cost for Professional Management is based on 26% of direct O&M costs. These costs will vary as O&M costs vary, such as when subsurface VOC vapor monitoring is complete at the end of the first 30 yr.
- Design costs are calculated using the percentage method (16% of direct capital costs).
- Contingency is based on 50% total of prior costs.

F-3.5 Alternative 3B: ET Cover (shafts), Excavation (pit and impoundments), SVE, and Institutional Controls

This technology includes the following tasks:

- excavation of the waste in the pit and impoundments using standard excavation methods
- analysis and segregation of the waste
- site preparation and installation of an ET cover over the shafts
- SVE to remove VOCs
- vapor monitoring for 30 yr
- maintenance of the cover and institutional controls for 100 yr
- preparation of an annual long-term monitoring report for 100 yr

F-3.5.1 Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Excavation and disposal activities will be complete within 1 yr.
- Excavation volume of 3250 yd^3 of materials is based on the profile shown in Figure F-3.4-1 and a length of 240 ft for Pit A, 80 ft for Impoundment B, 40 ft for Impoundment C, and 90 ft for Impoundment D (see Table F-3.4-1).
- Excavation volume of road access material is 7194 yd^3 based on a road 740 ft long, 35 ft wide, and 15 ft deep; all material is assumed to be clean and can be returned to the site.
- Any environmental media meeting the residential exposure standards will be replaced in the original excavation of (estimated to be 31% of excavated material, which is 1008 yd^3).
- Disposal of approximately 2243 yd^3 of waste is estimated to account for 69% of excavated material costs.
- Area to be covered by the ET cover is 0.40 acres.
- Fencing around the site will total 1450 ft.

- Construction of the ET cover will consist of
  - site preparation the existing soil surface and cover preparation, which includes 3 ft of operational cover above the waste material;
  - a 1-ft layer of angular cobbles with a minimum diameter of 4 to 6 in. to act as a biointrusion barrier;
  - a 0.5-ft layer of sand and gravel mixture to prevent the mixing of soil layers;
  - a 3.5-ft layer of natural or amended soil meeting the water storage capacity of a typical sandy loam;
  - a 1.5-ft layer of natural or amended soil and vegetation, with minimal slopes, to ensure a desired stand of vegetation is maintained; and
  - shoulder fill to meet grades and armoring of slopes with the assumption of 15-ft-wide riprap around the circumference of the cover.
- Time to complete construction of cover will be 6 mo; irrigation will continue for 1 yr.
- Shoulder fill material and armoring material parametric unit costs are higher than other cover materials due to the increase in hand labor needed to place these on steeper slopes.
- TDRs will be installed for moisture monitoring.
- Site maintenance, including visual inspection, removal of debris and large woody plants, and erosion control for the entire site, will continue for 100 yr.
- Site maintenance includes periodic revegetation of bare areas and mowing of the entire site every 5 yr.
- Four existing FLUTe monitoring boreholes will be removed.
- Five existing FLUTe monitoring boreholes will be converted to stainless-steel sampling systems.
- Operation of SVE will continue for 3 yr.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Three 10-in.-diameter extraction boreholes will be installed to a depth of 300 ft.
- Construction of each borehole will require 2 wk.
- SVE operations will involve three SVE units operating 30 d at each of the nine boreholes once per year for 3 yr.
- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples at 9 boreholes (45 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per year, at 19 ports (171 samples/yr).
- Yearly vapor monitoring will consist of 75 ports each sampled once per year (75 samples) for 27 yr.
- Indirect O&M cost for professional management is based on 26% of direct O&M costs. These costs will vary as O&M costs vary, such as when subsurface VOC vapor monitoring is complete at the end of the first 30 yr.

- Design costs are calculated using the percentage method (16% of direct capital costs).
- Contingency is based on 50% total of prior costs.

F.3.6 Alternative 4: Excavation, SVE, and Institutional Controls

This technology includes the following tasks:

- Excavation of the waste in the shafts, pit, and impoundments using standard excavation methods
- Analysis and segregation of the waste

F-3.6.1 Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Excavation and disposal activities will be complete within 1 yr.
- Fencing around the site will total 1450 ft.
- Excavation volume for the shafts will consist of 32,019 yd^3 of materials based on the profile shown in Figure F-3.6-1 and a length of 80 ft for the length of the shafts in the northwest corner, 235 ft for the length of the shafts in the southeast corner, and 65 ft for the length of the shafts in the east corner (see Table F-3.4-1).
- Excavation volume of road access to the shafts is 38,338 yd^3 based on a road 910 ft long, 35 ft wide, and 65 ft deep. All material is assumed to be clean and can be returned to the site.
- Any environmental media meeting the residential exposure standards will be replaced in the original excavation for the shafts (estimated to be 88% of excavated material, which is 28,177 yd^3).
- Disposal of approximately 3842 yd^3 of waste from the shafts is estimated to account for 12% of excavated material costs.
- Excavation volume for the pit and impoundments of 3250 yd^3 of materials is based on the profile shown in Figure F-3.4-1 and a length of 240 ft for Pit A, 80 ft for Impoundment B, 40 ft for Impoundment C, and 90 ft for Impoundment D.
- Excavation volume of road access to the pit and impoundments is 7194 yd^3 based on a road 740 ft long, 35 ft wide, and 15 ft deep; All material is assumed to be clean and can be returned to the site.
- Any environmental media meeting the residential exposure standards will be replaced in the original excavation for the pit and impoundments (estimated to be 31% of excavated material, which is 1008 yd^3).
- Disposal of approximately 2243 yd^3 of waste from the pit and impoundments is estimated to account for 69% of excavated material costs.
- Operation of SVE will continue for 3 yr.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Three 10-in.-diameter extraction boreholes will be installed to a depth of 300 ft.
- Construction of each borehole will require 2 wk.

- SVE operations: will involve three SVE units operating 90 d at each of the nine boreholes for 3 yr.
- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples at 9 boreholes (45 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per year, at 19 ports (171 samples/yr).
- Indirect O&M cost for professional management is based on 26% of direct O&M costs. These costs will vary as O&M costs vary, such as when subsurface VOC vapor monitoring is complete at the end of the first 30 yr.
- Design costs are calculated using the percentage method (16% of direct capital costs).
- Contingency is based on 50% total of prior costs.

F-4.0 REFERENCES

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

Copies of the master reference set are maintained at the 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.

EPA (U.S. Environmental Protection Agency), July 2000. "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study," EPA 540-R-00-002, prepared by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency Office of Emergency and Remedial Response, Washington, D.C. (EPA 2000, 071540)

Office of Management and Budget, October 29, 1992. "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," Circular No. A-94, Washington, D.C. (Office of Management and Budget 1992, 094804)

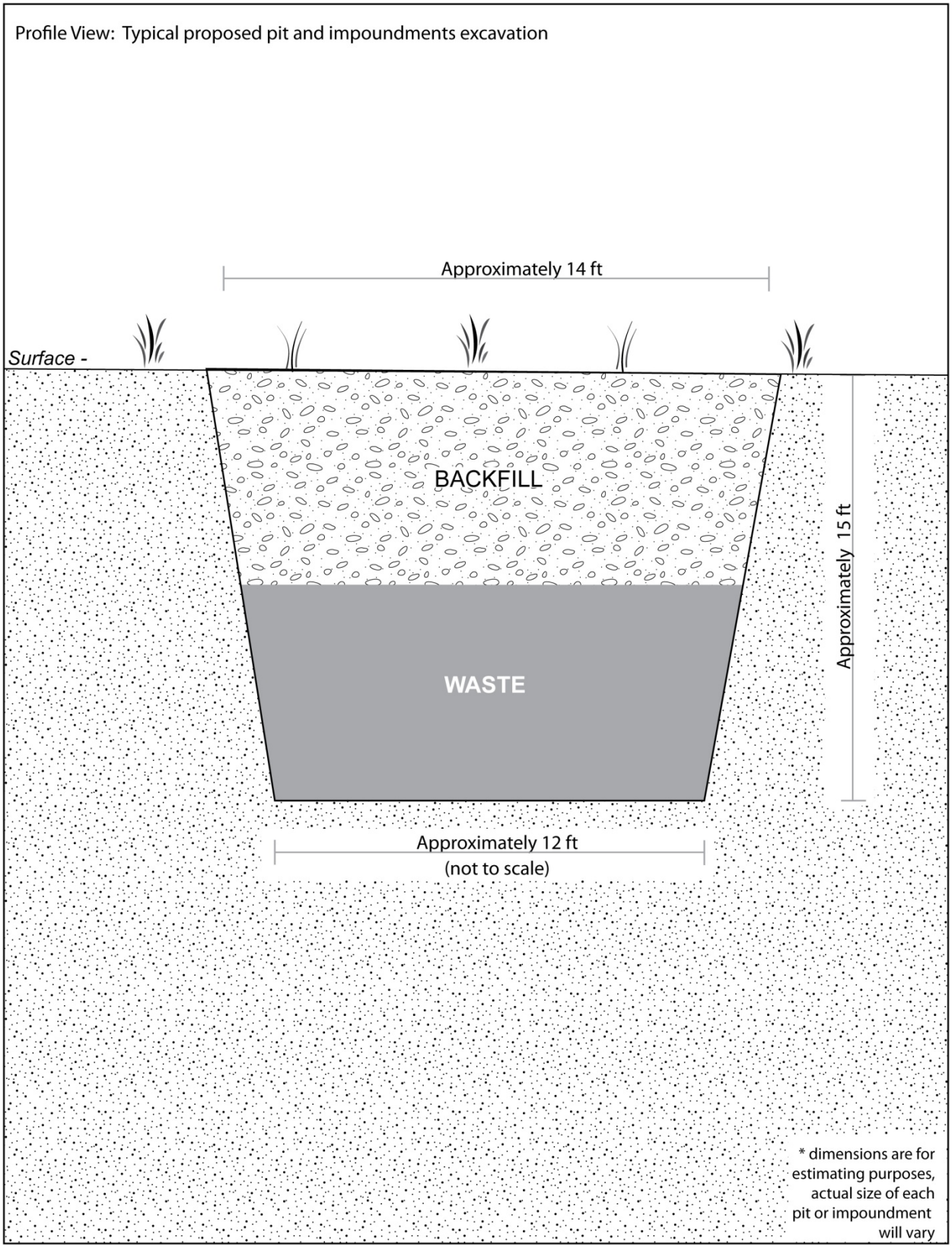


Figure F-3.4-1 Typical cross-section of pit and impoundment excavation

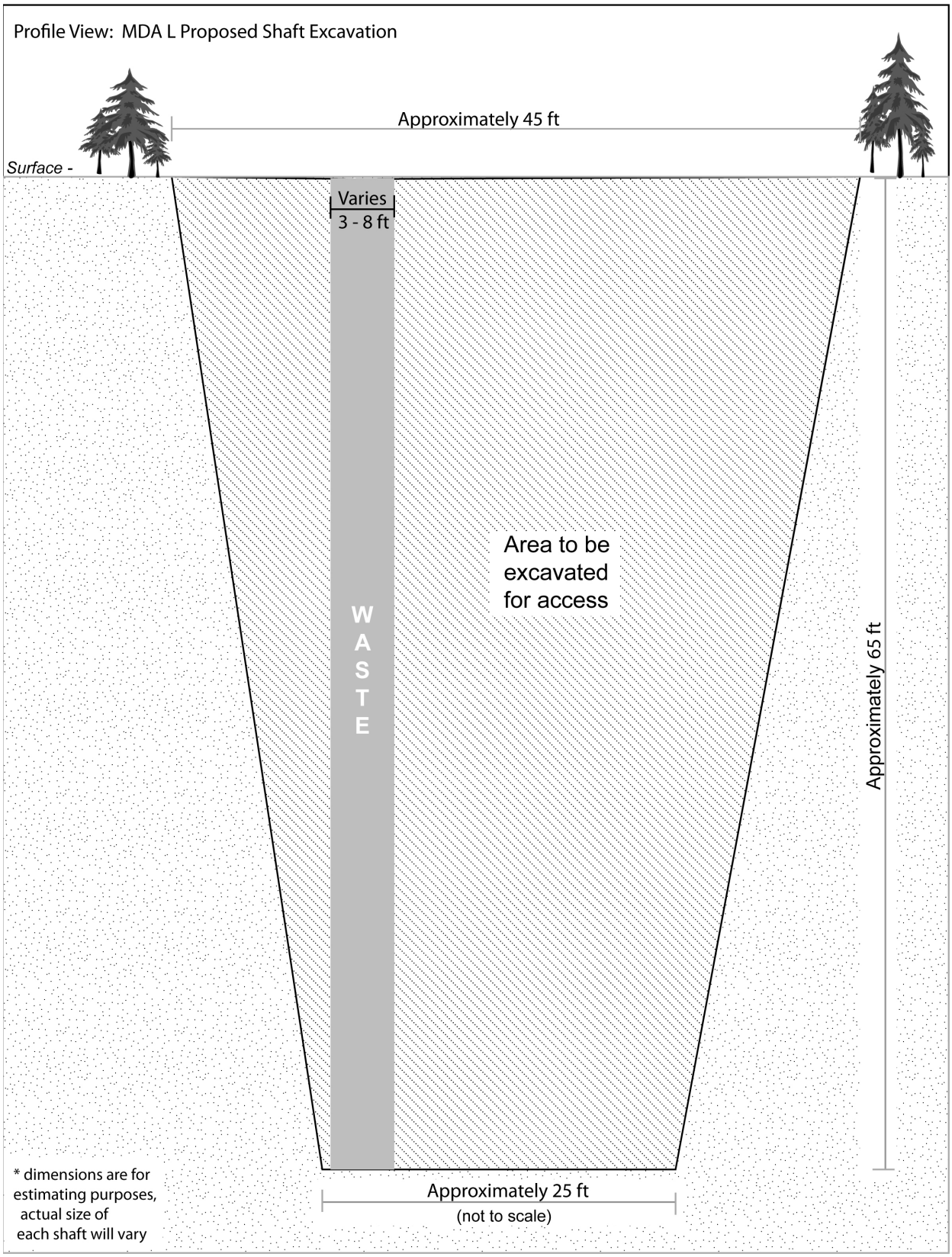


Figure F-3.6-1 Typical cross-section of shaft excavation

Table F-3.4-1
Estimated Volumes of Waste and Excavated Clean Fill in MDA L

Excavation Groupings	Surface Area Profile (ft^2)[a]	Length of Pit/Shaft (ft)[b]	Estimated Main Excavation Volume (yd^3)	Estimated Access Road Length (ft)[c]	Estimated Access Road Width (ft)[c]	Estimated Access Road Excavation Volume (yd^3)[d]	Estimated Total Waste Volume (yd^3)[e]	Estimated Material Suitable for Backfill (yd^3)[f]	Estimated Mixed Low-Level Waste (yd^3)	Estimated Material to Ship for Off-Site Disposal (yd^3)
Pit A	195	240	1733	n/a[g]	n/a	n/a	1196	537	173	1196
Impoundment B	195	80	578	n/a	n/a	n/a	399	179	58	399
Impoundment C	195	40	289	n/a	n/a	n/a	199	90	29	199
Impoundment D	195	90	650	740	35	7194	449	202	65	449
Percent of Estimated Main Excavation Volume (yd^3)							69%	31%	10%	69%
Shafts 1–34	2275	380	32019	910	35	38338	3842	28177	640	3842
Percent of Estimated Main Excavation Volume (yd^3)							12%	88%	2%	12%

[a] Surface area profile was developed from MDA L proposed pit and impoundments excavation profile view using outer limits.

[b] Length of pit/shaft was developed from MDA L plan view (80-ft NW shafts, 235-ft SE shafts, 65-ft SE shafts).

[c] Estimated access road length and width were developed from MDA L plan view.

[d] Estimated access road excavation volume was calculated using the road length, width mentioned above, and maximum pit depth as the third element, taking one-half of that value because the access road is a ramp.

[e] Estimated total waste volume: Calculated from total volume of excavation = 31%, reusable excavated material = 69%.

[f] Estimated materials suitable for backfill is 31% reusable excavated material.

[g] n/a = Not applicable.

Attachment F-1

Detailed Cost Estimate Report

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1	**Project WBS: Material Disposal Area "L" Feasability Study**										
1.MDAL2A	**Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls**										
1.MDAL2A.1	**Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L – Direct Capital Costs**										
1.MDAL2A.1.01	**Project WBS: RCRA Cover MDA L -DC- Fence**										
1.MDAL2A.1.01	**Project WBS: RCRA Cover MDA L -DC- Fence**										
1.MDAL2A.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' (	1,450.0	LF	56.72	352.2	28,129.44	109,169.41	3,423.95			140,723
1.MDAL2A.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire,	15.0	EA	162.19	16.4	1,308.81	2,695.01	159.13			4,163
1.MDAL2A.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, include	2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAL2A.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes p	20.0	EA	120.98	16.6	1,328.91	2,446.90	364.47			4,140
1.MDAL2A.1.01	**Total**				**465.4**	**37,165.62**	**119,958.02**	**5,710.01**			**162,834**
1.MDAL2A.1.01	**Total**				**465.4**	**37,165.62**	**119,958.02**	**5,710.01**			**162,834**
1.MDAL2A.1.02	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover**										
1.MDAL2A.1.02.01	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - Site Prep**										
1.MDAL2A.1.02.01	Selective clearing, brush, with brush saw, includes cutting and site cleanup,	0.9	acre	3,022.82	51.3	4,382.43		169.28			4,552
1.MDAL2A.1.02.01	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	10.0	EA	529.39	48.6	3,839.50		5,218.91			9,058
1.MDAL2A.1.02.01	Track out device	1.0	EA	5,234.35	5.5	400.99	8,555.60				8,957
1.MDAL2A.1.02.01	Clean out track out device.	8.0	EA	1,185.53	87.4	6,415.88		9,812.73			16,229
1.MDAL2A.1.02.01	Rent toilet portable chemical	10.0	mnth	400.00				6,844.48			6,844
1.MDAL2A.1.02.01	Chemical toilet cleaning.	10.0	mnth	946.50	163.8	10,231.92		5,963.83			16,196
1.MDAL2A.1.02.01	Chemical toilet cleaning (labor)	10.0	mnth	573.07	163.8	9,805.84					9,806
1.MDAL2A.1.02.01	Excavation permit	2.0	ea	700.00					2,395.57		2,396
1.MDAL2A.1.02.01	Lister support	24.0	hour	100.10	43.7	4,110.79					4,111
1.MDAL2A.1.02.01	Laydown - Base course drainage layers, aggregate base course for roadway	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAL2A.1.02.01	Laydown - Backfill, bulk, 6" to 12" lifts, dozer backfilling	1,481.0	CY	3.30	40.8	3,221.78		5,144.23			8,366
1.MDAL2A.1.02.01	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAL2A.1.02.01	**Total**				**734.5**	**53,409.42**	**109,853.86**	**44,604.07**	**2,395.57**		**210,263**
1.MDAL2A.1.02.02	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - Cover Prep**										
1.MDAL2A.1.02.02	Borrow, fill material only.	11,342.0	ton	20.50			397,854.05				397,854
1.MDAL2A.1.02.02	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	5,670.9	CY	4.46	205.6	17,563.86		25,714.50			43,278
1.MDAL2A.1.02.02	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	5,670.9	CY	4.62	374.7	32,015.13		12,809.91			44,825
1.MDAL2A.1.02.02	Water wagon 1,000 gal compaction	5,670.9	CY	0.44	68.1	4,255.11					4,255
1.MDAL2A.1.02.02	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	5,670.9	CY	0.94	52.0	4,112.17		5,046.03			9,158
1.MDAL2A.1.02.02	**Total**				**700.4**	**57,946.27**	**397,854.05**	**43,570.44**			**499,371**
1.MDAL2A.1.02.03	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - 2' of 10-7 Clay Compacted**										
1.MDAL2A.1.02.03	Clay backfill material delivered, medium cost, up to 20 miles haul distance (4	2,904.0	L.C.Y.	50.00			248,454.52				248,455
1.MDAL2A.1.02.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	2,904.0	CY	4.46	105.3	8,994.24		13,168.09			22,162
1.MDAL2A.1.02.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	2,904.0	CY	4.62	191.9	16,394.57		6,559.80			22,954
1.MDAL2A.1.02.03	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	2,904.0	CY	0.94	26.6	2,105.79		2,584.01			4,690
1.MDAL2A.1.02.03	Water wagon 1,000 gal compaction	2,904.0	CY	0.44	34.9	2,178.99					2,179
1.MDAL2A.1.02.03	Clay handling and rework	2,904.0	CY	34.44	812.7	69,443.15		101,668.78			171,112
1.MDAL2A.1.02.03	**Total**				**1,171.4**	**99,116.74**	**248,454.52**	**123,980.68**			**471,552**
1.MDAL2A.1.02.04	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - 40 mm HDPE Geomembrane**										
1.MDAL2A.1.02.04	40 mm HDPE Liner	4,573.8	SY	7.21	55.3	4,727.57	46,957.90	4,733.62			56,419
1.MDAL2A.1.02.04	Liner binding	1,960.2	SF	7.26	119.4	13,222.37	10,599.07	525.35			24,347
1.MDAL2A.1.02.04	**Total**				**174.7**	**17,949.94**	**57,556.97**	**5,258.97**			**80,766**
1.MDAL2A.1.02.05	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - 1' of 10-2 Drainage Laye**										
1.MDAL2A.1.02.05	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	1,452.0	CY	24.50			60,871.36				60,871
1.MDAL2A.1.02.05	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	1,452.0	CY	4.46	52.6	4,497.12		6,584.04			11,081
1.MDAL2A.1.02.05	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,452.0	CY	4.62	95.9	8,197.28		3,279.90			11,477
1.MDAL2A.1.02.05	Water wagon 1,000 gal compaction	1,452.0	CY	0.44	17.4	1,089.49					1,089
1.MDAL2A.1.02.05	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	1,452.0	CY	0.94	13.3	1,052.90		1,292.01			2,345
1.MDAL2A.1.02.05	**Total**				**179.3**	**14,836.79**	**60,871.36**	**11,155.95**			**86,864**
1.MDAL2A.1.02.06	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - 2' of Cover Soil/Surface Treatment**										
1.MDAL2A.1.02.06	TUFF - Borrow, fill material only.	2,904.0	ton	20.50			101,866.35				101,866
1.MDAL2A.1.02.06	Tuff - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, w	1,452.0	CY	4.46	52.6	4,497.12		6,584.04			11,081
1.MDAL2A.1.02.06	TUFF - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,452.0	CY	4.62	95.9	8,197.28		3,279.90			11,477
1.MDAL2A.1.02.06	TUFF - Water wagon 1,000 gal compaction	1,452.0	CY	0.44	17.4	1,089.49					1,089
1.MDAL2A.1.02.06	Soil - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, wi	1,452.0	CY	4.46	52.6	4,497.12		6,584.04			11,081
1.MDAL2A.1.02.06	Soil - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,452.0	CY	4.62	95.9	8,197.28		3,279.90			11,477
1.MDAL2A.1.02.06	Soil - Water wagon 1,000 gal compaction	1,452.0	CY	0.44	17.4	1,089.49					1,089
1.MDAL2A.1.02.06	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel ro	1,452.0	CY	0.94	13.3	1,052.90		1,292.01			2,345
1.MDAL2A.1.02.06	Soil - Soils for earthwork, common borrow, spread with 200 H.P. dozer, inclu	1,452.0	CY	15.54	123.5	9,760.63	18,385.63	10,459.60			38,606
1.MDAL2A.1.02.06	Soil - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel rolle	1,452.0	CY	0.94	13.3	1,052.90		1,292.01			2,345
1.MDAL2A.1.02.06	**Total**				**482.2**	**39,434.22**	**120,251.99**	**32,771.50**			**192,458**
1.MDAL2A.1.02.07	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - Shoulder Fill**										
1.MDAL2A.1.02.07	Borrow, fill material only.	1,260.2	ton	20.50			44,205.23				44,205
1.MDAL2A.1.02.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	630.1	CY	4.46	22.8	1,951.54		2,857.17			4,809
1.MDAL2A.1.02.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	630.1	CY	4.62	41.6	3,557.24		1,423.32			4,981
1.MDAL2A.1.02.07	Water wagon 1,000 gal compaction	630.1	CY	0.44	7.6	472.79					473
1.MDAL2A.1.02.07	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	630.1	CY	0.94	5.8	456.91		560.67			1,018
1.MDAL2A.1.02.07	Manual Backfill, by hand, slope building	630.1	CY	90.61	1,143.3	97,692.67					97,693
1.MDAL2A.1.02.07	compact, by hand, 6" layers, air rammer/tamper	630.1	E.C.Y.	20.44	240.9	20,584.68		1,457.61			22,042
1.MDAL2A.1.02.07	**Total**				**1,462.0**	**124,715.82**	**44,205.23**	**6,298.77**			**175,220**
1.MDAL2A.1.02.08	**Project WBS: RCRA Cover MDA L -DC- RCRA Cover - Cover Armoring**										
1.MDAL2A.1.02.08	Cobble - Cobble Material and Delivery	434.7	TN	20.50			15,248.38				15,248

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL2A.1.02.08	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	322.0	CY	3.30	8.9	700.48		1,118.46			1,819
1.MDAL2A.1.02.08	Manual Backfill, by hand, slope building	322.0	CY	90.61	584.3	49,923.88					49,924
1.MDAL2A.1.02.08	Total				593.1	50,624.36	15,248.38	1,118.46			66,991
1.MDAL2A.1.02.09	Project WBS: RCRA Cover MDA L -DC- RCRA Cover - Re Vegetation										
1.MDAL2A.1.02.09	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL2A.1.02.09	Hydroseeding materials.	1.0	lsum	39,421.80			67,455.40				67,455
1.MDAL2A.1.02.09	Broadcasting Mulch and Humate	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL2A.1.02.09	Mulch and Humate materials.	1.0	LS	17,685.00			30,261.14				30,261
1.MDAL2A.1.02.09	Total				42.8	3,146.78	97,716.55	1,458.90			102,322
1.MDAL2A.1.02	Total				5,540.5	461,180.35	1,152,012.90	270,217.75	2,395.57		1,885,807
1.MDAL2A.1.03	Project WBS: SVE MDA L -DC- SVE										
1.MDAL2A.1.03.01	Project WBS: SVE MDA L -DC- SVE - SVE Unit										
1.MDAL2A.1.03.01	SVE Unit - Contractors Price	3.0	ea	35,000.00	3.0				179,667.52		179,668
1.MDAL2A.1.03.01	SVE Piping Equipment (1 per extraction borehole)	9.0	ea	2,000.00	16.4				30,800.15		30,800
1.MDAL2A.1.03.01	Total				19.4				210,467.67		210,468
1.MDAL2A.1.03.02	Project WBS: SVE MDA L -DC- SVE - Extraction Boreholes										
1.MDAL2A.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	30.0	bag	9.80			503.07				503
1.MDAL2A.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' de	9.0	EA	1,018.17	136.2	9,701.92	5,929.03	48.92			15,680
1.MDAL2A.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.5	CY	210.12	20.5	1,617.94					1,618
1.MDAL2A.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exca	43.8	CY	103.13	95.7	7,559.00		170.13			7,729
1.MDAL2A.1.03.02	Pore Gas Monitoring - LLW Disposition	43.8	CY	1,200.00					89,936.43		89,936
1.MDAL2A.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	9.0	EA	1,158.34	131.2	10,369.45		7,469.04			17,838
1.MDAL2A.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	450.0	LF	138.80	675.0	69,975.75	35,420.17	1,478.41			106,874
1.MDAL2A.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded	2,100.0	LF	33.52	1,001.7	110,942.41	9,522.38				120,465
1.MDAL2A.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	14.3	Csf	334.06	64.7	7,163.35	192.08	818.62			8,174
1.MDAL2A.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	23.0	CY	24.50			964.22				964
1.MDAL2A.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	27.0	CF	3.74			172.79				173
1.MDAL2A.1.03.02	Structural concrete, placing, excludes material	27.0	CF	1.90	1.1	75.38		12.47			88
1.MDAL2A.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.0	CY	275.66	18.2	1,886.75					1,887
1.MDAL2A.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland	494.0	CF	3.74			3,161.40				3,161
1.MDAL2A.1.03.02	Grout - concrete, placing, excludes material	494.0	CF	1.90	19.4	1,379.11		228.23			1,607
1.MDAL2A.1.03.02	Project Geologist	180.0	hour	77.00	180.0	30,369.05					30,369
1.MDAL2A.1.03.02	Field Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL2A.1.03.02	Radiological Control Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL2A.1.03.02	Health and Safety Officer - Site	18.0	hour	77.00	18.0	3,036.91					3,037
1.MDAL2A.1.03.02	Project Engineer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2A.1.03.02	Project Manager	45.0	hour	77.00	45.0	7,592.26					7,592
1.MDAL2A.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2A.1.03.02	Project Scientist - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2A.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2A.1.03.02	Health and Safety Officer - Site	56.3	hour	77.00	56.3	9,490.33					9,490
1.MDAL2A.1.03.02	Project Geologist	720.0	hour	77.00	720.0	121,476.22					121,476
1.MDAL2A.1.03.02	Total				3,602.8	454,031.28	55,865.13	10,225.81	89,936.43		610,059
1.MDAL2A.1.03.03	Project WBS: SVE MDA L -DC- SVE - Monitoring Boreholes										
1.MDAL2A.1.03.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	5.0	EA	1,158.34	72.9	5,760.81		4,149.46			9,910
1.MDAL2A.1.03.03	Structural excavation for minor structures, bank measure, normal soil, pits to	2.5	CY	210.12	11.4	898.85					899
1.MDAL2A.1.03.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	5.0	EA	80.25	3.0	314.46	372.17				687
1.MDAL2A.1.03.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exca	23.0	CY	12.87	3.1	246.58		260.04			507
1.MDAL2A.1.03.03	Pore Gas Monitoring - LLW Disposition	23.0	CY	1,200.00					47,226.89		47,227
1.MDAL2A.1.03.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAL2A.1.03.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	250.0	LF	138.80	375.0	38,875.42	19,677.87	821.34			59,375
1.MDAL2A.1.03.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yo	1,050.0	LF	37.76	500.9	51,926.04	14,283.57	1,634.97			67,845
1.MDAL2A.1.03.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	15.0	CF	3.74			95.99				96
1.MDAL2A.1.03.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includ	15.0	CF	1.90	0.6	41.88		6.93			49
1.MDAL2A.1.03.03	Bentonite clay, 50# bag, 1 per 10' of rod	230.0	EA	38.00			14,955.18				14,955
1.MDAL2A.1.03.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	1.7	CY	24.50			71.27				71
1.MDAL2A.1.03.03	Backfill, heavy soil, by hand, no compaction	16.0	CY	123.87	262.1	3,391.40					3,391
1.MDAL2A.1.03.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes	4,000.0	LF	16.95	912.6	94,606.45	18,397.95	3,011.57			116,016
1.MDAL2A.1.03.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, i	30.0	EA	121.05	49.8	5,160.35	890.12	163.24			6,214
1.MDAL2A.1.03.03	Mud Dauber (monitoring port)	30.0	EA	122.45	49.8	5,160.35	962.20	163.24			6,286
1.MDAL2A.1.03.03	Total				2,260.6	207,918.39	69,706.33	12,298.36	47,226.89		337,150
1.MDAL2A.1.03.04	Project WBS: SVE MDA L -DC- SVE - Removal of FLUTE Boreholes										
1.MDAL2A.1.03.04	Removal of Monitoring Tubing	16.0	hour	351.11	29.1	2,757.78		6,854.88			9,613
1.MDAL2A.1.03.04	Structural concrete, ready mix, lightweight, 110 #/C.F., 3000 psi, includes loc	48.0	CF	25.55	21.8	1,556.06	542.08				2,098
1.MDAL2A.1.03.04	Total				51.0	4,313.85	542.08	6,854.88			11,711
1.MDAL2A.1.03	Total				5,933.7	666,263.52	126,113.54	29,379.05	347,630.99		1,169,387
1.MDAL2A.1.04	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -DC- Distribs										
1.MDAL2A.1.04	Field Non-Manual - JHRS	2,387.0	hour	66.10	2,387.0	269,981.60					269,982
1.MDAL2A.1.04	Craft Distributable - Labor	2,984.0	hour	46.33	2,984.0	236,558.40					236,558
1.MDAL2A.1.04	Craft Distributable - Materials	2,984.0	hour	7.00	2,984.0		35,741.86				35,742
1.MDAL2A.1.04	Total				8,355.0	506,540.00	35,741.86				542,282
1.MDAL2A.1	Total				20,294.6	1,671,149.48	1,433,826.31	305,306.81	350,026.56		3,760,309
1.MDAL2A.2	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L - Indirect Capital Costs										
1.MDAL2A.2.01	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -IC- Design										
1.MDAL2A.2.01	RCRA MDA L Pad Design	1.0	lsum	601,649.00					875,940.78		875,941

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL2A.2.01	Total								875,940.78		875,941
1.MDAL2A.2.02	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -IC- Professional Management										
1.MDAL2A.2.02	Professional Management	1.0	lsum	1,205,425.00	12,102.7	2,641,242.28					2,641,242
1.MDAL2A.2.02	Total				12,102.7	2,641,242.28					2,641,242
1.MDAL2A.2.03	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -IC- Contingency										
1.MDAL2A.2.03	Contingency - Cost 30%	1.0	lsum	2,183,247.00	1.0					2,183,247.00	2,183,247
1.MDAL2A.2.03	Contingency - Schedule 10%	1.0	lsum	727,749.00	1.0					727,749.00	727,749
1.MDAL2A.2.03	Contingency - TPRA 10%	1.0	lsum	727,749.00	1.0					727,749.00	727,749
1.MDAL2A.2.03	Total				3.0					3,638,745.00	3,638,745
1.MDAL2A.2	Total				12,105.7	2,641,242.28			875,940.78	3,638,745.00	7,155,928
1.MDAL2A.3	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L - Direct O&M Costs										
1.MDAL2A.3.01	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -DOM- Cover Maintenance & Inspections										
1.MDAL2A.3.01	Active SVE Operation (3 years)	1.0	lsum	862,947.00	18,626.2	1,256,364.54					1,256,365
1.MDAL2A.3.01	Active SVE Monitoring (3 years)	1.0	lsum	123,456.00	1,576.7	179,739.59					179,740
1.MDAL2A.3.01	Rebound SVE Monitoring (3 years)	1.0	lsum	469,133.00	10,126.0	683,010.73					683,011
1.MDAL2A.3.01	Subsurface VOC Vapor Monitoring (30 years)	1.0	lsum	1,326,475.00	16,940.9	1,931,214.95					1,931,215
1.MDAL2A.3.01	Cover Inspections and Maintenance (100 years)	1.0	lsum	148,476.00	3,204.8	216,166.21					216,166
1.MDAL2A.3.01	Annual Long Term Monitoring Report (100 years)	1.0	lsum	157,125.00	2,006.7	228,758.29					228,758
1.MDAL2A.3.01	Total				52,481.3	4,495,254.31					4,495,254
1.MDAL2A.3	Total				52,481.3	4,495,254.31					4,495,254
1.MDAL2A.4	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L - Indirect O&M Costs										
1.MDAL2A.4.02	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -IOM- Professional Management										
1.MDAL2A.4.02	Professional Management (years 0-3)	1.0	lsum	316,758.00	3,180.3	694,057.80					694,058
1.MDAL2A.4.02	Professional Management (years 4-30)	1.0	lsum	356,750.00	3,581.8	781,685.45					781,685
1.MDAL2A.4.02	Professional Management (years 31-100)	1.0	lsum	32,455.00	325.9	71,113.11					71,113
1.MDAL2A.4.02	Total				7,088.0	1,546,856.36					1,546,856
1.MDAL2A.4.03	Project WBS: 2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA L -IOM- Contingency										
1.MDAL2A.4.03	Contingency - Cost 30%	1.0	lsum	1,812,633.00	1.0					1,812,633.00	1,812,633
1.MDAL2A.4.03	Contingency - Schedule 10%	1.0	lsum	604,211.00	1.0					604,211.00	604,211
1.MDAL2A.4.03	Contingency - TPRA 10%	1.0	lsum	604,211.00	1.0					604,211.00	604,211
1.MDAL2A.4.03	Total				3.0					3,021,055.00	3,021,055
1.MDAL2A.4	Total				7,091.0	1,546,856.36				3,021,055.00	4,567,911
1.MDAL2A	Total				91,972.5	10,354,502.42	1,433,826.31	305,306.81	1,225,967.34	6,659,800.00	19,979,403
1.MDAL2B	Project WBS: 2B ET Cover, SVE, Institutional Controls										
1.MDAL2B.1	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L - Direct Capital Costs										
1.MDAL2B.1.01	Project WBS: ET Cover MDA L -DC- Fence										
1.MDAL2B.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' (	1,450.0	LF	56.72	352.2	28,129.44	109,169.41	3,423.95			140,723
1.MDAL2B.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire,	15.0	EA	162.19	16.4	1,308.81	2,695.01	159.13			4,163
1.MDAL2B.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, include	2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAL2B.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes p	20.0	EA	120.98	16.6	1,328.91	2,446.90	364.47			4,140
1.MDAL2B.1.01	Total				465.4	37,165.62	119,958.02	5,710.01			162,834
1.MDAL2B.1.02	Project WBS: ET Cover MDA L -DC- ET Cover										
1.MDAL2B.1.02.01	Project WBS: ET Cover MDA L -DC- ET Cover - Site Prep										
1.MDAL2B.1.02.01	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	10.0	EA	529.39	48.6	3,839.50		5,218.91			9,058
1.MDAL2B.1.02.01	Track out device	1.0	EA	5,234.35	5.5	400.99	8,555.60				8,957
1.MDAL2B.1.02.01	Clean out track out device.	8.0	EA	1,185.53	87.4	6,415.88		9,812.73			16,229
1.MDAL2B.1.02.01	Rent toilet portable chemical	10.0	mnth	400.00				6,844.48			6,844
1.MDAL2B.1.02.01	Chemical toilet cleaning.	10.0	mnth	946.50	163.8	10,231.92		5,963.83			16,196
1.MDAL2B.1.02.01	Chemical toilet cleaning (labor)	10.0	mnth	573.07	163.8	9,805.84					9,806
1.MDAL2B.1.02.01	Excavation permit	2.0	ea	700.00					2,395.57		2,396
1.MDAL2B.1.02.01	Lister support	24.0	hour	100.10	43.7	4,110.79					4,111
1.MDAL2B.1.02.01	Laydown - Base course drainage layers, aggregate base course for roadway	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAL2B.1.02.01	Laydown - Backfill, bulk, 6" to 12" lifts, dozer backfilling	1,481.0	CY	3.30	40.8	3,221.78		5,144.23			8,366
1.MDAL2B.1.02.01	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAL2B.1.02.01	Selective clearing, brush, with brush saw, includes cutting and site cleanup,	0.9	acre	3,022.82	51.3	4,382.43		169.28			4,552
1.MDAL2B.1.02.01	Total				734.5	53,409.42	109,853.86	44,604.07	2,395.57		210,263
1.MDAL2B.1.02.02	Project WBS: ET Cover MDA L -DC- ET Cover - Cover Prep										
1.MDAL2B.1.02.02	Borrow, fill material only.	11,342.0	ton	20.50			397,854.05				397,854
1.MDAL2B.1.02.02	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	5,670.9	CY	4.46	205.6	17,563.86		25,714.50			43,278
1.MDAL2B.1.02.02	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	5,670.9	CY	4.62	374.7	32,015.13		12,809.91			44,825
1.MDAL2B.1.02.02	Water wagon 1,000 gal compaction	5,670.9	CY	0.44	68.1	4,255.11					4,255
1.MDAL2B.1.02.02	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	5,670.9	CY	0.94	52.0	4,112.17		5,046.03			9,158
1.MDAL2B.1.02.02	Total				700.4	57,946.27	397,854.05	43,570.44			499,371
1.MDAL2B.1.02.03	Project WBS: ET Cover MDA L -DC- ET Cover - Installation of 1' Biobarrier										
1.MDAL2B.1.02.03	Cobble - Cobble Material and Delivery	1,960.2	TN	20.50			68,759.79				68,760
1.MDAL2B.1.02.03	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	1,452.0	CY	3.30	40.0	3,158.69		5,043.50			8,202
1.MDAL2B.1.02.03	Total				40.0	3,158.69	68,759.79	5,043.50			76,962
1.MDAL2B.1.02.04	Project WBS: ET Cover MDA L -DC- ET Cover - Installation of .5' Filter Layer										
1.MDAL2B.1.02.04	Base course drainage layers, aggregate base course for roadways and large	4,356.0	SY	8.87	63.3	5,404.90	55,156.90	5,517.31			66,079
1.MDAL2B.1.02.04	Total				63.3	5,404.90	55,156.90	5,517.31			66,079
1.MDAL2B.1.02.05	Project WBS: ET Cover MDA L -DC- ET Cover - Installation of 3.5' Fine Grained Cover Soil (ET Layer)										
1.MDAL2B.1.02.05	TUFF - TUFF Material and Delivery	10,164.0	TN	20.50			356,532.23				356,532
1.MDAL2B.1.02.05	TUFF - Backfill, bulk, 6" to 12" lifts, dozer backfilling	5,082.0	CY	3.30	139.9	11,055.41		17,652.26			28,708
1.MDAL2B.1.02.05	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel ro	5,082.0	CY	0.94	46.6	3,685.14		4,522.02			8,207
1.MDAL2B.1.02.05	TUFF & SOIL - Rent water truck, off highway, 6000 gallon capacity - Rent pe	10.2	days	1,309.30	111.4	8,801.69		14,050.00			22,852
1.MDAL2B.1.02.05	Total				297.9	23,542.24	356,532.23	36,224.28			416,299

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL2B.1.02.06	Project WBS: ET Cover MDA L -DC- ET Cover - Installation of 1.5' Cover Soil/ Surface Treatment										
1.MDAL2B.1.02.06	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel ro	1,089.0	CY	0.94	10.0	789.67		969.00			1,759
1.MDAL2B.1.02.06	Soil - Soils for earthwork, common borrow, spread with 200 H.P. dozer, inclu	1,089.0	CY	15.54	92.6	7,320.48	13,789.23	7,844.70			28,954
1.MDAL2B.1.02.06	Soil - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel rolle	1,089.0	CY	0.94	10.0	789.67		969.00			1,759
1.MDAL2B.1.02.06	TUFF - Borrow, fill material only.	2,178.0	ton	20.50			76,399.76				76,400
1.MDAL2B.1.02.06	Tuff - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, w	1,089.0	CY	4.46	39.5	3,372.84		4,938.03			8,311
1.MDAL2B.1.02.06	TUFF - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,089.0	CY	4.62	72.0	6,147.96		2,459.93			8,608
1.MDAL2B.1.02.06	TUFF - Water wagon 1,000 gal compaction	1,089.0	CY	0.44	13.1	817.12					817
1.MDAL2B.1.02.06	Soil - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, wi	1,089.0	CY	4.46	39.5	3,372.84		4,938.03			8,311
1.MDAL2B.1.02.06	Soil - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,089.0	CY	4.62	72.0	6,147.96		2,459.93			8,608
1.MDAL2B.1.02.06	Soil - Water wagon 1,000 gal compaction	1,089.0	CY	0.44	13.1	817.12					817
1.MDAL2B.1.02.06	Total				361.6	29,575.67	90,188.99	24,578.63			144,343
1.MDAL2B.1.02.07	Project WBS: ET Cover MDA L -DC- ET Cover - Shoulder Fill										
1.MDAL2B.1.02.07	Borrow, fill material only.	1,260.2	ton	20.50			44,205.23				44,205
1.MDAL2B.1.02.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	630.1	CY	4.46	22.8	1,951.54		2,857.17			4,809
1.MDAL2B.1.02.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	630.1	CY	4.62	41.6	3,557.24		1,423.32			4,981
1.MDAL2B.1.02.07	Water wagon 1,000 gal compaction	630.1	CY	0.44	7.6	472.79					473
1.MDAL2B.1.02.07	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	630.1	CY	0.94	5.8	456.91		560.67			1,018
1.MDAL2B.1.02.07	Manual Backfill, by hand, slope building	630.1	CY	90.61	1,143.3	97,692.67					97,693
1.MDAL2B.1.02.07	compact, by hand, 6" layers, air rammer/tamper	630.1	E.C.Y.	20.44	240.9	20,584.68		1,457.61			22,042
1.MDAL2B.1.02.07	Total				1,462.0	124,715.82	44,205.23	6,298.77			175,220
1.MDAL2B.1.02.08	Project WBS: ET Cover MDA L -DC- ET Cover - Cover Armoring										
1.MDAL2B.1.02.08	Cobble - Cobble Material and Delivery	434.7	TN	20.50			15,248.38				15,248
1.MDAL2B.1.02.08	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	322.0	CY	3.30	8.9	700.48		1,118.46			1,819
1.MDAL2B.1.02.08	Manual Backfill, by hand, slope building	322.0	CY	90.61	584.3	49,923.88					49,924
1.MDAL2B.1.02.08	Total				593.1	50,624.36	15,248.38	1,118.46			66,991
1.MDAL2B.1.02.09	Project WBS: ET Cover MDA L -DC- ET Cover - Revegetation										
1.MDAL2B.1.02.09	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL2B.1.02.09	Hydroseeding materials.	1.0	lsum	39,421.80			67,455.40				67,455
1.MDAL2B.1.02.09	Broadcasting Mulch and Humate	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL2B.1.02.09	Mulch and Humate materials.	1.0	LS	17,685.00			30,261.14				30,261
1.MDAL2B.1.02.09	Total				42.8	3,146.78	97,716.55	1,458.90			102,322
1.MDAL2B.1.02.10	Project WBS: ET Cover MDA L -DC- ET Cover - TDR Monitor										
1.MDAL2B.1.02.10	TDR Monitoring of ET Cover	1.0	EA	41,921.77	72.8	7,566.18	64,166.97				71,733
1.MDAL2B.1.02.10	Total				72.8	7,566.18	64,166.97				71,733
1.MDAL2B.1.02	Total				4,368.5	359,090.32	1,299,682.95	168,414.36	2,395.57		1,829,583
1.MDAL2B.1.03	Project WBS: SVE MDA L -DC- SVE										
1.MDAL2B.1.03.01	Project WBS: SVE MDA L -DC- SVE - SVE Unit										
1.MDAL2B.1.03.01	SVE Unit - Contractors Price	3.0	ea	35,000.00	3.0				179,667.52		179,668
1.MDAL2B.1.03.01	SVE Piping Equipment (1 per extraction borehole)	9.0	ea	2,000.00	16.4				30,800.15		30,800
1.MDAL2B.1.03.01	Total				19.4				210,467.67		210,468
1.MDAL2B.1.03.02	Project WBS: SVE MDA L -DC- SVE - Extraction Boreholes										
1.MDAL2B.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	30.0	bag	9.80			503.07				503
1.MDAL2B.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' de	9.0	EA	1,018.17	136.2	9,701.92	5,929.03	48.92			15,680
1.MDAL2B.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.5	CY	210.12	20.5	1,617.94					1,618
1.MDAL2B.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exc	43.8	CY	103.13	95.7	7,559.00		170.13			7,729
1.MDAL2B.1.03.02	Pore Gas Monitoring - LLW Disposition	43.8	CY	1,200.00					89,936.43		89,936
1.MDAL2B.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	9.0	EA	1,158.34	131.2	10,369.45		7,469.04			17,838
1.MDAL2B.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes	450.0	LF	138.80	675.0	69,975.75	35,420.17	1,478.41			106,874
1.MDAL2B.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded	2,100.0	LF	33.52	1,001.7	110,942.41	9,522.38				120,465
1.MDAL2B.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	14.3	Csf	334.06	64.7	7,163.35	192.08	818.62			8,174
1.MDAL2B.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	23.0	CY	24.50			964.22				964
1.MDAL2B.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	27.0	CF	3.74			172.79				173
1.MDAL2B.1.03.02	Structural concrete, placing, excludes material	27.0	CF	1.90	1.1	75.38		12.47			88
1.MDAL2B.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.0	CY	275.66	18.2	1,886.75					1,887
1.MDAL2B.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland	494.0	CF	3.74			3,161.40				3,161
1.MDAL2B.1.03.02	Grout - concrete, placing, excludes material	494.0	CF	1.90	19.4	1,379.11		228.23			1,607
1.MDAL2B.1.03.02	Project Geologist	180.0	hour	77.00	180.0	30,369.05					30,369
1.MDAL2B.1.03.02	Field Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL2B.1.03.02	Radiological Control Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL2B.1.03.02	Health and Safety Officer - Site	18.0	hour	77.00	18.0	3,036.91					3,037
1.MDAL2B.1.03.02	Project Engineer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2B.1.03.02	Project Manager	45.0	hour	77.00	45.0	7,592.26					7,592
1.MDAL2B.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2B.1.03.02	Project Scientist - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2B.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL2B.1.03.02	Health and Safety Officer - Site	56.3	hour	77.00	56.3	9,490.33					9,490
1.MDAL2B.1.03.02	Project Geologist	720.0	hour	77.00	720.0	121,476.22					121,476
1.MDAL2B.1.03.02	Total				3,602.8	454,031.28	55,865.13	10,225.81	89,936.43		610,059
1.MDAL2B.1.03.03	Project WBS: SVE MDA L -DC- SVE - Monitoring Boreholes										
1.MDAL2B.1.03.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	5.0	EA	1,158.34	72.9	5,760.81		4,149.46			9,910
1.MDAL2B.1.03.03	Structural excavation for minor structures, bank measure, normal soil, pits to	2.5	CY	210.12	11.4	898.85					899
1.MDAL2B.1.03.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	5.0	EA	80.25	3.0	314.46	372.17				687
1.MDAL2B.1.03.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exc	23.0	CY	12.87	3.1	246.58		260.04			507

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL2B.1.03.03	Pore Gas Monitoring - LLW Disposition	23.0	CY	1,200.00					47,226.89		47,227
1.MDAL2B.1.03.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAL2B.1.03.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	250.0	LF	138.80	375.0	38,875.42	19,677.87	821.34			59,375
1.MDAL2B.1.03.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yc	1,050.0	LF	37.76	500.9	51,926.04	14,283.57	1,634.97			67,845
1.MDAL2B.1.03.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	15.0	CF	3.74			95.99				96
1.MDAL2B.1.03.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includ	15.0	CF	1.90	0.6	41.88		6.93			49
1.MDAL2B.1.03.03	Bentonite clay, 50# bag, 1 per 10' of rod	230.0	EA	38.00			14,955.18				14,955
1.MDAL2B.1.03.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	1.7	CY	24.50			71.27				71
1.MDAL2B.1.03.03	Backfill, heavy soil, by hand, no compaction	16.0	CY	123.87	39.7	3,391.40					3,391
1.MDAL2B.1.03.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes	4,000.0	LF	16.95	912.6	94,606.45	18,397.95	3,011.57			116,016
1.MDAL2B.1.03.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, i	30.0	EA	121.05	49.8	5,160.35	890.12	163.24			6,214
1.MDAL2B.1.03.03	Mud Dauber (monitoring port)	30.0	EA	122.45	49.8	5,160.35	962.20	163.24			6,286
1.MDAL2B.1.03.03	Total				2,038.2	207,918.39	69,706.33	12,298.36	47,226.89		337,150
1.MDAL2B.1.03.04	Project WBS: SVE MDA L -DC- SVE - Removal of FLUTE Boreholes										
1.MDAL2B.1.03.04	Removal of Monitoring Tubing	16.0	hour	351.11	29.1	2,757.78		6,854.88			9,613
1.MDAL2B.1.03.04	Structural concrete, ready mix, lightweight, 110 #/C.F., 3000 psi, includes loc	48.0	CF	25.55	21.8	1,556.06	542.08				2,098
1.MDAL2B.1.03.04	Total				51.0	4,313.85	542.08	6,854.88			11,711
1.MDAL2B.1.03	Total				5,711.3	666,263.52	126,113.54	29,379.05	347,630.99		1,169,387
1.MDAL2B.1.04	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L -DC- Distribs										
1.MDAL2B.1.04	Field Non-Manual - JHRS	2,109.0	hour	66.10	2,109.0	238,538.41					238,538
1.MDAL2B.1.04	Craft Distributable - Labor	2,636.0	hour	46.33	2,636.0	208,970.49					208,970
1.MDAL2B.1.04	Craft Distributable - Materials	2,636.0	hour	7.00	2,636.0		31,573.57				31,574
1.MDAL2B.1.04	Total				7,381.0	447,508.90	31,573.57				479,082
1.MDAL2B.1	Total				17,926.2	1,510,028.36	1,577,328.08	203,503.42	350,026.56		3,640,886
1.MDAL2B.2	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L - Indirect Capital Costs										
1.MDAL2B.2.01	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L -IC- Design										
1.MDAL2B.2.01	ET MDA L Mat Design	1.0	lsum	582,541.00					848,121.44		848,121
1.MDAL2B.2.01	Total								848,121.44		848,121
1.MDAL2B.2.02	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L-IC- Professional Management										
1.MDAL2B.2.02	Professional Management	1.0	lsum	1,174,941.00	11,796.6	2,574,447.89					2,574,448
1.MDAL2B.2.02	Total				11,796.6	2,574,447.89					2,574,448
1.MDAL2B.2.03	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L -IC- Contingency										
1.MDAL2B.2.03	Contingency - Cost 30%	1.0	lsum	2,128,036.00	1.0					2,128,036.00	2,128,036
1.MDAL2B.2.03	Contingency - Schedule 10%	1.0	lsum	709,345.00	1.0					709,345.00	709,345
1.MDAL2B.2.03	Contingency - TPRA 10%	1.0	lsum	709,345.00	1.0					709,345.00	709,345
1.MDAL2B.2.03	Total				3.0					3,546,726.00	3,546,726
1.MDAL2B.2	Total				11,799.6	2,574,447.89			848,121.44	3,546,726.00	6,969,295
1.MDAL2B.3	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L - Direct O&M Costs										
1.MDAL2B.3.01	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L -DOM- Cover Maintenance & Inspections										
1.MDAL2B.3.01	Active SVE Operation (3 years)	1.0	lsum	862,947.00	18,626.2	1,256,364.54					1,256,365
1.MDAL2B.3.01	Aceive SVE Monitoring (3 years)	1.0	lsum	123,456.00	1,576.7	179,739.59					179,740
1.MDAL2B.3.01	TDR Moisture Monitoring (100 years)	1.0	lsum	323,898.00	3,252.0	471,563.10					471,563
1.MDAL2B.3.01	Rebound SVE Monitoring (3 years)	1.0	lsum	469,133.00	10,126.0	683,010.73					683,011
1.MDAL2B.3.01	Subsurface VOC Vapor Monitoring (30 years)	1.0	lsum	1,326,475.00	16,940.9	1,931,214.95					1,931,215
1.MDAL2B.3.01	Cover Inspections and Maintenance (100 years)	1.0	lsum	148,476.00	1,490.7	216,166.21					216,166
1.MDAL2B.3.01	Annual Long Term Monitoring Report (100 years)	1.0	lsum	157,125.00	2,006.7	228,758.29					228,758
1.MDAL2B.3.01	Total				54,019.2	4,966,817.41					4,966,817
1.MDAL2B.3	Total				54,019.2	4,966,817.41					4,966,817
1.MDAL2B.4	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L - Indirect O&M Costs										
1.MDAL2B.4.02	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L -IOM- Professional Management										
1.MDAL2B.4.02	Professional Management (years 0-3)	1.0	lsum	316,758.00	3,180.3	694,057.80					694,058
1.MDAL2B.4.02	Professional Management (years 4-30)	1.0	lsum	256,750.00	2,577.8	562,572.50					562,572
1.MDAL2B.4.02	Professional Management (years 31-100)	1.0	lsum	32,455.00	325.9	71,113.11					71,113
1.MDAL2B.4.02	Total				6,084.0	1,327,743.41					1,327,743
1.MDAL2B.4.03	Project WBS: 2B ET Cover, SVE, Institutional Controls MDA L -IOM- Contingency										
1.MDAL2B.4.03	Contingency - Cost 30%	1.0	lsum	1,888,368.00	1.0					1,888,368.00	1,888,368
1.MDAL2B.4.03	Contingency - Schedule 10%	1.0	lsum	629,456.00	1.0					629,456.00	629,456
1.MDAL2B.4.03	Contingency - TPRA 10%	1.0	lsum	629,456.00	1.0					629,456.00	629,456
1.MDAL2B.4.03	Total				3.0					3,147,280.00	3,147,280
1.MDAL2B.4	Total				6,087.0	1,327,743.41				3,147,280.00	4,475,023
1.MDAL2B	Total				89,832.0	10,379,037.06	1,577,328.08	203,503.42	1,198,148.00	6,694,006.00	20,052,023
1.MDAL3A	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls										
1.MDAL3A.1	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Direct Capital Costs										
1.MDAL3A.1.01	Project WBS: RCRA Cover Shafts -DC- Fence										
1.MDAL3A.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' (	1,450.0	LF	56.72	352.2	28,129.44	109,169.41	3,423.95			140,723
1.MDAL3A.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire,	15.0	EA	162.19	16.4	1,308.81	2,695.01	159.13			4,163
1.MDAL3A.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, include	2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAL3A.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes p	20.0	EA	120.98	16.6	1,328.91	2,446.90	364.47			4,140
1.MDAL3A.1.01	Total				465.4	37,165.62	119,958.02	5,710.01			162,834
1.MDAL3A.1.02	Project WBS: RCRA Cover Shafts - DC										
1.MDAL3A.1.02.01	Project WBS: RCRA Cover Shafts - DC- Site Prep										
1.MDAL3A.1.02.01	Selective clearing, brush, with brush saw, includes cutting and site cleanup,	0.9	acre	3,022.82	51.3	4,382.43		169.28			4,552
1.MDAL3A.1.02.01	Track out device	1.0	EA	5,234.35	5.5	400.99	8,555.60				8,957
1.MDAL3A.1.02.01	Clean out track out device.	8.0	EA	1,185.53	87.4	6,415.88		9,812.73			16,229
1.MDAL3A.1.02.01	Rent toilet portable chemical	10.0	mnth	400.00				6,844.48			6,844
1.MDAL3A.1.02.01	Chemical toilet cleaning.	10.0	mnth	946.50	163.8	10,231.92		5,963.83			16,196

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3A.1.02.01	Chemical toilet cleaning (labor)	10.0	mnth	573.07	163.8	9,805.84					9,806
1.MDAL3A.1.02.01	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	10.0	EA	529.39	48.6	3,839.50		5,218.91			9,058
1.MDAL3A.1.02.01	Excavation permit	2.0	ea	700.00					2,395.57		2,396
1.MDAL3A.1.02.01	Lister support	24.0	hour	100.10	43.7	4,110.79					4,111
1.MDAL3A.1.02.01	Laydown - Base course drainage layers, aggregate base course for roadway	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAL3A.1.02.01	Laydown - Backfill, bulk, 6" to 12" lifts, dozer backfilling	1,481.0	CY	3.30	40.8	3,221.78		5,144.23			8,366
1.MDAL3A.1.02.01	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAL3A.1.02.01	**Total**				**734.5**	**53,409.42**	**109,853.86**	**44,604.07**	**2,395.57**		**210,263**
1.MDAL3A.1.02.02	**Project WBS: RCRA Cover Shafts - DC - Cover Prep**										
1.MDAL3A.1.02.02	Borrow, fill material only.	10,895.4	ton	20.50			382,188.24				382,188
1.MDAL3A.1.02.02	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	5,447.7	CY	4.46	197.5	16,872.57		24,702.41			41,575
1.MDAL3A.1.02.02	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	5,447.7	CY	4.62	359.9	30,755.06		12,305.72			43,061
1.MDAL3A.1.02.02	Water wagon 1,000 gal compaction	5,447.7	CY	0.44	65.4	4,087.63					4,088
1.MDAL3A.1.02.02	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	5,447.7	CY	0.94	50.0	3,950.32		4,847.42			8,798
1.MDAL3A.1.02.02	**Total**				**672.8**	**55,665.57**	**382,188.24**	**41,855.56**			**479,709**
1.MDAL3A.1.02.03	**Project WBS: RCRA Cover Shafts - DC - Installation of 2' of 10-7 Clay Compacted**										
1.MDAL3A.1.02.03	Clay backfill material delivered, medium cost, up to 20 miles haul distance (4	1,291.0	L.C.Y.	50.00			110,452.75				110,453
1.MDAL3A.1.02.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	1,291.0	CY	4.46	46.8	3,998.47		5,854.00			9,852
1.MDAL3A.1.02.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,291.0	CY	4.62	85.3	7,288.36		2,916.22			10,205
1.MDAL3A.1.02.03	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	1,291.0	CY	0.94	11.8	936.15		1,148.75			2,085
1.MDAL3A.1.02.03	Water wagon 1,000 gal compaction	1,291.0	CY	0.44	15.5	968.69					969
1.MDAL3A.1.02.03	Clay handling and rework	1,291.0	CY	34.44	361.3	30,871.59		45,197.79			76,069
1.MDAL3A.1.02.03	**Total**				**520.7**	**44,063.26**	**110,452.75**	**55,116.76**			**209,633**
1.MDAL3A.1.02.04	**Project WBS: RCRA Cover Shafts - DC - Installation 40 mm HDPE Geomembrane**										
1.MDAL3A.1.02.04	40 mm HDPE Liner	1,936.0	SY	7.39	23.4	2,593.77	19,876.36	2,003.65			24,474
1.MDAL3A.1.02.04	Liner binding	871.2	SF	7.26	53.1	5,876.61	4,710.70	233.49			10,821
1.MDAL3A.1.02.04	**Total**				**76.5**	**8,470.38**	**24,587.06**	**2,237.14**			**35,295**
1.MDAL3A.1.02.05	**Project WBS: RCRA Cover Shafts - DC - Installation of 1' of 10-2 Drainage Layer**										
1.MDAL3A.1.02.05	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	645.0	CY	24.50			27,039.96				27,040
1.MDAL3A.1.02.05	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	645.0	CY	4.46	23.4	1,997.69		2,924.73			4,922
1.MDAL3A.1.02.05	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	645.0	CY	4.62	42.6	3,641.36		1,456.98			5,098
1.MDAL3A.1.02.05	Water wagon 1,000 gal compaction	645.0	CY	0.44	7.7	483.97					484
1.MDAL3A.1.02.05	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	645.0	CY	0.94	5.9	467.71		573.93			1,042
1.MDAL3A.1.02.05	**Total**				**79.7**	**6,590.73**	**27,039.96**	**4,955.64**			**38,586**
1.MDAL3A.1.02.06	**Project WBS: RCRA Cover Shafts - DC - Installation of 2' of Cover Soil/Surface Treatment**										
1.MDAL3A.1.02.06	TUFF - Borrow, fill material only.	1,290.0	ton	20.50			45,250.55				45,251
1.MDAL3A.1.02.06	TUFF - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill,	645.0	CY	4.46	23.4	1,997.69		2,924.73			4,922
1.MDAL3A.1.02.06	TUFF - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	645.0	CY	4.62	42.6	3,641.36		1,456.98			5,098
1.MDAL3A.1.02.06	TUFF - Water wagon 1,000 gal compaction	645.0	CY	0.44	7.7	483.97					484
1.MDAL3A.1.02.06	Soil - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, wi	645.0	CY	4.46	23.4	1,997.69		2,924.73			4,922
1.MDAL3A.1.02.06	Soil - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	645.0	CY	4.62	42.6	3,641.36		1,456.98			5,098
1.MDAL3A.1.02.06	Soil - Water wagon 1,000 gal compaction	645.0	CY	0.44	7.7	483.97					484
1.MDAL3A.1.02.06	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel ro	645.0	CY	0.94	5.9	467.71		573.93			1,042
1.MDAL3A.1.02.06	Soil - Soils for earthwork, common borrow, spread with 200 H.P. dozer, inclu	645.0	CY	15.54	54.9	4,335.82	8,167.17	4,646.31			17,149
1.MDAL3A.1.02.06	Soil - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel rolle	645.0	CY	0.94	5.9	467.71		573.93			1,042
1.MDAL3A.1.02.06	**Total**				**214.2**	**17,517.27**	**53,417.72**	**14,557.59**			**85,493**
1.MDAL3A.1.02.07	**Project WBS: RCRA Cover Shafts - DC - Shoulder Fill**										
1.MDAL3A.1.02.07	Borrow, fill material only.	1,210.6	ton	20.50			42,465.36				42,465
1.MDAL3A.1.02.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	605.0	CY	4.46	21.9	1,873.80		2,743.35			4,617
1.MDAL3A.1.02.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	605.0	CY	4.62	40.0	3,415.53		1,366.63			4,782
1.MDAL3A.1.02.07	Water wagon 1,000 gal compaction	605.0	CY	0.44	7.3	453.96					454
1.MDAL3A.1.02.07	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	605.0	CY	0.94	5.6	438.71		538.34			977
1.MDAL3A.1.02.07	Manual Backfill, by hand, slope building	605.0	CY	90.61	1,097.8	93,801.09					93,801
1.MDAL3A.1.02.07	compact, by hand, 6" layers, air rammer/tamper	605.0	E.C.Y.	20.44	231.3	19,764.69		1,399.55			21,164
1.MDAL3A.1.02.07	**Total**				**1,403.8**	**119,747.77**	**42,465.36**	**6,047.86**			**168,261**
1.MDAL3A.1.02.08	**Project WBS: RCRA Cover Shafts - DC - Cover Armoring**										
1.MDAL3A.1.02.08	Cobble - Cobble Material and Delivery	339.0	TN	20.50			11,891.42				11,891
1.MDAL3A.1.02.08	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	251.0	CY	3.30	6.9	546.03		871.85			1,418
1.MDAL3A.1.02.08	Manual Backfill, by hand, slope building	251.0	CY	90.61	455.4	38,915.82					38,916
1.MDAL3A.1.02.08	**Total**				**462.3**	**39,461.85**	**11,891.42**	**871.85**			**52,225**
1.MDAL3A.1.02.09	**Project WBS: RCRA Cover Shafts - DC - Revegetation**										
1.MDAL3A.1.02.09	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL3A.1.02.09	Hydroseeding materials.	1.0	lsum	39,421.80			67,455.40				67,455
1.MDAL3A.1.02.09	Broadcasting Mulch and Humate	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL3A.1.02.09	Mulch and Humate materials.	1.0	LS	17,685.00			30,261.14				30,261
1.MDAL3A.1.02.09	**Total**				**42.8**	**3,146.78**	**97,716.55**	**1,458.90**			**102,322**
1.MDAL3A.1.02	**Total**				**4,207.4**	**348,073.02**	**859,612.92**	**171,705.36**	**2,395.57**		**1,381,787**
1.MDAL3A.1.03	**Project WBS: SVE -DC- SVE**										
1.MDAL3A.1.03.01	**Project WBS: SVE -DC- SVE - Unit**										
1.MDAL3A.1.03.01	SVE Unit - Contractors Price	3.0	ea	35,000.00	3.0				179,667.52		179,668
1.MDAL3A.1.03.01	SVE Piping Equipment (1 per extraction borehole)	9.0	ea	2,000.00	16.4				30,800.15		30,800
1.MDAL3A.1.03.01	**Total**				**19.4**				**210,467.67**		**210,468**
1.MDAL3A.1.03.02	**Project WBS: SVE -DC- SVE - Extraction Boreholes**										
1.MDAL3A.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	30.0	bag	9.80			503.07				503
1.MDAL3A.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' de	9.0	EA	1,018.17	136.2	9,701.92	5,929.03	48.92			15,680

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3A.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.5	CY	210.12	20.5	1,617.94					1,618
1.MDAL3A.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exc	43.8	CY	103.13	95.7	7,559.00		170.13			7,729
1.MDAL3A.1.03.02	Pore Gas Monitoring - LLW Disposition	43.8	CY	1,200.00					89,936.43		89,936
1.MDAL3A.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	9.0	EA	1,158.34	131.2	10,369.45		7,469.04			17,838
1.MDAL3A.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	450.0	LF	138.80	675.0	69,975.75	35,420.17	1,478.41			106,874
1.MDAL3A.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded	2,100.0	LF	33.52	1,001.7	110,942.41	9,522.38				120,465
1.MDAL3A.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	14.3	Csf	334.06	64.7	7,163.35	192.08	818.62			8,174
1.MDAL3A.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	23.0	CY	24.50			964.22				964
1.MDAL3A.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	27.0	CF	3.74			172.79				173
1.MDAL3A.1.03.02	Structural concrete, placing, excludes material	27.0	CF	1.90	1.1	75.38		12.47			88
1.MDAL3A.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.0	CY	275.66	18.2	1,886.75					1,887
1.MDAL3A.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland	494.0	CF	3.74			3,161.40				3,161
1.MDAL3A.1.03.02	Grout - concrete, placing, excludes material	494.0	CF	1.90	19.4	1,379.11		228.23			1,607
1.MDAL3A.1.03.02	Project Geologist	180.0	hour	77.00	180.0	30,369.05					30,369
1.MDAL3A.1.03.02	Field Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL3A.1.03.02	Radiological Control Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL3A.1.03.02	Health and Safety Officer - Site	18.0	hour	77.00	18.0	3,036.91					3,037
1.MDAL3A.1.03.02	Project Engineer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3A.1.03.02	Project Manager	45.0	hour	77.00	45.0	7,592.26					7,592
1.MDAL3A.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3A.1.03.02	Project Scientist - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3A.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3A.1.03.02	Health and Safety Officer - Site	56.3	hour	77.00	56.3	9,490.33					9,490
1.MDAL3A.1.03.02	Project Geologist	720.0	hour	77.00	720.0	121,476.22					121,476
1.MDAL3A.1.03.02	**Total**				**3,602.8**	**454,031.28**	**55,865.13**	**10,225.81**	**89,936.43**		**610,059**
1.MDAL3A.1.03.03	**Project WBS: SVE -DC- SVE - Monitoring Boreholes**										
1.MDAL3A.1.03.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	5.0	EA	1,158.34	72.9	5,760.81		4,149.46			9,910
1.MDAL3A.1.03.03	Structural excavation for minor structures, bank measure, normal soil, pits to	2.5	CY	210.12	11.4	898.85					899
1.MDAL3A.1.03.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	5.0	EA	80.25	3.0	314.46	372.17				687
1.MDAL3A.1.03.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exc	23.0	CY	12.87	3.1	246.58		260.04			507
1.MDAL3A.1.03.03	Pore Gas Monitoring - LLW Disposition	23.0	CY	1,200.00					47,226.89		47,227
1.MDAL3A.1.03.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAL3A.1.03.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	250.0	LF	138.80	375.0	38,875.42	19,677.87	821.34			59,375
1.MDAL3A.1.03.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yo	1,050.0	LF	37.76	500.9	51,926.04	14,283.57	1,634.97			67,845
1.MDAL3A.1.03.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	15.0	CF	3.74			95.99				96
1.MDAL3A.1.03.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includ	15.0	CF	1.90	0.6	41.88		6.93			49
1.MDAL3A.1.03.03	Bentonite clay, 50# bag, 1 per 10' of rod	230.0	EA	38.00			14,955.18				14,955
1.MDAL3A.1.03.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	1.7	CY	24.50			71.27				71
1.MDAL3A.1.03.03	Backfill, heavy soil, by hand, no compaction	16.0	CY	123.87	39.7	3,391.40					3,391
1.MDAL3A.1.03.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes	4,000.0	LF	16.95	912.6	94,606.45	18,397.95	3,011.57			116,016
1.MDAL3A.1.03.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, i	30.0	EA	121.05	49.8	5,160.35	890.12	163.24			6,214
1.MDAL3A.1.03.03	Mud Dauber (monitoring port)	30.0	EA	122.45	49.8	5,160.35	962.20	163.24			6,286
1.MDAL3A.1.03.03	**Total**				**2,038.2**	**207,918.39**	**69,706.33**	**12,298.36**	**47,226.89**		**337,150**
1.MDAL3A.1.03.04	**Project WBS: SVE -DC- SVE - Removal of FLUTE boreholes**										
1.MDAL3A.1.03.04	Removal of Monitoring Tubing	16.0	hour	351.11	29.1	2,757.78		6,854.88			9,613
1.MDAL3A.1.03.04	Structural concrete, ready mix, lightweight, 110 #/C.F., 3000 psi, includes loc	48.0	CF	25.55	21.8	1,556.06	542.08				2,098
1.MDAL3A.1.03.04	**Total**				**51.0**	**4,313.85**	**542.08**	**6,854.88**			**11,711**
1.MDAL3A.1.03	**Total**				**5,711.3**	**666,263.52**	**126,113.54**	**29,379.05**	**347,630.99**		**1,169,387**
1.MDAL3A.1.04	**Project WBS: Excavation of pit and impoundments – DC - Excavation**										
1.MDAL3A.1.04.01	**Project WBS: Excavation of pit and impoundments – DC - Excavate Pit & Impoundments Pit A**										
1.MDAL3A.1.04.01	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	1,733.0	CY	25.78	726.3	62,061.66		14,391.77			76,453
1.MDAL3A.1.04.01	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	1,196.0	CY	173.19	4,148.0	354,433.10					354,433
1.MDAL3A.1.04.01	Dozer D9 rip tuff material for processing	1,196.0	CY	1.13	29.5	2,312.54					2,313
1.MDAL3A.1.04.01	980 Frontend loader soil processing	537.0	CY	1.13	13.2	1,038.32					1,038
1.MDAL3A.1.04.01	825H High speed compactor (sheepsfoot) soil processing	537.0	CY	0.60	7.0	551.32					551
1.MDAL3A.1.04.01	963 Hydraulic Excavator soil processing	537.0	CY	0.60	7.0	551.32					551
1.MDAL3A.1.04.01	Dozer D9 rental	0.3	MNTH	29,404.00				12,578.44			12,578
1.MDAL3A.1.04.01	Dozer D9 Scheduled Maintenance	0.1	YR	7,253.69						992.95	993
1.MDAL3A.1.04.01	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3A.1.04.01	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3A.1.04.01	980, 7 cy frontend loader rental	0.3	MNTH	16,734.00				7,158.47			7,158
1.MDAL3A.1.04.01	980 Loader: Scheduled Maintenance	0.1	YR	5,865.19						802.88	803
1.MDAL3A.1.04.01	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3A.1.04.01	825H High speed compactor (sheepsfoot) rental	0.1	MNTH	10,585.00				1,448.98			1,449
1.MDAL3A.1.04.01	825H: Scheduled Maintenance	0.1	YR	5,944.56						813.75	814
1.MDAL3A.1.04.01	963 Hydraulic Excavator rental	0.3	MNTH	18,640.00				7,973.82			7,974
1.MDAL3A.1.04.01	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3A.1.04.01	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3A.1.04.01	Water wagon 1,000 gal tuff processing	151.0	CY	0.44	1.8	113.30					113
1.MDAL3A.1.04.01	Equipment only. Water wagon 1,000 gal tuff processing	151.0	CY	0.26				68.21			68
1.MDAL3A.1.04.01	Rock crusher plant rental	0.1	MNTH	28,000.00				3,832.91			3,833
1.MDAL3A.1.04.01	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3A.1.04.01	Screening plant rental	0.3	MNTH	15,500.00				6,630.59			6,631

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3A.1.04.01	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3A.1.04.01	Temporary, roads, excl surfacing.	35,390.0	SY	16.77	5,028.5	369,304.61	602,537.28	43,600.69			1,015,443
1.MDAL3A.1.04.01	Total				9,979.6	791,795.31	605,719.95	97,683.86		26,654.44	1,521,854
1.MDAL3A.1.04.02	Project WBS: Excavation of pit and impoundments – DC - Confirmatory Sampling Pit A										
1.MDAL3A.1.04.02	Confirmatory Sampling	135.0	EA	3,658.77	245.7	30,203.12		83.74	814,893.35		845,180
1.MDAL3A.1.04.02	Total				245.7	30,203.12		83.74	814,893.35		845,180
1.MDAL3A.1.04.03	Project WBS: Excavation of pit and impoundments – DC - Backfill Pit A										
1.MDAL3A.1.04.03	Borrow, fill material only.	1,794.0	ton	16.50			50,650.84				50,651
1.MDAL3A.1.04.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	1,733.0	CY	4.46	62.8	5,367.43		7,858.23			13,226
1.MDAL3A.1.04.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,733.0	CY	4.62	114.5	9,783.67		3,914.65			13,698
1.MDAL3A.1.04.03	Water wagon 1,000 gal tuff processing	1,733.0	CY	0.44	20.8	1,300.34					1,300
1.MDAL3A.1.04.03	Equipment only. Water wagon 1,000 gal tuff processing	1,733.0	CY	0.26				782.86			783
1.MDAL3A.1.04.03	Total				198.1	16,451.44	50,650.84	12,555.73			79,658
1.MDAL3A.1.04.04	Project WBS: Excavation of pit and impoundments – DC - Disposal of Waste Pit A										
1.MDAL3A.1.04.04	Waste container delivery.	18.0	ea	1,453.61	446.9	29,623.70		15,147.70			44,771
1.MDAL3A.1.04.04	Waste container unload on site and handling during project.	359.0	ea	4,607.32	29,403.0	2,323,431.87		506,807.11			2,830,239
1.MDAL3A.1.04.04	Waste containers.	359.0	ea	2,018.34			1,239,849.75				1,239,850
1.MDAL3A.1.04.04	Fill waste containers.	359.0	ea	549.81	3,834.6	303,013.39		34,730.40			337,744
1.MDAL3A.1.04.04	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	1,196.0	cy	1,114.00					2,279,799.49		2,279,799
1.MDAL3A.1.04.04	Trucking cost per 43,000 pound load	72.0	Trip	4,471.00						550,829.83	550,830
1.MDAL3A.1.04.04	Confirmatory Sampling	12.0	EA	3,658.77	21.8	2,684.72		7.44	72,434.96		75,127
1.MDAL3A.1.04.04	Total				33,706.4	2,658,753.69	1,239,849.75	556,692.64	2,352,234.46	550,829.83	7,358,360
1.MDAL3A.1.04.05	Project WBS: Excavation of pit and impoundments – DC - Excavate Pit & Impoundments Pit B										
1.MDAL3A.1.04.05	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	578.0	CY	25.78	242.2	20,699.16		4,800.03			25,499
1.MDAL3A.1.04.05	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	399.0	CY	173.19	1,383.8	118,243.15					118,243
1.MDAL3A.1.04.05	Dozer D9 rip tuff material for processing	399.0	CY	1.13	9.8	771.49					771
1.MDAL3A.1.04.05	980 Frontend loader soil processing	179.0	CY	1.13	4.4	346.11					346
1.MDAL3A.1.04.05	825H High speed compactor (sheepsfoot) soil processing	179.0	CY	0.60	2.3	183.77					184
1.MDAL3A.1.04.05	963 Hydraulic Excavator soil processing	179.0	CY	0.60	2.3	183.77					184
1.MDAL3A.1.04.05	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL3A.1.04.05	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL3A.1.04.05	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3A.1.04.05	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3A.1.04.05	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL3A.1.04.05	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL3A.1.04.05	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3A.1.04.05	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL3A.1.04.05	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL3A.1.04.05	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL3A.1.04.05	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3A.1.04.05	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3A.1.04.05	Water wagon 1,000 gal soil processing	179.0	CY	0.44	2.2	134.31					134
1.MDAL3A.1.04.05	Equipment only. Water wagon 1,000 gal soil processing	179.0	CY	0.26				80.86			81
1.MDAL3A.1.04.05	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL3A.1.04.05	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3A.1.04.05	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL3A.1.04.05	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3A.1.04.05	Total				1,665.3	141,990.89	3,182.66	141,279.34		30,568.82	317,022
1.MDAL3A.1.04.06	Project WBS: Excavation of pit and impoundments – DC - Confirmatory Sampling Pit B										
1.MDAL3A.1.04.06	Confirmatory Sampling	45.0	EA	3,658.77	81.9	10,067.71		27.91	271,631.12		281,727
1.MDAL3A.1.04.06	Total				81.9	10,067.71		27.91	271,631.12		281,727
1.MDAL3A.1.04.07	Project WBS: Excavation of pit and impoundments – DC - Backfill Pit B										
1.MDAL3A.1.04.07	Borrow, fill material only.	867.0	ton	16.50			24,478.42				24,478
1.MDAL3A.1.04.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	578.0	CY	4.46	21.0	1,790.18		2,620.92			4,411
1.MDAL3A.1.04.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	578.0	CY	4.62	38.2	3,263.11		1,305.64			4,569
1.MDAL3A.1.04.07	Water wagon 1,000 gal tuff processing	578.0	CY	0.44	6.9	433.70					434
1.MDAL3A.1.04.07	Equipment only. Water wagon 1,000 gal soil processing	578.0	CY	0.26				261.10			261
1.MDAL3A.1.04.07	Total				66.1	5,486.98	24,478.42	4,187.66			34,153
1.MDAL3A.1.04.08	Project WBS: Excavation of pit and impoundments – DC - Disposal of Waste Pit B										
1.MDAL3A.1.04.08	Waste container delivery.	7.0	ea	1,453.61	173.8	11,520.33		5,890.77			17,411
1.MDAL3A.1.04.08	Waste container unload on site and handling during project.	120.0	ea	4,607.32	9,828.3	776,634.61		169,406.28			946,041
1.MDAL3A.1.04.08	Waste containers.	120.0	ea	2,018.34			414,434.46				414,434
1.MDAL3A.1.04.08	Fill waste containers.	120.0	ea	549.81	1,281.8	101,285.81		11,609.05			112,895
1.MDAL3A.1.04.08	10% Mixed Waste, ship off site. Packaging, Handling, Shipping and Disposa	399.0	cy	1,114.00					760,568.56		760,569
1.MDAL3A.1.04.08	Trucking cost per 43,000 pound load	26.0	Trip	4,471.00						198,910.77	198,911
1.MDAL3A.1.04.08	Confirmatory Sampling	4.0	EA	3,658.77	7.3	894.91		2.48	24,144.99		25,042
1.MDAL3A.1.04.08	Total				11,291.2	890,335.66	414,434.46	186,908.57	784,713.55	198,910.77	2,475,303
1.MDAL3A.1.04.09	Project WBS: Excavation of pit and impoundments – DC - Excavate Pit & Impoundments Pit C										
1.MDAL3A.1.04.09	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	289.0	CY	25.78	121.1	10,349.58		2,400.01			12,750
1.MDAL3A.1.04.09	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	200.0	CY	173.19	693.6	59,269.75					59,270
1.MDAL3A.1.04.09	Dozer D9 rip tuff material for processing	199.0	CY	1.13	4.9	384.78					385
1.MDAL3A.1.04.09	980 Frontend loader soil processing	90.0	CY	1.13	2.2	174.02					174
1.MDAL3A.1.04.09	825H High speed compactor (sheepsfoot) soil processing	90.0	CY	0.60	1.2	92.40					92
1.MDAL3A.1.04.09	963 Hydraulic Excavator soil processing	90.0	CY	0.60	1.2	92.40					92

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3A.1.04.09	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL3A.1.04.09	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL3A.1.04.09	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3A.1.04.09	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3A.1.04.09	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL3A.1.04.09	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL3A.1.04.09	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3A.1.04.09	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL3A.1.04.09	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL3A.1.04.09	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL3A.1.04.09	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3A.1.04.09	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3A.1.04.09	Water wagon 1,000 gal soil processing	90.0	CY	0.44	1.1	67.53					68
1.MDAL3A.1.04.09	Equipment only. Water wagon 1,000 gal soil processing	90.0	CY	0.26				40.66			41
1.MDAL3A.1.04.09	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL3A.1.04.09	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3A.1.04.09	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL3A.1.04.09	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3A.1.04.09	**Total**				**843.5**	**71,859.58**	**3,182.66**	**138,839.12**		**30,568.82**	**244,450**
1.MDAL3A.1.04.10	**Project WBS: Excavation of pit and impoundments – DC - Confirmatory Sampling Pit C**										
1.MDAL3A.1.04.10	Confirmatory Sampling	23.0	EA	3,658.77	41.9	5,145.72		14.27	138,833.68		143,994
1.MDAL3A.1.04.10	**Total**				**41.9**	**5,145.72**		**14.27**	**138,833.68**		**143,994**
1.MDAL3A.1.04.11	**Project WBS: Excavation of pit and impoundments – DC - Backfill Pit C**										
1.MDAL3A.1.04.11	Borrow, fill material only.	434.0	ton	16.50			12,253.33				12,253
1.MDAL3A.1.04.11	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	289.0	CY	4.46	10.5	895.09		1,310.46			2,206
1.MDAL3A.1.04.11	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	289.0	CY	4.62	19.1	1,631.55		652.82			2,284
1.MDAL3A.1.04.11	Water wagon 1,000 gal tuff processing	289.0	CY	0.44	3.5	216.85					217
1.MDAL3A.1.04.11	Equipment only. Water wagon 1,000 gal soil processing	289.0	CY	0.26				130.55			131
1.MDAL3A.1.04.11	**Total**				**33.0**	**2,743.49**	**12,253.33**	**2,093.83**			**17,091**
1.MDAL3A.1.04.12	**Project WBS: Excavation of pit and impoundments – DC - Disposal of Waste Pit C**										
1.MDAL3A.1.04.12	Waste container delivery.	3.0	ea	1,453.61	74.5	4,937.28		2,524.62			7,462
1.MDAL3A.1.04.12	Waste container unload on site and handling during project.	63.0	ea	4,607.32	5,159.9	407,733.17		88,938.29			496,671
1.MDAL3A.1.04.12	Waste containers.	63.0	ea	2,018.34			217,578.09				217,578
1.MDAL3A.1.04.12	Fill waste containers.	63.0	ea	549.81	672.9	53,175.05		6,094.75			59,270
1.MDAL3A.1.04.12	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	200.0	cy	1,114.00					381,237.37		381,237
1.MDAL3A.1.04.12	Trucking cost per 43,000 pound load	7.0	Trip	4,471.00						53,552.90	53,553
1.MDAL3A.1.04.12	Confirmatory Sampling	2.0	EA	3,658.77	3.6	447.45		1.24	12,072.49		12,521
1.MDAL3A.1.04.12	**Total**				**5,910.9**	**466,292.96**	**217,578.09**	**97,558.90**	**393,309.87**	**53,552.90**	**1,228,293**
1.MDAL3A.1.04.13	**Project WBS: Excavation of pit and impoundments – DC - Excavate Pit & Impoundments Pit D**										
1.MDAL3A.1.04.13	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	650.0	CY	25.78	272.4	23,277.60		5,397.95			28,676
1.MDAL3A.1.04.13	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	449.0	CY	173.19	1,557.2	133,060.59					133,061
1.MDAL3A.1.04.13	Dozer D9 rip tuff material for processing	449.0	CY	1.13	11.1	868.17					868
1.MDAL3A.1.04.13	980 Frontend loader soil processing	202.0	CY	1.13	5.0	390.58					391
1.MDAL3A.1.04.13	825H High speed compactor (sheepsfoot) soil processing	202.0	CY	0.60	2.6	207.39					207
1.MDAL3A.1.04.13	963 Hydraulic Excavator soil processing	202.0	CY	0.60	2.6	207.39					207
1.MDAL3A.1.04.13	Dozer D9 Mobilization	2.0	ea	1,750.00						5,988.92	5,989
1.MDAL3A.1.04.13	980 Loader Mobilization	2.0	ea	697.00						2,385.30	2,385
1.MDAL3A.1.04.13	Screening plant, Mobilization	2.0	ea	3,000.00						10,266.72	10,267
1.MDAL3A.1.04.13	963 Hydraulic Excavator Mobilization	2.0	ea	2,050.00						7,015.59	7,016
1.MDAL3A.1.04.13	Rock crusher plant, Mobilization	2.0	ea	5,000.00						17,111.19	17,111
1.MDAL3A.1.04.13	Rock crusher plant, Set up costs.	1.0	ea	2,000.00						3,422.24	3,422
1.MDAL3A.1.04.13	825H Mobilization	2.0	ea	812.00						2,778.86	2,779
1.MDAL3A.1.04.13	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL3A.1.04.13	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL3A.1.04.13	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3A.1.04.13	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3A.1.04.13	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL3A.1.04.13	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL3A.1.04.13	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3A.1.04.13	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL3A.1.04.13	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL3A.1.04.13	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL3A.1.04.13	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3A.1.04.13	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3A.1.04.13	Water wagon 1,000 gal soil processing	90.0	CY	0.44	1.1	67.53					68
1.MDAL3A.1.04.13	Equipment only. Water wagon 1,000 gal soil processing	90.0	CY	0.26				40.66			41
1.MDAL3A.1.04.13	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL3A.1.04.13	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3A.1.04.13	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL3A.1.04.13	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3A.1.04.13	**Total**				**1,870.3**	**159,508.37**	**3,182.66**	**141,837.06**		**79,537.63**	**384,066**
1.MDAL3A.1.04.14	**Project WBS: Excavation of pit and impoundments – DC - Confirmatory Sampling Pit D**										
1.MDAL3A.1.04.14	Confirmatory Sampling	51.0	EA	3,658.77	92.8	11,410.07		31.63	307,848.60		319,290
1.MDAL3A.1.04.14	**Total**				**92.8**	**11,410.07**		**31.63**	**307,848.60**		**319,290**

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3A.1.04.15	Project WBS: Excavation of pit and impoundments – DC - Backfill Pit D										
1.MDAL3A.1.04.15	Borrow, fill material only.	975.0	ton	16.50			27,527.63				27,528
1.MDAL3A.1.04.15	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	650.0	CY	4.46	23.6	2,013.17		2,947.40			4,961
1.MDAL3A.1.04.15	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	650.0	CY	4.62	42.9	3,669.58		1,468.27			5,138
1.MDAL3A.1.04.15	Water wagon 1,000 gal tuff processing	650.0	CY	0.44	7.8	487.72					488
1.MDAL3A.1.04.15	Equipment only. Water wagon 1,000 gal soil processing	650.0	CY	0.26				293.63			294
1.MDAL3A.1.04.15	Total				74.3	6,170.48	27,527.63	4,709.31			38,407
1.MDAL3A.1.04.16	Project WBS: Excavation of pit and impoundments – DC - Disposal of Waste Pit D										
1.MDAL3A.1.04.16	Waste container delivery.	7.0	ea	1,453.61	173.8	11,520.33		5,890.77			17,411
1.MDAL3A.1.04.16	Waste container unload on site and handling during project.	135.0	ea	4,607.32	11,056.9	873,713.94		190,582.06			1,064,296
1.MDAL3A.1.04.16	Waste containers.	135.0	ea	2,018.34			466,238.76				466,239
1.MDAL3A.1.04.16	Fill waste containers.	135.0	ea	549.81	1,442.0	113,946.54		13,060.18			127,007
1.MDAL3A.1.04.16	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	449.0	cy	1,114.00					855,877.90		855,878
1.MDAL3A.1.04.16	Trucking cost per 43,000 pound load	15.0	Trip	4,471.00						114,756.21	114,756
1.MDAL3A.1.04.16	Confirmatory Sampling	5.0	EA	3,658.77	9.1	1,118.63		3.10	30,181.24		31,303
1.MDAL3A.1.04.16	Total				12,681.8	1,000,299.44	466,238.76	209,536.11	886,059.14	114,756.21	2,676,890
1.MDAL3A.1.04.17	Project WBS: Excavation of pit and impoundments – DC - Equipment Decontamination										
1.MDAL3A.1.04.17	Swipes	50.0	hour	649.94	50.0	4,272.33	51,333.58				55,606
1.MDAL3A.1.04.17	RCT involvment in swipes and decontamination process	50.0	hour	124.97	25.0	2,136.17	8,555.60				10,692
1.MDAL3A.1.04.17	Decontamination of equipment.	100.0	hour	149.94	100.0	8,544.67	17,111.19				25,656
1.MDAL3A.1.04.17	Total				175.0	14,953.17	77,000.37				91,954
1.MDAL3A.1.04	Total				78,957.8	6,283,468.06	3,145,279.58	1,594,039.68	5,949,523.75	1,085,379.41	18,057,690
1.MDAL3A.1.05	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -DC- Distribs										
1.MDAL3A.1.05	Field Non-Manual - JHRS	17,868.0	hour	66.10	17,868.0	2,020,959.85					2,020,960
1.MDAL3A.1.05	Craft Distributable - Labor	22,335.0	hour	46.33	22,335.0	1,770,620.61					1,770,621
1.MDAL3A.1.05	Craft Distributable - Materials	22,335.0	hour	7.00	22,335.0		267,524.94				267,525
1.MDAL3A.1.05	Total				62,538.0	3,791,580.46	267,524.94				4,059,105
1.MDAL3A.1	Total				151,879.9	11,126,550.67	4,518,489.00	1,800,834.10	6,299,550.31	1,085,379.41	24,830,803
1.MDAL3A.2	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Indirect Capital Cost										
1.MDAL3A.2.01	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IC- Design										
1.MDAL3A.2.01	RCRA Shafts Pad Design	1.0	lsum	1,774,713.12					2,583,804.83		2,583,805
1.MDAL3A.2.01	Total								2,583,804.83		2,583,805
1.MDAL3A.2.02	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IC- Professional Manag										
1.MDAL3A.2.02	Professional Management	1.0	lsum	7,127,798.00	71,564.2	15,617,928.47					15,617,928
1.MDAL3A.2.02	Total				71,564.2	15,617,928.47					15,617,928
1.MDAL3A.2.03	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IC- Contingency										
1.MDAL3A.2.03	Contingency - Cost 30%	1.0	lsum	12,909,760.00	1.0					12,909,760.00	12,909,760
1.MDAL3A.2.03	Contingency - Schedule 10%	1.0	lsum	4,303,253.00	1.0					4,303,253.00	4,303,253
1.MDAL3A.2.03	Contingency - TPRA 10%	1.0	lsum	4,303,253.00	1.0					4,303,253.00	4,303,253
1.MDAL3A.2.03	Total				3.0					21,516,266.00	21,516,266
1.MDAL3A.2	Total				71,567.2	15,617,928.47			2,583,804.83	21,516,266.00	39,717,999
1.MDAL3A.3	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Direct O&M Costs										
1.MDAL3A.3.01	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -DOM- Cover Maintenance										
1.MDAL3A.3.01	Active SVE Operation (3 years)	1.0	lsum	862,947.00	18,626.2	1,256,364.54					1,256,365
1.MDAL3A.3.01	Active SVE Monitoring (3 years)	1.0	lsum	123,456.00	1,576.7	179,739.59					179,740
1.MDAL3A.3.01	Rebound SVE Monitoring (3 years)	1.0	lsum	469,133.00	10,126.0	683,010.73					683,011
1.MDAL3A.3.01	Subsurface VOC Vapor Monitoring (30 years)	1.0	lsum	1,326,475.00	16,940.9	1,931,214.95					1,931,215
1.MDAL3A.3.01	Cover INspections and Maintenance (100 years)	1.0	lsum	148,476.00	3,204.8	216,166.21					216,166
1.MDAL3A.3.01	Annual Long Term Monitoring Report - 100 years	1.0	lsum	157,125.00	2,006.7	228,758.29					228,758
1.MDAL3A.3.01	Total				52,481.3	4,495,254.31					4,495,254
1.MDAL3A.3	Total				52,481.3	4,495,254.31					4,495,254
1.MDAL3A.4	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Indirect O&M Costs										
1.MDAL3A.4.02	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IOM- Professional Man										
1.MDAL3A.4.02	Professional Management (years 0-3)	1.0	lsum	316,758.00	3,180.3	694,057.80					694,058
1.MDAL3A.4.02	Professional Management (years 4-30)	1.0	lsum	356,750.00	3,581.8	781,685.45					781,685
1.MDAL3A.4.02	Professional Management (years 31-100)	1.0	lsum	32,455.00	325.9	71,113.11					71,113
1.MDAL3A.4.02	Total				7,088.0	1,546,856.36					1,546,856
1.MDAL3A.4.03	Project WBS: 3A Multilayer (RCRA) Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IOM- Contingency										
1.MDAL3A.4.03	Contingency - Cost 30%	1.0	lsum	1,812,633.00	1.0					1,812,633.00	1,812,633
1.MDAL3A.4.03	Contingency - Schedule 10%	1.0	lsum	604,211.00	1.0					604,211.00	604,211
1.MDAL3A.4.03	Contingency - TPRA 10%	1.0	lsum	604,211.00	1.0					604,211.00	604,211
1.MDAL3A.4.03	Total				3.0					3,021,055.00	3,021,055
1.MDAL3A.4	Total				7,091.0	1,546,856.36				3,021,055.00	4,567,911
1.MDAL3A	Total				283,019.4	32,786,589.81	4,518,489.00	1,800,834.10	8,883,355.14	25,622,700.41	73,611,968
1.MDAL3B	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls										
1.MDAL3B.1	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Direct Capital Costs										
1.MDAL3B.1.01	Project WBS: ET Cover Shafts -DC- Fence										
1.MDAL3B.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' (	1,450.0	LF	56.72	352.2	28,129.44	109,169.41	3,423.95			140,723
1.MDAL3B.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire,	15.0	EA	162.19	16.4	1,308.81	2,695.01	159.13			4,163
1.MDAL3B.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, include	2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAL3B.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes p	20.0	EA	120.98	16.6	1,328.91	2,446.90	364.47			4,140
1.MDAL3B.1.01	Total				465.4	37,165.62	119,958.02	5,710.01			162,834
1.MDAL3B.1.02	Project WBS: ET Cover Shafts -DC- ET Cover										
1.MDAL3B.1.02.01	Project WBS: ET Cover Shafts -DC- ET Cover - Site Prep										
1.MDAL3B.1.02.01	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	10.0	EA	529.39	48.6	3,839.50		5,218.91			9,058
1.MDAL3B.1.02.01	Track out device	1.0	EA	5,234.35	5.5	400.99	8,555.60				8,957

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3B.1.02.01	Clean out track out device.	8.0	EA	1,185.53	87.4	6,415.88		9,812.73			16,229
1.MDAL3B.1.02.01	Rent toilet portable chemical	10.0	mnth	400.00				6,844.48			6,844
1.MDAL3B.1.02.01	Chemical toilet cleaning.	10.0	mnth	946.50	163.8	10,231.92		5,963.83			16,196
1.MDAL3B.1.02.01	Chemical toilet cleaning (labor)	10.0	mnth	573.07	163.8	9,805.84					9,806
1.MDAL3B.1.02.01	Excavation permit	2.0	ea	700.00					2,395.57		2,396
1.MDAL3B.1.02.01	Selective clearing, brush, with brush saw, includes cutting and site cleanup,	0.9	acre	3,022.82	51.3	4,382.43		169.28			4,552
1.MDAL3B.1.02.01	Lister support	24.0	hour	100.10	43.7	4,110.79					4,111
1.MDAL3B.1.02.01	Laydown - Base course drainage layers, aggregate base course for roadway	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAL3B.1.02.01	Laydown - Backfill, bulk, 6" to 12" lifts, dozer backfilling	1,481.0	CY	3.30	40.8	3,221.78		5,144.23			8,366
1.MDAL3B.1.02.01	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAL3B.1.02.01	**Total**				**734.5**	**53,409.42**	**109,853.86**	**44,604.07**	**2,395.57**		**210,263**
1.MDAL3B.1.02.02	**Project WBS: ET Cover Shafts -DC- ET Cover - Cover Prep**										
1.MDAL3B.1.02.02	Borrow, fill material only.	10,895.4	ton	20.50			382,188.24				382,188
1.MDAL3B.1.02.02	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	5,447.7	CY	4.46	197.5	16,872.57		24,702.41			41,575
1.MDAL3B.1.02.02	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	5,447.7	CY	4.62	359.9	30,755.06		12,305.72			43,061
1.MDAL3B.1.02.02	Water wagon 1,000 gal compaction	5,447.7	CY	0.44	65.4	4,087.63					4,088
1.MDAL3B.1.02.02	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	5,447.7	CY	0.94	50.0	3,950.32		4,847.42			8,798
1.MDAL3B.1.02.02	**Total**				**672.8**	**55,665.57**	**382,188.24**	**41,855.56**			**479,709**
1.MDAL3B.1.02.03	**Project WBS: ET Cover Shafts -DC- ET Cover - Installation of 1' Biobarrier**										
1.MDAL3B.1.02.03	Cobble - Cobble Material and Delivery	871.0	TN	20.50			30,552.89				30,553
1.MDAL3B.1.02.03	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	645.0	CY	3.30	17.8	1,403.14		2,240.40			3,644
1.MDAL3B.1.02.03	**Total**				**17.8**	**1,403.14**	**30,552.89**	**2,240.40**			**34,196**
1.MDAL3B.1.02.04	**Project WBS: ET Cover Shafts -DC- ET Cover - Installation of .5' Filter Layer**										
1.MDAL3B.1.02.04	Base course drainage layers, aggregate base course for roadways and large	1,936.0	SY	8.87	28.1	2,402.18	24,514.18	2,452.14			29,368
1.MDAL3B.1.02.04	**Total**				**28.1**	**2,402.18**	**24,514.18**	**2,452.14**			**29,368**
1.MDAL3B.1.02.05	**Project WBS: ET Cover Shafts -DC- ET Cover - Installation of 3.5' Fine grained cover soil**										
1.MDAL3B.1.02.05	TUFF - TUFF Material and Delivery	4,518.0	TN	20.50			158,482.16				158,482
1.MDAL3B.1.02.05	TUFF - Backfill, bulk, 6" to 12" lifts, dozer backfilling	2,259.0	CY	3.30	62.2	4,914.24		7,846.61			12,761
1.MDAL3B.1.02.05	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel ro	2,259.0	CY	0.94	20.7	1,638.08		2,010.08			3,648
1.MDAL3B.1.02.05	TUFF & SOIL - Rent water truck, off highway, 6000 gallon capacity - Rent pe	5.0	days	1,309.30	54.6	4,314.55		6,887.26			11,202
1.MDAL3B.1.02.05	**Total**				**137.5**	**10,866.88**	**158,482.16**	**16,743.94**			**186,093**
1.MDAL3B.1.02.06	**Project WBS: ET Cover Shafts -DC- ET Cover - Installation of 1.5' cover soil/surface treatment**										
1.MDAL3B.1.02.06	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel ro	484.0	CY	0.94	4.4	350.97		430.67			782
1.MDAL3B.1.02.06	Soil - Soils for earthwork, common borrow, spread with 200 H.P. dozer, inclu	484.0	CY	15.54	41.2	3,253.54	6,128.54	3,486.53			12,869
1.MDAL3B.1.02.06	Soil - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel rolle	484.0	CY	0.94	4.4	350.97		430.67			782
1.MDAL3B.1.02.06	TUFF - Borrow, fill material only.	968.0	ton	20.50			33,955.45				33,955
1.MDAL3B.1.02.06	TUFF - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill,	484.0	CY	4.46	17.5	1,499.04		2,194.68			3,694
1.MDAL3B.1.02.06	TUFF - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	484.0	CY	4.62	32.0	2,732.43		1,093.30			3,826
1.MDAL3B.1.02.06	TUFF - Water wagon 1,000 gal compaction	484.0	CY	0.44	5.8	363.16					363
1.MDAL3B.1.02.06	Soil - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, wi	484.0	CY	4.46	17.5	1,499.04		2,194.68			3,694
1.MDAL3B.1.02.06	Soil - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	484.0	CY	4.62	32.0	2,732.43		1,093.30			3,826
1.MDAL3B.1.02.06	Soil - Water wagon 1,000 gal compaction	484.0	CY	0.44	5.8	363.16					363
1.MDAL3B.1.02.06	**Total**				**160.7**	**13,144.74**	**40,084.00**	**10,923.83**			**64,153**
1.MDAL3B.1.02.07	**Project WBS: ET Cover Shafts -DC- ET Cover - Shoulder Fill**										
1.MDAL3B.1.02.07	Borrow, fill material only.	1,210.6	ton	20.50			42,465.36				42,465
1.MDAL3B.1.02.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	605.0	CY	4.46	21.9	1,873.80		2,743.35			4,617
1.MDAL3B.1.02.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	605.0	CY	4.62	40.0	3,415.53		1,366.63			4,782
1.MDAL3B.1.02.07	Water wagon 1,000 gal compaction	605.0	CY	0.44	7.3	453.96					454
1.MDAL3B.1.02.07	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	605.0	CY	0.94	5.6	438.71		538.34			977
1.MDAL3B.1.02.07	Manual Backfill, by hand, slope building	605.0	CY	90.61	1,097.8	93,801.09					93,801
1.MDAL3B.1.02.07	compact, by hand, 6" layers, air rammer/tamper	605.0	E.C.Y.	20.44	231.3	19,764.69		1,399.55			21,164
1.MDAL3B.1.02.07	**Total**				**1,403.8**	**119,747.77**	**42,465.36**	**6,047.86**			**168,261**
1.MDAL3B.1.02.08	**Project WBS: ET Cover Shafts -DC- ET Cover - Cover Armoring**										
1.MDAL3B.1.02.08	Cobble - Cobble Material and Delivery	339.0	TN	20.50			11,891.42				11,891
1.MDAL3B.1.02.08	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	251.0	CY	3.30	6.9	546.03		871.85			1,418
1.MDAL3B.1.02.08	Manual Backfill, by hand, slope building	251.0	CY	90.61	455.4	38,915.82					38,916
1.MDAL3B.1.02.08	**Total**				**462.3**	**39,461.85**	**11,891.42**	**871.85**			**52,225**
1.MDAL3B.1.02.09	**Project WBS: ET Cover Shafts -DC- ET Cover - Revegetation**										
1.MDAL3B.1.02.09	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL3B.1.02.09	Hydroseeding materials.	1.0	lsum	39,421.80			67,455.40				67,455
1.MDAL3B.1.02.09	Broadcasting Mulch and Humate	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL3B.1.02.09	Mulch and Humate materials.	1.0	LS	17,685.00			30,261.14				30,261
1.MDAL3B.1.02.09	**Total**				**42.8**	**3,146.78**	**97,716.55**	**1,458.90**			**102,322**
1.MDAL3B.1.02.10	**Project WBS: ET Cover Shafts -DC- ET Cover - TDR Monitor**										
1.MDAL3B.1.02.10	TDR Monitoring of ET Cover	1.0	EA	41,921.77	72.8	7,566.18	64,166.97				71,733
1.MDAL3B.1.02.10	**Total**				**72.8**	**7,566.18**	**64,166.97**				**71,733**
1.MDAL3B.1.02	**Total**				**3,733.2**	**306,814.50**	**961,915.62**	**127,198.55**	**2,395.57**		**1,398,324**
1.MDAL3B.1.03	**Project WBS: Excavation of pit and impoundments – DC - Excavation**										
1.MDAL3B.1.03.01	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Excavate Pit & Impoundments Pit A**										
1.MDAL3B.1.03.01	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	1,733.0	CY	25.78	726.3	62,061.66		14,391.77			76,453
1.MDAL3B.1.03.01	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	1,196.0	CY	173.19	4,148.0	354,433.10					354,433
1.MDAL3B.1.03.01	Dozer D9 rip tuff material for processing	1,196.0	CY	1.13	29.5	2,312.54					2,313
1.MDAL3B.1.03.01	980 Frontend loader soil processing	537.0	CY	1.13	13.2	1,038.32					1,038
1.MDAL3B.1.03.01	825H High speed compactor (sheepsfoot) soil processing	537.0	CY	0.60	7.0	551.32					551
1.MDAL3B.1.03.01	963 Hydraulic Excavator soil processing	537.0	CY	0.60	7.0	551.32					551

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3B.1.03.01	Dozer D9 rental	0.3	MNTH	29,404.00				12,578.44			12,578
1.MDAL3B.1.03.01	Dozer D9 Scheduled Maintenance	0.1	YR	7,253.69						992.95	993
1.MDAL3B.1.03.01	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3B.1.03.01	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3B.1.03.01	980, 7 cy frontend loader rental	0.3	MNTH	16,734.00				7,158.47			7,158
1.MDAL3B.1.03.01	980 Loader: Scheduled Maintenance	0.1	YR	5,865.19						802.88	803
1.MDAL3B.1.03.01	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3B.1.03.01	825H High speed compactor (sheepsfoot) rental	0.1	MNTH	10,585.00				1,448.98			1,449
1.MDAL3B.1.03.01	825H: Scheduled Maintenance	0.1	YR	5,944.56						813.75	814
1.MDAL3B.1.03.01	963 Hydraulic Excavator rental	0.3	MNTH	18,640.00				7,973.82			7,974
1.MDAL3B.1.03.01	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3B.1.03.01	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3B.1.03.01	Water wagon 1,000 gal tuff processing	151.0	CY	0.44	1.8	113.30					113
1.MDAL3B.1.03.01	Equipment only. Water wagon 1,000 gal tuff processing	151.0	CY	0.26				68.21			68
1.MDAL3B.1.03.01	Rock crusher plant rental	0.1	MNTH	28,000.00				3,832.91			3,833
1.MDAL3B.1.03.01	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3B.1.03.01	Screening plant rental	0.3	MNTH	15,500.00				6,630.59			6,631
1.MDAL3B.1.03.01	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3B.1.03.01	Temporary, roads, excl surfacing.	35,390.0	SY	16.77	5,028.5	369,304.61	602,537.28	43,600.69			1,015,443
1.MDAL3B.1.03.01	**Total**				**9,979.6**	**791,795.31**	**605,719.95**	**97,683.86**		**26,654.44**	**1,521,854**
1.MDAL3B.1.03.02	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Confirmatory Sampling Pit A**										
1.MDAL3B.1.03.02	Confirmatory Sampling	135.0	EA	3,658.77	245.7	30,203.12		83.74	814,893.35		845,180
1.MDAL3B.1.03.02	**Total**				**245.7**	**30,203.12**		**83.74**	**814,893.35**		**845,180**
1.MDAL3B.1.03.03	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Backfill Pit A**										
1.MDAL3B.1.03.03	Borrow, fill material only.	1,794.0	ton	16.50			50,650.84				50,651
1.MDAL3B.1.03.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	1,733.0	CY	4.46	62.8	5,367.43		7,858.23			13,226
1.MDAL3B.1.03.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,733.0	CY	4.62	114.5	9,783.67		3,914.65			13,698
1.MDAL3B.1.03.03	Water wagon 1,000 gal tuff processing	1,733.0	CY	0.44	20.8	1,300.34					1,300
1.MDAL3B.1.03.03	Equipment only. Water wagon 1,000 gal tuff processing	1,733.0	CY	0.26				782.86			783
1.MDAL3B.1.03.03	**Total**				**198.1**	**16,451.44**	**50,650.84**	**12,555.73**			**79,658**
1.MDAL3B.1.03.04	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Disposal of Waste Pit A**										
1.MDAL3B.1.03.04	Waste container delivery.	18.0	ea	1,453.61	446.9	29,623.70		15,147.70			44,771
1.MDAL3B.1.03.04	Waste container unload on site and handling during project.	359.0	ea	4,607.32	29,403.0	2,323,431.87		506,807.11			2,830,239
1.MDAL3B.1.03.04	Waste containers.	359.0	ea	2,018.34			1,239,849.75				1,239,850
1.MDAL3B.1.03.04	Fill waste containers.	359.0	ea	549.81	3,834.6	303,013.39		34,730.40			337,744
1.MDAL3B.1.03.04	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	1,196.0	cy	1,114.00					2,279,799.49		2,279,799
1.MDAL3B.1.03.04	Trucking cost per 43,000 pound load	72.0	Trip	4,471.00						550,829.83	550,830
1.MDAL3B.1.03.04	Confirmatory Sampling	12.0	EA	3,658.77	21.8	2,684.72		7.44	72,434.96		75,127
1.MDAL3B.1.03.04	**Total**				**33,706.4**	**2,658,753.69**	**1,239,849.75**	**556,692.64**	**2,352,234.46**	**550,829.83**	**7,358,360**
1.MDAL3B.1.03.05	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Excavate Pit & Impoundments Pit B**										
1.MDAL3B.1.03.05	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	578.0	CY	25.78	242.2	20,699.16		4,800.03			25,499
1.MDAL3B.1.03.05	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	399.0	CY	173.19	1,383.8	118,243.15					118,243
1.MDAL3B.1.03.05	Dozer D9 rip tuff material for processing	399.0	CY	1.13	9.8	771.49					771
1.MDAL3B.1.03.05	980 Frontend loader soil processing	179.0	CY	1.13	4.4	346.11					346
1.MDAL3B.1.03.05	825H High speed compactor (sheepsfoot) soil processing	179.0	CY	0.60	2.3	183.77					184
1.MDAL3B.1.03.05	963 Hydraulic Excavator soil processing	179.0	CY	0.60	2.3	183.77					184
1.MDAL3B.1.03.05	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL3B.1.03.05	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL3B.1.03.05	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3B.1.03.05	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3B.1.03.05	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL3B.1.03.05	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL3B.1.03.05	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3B.1.03.05	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL3B.1.03.05	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL3B.1.03.05	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL3B.1.03.05	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3B.1.03.05	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3B.1.03.05	Water wagon 1,000 gal soil processing	179.0	CY	0.44	2.2	134.31					134
1.MDAL3B.1.03.05	Equipment only. Water wagon 1,000 gal soil processing	179.0	CY	0.26				80.86			81
1.MDAL3B.1.03.05	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL3B.1.03.05	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3B.1.03.05	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL3B.1.03.05	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3B.1.03.05	**Total**				**1,665.3**	**141,990.89**	**3,182.66**	**141,279.34**		**30,568.82**	**317,022**
1.MDAL3B.1.03.06	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Confirmatory Sampling Pit B**										
1.MDAL3B.1.03.06	Confirmatory Sampling	45.0	EA	3,658.77	81.9	10,067.71		27.91	271,631.12		281,727
1.MDAL3B.1.03.06	**Total**				**81.9**	**10,067.71**		**27.91**	**271,631.12**		**281,727**
1.MDAL3B.1.03.07	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Backfill Pit B**										
1.MDAL3B.1.03.07	Borrow, fill material only.	867.0	ton	16.50			24,478.42				24,478
1.MDAL3B.1.03.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	578.0	CY	4.46	21.0	1,790.18		2,620.92			4,411
1.MDAL3B.1.03.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	578.0	CY	4.62	38.2	3,263.11		1,305.64			4,569
1.MDAL3B.1.03.07	Water wagon 1,000 gal tuff processing	578.0	CY	0.44	6.9	433.70					434
1.MDAL3B.1.03.07	Equipment only. Water wagon 1,000 gal soil processing	578.0	CY	0.26				261.10			261

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3B.1.03.07	Total				66.1	5,486.98	24,478.42	4,187.66			34,153
1.MDAL3B.1.03.08	Project WBS: Excavation of pit and impoundments – DC - Excavation - Disposal of Waste Pit B										
1.MDAL3B.1.03.08	Waste container delivery.	7.0	ea	1,453.61	173.8	11,520.33		5,890.77			17,411
1.MDAL3B.1.03.08	Waste container unload on site and handling during project.	120.0	ea	4,607.32	9,828.3	776,634.61		169,406.28			946,041
1.MDAL3B.1.03.08	Waste containers.	120.0	ea	2,018.34			414,434.46				414,434
1.MDAL3B.1.03.08	Fill waste containers.	120.0	ea	549.81	1,281.8	101,285.81		11,609.05			112,895
1.MDAL3B.1.03.08	10% Mixed Waste, ship off site. Packaging, Handling, Shipping and Disposa	399.0	cy	1,114.00					760,568.56		760,569
1.MDAL3B.1.03.08	Trucking cost per 43,000 pound load	26.0	Trip	4,471.00						198,910.77	198,911
1.MDAL3B.1.03.08	Confirmatory Sampling	4.0	EA	3,658.77	7.3	894.91		2.48	24,144.99		25,042
1.MDAL3B.1.03.08	Total				11,291.2	890,335.66	414,434.46	186,908.57	784,713.55	198,910.77	2,475,303
1.MDAL3B.1.03.09	Project WBS: Excavation of pit and impoundments – DC - Excavation - Excavate Pit & Impoundments Pit C										
1.MDAL3B.1.03.09	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	289.0	CY	25.78	121.1	10,349.58		2,400.01			12,750
1.MDAL3B.1.03.09	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	200.0	CY	173.19	693.6	59,269.75					59,270
1.MDAL3B.1.03.09	Dozer D9 rip tuff material for processing	199.0	CY	1.13	4.9	384.78					385
1.MDAL3B.1.03.09	980 Frontend loader soil processing	90.0	CY	1.13	2.2	174.02					174
1.MDAL3B.1.03.09	825H High speed compactor (sheepsfoot) soil processing	90.0	CY	0.60	1.2	92.40					92
1.MDAL3B.1.03.09	963 Hydraulic Excavator soil processing	90.0	CY	0.60	1.2	92.40					92
1.MDAL3B.1.03.09	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL3B.1.03.09	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL3B.1.03.09	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3B.1.03.09	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3B.1.03.09	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL3B.1.03.09	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL3B.1.03.09	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3B.1.03.09	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL3B.1.03.09	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL3B.1.03.09	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL3B.1.03.09	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3B.1.03.09	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3B.1.03.09	Water wagon 1,000 gal soil processing	90.0	CY	0.44	1.1	67.53					68
1.MDAL3B.1.03.09	Equipment only. Water wagon 1,000 gal soil processing	90.0	CY	0.26				40.66			41
1.MDAL3B.1.03.09	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL3B.1.03.09	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3B.1.03.09	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL3B.1.03.09	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3B.1.03.09	Total				843.5	71,859.58	3,182.66	138,839.12		30,568.82	244,450
1.MDAL3B.1.03.10	Project WBS: Excavation of pit and impoundments – DC - Excavation - Confirmatory Sampling Pit C										
1.MDAL3B.1.03.10	Confirmatory Sampling	23.0	EA	3,658.77	41.9	5,145.72		14.27	138,833.68		143,994
1.MDAL3B.1.03.10	Total				41.9	5,145.72		14.27	138,833.68		143,994
1.MDAL3B.1.03.11	Project WBS: Excavation of pit and impoundments – DC - Excavation - Backfill Pit C										
1.MDAL3B.1.03.11	Borrow, fill material only.	434.0	ton	16.50			12,253.33				12,253
1.MDAL3B.1.03.11	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	289.0	CY	4.46	10.5	895.09		1,310.46			2,206
1.MDAL3B.1.03.11	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	289.0	CY	4.62	19.1	1,631.55		652.82			2,284
1.MDAL3B.1.03.11	Water wagon 1,000 gal tuff processing	289.0	CY	0.44	3.5	216.85					217
1.MDAL3B.1.03.11	Equipment only. Water wagon 1,000 gal soil processing	289.0	CY	0.26				130.55			131
1.MDAL3B.1.03.11	Total				33.0	2,743.49	12,253.33	2,093.83			17,091
1.MDAL3B.1.03.12	Project WBS: Excavation of pit and impoundments – DC - Excavation - Disposal of Waste Pit C										
1.MDAL3B.1.03.12	Waste container delivery.	3.0	ea	1,453.61	74.5	4,937.28		2,524.62			7,462
1.MDAL3B.1.03.12	Waste container unload on site and handling during project.	63.0	ea	4,607.32	5,159.9	407,733.17		88,938.29			496,671
1.MDAL3B.1.03.12	Waste containers.	63.0	ea	2,018.34			217,578.09				217,578
1.MDAL3B.1.03.12	Fill waste containers.	63.0	ea	549.81	672.9	53,175.05		6,094.75			59,270
1.MDAL3B.1.03.12	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	200.0	cy	1,114.00					381,237.37		381,237
1.MDAL3B.1.03.12	Trucking cost per 43,000 pound load	7.0	Trip	4,471.00						53,552.90	53,553
1.MDAL3B.1.03.12	Confirmatory Sampling	2.0	EA	3,658.77	3.6	447.45		1.24	12,072.49		12,521
1.MDAL3B.1.03.12	Total				5,910.9	466,292.96	217,578.09	97,558.90	393,309.87	53,552.90	1,228,293
1.MDAL3B.1.03.13	Project WBS: Excavation of pit and impoundments – DC - Excavation - Excavate Pit & Impoundments Pit D										
1.MDAL3B.1.03.13	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	650.0	CY	25.78	272.4	23,277.60		5,397.95			28,676
1.MDAL3B.1.03.13	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	449.0	CY	173.19	1,557.2	133,060.59					133,061
1.MDAL3B.1.03.13	Dozer D9 rip tuff material for processing	449.0	CY	1.13	11.1	868.17					868
1.MDAL3B.1.03.13	980 Frontend loader soil processing	202.0	CY	1.13	5.0	390.58					391
1.MDAL3B.1.03.13	825H High speed compactor (sheepsfoot) soil processing	202.0	CY	0.60	2.6	207.39					207
1.MDAL3B.1.03.13	963 Hydraulic Excavator soil processing	202.0	CY	0.60	2.6	207.39					207
1.MDAL3B.1.03.13	Dozer D9 Mobilization	2.0	ea	1,750.00						5,988.92	5,989
1.MDAL3B.1.03.13	980 Loader Mobilization	2.0	ea	697.00						2,385.30	2,385
1.MDAL3B.1.03.13	Screening plant, Mobilization	2.0	ea	3,000.00						10,266.72	10,267
1.MDAL3B.1.03.13	963 Hydraulic Excavator Mobilization	2.0	ea	2,050.00						7,015.59	7,016
1.MDAL3B.1.03.13	Rock crusher plant, Mobilization	2.0	ea	5,000.00						17,111.19	17,111
1.MDAL3B.1.03.13	Rock crusher plant, Set up costs.	1.0	ea	2,000.00						3,422.24	3,422
1.MDAL3B.1.03.13	825H Mobilization	2.0	ea	812.00						2,778.86	2,779
1.MDAL3B.1.03.13	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL3B.1.03.13	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL3B.1.03.13	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL3B.1.03.13	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL3B.1.03.13	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3B.1.03.13	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL3B.1.03.13	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL3B.1.03.13	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL3B.1.03.13	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL3B.1.03.13	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL3B.1.03.13	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL3B.1.03.13	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL3B.1.03.13	Water wagon 1,000 gal soil processing	90.0	CY	0.44	1.1	67.53					68
1.MDAL3B.1.03.13	Equipment only. Water wagon 1,000 gal soil processing	90.0	CY	0.26				40.66			41
1.MDAL3B.1.03.13	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL3B.1.03.13	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL3B.1.03.13	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL3B.1.03.13	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL3B.1.03.13	**Total**				**1,870.3**	**159,508.37**	**3,182.66**	**141,837.06**		**79,537.63**	**384,066**
1.MDAL3B.1.03.14	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Confirmatory Sampling Pit D**										
1.MDAL3B.1.03.14	Confirmatory Sampling	51.0	EA	3,658.77	92.8	11,410.07		31.63	307,848.60		319,290
1.MDAL3B.1.03.14	**Total**				**92.8**	**11,410.07**		**31.63**	**307,848.60**		**319,290**
1.MDAL3B.1.03.15	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Backfill Pit D**										
1.MDAL3B.1.03.15	Borrow, fill material only.	975.0	ton	16.50			27,527.63				27,528
1.MDAL3B.1.03.15	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fror	650.0	CY	4.46	23.6	2,013.17		2,947.40			4,961
1.MDAL3B.1.03.15	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	650.0	CY	4.62	42.9	3,669.58		1,468.27			5,138
1.MDAL3B.1.03.15	Water wagon 1,000 gal tuff processing	650.0	CY	0.44	7.8	487.72					488
1.MDAL3B.1.03.15	Equipment only. Water wagon 1,000 gal soil processing	650.0	CY	0.26				293.63			294
1.MDAL3B.1.03.15	**Total**				**74.3**	**6,170.48**	**27,527.63**	**4,709.31**			**38,407**
1.MDAL3B.1.03.16	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Disposal of Waste Pit D**										
1.MDAL3B.1.03.16	Waste container delivery.	7.0	ea	1,453.61	173.8	11,520.33		5,890.77			17,411
1.MDAL3B.1.03.16	Waste container unload on site and handling during project.	135.0	ea	4,607.32	11,056.9	873,713.94		190,582.06			1,064,296
1.MDAL3B.1.03.16	Waste containers.	135.0	ea	2,018.34			466,238.76				466,239
1.MDAL3B.1.03.16	Fill waste containers.	135.0	ea	549.81	1,442.0	113,946.54		13,060.18			127,007
1.MDAL3B.1.03.16	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	449.0	cy	1,114.00					855,877.90		855,878
1.MDAL3B.1.03.16	Trucking cost per 43,000 pound load	15.0	Trip	4,471.00						114,756.21	114,756
1.MDAL3B.1.03.16	Confirmatory Sampling	5.0	EA	3,658.77	9.1	1,118.63		3.10	30,181.24		31,303
1.MDAL3B.1.03.16	**Total**				**12,681.8**	**1,000,299.44**	**466,238.76**	**209,536.11**	**886,059.14**	**114,756.21**	**2,676,890**
1.MDAL3B.1.03.17	**Project WBS: Excavation of pit and impoundments – DC - Excavation - Equipment Decontamination**										
1.MDAL3B.1.03.17	Decontamination of equipment.	100.0	hour	149.94	100.0	8,544.67	17,111.19				25,656
1.MDAL3B.1.03.17	Swipes	50.0	hour	649.94	50.0	4,272.33	51,333.58				55,606
1.MDAL3B.1.03.17	RCT involvment in swipes and decontamination process	50.0	hour	124.97	25.0	2,136.17	8,555.60				10,692
1.MDAL3B.1.03.17	**Total**				**175.0**	**14,953.17**	**77,000.37**				**91,954**
1.MDAL3B.1.03	**Total**				**78,957.8**	**6,283,468.06**	**3,145,279.58**	**1,594,039.68**	**5,949,523.75**	**1,085,379.41**	**18,057,690**
1.MDAL3B.1.04	**Project WBS: SVE MDA L -DC- SVE**										
1.MDAL3B.1.04.01	**Project WBS: SVE MDA L -DC- SVE - SVE Unit**										
1.MDAL3B.1.04.01	SVE Unit - Contractors Price	3.0	ea	35,000.00	3.0				179,667.52		179,668
1.MDAL3B.1.04.01	SVE Piping Equipment (1 per extraction borehole)	9.0	ea	2,000.00	16.4				30,800.15		30,800
1.MDAL3B.1.04.01	**Total**				**19.4**				**210,467.67**		**210,468**
1.MDAL3B.1.04.02	**Project WBS: SVE MDA L -DC- SVE - Extraction Boreholes**										
1.MDAL3B.1.04.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	30.0	bag	9.80			503.07				503
1.MDAL3B.1.04.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' de	9.0	EA	1,018.17	136.2	9,701.92	5,929.03	48.92			15,680
1.MDAL3B.1.04.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.5	CY	210.12	20.5	1,617.94					1,618
1.MDAL3B.1.04.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exc	43.8	CY	103.13	95.7	7,559.00		170.13			7,729
1.MDAL3B.1.04.02	Pore Gas Monitoring - LLW Disposition	43.8	CY	1,200.00					89,936.43		89,936
1.MDAL3B.1.04.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	9.0	EA	1,158.34	131.2	10,369.45		7,469.04			17,838
1.MDAL3B.1.04.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	450.0	LF	138.80	675.0	69,975.75	35,420.17	1,478.41			106,874
1.MDAL3B.1.04.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded	2,100.0	LF	33.52	1,001.7	110,942.41	9,522.38				120,465
1.MDAL3B.1.04.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	14.3	Csf	334.06	64.7	7,163.35	192.08	818.62			8,174
1.MDAL3B.1.04.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	23.0	CY	24.50			964.22				964
1.MDAL3B.1.04.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	27.0	CF	3.74			172.79				173
1.MDAL3B.1.04.02	Structural concrete, placing, excludes material	27.0	CF	1.90	1.1	75.38		12.47			88
1.MDAL3B.1.04.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.0	CY	275.66	18.2	1,886.75					1,887
1.MDAL3B.1.04.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland	494.0	CF	3.74			3,161.40				3,161
1.MDAL3B.1.04.02	Grout - concrete, placing, excludes material	494.0	CF	1.90	19.4	1,379.11		228.23			1,607
1.MDAL3B.1.04.02	Project Geologist	180.0	hour	77.00	180.0	30,369.05					30,369
1.MDAL3B.1.04.02	Field Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL3B.1.04.02	Radiological Control Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL3B.1.04.02	Health and Safety Officer - Site	18.0	hour	77.00	18.0	3,036.91					3,037
1.MDAL3B.1.04.02	Project Engineer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3B.1.04.02	Project Manager	45.0	hour	77.00	45.0	7,592.26					7,592
1.MDAL3B.1.04.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3B.1.04.02	Project Scientist - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3B.1.04.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL3B.1.04.02	Health and Safety Officer - Site	56.3	hour	77.00	56.3	9,490.33					9,490
1.MDAL3B.1.04.02	Project Geologist	720.0	hour	77.00	720.0	121,476.22					121,476
1.MDAL3B.1.04.02	**Total**				**3,602.8**	**454,031.28**	**55,865.13**	**10,225.81**	**89,936.43**		**610,059**
1.MDAL3B.1.04.03	**Project WBS: SVE MDA L -DC- SVE - Monitoring Boreholes**										
1.MDAL3B.1.04.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	5.0	EA	1,158.34	72.9	5,760.81		4,149.46			9,910

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL3B.1.04.03	Structural excavation for minor structures, bank measure, normal soil, pits to	2.5	CY	210.12	11.4	898.85					899
1.MDAL3B.1.04.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	5.0	EA	80.25	3.0	314.46	372.17				687
1.MDAL3B.1.04.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exca	23.0	CY	12.87	3.1	246.58		260.04			507
1.MDAL3B.1.04.03	Pore Gas Monitoring - LLW Disposition	23.0	CY	1,200.00					47,226.89		47,227
1.MDAL3B.1.04.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAL3B.1.04.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	250.0	LF	138.80	375.0	38,875.42	19,677.87	821.34			59,375
1.MDAL3B.1.04.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yo	1,050.0	LF	37.76	500.9	51,926.04	14,283.57	1,634.97			67,845
1.MDAL3B.1.04.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	15.0	CF	3.74			95.99				96
1.MDAL3B.1.04.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includ	15.0	CF	1.90	0.6	41.88		6.93			49
1.MDAL3B.1.04.03	Bentonite clay, 50# bag, 1 per 10' of rod	230.0	EA	38.00			14,955.18				14,955
1.MDAL3B.1.04.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	1.7	CY	24.50			71.27				71
1.MDAL3B.1.04.03	Backfill, heavy soil, by hand, no compaction	16.0	CY	123.87	39.7	3,391.40					3,391
1.MDAL3B.1.04.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes	4,000.0	LF	16.95	912.6	94,606.45	18,397.95	3,011.57			116,016
1.MDAL3B.1.04.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, i	30.0	EA	121.05	49.8	5,160.35	890.12	163.24			6,214
1.MDAL3B.1.04.03	Mud Dauber (monitoring port)	30.0	EA	122.45	49.8	5,160.35	962.20	163.24			6,286
1.MDAL3B.1.04.03	Total				2,038.2	207,918.39	69,706.33	12,298.36	47,226.89		337,150
1.MDAL3B.1.04.04	Project WBS: SVE MDA L -DC- SVE - Removal of FLUTE Boreholes										
1.MDAL3B.1.04.04	Removal of Monitoring Tubing	16.0	hour	351.11	29.1	2,757.78		6,854.88			9,613
1.MDAL3B.1.04.04	Structural concrete, ready mix, lightweight, 110 #/C.F., 3000 psi, includes loc	48.0	CF	25.55	21.8	1,556.06	542.08				2,098
1.MDAL3B.1.04.04	Total				51.0	4,313.85	542.08	6,854.88			11,711
1.MDAL3B.1.04	Total				5,711.3	666,263.52	126,113.54	29,379.05	347,630.99		1,169,387
1.MDAL3B.1.07	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -DC- Distribs										
1.MDAL3B.1.07	Field Non-Manual - JHRS	17,773.0	hour	66.10	17,773.0	2,010,214.88					2,010,215
1.MDAL3B.1.07	Craft Distributable - Labor	22,216.0	hour	46.33	22,216.0	1,761,186.81					1,761,187
1.MDAL3B.1.07	Craft Distributable - Materials	22,216.0	hour	7.00	22,216.0		266,099.58				266,100
1.MDAL3B.1.07	Total				62,205.0	3,771,401.69	266,099.58				4,037,501
1.MDAL3B.1	Total				151,072.8	11,065,113.38	4,619,366.34	1,756,327.29	6,299,550.31	1,085,379.41	24,825,737
1.MDAL3B.2	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Indirect Capital Costs										
1.MDAL3B.2.01	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IC- Design										
1.MDAL3B.2.01	ET Shafts Mat Design	1.0	lsum	1,773,902.00					2,582,623.92		2,582,624
1.MDAL3B.2.01	Total								2,582,623.92		2,582,624
1.MDAL3B.2.02	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IC- Professional Management										
1.MDAL3B.2.02	Professional Management	1.0	lsum	7,126,173.00	71,547.9	15,614,367.88					15,614,368
1.MDAL3B.2.02	Total				71,547.9	15,614,367.88					15,614,368
1.MDAL3B.2.03	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IC- Contingency										
1.MDAL3B.2.03	Contingency - Cost 30%	1.0	lsum	12,906,818.00	1.0					12,906,818.00	12,906,818
1.MDAL3B.2.03	Contingency - Schedule 10%	1.0	lsum	4,302,272.00	1.0					4,302,272.00	4,302,272
1.MDAL3B.2.03	Contingency - TPRA 10%	1.0	lsum	4,302,272.00	1.0					4,302,272.00	4,302,272
1.MDAL3B.2.03	Total				3.0					21,511,362.00	21,511,362
1.MDAL3B.2	Total				71,550.9	15,614,367.88			2,582,623.92	21,511,362.00	39,708,354
1.MDAL3B.3	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Direct O&M Costs										
1.MDAL3B.3.01	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -DOM- Cover Maintenance & Inspections										
1.MDAL3B.3.01	Active SVE Operation (3 years)	1.0	lsum	862,947.00	18,626.2	1,256,364.54					1,256,365
1.MDAL3B.3.01	Active SVE Monitoring (3 years)	1.0	lsum	123,456.00	1,576.7	179,739.59					179,740
1.MDAL3B.3.01	TDR Moisture Monitoring (100 years)	1.0	lsum	323,898.00	3,252.0	471,563.10					471,563
1.MDAL3B.3.01	Rebound SVE Monitoring (3 years)	1.0	lsum	469,133.00	10,126.0	683,010.73					683,011
1.MDAL3B.3.01	Subsurface VOC Vapor Monitoring (30 years)	1.0	lsum	1,326,475.00	16,940.9	1,931,214.95					1,931,215
1.MDAL3B.3.01	Cover Inspections and Maintenance (100 years)	1.0	lsum	148,476.00	3,204.8	216,166.21					216,166
1.MDAL3B.3.01	Annual Long Term Monitoring Report - 100 years	1.0	lsum	157,125.00	2,006.7	228,758.29					228,758
1.MDAL3B.3.01	Total				55,733.3	4,966,817.41					4,966,817
1.MDAL3B.3	Total				55,733.3	4,966,817.41					4,966,817
1.MDAL3B.4	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L - Indirect O&M Costs										
1.MDAL3B.4.02	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IOM- Professional Management										
1.MDAL3B.4.02	Professional Management (years 0-3)	1.0	lsum	316,758.00	3,180.3	694,057.80					694,058
1.MDAL3B.4.02	Professional Management (years 4-30)	1.0	lsum	356,750.00	3,581.8	781,685.45					781,685
1.MDAL3B.4.02	Professional Management (years 31-100)	1.0	lsum	32,455.00	325.9	71,113.11					71,113
1.MDAL3B.4.02	Total				7,088.0	1,546,856.36					1,546,856
1.MDAL3B.4.03	Project WBS: 3B ET Cover (Shafts), Excavation (pit & impoundments), SVE, Institutional Controls MDA L -IOM- Contingency										
1.MDAL3B.4.03	Contingency - Cost 30%	1.0	lsum	1,954,101.90	1.0					1,954,101.90	1,954,102
1.MDAL3B.4.03	Contingency - Schedule 10%	1.0	lsum	651,367.30	1.0					651,367.30	651,367
1.MDAL3B.4.03	Contingency - TPRA 10%	1.0	lsum	651,367.30	1.0					651,367.30	651,367
1.MDAL3B.4.03	Total				3.0					3,256,836.50	3,256,837
1.MDAL3B.4	Total				7,091.0	1,546,856.36				3,256,836.50	4,803,693
1.MDAL3B	Total				285,448.0	33,193,155.03	4,619,366.34	1,756,327.29	8,882,174.23	25,853,577.91	74,304,601
1.MDAL4X	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L										
1.MDAL4X.1	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L - Direct Capital Costs										
1.MDAL4X.1.01	Project WBS: 4 Excavation -DC- Fence										
1.MDAL4X.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' (	1,450.0	LF	56.72	352.2	28,129.44	109,169.41	3,423.95			140,723
1.MDAL4X.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire,	15.0	EA	162.19	16.4	1,308.81	2,695.01	159.13			4,163
1.MDAL4X.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, include	2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAL4X.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes p	20.0	EA	120.98	16.6	1,328.91	2,446.90	364.47			4,140
1.MDAL4X.1.01	Total				465.4	37,165.62	119,958.02	5,710.01			162,834
1.MDAL4X.1.02	Project WBS: 4 Excavation -DC- Site Prep										
1.MDAL4X.1.02	Temporary, roads, excl surfacing.	35,390.0	SY	72.31	21,684.6	1,592,555.48	2,598,326.76	188,019.63			4,378,902
1.MDAL4X.1.02	Lister support	24.0	hour	100.10	43.7	4,110.79					4,111
1.MDAL4X.1.02	Selective clearing, brush, with brush saw, includes cutting and site cleanup,	0.9	acre	3,022.82	51.3	4,382.43		169.28			4,552

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL4X.1.02	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	10.0	EA	529.39	48.6	3,839.50		5,218.91			9,058
1.MDAL4X.1.02	Track out device	1.0	EA	5,234.35	5.5	400.99	8,555.60				8,957
1.MDAL4X.1.02	Clean out track out device.	8.0	EA	1,185.53	87.4	6,415.88		9,812.73			16,229
1.MDAL4X.1.02	Rent toilet portable chemical	10.0	mnth	400.00				6,844.48			6,844
1.MDAL4X.1.02	Chemical toilet cleaning.	10.0	mnth	946.50	163.8	10,231.92		5,963.83			16,196
1.MDAL4X.1.02	Chemical toilet cleaning (labor)	10.0	mnth	573.07	163.8	9,805.84					9,806
1.MDAL4X.1.02	Excavation permit	2.0	ea	700.00					2,395.57		2,396
1.MDAL4X.1.02	Laydown - Base course drainage layers, aggregate base course for roadway	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAL4X.1.02	Laydown - Backfill, bulk, 6" to 12" lifts, dozer backfilling	1,481.0	CY	3.30	40.8	3,221.78		5,144.23			8,366
1.MDAL4X.1.02	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAL4X.1.02	**Total**				**22,419.1**	**1,645,964.90**	**2,708,180.62**	**232,623.70**	**2,395.57**		**4,589,165**
1.MDAL4X.1.03	**Project WBS: SVE MDA L -DC- SVE**										
1.MDAL4X.1.03.01	**Project WBS: SVE MDA L -DC- SVE - SVE Unit**										
1.MDAL4X.1.03.01	SVE Unit - Contractors Price	3.0	ea	35,000.00	3.0				179,667.52		179,668
1.MDAL4X.1.03.01	SVE Piping Equipment (1 per extraction borehole)	9.0	ea	2,000.00	16.4				30,800.15		30,800
1.MDAL4X.1.03.01	**Total**				**19.4**				**210,467.67**		**210,468**
1.MDAL4X.1.03.02	**Project WBS: SVE MDA L -DC- SVE - Extraction Boreholes**										
1.MDAL4X.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	30.0	bag	9.80			503.07				503
1.MDAL4X.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' de	9.0	EA	1,018.17	136.2	9,701.92	5,929.03	48.92			15,680
1.MDAL4X.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.5	CY	210.12	20.5	1,617.94					1,618
1.MDAL4X.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exca	43.8	CY	103.13	95.7	7,559.00		170.13			7,729
1.MDAL4X.1.03.02	Pore Gas Monitoring - LLW Disposition	43.8	CY	1,200.00					89,936.43		89,936
1.MDAL4X.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	9.0	EA	1,158.34	131.2	10,369.45		7,469.04			17,838
1.MDAL4X.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	450.0	LF	138.80	675.0	69,975.75	35,420.17	1,478.41			106,874
1.MDAL4X.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded	2,100.0	LF	33.52	1,001.7	110,942.41	9,522.38				120,465
1.MDAL4X.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	14.3	Csf	334.06	64.7	7,163.35	192.08	818.62			8,174
1.MDAL4X.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	23.0	CY	24.50			964.22				964
1.MDAL4X.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	27.0	CF	3.74			172.79				173
1.MDAL4X.1.03.02	Structural concrete, placing, excludes material	27.0	CF	1.90	1.1	75.38		12.47			88
1.MDAL4X.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to	4.0	CY	275.66	18.2	1,886.75					1,887
1.MDAL4X.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland	494.0	CF	3.74			3,161.40				3,161
1.MDAL4X.1.03.02	Grout - concrete, placing, excludes material	494.0	CF	1.90	19.4	1,379.11		228.23			1,607
1.MDAL4X.1.03.02	Project Geologist	180.0	hour	77.00	180.0	30,369.05					30,369
1.MDAL4X.1.03.02	Field Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL4X.1.03.02	Radiological Control Technician	180.0	hour	65.00	180.0	25,636.22					25,636
1.MDAL4X.1.03.02	Health and Safety Officer - Site	18.0	hour	77.00	18.0	3,036.91					3,037
1.MDAL4X.1.03.02	Project Engineer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL4X.1.03.02	Project Manager	45.0	hour	77.00	45.0	7,592.26					7,592
1.MDAL4X.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL4X.1.03.02	Project Scientist - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL4X.1.03.02	Health and Safety Officer - Readiness	15.0	hour	77.00	15.0	2,530.75					2,531
1.MDAL4X.1.03.02	Health and Safety Officer - Site	56.3	hour	77.00	56.3	9,490.33					9,490
1.MDAL4X.1.03.02	Project Geologist	720.0	hour	77.00	720.0	121,476.22					121,476
1.MDAL4X.1.03.02	**Total**				**3,602.8**	**454,031.28**	**55,865.13**	**10,225.81**	**89,936.43**		**610,059**
1.MDAL4X.1.03.03	**Project WBS: SVE MDA L -DC- SVE - Monitoring Boreholes**										
1.MDAL4X.1.03.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit	5.0	EA	1,158.34	72.9	5,760.81		4,149.46			9,910
1.MDAL4X.1.03.03	Structural excavation for minor structures, bank measure, normal soil, pits to	2.5	CY	210.12	11.4	898.85					899
1.MDAL4X.1.03.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	5.0	EA	80.25	3.0	314.46	372.17				687
1.MDAL4X.1.03.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, exca	23.0	CY	12.87	3.1	246.58		260.04			507
1.MDAL4X.1.03.03	Pore Gas Monitoring - LLW Disposition	23.0	CY	1,200.00					47,226.89		47,227
1.MDAL4X.1.03.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 1	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAL4X.1.03.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes y	250.0	LF	138.80	375.0	38,875.42	19,677.87	821.34			59,375
1.MDAL4X.1.03.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yo	1,050.0	LF	37.76	500.9	51,926.04	14,283.57	1,634.97			67,845
1.MDAL4X.1.03.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggre	15.0	CF	3.74			95.99				96
1.MDAL4X.1.03.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includ	15.0	CF	1.90	0.6	41.88		6.93			49
1.MDAL4X.1.03.03	Bentonite clay, 50# bag, 1 per 10' of rod	230.0	EA	38.00			14,955.18				14,955
1.MDAL4X.1.03.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material o	1.7	CY	24.50			71.27				71
1.MDAL4X.1.03.03	Backfill, heavy soil, by hand, no compaction	16.0	CY	123.87	39.7	3,391.40					3,391
1.MDAL4X.1.03.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes	4,000.0	LF	16.95	912.6	94,606.45	18,397.95	3,011.57			116,016
1.MDAL4X.1.03.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, i	30.0	EA	121.05	49.8	5,160.35	890.12	163.24			6,214
1.MDAL4X.1.03.03	Mud Dauber (monitoring port)	30.0	EA	122.45	49.8	5,160.35	962.20	163.24			6,286
1.MDAL4X.1.03.03	**Total**				**2,038.2**	**207,918.39**	**69,706.33**	**12,298.36**	**47,226.89**		**337,150**
1.MDAL4X.1.03.04	**Project WBS: SVE MDA L -DC- SVE - Removal of FLUTE Boreholes**										
1.MDAL4X.1.03.04	Removal of Monitoring Tubing	16.0	hour	351.11	29.1	2,757.78		6,854.88			9,613
1.MDAL4X.1.03.04	Structural concrete, ready mix, lightweight, 110 #/C.F., 3000 psi, includes loc	48.0	CF	25.55	21.8	1,556.06	542.08				2,098
1.MDAL4X.1.03.04	**Total**				**51.0**	**4,313.85**	**542.08**	**6,854.88**			**11,711**
1.MDAL4X.1.03	**Total**				**5,711.3**	**666,263.52**	**126,113.54**	**29,379.05**	**347,630.99**		**1,169,387**
1.MDAL4X.1.04	**Project WBS: Excavation of pit and impoundments -DC- Excavation Shafts**										
1.MDAL4X.1.04.01	**Project WBS: Excavation of pit and impoundments -DC- Excavation Shafts - Excavation**										
1.MDAL4X.1.04.01	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	32,019.0	CY	25.78	13,419.5	1,146,654.59		265,903.15			1,412,558
1.MDAL4X.1.04.01	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	3,842.0	CY	173.19	13,324.9	1,138,571.88					1,138,572
1.MDAL4X.1.04.01	Dozer D9 rip tuff material for processing	28,177.0	CY	1.13	693.8	54,482.05					54,482
1.MDAL4X.1.04.01	980 Frontend loader soil processing	28,177.0	CY	1.13	693.8	54,482.05					54,482
1.MDAL4X.1.04.01	825H High speed compactor (sheepsfoot) soil processing	28,177.0	CY	0.60	368.4	28,928.52					28,929

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Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL4X.1.04.01	963 Hydraulic Excavator soil processing	28,177.0	CY	0.60	368.4	28,928.52					28,929
1.MDAL4X.1.04.01	Dozer D9 Mobilization	1.0	ea	1,750.00						2,994.46	2,994
1.MDAL4X.1.04.01	980 Loader Mobilization	1.0	ea	697.00						1,192.65	1,193
1.MDAL4X.1.04.01	Screening plant, Mobilization	2.0	ea	3,000.00						10,266.72	10,267
1.MDAL4X.1.04.01	963 Hydraulic Excavator Mobilization	2.0	ea	2,050.00						7,015.59	7,016
1.MDAL4X.1.04.01	Rock crusher plant, Mobilization	2.0	ea	5,000.00						17,111.19	17,111
1.MDAL4X.1.04.01	Rock crusher plant, Set up costs.	1.0	ea	2,000.00						3,422.24	3,422
1.MDAL4X.1.04.01	825H Mobilization	2.0	ea	812.00						2,778.86	2,779
1.MDAL4X.1.04.01	Dozer D9 rental	12.0	MNTH	29,404.00				603,765.01			603,765
1.MDAL4X.1.04.01	Dozer D9 Scheduled Maintenance	1.0	YR	7,253.69						12,411.93	12,412
1.MDAL4X.1.04.01	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL4X.1.04.01	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL4X.1.04.01	980, 7 cy frontend loader rental	12.0	MNTH	16,734.00				343,606.44			343,606
1.MDAL4X.1.04.01	980 Loader: Scheduled Maintenance	1.0	YR	5,865.19						10,036.04	10,036
1.MDAL4X.1.04.01	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL4X.1.04.01	825H High speed compactor (sheepsfoot) rental	12.0	MNTH	10,585.00				217,346.37			217,346
1.MDAL4X.1.04.01	825H: Scheduled Maintenance	1.0	YR	5,944.56						10,171.85	10,172
1.MDAL4X.1.04.01	963 Hydraulic Excavator rental	12.0	MNTH	18,640.00				382,743.16			382,743
1.MDAL4X.1.04.01	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL4X.1.04.01	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL4X.1.04.01	Water wagon 1,000 gal tuff processing	28,177.0	CY	0.44	338.5	21,142.35					21,142
1.MDAL4X.1.04.01	Equipment only. Water wagon 1,000 gal tuff processing	28,177.0	CY	0.26				12,728.55			12,729
1.MDAL4X.1.04.01	Rock crusher plant rental	12.0	MNTH	28,000.00				574,936.07			574,936
1.MDAL4X.1.04.01	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL4X.1.04.01	Screening plant rental	12.0	MNTH	15,500.00				318,268.18			318,268
1.MDAL4X.1.04.01	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL4X.1.04.01	**Total**				**29,225.6**	**2,474,619.10**	**3,182.66**	**2,719,296.94**		**101,446.38**	**5,298,545**
1.MDAL4X.1.04.02	**Project WBS: Excavation of pit and impoundments -DC- Excavation Shafts - Confirmatory Sampling**										
1.MDAL4X.1.04.02	Confirmatory Sampling	686.0	EA	3,658.77	1,248.5	153,476.58		425.51	4,140,865.44		4,294,768
1.MDAL4X.1.04.02	**Total**				**1,248.5**	**153,476.58**		**425.51**	**4,140,865.44**		**4,294,768**
1.MDAL4X.1.04.03	**Project WBS: Excavation of pit and impoundments -DC- Excavation Shafts - Backfill**										
1.MDAL4X.1.04.03	Borrow, fill material only.	5,763.0	ton	16.50			162,709.48				162,709
1.MDAL4X.1.04.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	32,019.0	CY	4.46	1,160.6	99,168.94		145,189.07			244,358
1.MDAL4X.1.04.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	32,019.0	CY	4.62	2,115.5	180,763.65		72,327.22			253,091
1.MDAL4X.1.04.03	Water wagon 1,000 gal tuff processing	32,019.0	CY	0.44	384.6	24,025.16					24,025
1.MDAL4X.1.04.03	Equipment only. Water wagon 1,000 gal tuff processing	32,019.0	CY	0.26				14,464.12			14,464
1.MDAL4X.1.04.03	**Total**				**3,660.7**	**303,957.75**	**162,709.48**	**231,980.41**			**698,648**
1.MDAL4X.1.04.04	**Project WBS: Excavation of pit and impoundments -DC- Excavation Shaft - Disposal of Waste**										
1.MDAL4X.1.04.04	Waste container delivery.	58.0	ea	1,453.61	1,440.1	95,454.16		48,809.25			144,263
1.MDAL4X.1.04.04	Waste container unload on site and handling during project.	1,153.0	ea	4,607.32	94,433.7	7,462,164.20		1,627,711.96			9,089,876
1.MDAL4X.1.04.04	Waste containers.	1,153.0	ea	2,018.34			3,982,024.40				3,982,024
1.MDAL4X.1.04.04	Fill waste containers.	1,153.0	ea	549.81	12,315.7	973,187.85		111,543.58			1,084,731
1.MDAL4X.1.04.04	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	3,842.0	cy	1,114.00					7,323,569.94		7,323,570
1.MDAL4X.1.04.04	Trucking cost per 43,000 pound load	231.0	Trip	4,471.00						1,767,245.69	1,767,246
1.MDAL4X.1.04.04	Confirmatory Sampling	39.0	EA	3,658.77	71.0	8,725.34		24.19	235,413.63		244,163
1.MDAL4X.1.04.04	**Total**				**108,260.5**	**8,539,531.56**	**3,982,024.40**	**1,788,088.98**	**7,558,983.58**	**1,767,245.69**	**23,635,874**
1.MDAL4X.1.04	**Total**				**142,395.4**	**11,471,584.98**	**4,147,916.54**	**4,739,791.83**	**11,699,849.02**	**1,868,692.07**	**33,927,834**
1.MDAL4X.1.05	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments**										
1.MDAL4X.1.05.01	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Excavation Pit A**										
1.MDAL4X.1.05.01	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	1,733.0	CY	25.78	726.3	62,061.66		14,391.77			76,453
1.MDAL4X.1.05.01	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	1,196.0	CY	173.19	4,148.0	354,433.10					354,433
1.MDAL4X.1.05.01	Dozer D9 rip tuff material for processing	1,196.0	CY	1.13	29.5	2,312.54					2,313
1.MDAL4X.1.05.01	980 Frontend loader soil processing	537.0	CY	1.13	13.2	1,038.32					1,038
1.MDAL4X.1.05.01	825H High speed compactor (sheepsfoot) soil processing	537.0	CY	0.60	7.0	551.32					551
1.MDAL4X.1.05.01	963 Hydraulic Excavator soil processing	537.0	CY	0.60	7.0	551.32					551
1.MDAL4X.1.05.01	Dozer D9 rental	0.3	MNTH	29,404.00				12,578.44			12,578
1.MDAL4X.1.05.01	Dozer D9 Scheduled Maintenance	0.1	YR	7,253.69						992.95	993
1.MDAL4X.1.05.01	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL4X.1.05.01	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL4X.1.05.01	980, 7 cy frontend loader rental	0.3	MNTH	16,734.00				7,158.47			7,158
1.MDAL4X.1.05.01	980 Loader: Scheduled Maintenance	0.1	YR	5,865.19						802.88	803
1.MDAL4X.1.05.01	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL4X.1.05.01	825H High speed compactor (sheepsfoot) rental	0.1	MNTH	10,585.00				1,448.98			1,449
1.MDAL4X.1.05.01	825H: Scheduled Maintenance	0.1	YR	5,944.56						813.75	814
1.MDAL4X.1.05.01	963 Hydraulic Excavator rental	0.3	MNTH	18,640.00				7,973.82			7,974
1.MDAL4X.1.05.01	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL4X.1.05.01	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL4X.1.05.01	Water wagon 1,000 gal tuff processing	151.0	CY	0.44	1.8	113.30					113
1.MDAL4X.1.05.01	Equipment only. Water wagon 1,000 gal tuff processing	151.0	CY	0.26				68.21			68
1.MDAL4X.1.05.01	Rock crusher plant rental	0.1	MNTH	28,000.00				3,832.91			3,833
1.MDAL4X.1.05.01	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL4X.1.05.01	Screening plant rental	0.3	MNTH	15,500.00				6,630.59			6,631
1.MDAL4X.1.05.01	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL4X.1.05.01	**Total**				**4,951.1**	**422,490.70**	**3,182.66**	**54,083.18**		**26,654.44**	**506,411**

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL4X.1.05.02	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Confirmatory Sampling Pit A										
1.MDAL4X.1.05.02	Confirmatory Sampling	135.0	EA	3,658.77	245.7	30,203.12		83.74	814,893.35		845,180
1.MDAL4X.1.05.02	Total				245.7	30,203.12		83.74	814,893.35		845,180
1.MDAL4X.1.05.03	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Backfill Pit A										
1.MDAL4X.1.05.03	Borrow, fill material only.	1,794.0	ton	16.50			50,650.84				50,651
1.MDAL4X.1.05.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	1,733.0	CY	4.46	62.8	5,367.43		7,858.23			13,226
1.MDAL4X.1.05.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,733.0	CY	4.62	114.5	9,783.67		3,914.65			13,698
1.MDAL4X.1.05.03	Water wagon 1,000 gal tuff processing	1,733.0	CY	0.44	20.8	1,300.34					1,300
1.MDAL4X.1.05.03	Equipment only. Water wagon 1,000 gal tuff processing	1,733.0	CY	0.26				782.86			783
1.MDAL4X.1.05.03	Total				198.1	16,451.44	50,650.84	12,555.73			79,658
1.MDAL4X.1.05.04	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Disposal of Waste Pit A										
1.MDAL4X.1.05.04	Waste container delivery.	18.0	ea	1,453.61	446.9	29,623.70		15,147.70			44,771
1.MDAL4X.1.05.04	Waste container unload on site and handling during project.	359.0	ea	4,607.32	29,403.0	2,323,431.87		506,807.11			2,830,239
1.MDAL4X.1.05.04	Waste containers.	359.0	ea	2,018.34			1,239,849.75				1,239,850
1.MDAL4X.1.05.04	Fill waste containers.	359.0	ea	549.81	3,834.6	303,013.39		34,730.40			337,744
1.MDAL4X.1.05.04	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	1,196.0	cy	1,114.00					2,279,799.49		2,279,799
1.MDAL4X.1.05.04	Trucking cost per 43,000 pound load	72.0	Trip	4,471.00						550,829.83	550,830
1.MDAL4X.1.05.04	Confirmatory Sampling	12.0	EA	3,658.77	21.8	2,684.72		7.44	72,434.96		75,127
1.MDAL4X.1.05.04	Total				33,706.4	2,658,753.69	1,239,849.75	556,692.64	2,352,234.46	550,829.83	7,358,360
1.MDAL4X.1.05.05	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Excavation Pit B										
1.MDAL4X.1.05.05	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	578.0	CY	25.78	242.2	20,699.16		4,800.03			25,499
1.MDAL4X.1.05.05	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	399.0	CY	173.19	1,383.8	118,243.15					118,243
1.MDAL4X.1.05.05	Dozer D9 rip tuff material for processing	399.0	CY	1.13	9.8	771.49					771
1.MDAL4X.1.05.05	980 Frontend loader soil processing	179.0	CY	1.13	4.4	346.11					346
1.MDAL4X.1.05.05	825H High speed compactor (sheepsfoot) soil processing	179.0	CY	0.60	2.3	183.77					184
1.MDAL4X.1.05.05	963 Hydraulic Excavator soil processing	179.0	CY	0.60	2.3	183.77					184
1.MDAL4X.1.05.05	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL4X.1.05.05	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL4X.1.05.05	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL4X.1.05.05	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL4X.1.05.05	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL4X.1.05.05	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL4X.1.05.05	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL4X.1.05.05	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL4X.1.05.05	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL4X.1.05.05	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL4X.1.05.05	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL4X.1.05.05	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL4X.1.05.05	Water wagon 1,000 gal soil processing	179.0	CY	0.44	2.2	134.31					134
1.MDAL4X.1.05.05	Equipment only. Water wagon 1,000 gal soil processing	179.0	CY	0.26				80.86			81
1.MDAL4X.1.05.05	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL4X.1.05.05	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL4X.1.05.05	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL4X.1.05.05	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL4X.1.05.05	Total				1,665.3	141,990.89	3,182.66	141,279.34		30,568.82	317,022
1.MDAL4X.1.05.06	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Confirmatory Sampling Pit B										
1.MDAL4X.1.05.06	Confirmatory Sampling	45.0	EA	3,658.77	81.9	10,067.71		27.91	271,631.12		281,727
1.MDAL4X.1.05.06	Total				81.9	10,067.71		27.91	271,631.12		281,727
1.MDAL4X.1.05.07	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Backfill Pit B										
1.MDAL4X.1.05.07	Borrow, fill material only.	867.0	ton	16.50			24,478.42				24,478
1.MDAL4X.1.05.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	578.0	CY	4.46	21.0	1,790.18		2,620.92			4,411
1.MDAL4X.1.05.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	578.0	CY	4.62	38.2	3,263.11		1,305.64			4,569
1.MDAL4X.1.05.07	Water wagon 1,000 gal tuff processing	578.0	CY	0.44	6.9	433.70					434
1.MDAL4X.1.05.07	Equipment only. Water wagon 1,000 gal tuff processing	578.0	CY	0.26				261.10			261
1.MDAL4X.1.05.07	Total				66.1	5,486.98	24,478.42	4,187.66			34,153
1.MDAL4X.1.05.08	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Disposal of Waste Pit B										
1.MDAL4X.1.05.08	Waste container delivery.	7.0	ea	1,453.61	173.8	11,520.33		5,890.77			17,411
1.MDAL4X.1.05.08	Waste container unload on site and handling during project.	120.0	ea	4,607.32	9,828.3	776,634.61		169,406.28			946,041
1.MDAL4X.1.05.08	Waste containers.	120.0	ea	2,018.34			414,434.46				414,434
1.MDAL4X.1.05.08	Fill waste containers.	120.0	ea	549.81	1,281.8	101,285.81		11,609.05			112,895
1.MDAL4X.1.05.08	10% Mixed Waste, ship off site. Packaging, Handling, Shipping and Disposa	399.0	cy	1,114.00					760,568.56		760,569
1.MDAL4X.1.05.08	Trucking cost per 43,000 pound load	26.0	Trip	4,471.00						198,910.77	198,911
1.MDAL4X.1.05.08	Confirmatory Sampling	4.0	EA	3,658.77	7.3	894.91		2.48	24,144.99		25,042
1.MDAL4X.1.05.08	Total				11,291.2	890,335.66	414,434.46	186,908.57	784,713.55	198,910.77	2,475,303
1.MDAL4X.1.05.09	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Excavation Pit C										
1.MDAL4X.1.05.09	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	289.0	CY	25.78	121.1	10,349.58		2,400.01			12,750
1.MDAL4X.1.05.09	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	200.0	CY	173.19	693.6	59,269.75					59,270
1.MDAL4X.1.05.09	Dozer D9 rip tuff material for processing	199.0	CY	1.13	4.9	384.78					385
1.MDAL4X.1.05.09	980 Frontend loader soil processing	90.0	CY	1.13	2.2	174.02					174
1.MDAL4X.1.05.09	825H High speed compactor (sheepsfoot) soil processing	90.0	CY	0.60	1.2	92.40					92
1.MDAL4X.1.05.09	963 Hydraulic Excavator soil processing	90.0	CY	0.60	1.2	92.40					92
1.MDAL4X.1.05.09	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL4X.1.05.09	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL4X.1.05.09	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL4X.1.05.09	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL4X.1.05.09	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL4X.1.05.09	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL4X.1.05.09	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL4X.1.05.09	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL4X.1.05.09	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL4X.1.05.09	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL4X.1.05.09	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL4X.1.05.09	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL4X.1.05.09	Water wagon 1,000 gal soil processing	90.0	CY	0.44	1.1	67.53					68
1.MDAL4X.1.05.09	Equipment only. Water wagon 1,000 gal soil processing	90.0	CY	0.26				40.66			41
1.MDAL4X.1.05.09	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL4X.1.05.09	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL4X.1.05.09	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL4X.1.05.09	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL4X.1.05.09	**Total**				**843.5**	**71,859.58**	**3,182.66**	**138,839.12**		**30,568.82**	**244,450**
1.MDAL4X.1.05.10	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Confirmatory Sampling Pit C**										
1.MDAL4X.1.05.10	Confirmatory Sampling	23.0	EA	3,658.77	41.9	5,145.72		14.27	138,833.68		143,994
1.MDAL4X.1.05.10	**Total**				**41.9**	**5,145.72**		**14.27**	**138,833.68**		**143,994**
1.MDAL4X.1.05.11	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Backfill Pit C**										
1.MDAL4X.1.05.11	Borrow, fill material only.	434.0	ton	16.50			12,253.33				12,253
1.MDAL4X.1.05.11	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	289.0	CY	4.46	10.5	895.09		1,310.46			2,206
1.MDAL4X.1.05.11	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	289.0	CY	4.62	19.1	1,631.55		652.82			2,284
1.MDAL4X.1.05.11	Water wagon 1,000 gal tuff processing	289.0	CY	0.44	3.5	216.85					217
1.MDAL4X.1.05.11	Equipment only. Water wagon 1,000 gal soil processing	289.0	CY	0.26				130.55			131
1.MDAL4X.1.05.11	**Total**				**33.0**	**2,743.49**	**12,253.33**	**2,093.83**			**17,091**
1.MDAL4X.1.05.12	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Disposal of Waste Pit C**										
1.MDAL4X.1.05.12	Waste container delivery.	3.0	ea	1,453.61	74.5	4,937.28		2,524.62			7,462
1.MDAL4X.1.05.12	Waste container unload on site and handling during project.	63.0	ea	4,607.32	5,159.9	407,733.17		88,938.29			496,671
1.MDAL4X.1.05.12	Waste containers.	63.0	ea	2,018.34			217,578.09				217,578
1.MDAL4X.1.05.12	Fill waste containers.	63.0	ea	549.81	672.9	53,175.05		6,094.75			59,270
1.MDAL4X.1.05.12	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	200.0	cy	1,114.00					381,237.37		381,237
1.MDAL4X.1.05.12	Trucking cost per 43,000 pound load	7.0	Trip	4,471.00						53,552.90	53,553
1.MDAL4X.1.05.12	Confirmatory Sampling	2.0	EA	3,658.77	3.6	447.45		1.24	12,072.49		12,521
1.MDAL4X.1.05.12	**Total**				**5,910.9**	**466,292.96**	**217,578.09**	**97,558.90**	**393,309.87**	**53,552.90**	**1,228,293**
1.MDAL4X.1.05.13	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Excavation Pit D**										
1.MDAL4X.1.05.13	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewaterir	650.0	CY	25.78	272.4	23,277.60		5,397.95			28,676
1.MDAL4X.1.05.13	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes s	449.0	CY	173.19	1,557.2	133,060.59					133,061
1.MDAL4X.1.05.13	Dozer D9 rip tuff material for processing	449.0	CY	1.13	11.1	868.17					868
1.MDAL4X.1.05.13	980 Frontend loader soil processing	202.0	CY	1.13	5.0	390.58					391
1.MDAL4X.1.05.13	825H High speed compactor (sheepsfoot) soil processing	202.0	CY	0.60	2.6	207.39					207
1.MDAL4X.1.05.13	963 Hydraulic Excavator soil processing	202.0	CY	0.60	2.6	207.39					207
1.MDAL4X.1.05.13	Dozer D9 Mobilization	2.0	ea	1,750.00						5,988.92	5,989
1.MDAL4X.1.05.13	980 Loader Mobilization	2.0	ea	697.00						2,385.30	2,385
1.MDAL4X.1.05.13	Screening plant, Mobilization	2.0	ea	3,000.00						10,266.72	10,267
1.MDAL4X.1.05.13	963 Hydraulic Excavator Mobilization	2.0	ea	2,050.00						7,015.59	7,016
1.MDAL4X.1.05.13	Rock crusher plant, Mobilization	2.0	ea	5,000.00						17,111.19	17,111
1.MDAL4X.1.05.13	Rock crusher plant, Set up costs.	1.0	ea	2,000.00						3,422.24	3,422
1.MDAL4X.1.05.13	825H Mobilization	2.0	ea	812.00						2,778.86	2,779
1.MDAL4X.1.05.13	Dozer D9 rental	1.0	MNTH	29,404.00				50,313.75			50,314
1.MDAL4X.1.05.13	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAL4X.1.05.13	Dozer D9 Ripper replacement	1.0	SET	469.64	3.6	285.82				517.78	804
1.MDAL4X.1.05.13	Dozer cutting edge replacement	1.0	EA	934.08	7.3	571.65	1,026.67				1,598
1.MDAL4X.1.05.13	980, 7 cy frontend loader rental	1.0	MNTH	16,734.00				28,633.87			28,634
1.MDAL4X.1.05.13	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAL4X.1.05.13	980-7cy loader bucket teeth replacement.	1.0	EA	999.04	3.6	285.82	1,423.65				1,709
1.MDAL4X.1.05.13	825H High speed compactor (sheepsfoot) rental	1.0	MNTH	10,585.00				18,112.20			18,112
1.MDAL4X.1.05.13	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAL4X.1.05.13	963 Hydraulic Excavator rental	1.0	MNTH	18,640.00				31,895.26			31,895
1.MDAL4X.1.05.13	963 Hydraulic Excavator : Scheduled Maintenance	1.0	YR	7,349.52						12,575.91	12,576
1.MDAL4X.1.05.13	963 Hydraulic Excavator tip long replacement.	1.0	EA	595.03	3.6	285.82	732.34				1,018
1.MDAL4X.1.05.13	Water wagon 1,000 gal soil processing	90.0	CY	0.44	1.1	67.53					68
1.MDAL4X.1.05.13	Equipment only. Water wagon 1,000 gal soil processing	90.0	CY	0.26				40.66			41
1.MDAL4X.1.05.13	Rock crusher plant rental	0.1	MNTH	28,000.00				4,791.13			4,791
1.MDAL4X.1.05.13	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAL4X.1.05.13	Screening plant rental	0.1	MNTH	15,500.00				2,652.23			2,652
1.MDAL4X.1.05.13	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAL4X.1.05.13	**Total**				**1,870.3**	**159,508.37**	**3,182.66**	**141,837.06**		**79,537.63**	**384,066**
1.MDAL4X.1.05.14	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Confirmatory Sampling Pit D**										
1.MDAL4X.1.05.14	Confirmatory Sampling	51.0	EA	3,658.77	92.8	11,410.07		31.63	307,848.60		319,290
1.MDAL4X.1.05.14	**Total**				**92.8**	**11,410.07**		**31.63**	**307,848.60**		**319,290**
1.MDAL4X.1.05.15	**Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Backfill Pit D**										
1.MDAL4X.1.05.15	Borrow, fill material only.	975.0	ton	16.50			27,527.63				27,528
1.MDAL4X.1.05.15	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with fro	650.0	CY	4.46	23.6	2,013.17		2,947.40			4,961

MDA-L Feasability CME

Project WBS	Activity Description	Quantity	Unit	Total Unit Price	Labor Hours	Labor Total - Gross	Material Total - Gross	Equip Total - Gross	Subs Total - Gross	Other Total - Gross	Gross Total Costs
1.MDAL4X.1.05.15	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	650.0	CY	4.62	42.9	3,669.58		1,468.27			5,138
1.MDAL4X.1.05.15	Water wagon 1,000 gal tuff processing	650.0	CY	0.44	7.8	487.72					488
1.MDAL4X.1.05.15	Equipment only. Water wagon 1,000 gal soil processing	650.0	CY	0.26				293.63			294
1.MDAL4X.1.05.15	Total				74.3	6,170.48	27,527.63	4,709.31			38,407
1.MDAL4X.1.05.16	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Disposal of Waste Pit D										
1.MDAL4X.1.05.16	Waste container delivery.	7.0	ea	1,453.61	173.8	11,520.33		5,890.77			17,411
1.MDAL4X.1.05.16	Waste container unload on site and handling during project.	135.0	ea	4,607.32	11,056.9	873,713.94		190,582.06			1,064,296
1.MDAL4X.1.05.16	Waste containers.	135.0	ea	2,018.34			466,238.76				466,239
1.MDAL4X.1.05.16	Fill waste containers.	135.0	ea	549.81	1,442.0	113,946.54		13,060.18			127,007
1.MDAL4X.1.05.16	Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	449.0	cy	1,114.00					855,877.90		855,878
1.MDAL4X.1.05.16	Trucking cost per 43,000 pound load	15.0	Trip	4,471.00						114,756.21	114,756
1.MDAL4X.1.05.16	Confirmatory Sampling	5.0	EA	3,658.77	9.1	1,118.63		3.10	30,181.24		31,303
1.MDAL4X.1.05.16	Total				12,681.8	1,000,299.44	466,238.76	209,536.11	886,059.14	114,756.21	2,676,890
1.MDAL4X.1.05.17	Project WBS: Excavation of pit and impoundments -DC- Excavation Pits & Impoundments - Equipment Decontamination										
1.MDAL4X.1.05.17	Decontamination of equipment.	100.0	hour	149.94	100.0	8,544.67	17,111.19				25,656
1.MDAL4X.1.05.17	Swipes	50.0	hour	649.94	50.0	4,272.33	51,333.58				55,606
1.MDAL4X.1.05.17	RCT involvment in swipes and decontamination process	50.0	hour	124.97	25.0	2,136.17	8,555.60				10,692
1.MDAL4X.1.05.17	Total				175.0	14,953.17	77,000.37				91,954
1.MDAL4X.1.05	Total				73,929.3	5,914,163.45	2,542,742.30	1,550,438.99	5,949,523.75	1,085,379.41	17,042,248
1.MDAL4X.1.06	Project WBS: 4 Excavation -DC- Revegetation										
1.MDAL4X.1.06	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL4X.1.06	Hydroseeding materials.	1.0	lsum	39,421.80			67,455.40				67,455
1.MDAL4X.1.06	Broadcasting Mulch and Humate	39.2	Msf	34.33	21.4	1,573.39		729.45			2,303
1.MDAL4X.1.06	Mulch and Humate materials.	1.0	LS	17,685.00			30,261.14				30,261
1.MDAL4X.1.06	Total				42.8	3,146.78	97,716.55	1,458.90			102,322
1.MDAL4X.1.07	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L -DC- Distribs										
1.MDAL4X.1.07	Field Non-Manual - JHRS	48,992.0	hour	66.10	48,992.0	5,541,239.36					5,541,239
1.MDAL4X.1.07	Craft Distributable - Labor	61,240.0	hour	46.33	61,240.0	4,854,837.98					4,854,838
1.MDAL4X.1.07	Craft Distributable - Materials	61,240.0	hour	7.00			733,522.61				733,523
1.MDAL4X.1.07	Total				110,232.0	10,396,077.34	733,522.61				11,129,600
1.MDAL4X.1	Total				355,195.3	30,134,366.58	10,476,150.17	6,559,402.48	17,999,399.33	2,954,071.48	68,123,390
1.MDAL4X.2	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L - Indirect Capital Costs										
1.MDAL4X.2.01	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L -IC- Design										
1.MDAL4X.2.01	Full Excavation Design	1.0	lsum	4,919,787.00					7,162,717.89		7,162,718
1.MDAL4X.2.01	Total								7,162,717.89		7,162,718
1.MDAL4X.2.02	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L -IC- Professional Management										
1.MDAL4X.2.02	Professional Management	1.0	lsum	19,574,388.00	196,530.0	42,890,018.99					42,890,019
1.MDAL4X.2.02	Total				196,530.0	42,890,018.99					42,890,019
1.MDAL4X.2.03	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L -IC- Contingency										
1.MDAL4X.2.03	Contingency - Cost 30%	1.0	lsum	35,452,838.00	1.0					35,452,838.00	35,452,838
1.MDAL4X.2.03	Contingency - Schedule 10%	1.0	lsum	11,817,612.00	1.0					11,817,612.00	11,817,612
1.MDAL4X.2.03	Contingency - TPRA 10%	1.0	lsum	11,817,612.00	1.0					11,817,612.00	11,817,612
1.MDAL4X.2.03	Total				3.0					59,088,062.00	59,088,062
1.MDAL4X.2	Total				196,533.0	42,890,018.99			7,162,717.89	59,088,062.00	109,140,799
1.MDAL4X.3	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L - Direct O&M Costs										
1.MDAL4X.3.01	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L -DOM- Cover Maintenance & Inspections										
1.MDAL4X.3.01	Active SVE Operation (3 years)	1.0	lsum	862,947.00	18,626.2	1,256,364.54					1,256,365
1.MDAL4X.3.01	Active SVE Monitoring (3 years)	1.0	lsum	123,456.00	1,576.7	179,739.59					179,740
1.MDAL4X.3.01	Rebound SVE Monitoring (3 years)	1.0	lsum	469,133.00	10,126.0	683,010.73					683,011
1.MDAL4X.3.01	Total				30,328.9	2,119,114.86					2,119,115
1.MDAL4X.3	Total				30,328.9	2,119,114.86					2,119,115
1.MDAL4X.4	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L - Indirect O&M Costs										
1.MDAL4X.4.02	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L-IOM- Professional Management										
1.MDAL4X.4.02	Professional Management (years 0-3)	1.0	lsum	431,937.00	4,336.7	946,429.90					946,430
1.MDAL4X.4.02	Total				4,336.7	946,429.90					946,430
1.MDAL4X.4.03	Project WBS: 4 Excavation, SVE, and Institutional Contols MDA L -IOM- Contingency										
1.MDAL4X.4.03	Contingency - Cost 30%	1.0	lsum	919,663.50	1.0					919,663.50	919,664
1.MDAL4X.4.03	Contingency - Schedule 10%	1.0	lsum	306,554.50	1.0					306,554.50	306,555
1.MDAL4X.4.03	Contingency - TPRA 10%	1.0	lsum	306,554.50	1.0					306,554.50	306,555
1.MDAL4X.4.03	Total				3.0					1,532,772.50	1,532,773
1.MDAL4X.4	Total				4,339.7	946,429.90				1,532,772.50	2,479,202
1.MDAL4X	Total				586,396.9	76,089,930.34	10,476,150.17	6,559,402.48	25,162,117.22	63,574,905.98	181,862,506
1	Total				1,336,668.8	162,803,214.65	22,625,159.89	10,625,374.10	45,351,761.92	128,404,990.31	369,810,501
	Grand Total				1,336,668.8	162,803,214.65	22,625,159.89	10,625,374.10	45,351,761.92	128,404,990.31	369,810,501

Acronyms and Abbreviations for Attachment F-1

AD	Associate Directorate
ADPM	Associate Directorate Project Management
BPS	Business and Project Services
CAMU	corrective action management unit
CF	cubic foot
CFO	chief financial officer
CLAS	class
CME	corrective measures evaluation
CMI	corrective measure implementation
CY	cubic yard
DC	direct capital (cost)
DOE	Department of Energy (U.S.)
DOM	direct operations and maintenance
DP	Defense Program
EA	each
EP	Environmental Programs Directorate
EPA	Environmental Protection Agency (U.S.)
Eq Rm	equipment room
ET	evapotranspiration
EST	estimate
FLUTe	Flexible Liner
G&A	general and administrative
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethelyene
H.P.	horsepower
IC	indirect capital (cost)
IOM	indirect operations and maintenance
LCY	loose cubic yard
LSUM	lump sum
JHRS	job hours
LDR	land disposal restriction
LF	linear foot

LLW	low-level waste
LOCN	location
MDA	material disposal area
MNTH	month
MPH	mile per hour
MSF	thousands of square feet
N/A	not applicable
NMGRT	New Mexico gross receipts tax
O&M	operation and maintenance
O&P	overhead and profit
OC	on center
OMB	Office of Management and Budget
OPC	other project cost
opng	opening
OSHA	Occupational Safety and Health Administration
PI	pit and impoundments
PPE	personal protective equipment
PV	present value
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
RCT	radiation control technician
S	shafts
S/C	subcontractor
SME	subject matter expert
spec	specification
STDP	standard productivity
SVE	soil-vapor extraction
SY	square yard
TA	technical area
TDR	time-domain reflectometry
TN	ton
TPC	total project cost
TPRA	technical programmatic risk assessment
TRM	turf-reinforcing mat

VOC	volatile organic compound
VZ	vadose zone
WBS	work breakdown structure
YR	year

Appendix G

Conceptual Multilayer
Resource Conservation and Recovery Act Cover Design

G-1.0 INTRODUCTION

This appendix describes modeling used to develop specifications for a conceptual multilayer, or Resource Conservation and Recovery Act (RCRA), cover at Material Disposal Area (MDA) L within Technical Area 54 (TA-54). The specifications for the MDA L RCRA cover are based on standard prescribed specifications for a RCRA cover. A standard RCRA cover for MDA G, also located at TA-54, was used in the modeling scenarios provided in Attachment G-1. Both MDAs G and MDA L are located on the eastern end of Mesita del Buey, have similar geological conditions, and are impacted by the same weather. The effectiveness of a RCRA cover depends on the amount of precipitation, the climate's demand for water or potential evapotranspiration, unsaturated soil hydraulic properties, and long-term reliability of engineering materials (i.e., geomembranes). These major factors would be identical for both MDA L and G and thus allow modeling work on MDA G covers to provide guidance at MDA L. The MDA L cover would be smaller and would likely have less steep and shorter slopes than MDA G. These differences allow the conceptual cover design cross-section produced for MDA G to fall into the design envelope for MDA L.

This report provides a summary of the basis for the conceptual multilayer cover design for MDA L as part of the corrective measures evaluation (CME) for remediation of the site. Conceptually this cover is designed to meet the minimum U.S. Environmental Protection Agency (EPA) performance guidelines including the following from bottom to top (EPA 1991, 097899):

1. *A Low-Hydraulic-Conductivity Geomembrane/Soil Layer.* A 60-cm (24-in.) layer of compacted natural or amended soil with a hydraulic conductively of 1×10^{-7} cm/s in intimate contact with a minimum 0.5-mm (20-mil) geomembrane liner.

2. *A Drainage Layer.* A minimum 30-cm (12-in.) soil layer having a minimum hydraulic conductivity of 1×10^{-2} cm/s or a layer of geosynthetic material having the same characteristics.

3. *A Top Vegetation/Soil Layer.* A top layer with vegetation (or armored top surface) and a minimum of 60 cm (24 in.) of soil graded at a slope between 3% and 5%.

The multilayer cover will cover the waste disposal units at MDA L, approximately 0.9 acres of the 2.5-acre site, and will be graded to provide the required slopes for surface drainage. In addition there will be a drain collection system designed to move water out of the drainage layer and away from the waste material.

The Hydrologic Evaluation of Landfill Performance (HELP) infiltration model (Schroeder et al. 1994, 205357) was used to evaluate the effectiveness of the multilayer cover. The HELP model is an EPA hydrologic model used for computing water balances of cover systems and other solid waste management facilities. The primary purpose of the model is to assist in comparing design alternatives. The HELP model uses weather, soil, and design data to compute a water balance for the cover system. This water balance accounts for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane, or composite liners.

G-2.0 CONCEPTUAL DESIGN

The RCRA cover conceptual design is shown in Figure G–2.0-1. The conceptual RCRA cover consists of 2 ft of surface treatment, a 1-ft soil drainage layer, a high-density polyethylene (HDPE) geomembrane

(40 mil), and 2 ft of compacted clay. A brief description of each layer in the cover profile is included in Table G-2.0-1, with expanded descriptions presented in sections G-2.1 to G-2.5.

G-2.1 Vegetation

Seed and/or live plants used to revegetate disturbed areas at the Laboratory will be native to the Los Alamos vicinity. Table G-2.1-1 lists the seed mix to be used for the cover system at MDA L.

Seeding of native vegetation on the cover systems will be performed in the spring, after the last frost of the season and before the arrival of the summer rains that typically occur in July and August. Seeding will not be done from August 1 to September 30 to avoid germination too close to the first frost, which can kill the new seedlings.

Revegetation will be done by first preparing the soil by tilling and applying fertilizer. Care will be taken to ensure the rock-soil surface treatment maintains the desired ratio during this activity. Care will also be taken to ensure the rock-soil surface treatment layer is not mixed deeper into the cover profile. Slow-release organic fertilizers will be applied as necessary to eliminate any deficiencies of the topsoil. Biosol or a similar fertilizer will be applied at rates of up to 1500 lb/acre. Analyses of cover soils used will dictate the actual fertilizer rate required. Granular humate can be applied at 400 lb/acre to 500 lb/acre if it is in a hydroseeding slurry and up to 1800 lb/acre if it is incorporated into the top 4 in. of the soil. Application rates of composted manure vary depending on the source (chicken, horse, etc.) and the type of materials (wood chips, paper, soil, etc.) used to compost. If composted manure is to be applied, the nutrient content will be tested and interpreted before it is used.

Drill seeding will be the method used to apply the seed mix. Drilling introduces seed directly into the prepared seedbed by machine. Seeding will be performed by drilling at a minimum rate of 25 pure live seed (PLS) lb/acre. In areas that limit equipment access, broadcast seeding may be used at a rate of 40 PLS lb/acre.

G-2.2 Cover Soil Layer (Surface Treatment–Rock/Soil Admixture)

To address potential erosion of the cover system, a surface treatment composed of a mixture of gravel and cover soil will be used. The purpose of the cover soil layer is to (1) support vegetation (minimizing erosion and maximizing evapotranspiration), (2) separate the waste from the surface, (3) store water that infiltrates the cover system, and (4) protect underlying materials from freezing during winter and from desiccation during dry periods. The soil in this top layer will be capable of sustaining nonwoody plants, will have an adequate water-holding capacity, and will be deep enough to allow for expected long-term erosional losses. A medium-textured soil will be used, such as a loam. The final slopes of the cover will be uniform and at an optimum slope of 3%–5%, and the edges will be constructed to not allow the formation of erosion rills and gullies.

The addition of a gravel-soil admixture to the surface will minimize annual soil loss because of wind and runoff. The gravel-soil admixture will include a mixture of 33% gravel by weight. The gravel size to be used will be between 1.5 in. (3.8 cm) and 3 in. (7.6 cm) in diameter. The total gravel-soil admixture thickness is to be no less than 24 in. (0.67 m). Slopes and slope lengths were estimated, and these estimates will be replaced with measured values during the final design phase.

G-2.3 Soil Drainage Layer

The soil drainage layer will minimize the time that infiltrated water is in contact with the bottom clay layer and hence lessen the potential for water to reach the waste. This soil drainage layer will also minimize the head built up on the geomembrane, thus minimizing the chance of ripping at localized stress points or seepage at welded seams. Water that infiltrates the top layer will be intercepted by this highly permeable soil drainage layer and rapidly move to an exit drain. The drainage pipes will be designed in a manner to avoid potential damage to the geomembrane. The granular material will be 12 in. thick and have a hydraulic conductivity of at least 1×10^{-2} cm/s. To maximize the hydraulic conductivity of this layer, the material will be relatively free of fines, defined as materials that will pass through the openings of a No. 200 sieve (.075 mm). In addition, a minimum amount of compaction will be specified in the final design so excessive compaction does not grind up soil particles, which could lower the hydraulic conductivity.

G-2.4 Geomembrane

An HDPE 40-mil-thick geomembrane is specified for the purposes of this conceptual design. This type of geomembrane is readily used in these applications and is a good choice to meet the minimum requirements. RCRA allows the use of a 20-mil-thick geomembrane, while the industry standard is typically 60 mil. To provide a level of conservatism against industry standards, a 40-mil geomembrane was used. One of the key reasons for choosing the HDPE over another type of material is its ability to withstand ultraviolet, which would potentially be a problem at MDA L.

The geomembrane will be placed on the smooth, even, compacted clay layer and have a minimum slope of 3%. The quality control of this step in the construction process will be critical to ensure the membrane is welded correctly and is in intimate contact with the compacted clay layer and no puncture holes are inflicted on the membrane during installation. Any of these quality-control issues can drastically impact the overall performance of this type of cover. A quality assurance/quality control plan will be strictly adhered to during the construction activity.

G-2.5 Compacted Clay Layer

The compacted clay layer, which is a low-hydraulic-conductivity soil component placed over the waste, will be at least 2 ft thick and free of detrimental rock, clods, and other soil debris; will have an upper surface with a 3% maximum slope; and will be below the maximum frost line. The surface will be smooth so no small-scale stress points are created for the geomembrane.

The primary requirement for the compacted clay liner is that it be capable of being compacted to produce a suitably low hydraulic conductivity. A hydraulic conductivity of 1×10^{-7} cm/s was used for modeling purposes. Some of the critical design parameters follow:

- Fines—The soil should contain at least 20% fines (fines are defined as the percentage, on a dry weight basis, of material passing a No. 200 sieve).
- Plasticity Index—The soil should have a plasticity index of at least 10% and generally between 10% and 35%.
- Percentage of Gravel—The percentage of gravel (defined as material retained on a No. 4 sieve) must not be excessive. A maximum amount of 10% gravel will be a requirement.

- Stones and Rocks—No stones or rocks larger than 1 to 2 in. in diameter will be allowed within this material.
- Water Content—The clay layer will be compacted wet of optimum to maximize the mixing of the any remnant clods typical of clay-rich soils and reduce the hydraulic conductivity.

G-3.0 HELP MODELING

The HELP model was developed at the U.S. Army Engineering Experiment Station under a cooperative agreement with the EPA to support RCRA and Superfund programs. Use of the HELP model is recommended by the EPA for RCRA cover designs; however, the user should be cautioned that the model does not work well with other cover types that do not contain geomembrane liners, in part because the HELP model does not take into account important physical processes that control unsaturated water movement, such as matric potential in soil barrier layers (Dwyer 2003, 097902).

The model is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The model accepts weather, soil, and design data and uses solution techniques that account for the effects of surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through soil, geomembrane, or composite liners. The free available water is used to compute the runoff by the Natural Resources Conservation Service (NRCS) rainfall-runoff relationship.

G-3.1 HELP Input Parameters

A set of input parameters was developed for simulations using HELP for the given cover profiles. These parameters were developed based on field and laboratory measurements, values from the literature, and expert opinion. The detailed parameters are listed in Attachment G-1, HELP Model Run Output and are discussed as they relate to the different conditions described below.

G-3.2 Model Geometry

The model geometry was based on the depth of the cover profile shown in Figure G-2.0-1. The modeled cover profile includes (1) a 2-ft surface-treatment layer, (2) a 1-ft drainage layer, (3) a 40-mil HDPE geomembrane, (4) 2 ft of compacted clay. Assumptions in the modeling include (1) 3 ft of existing operational cover over the waste, (2) approximately 60 ft of waste material, and (3) approximately 900 ft of vadose zone. The geometry for the modeled cover is found in the profile structure of Attachment G-1.

G-3.3 Boundary Conditions

Los Alamos, New Mexico, is located in a dry environment where the climate's demand for water, referred to as potential evapotranspiration, far exceeds the actual supply of water or precipitation. The HELP model divides precipitation into overland flow and infiltration based on a modified version of the NRCS runoff curve number method. Water that infiltrates remains in storage or is subjected to evapotranspiration, lateral drainage, and percolation. Water is removed by evapotranspiration only from the evaporative depth of the cover, which is defined as the maximum depth from which water may be removed by evapotranspiration. If the layer is a vertical percolation layer, water from soil-water storage is routed based on a unit hydraulic gradient in the vertically downward direction using Darcy's law and unsaturated hydraulic conductivity. Water from the vertical percolation layer is removed by percolation or evapotranspiration if the water content is above the wilting point. An assumption in the HELP model is

that the barrier soil liner is saturated with ponded water, which in an arid climate such as Los Alamos is not expected.

G-3.4 Upper Boundary Condition—Climate/Data

The surface boundary condition during evaporation was modeled as a flux that required daily weather data. Precipitation data for the wettest decade on record for Los Alamos National Laboratory (1985 to 1994) was used in the model assumptions (http://environweb.lanl.gov/weathermachine/). Because the RCRA requirements to minimize flux were the regulatory drivers for determining the storage capacity requirements of the cover profile, the wettest decade on record was deemed to provide a conservative measure for evaluation.

G-3.5 Vegetation Data

An average leaf area index of 0.65 was used (McDowell et al. 2008, 205356). This value represents an average of values reported for the site of 0.3 and 1.0. The assumed onset and termination of the growing season for the site were Julian days 98 and 299, respectively.

G-3.6 Soil Properties

Soil hydraulic properties were obtained from laboratory testing of soil samples collected from the TA-61 borrow site (Shaw Environmental Inc. 2006, 091368). The saturated hydraulic conductivity of the soils was obtained using flexible wall permeameters in accordance with the American Society for Testing and Materials (ASTM) Standard D 5084, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameters. Unsaturated soil properties were obtained from data using pressure plates and water columns (depending on the section values) to develop values of water content as a function of pressure head (ASTM D 6836, Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge). These data were then used as input into the RETention Curve Computer Code (RETC) (van Genuchten et al. 1991, 205358) to compute curve-fitting parameters used to estimate moisture characteristic curves for the soil layers (van Genuchten 1980, 063542). The Maulem conductivity function was used to describe the unsaturated hydraulic conductivity of the soils. The van Genuchten “m” parameter for this function is assumed to be “1 − 1/n”; “n” being one of the established van Genuchten parameters. The initial soil conditions are expressed in terms of suction-head values that correspond to the average moisture content between each soil layer’s field capacity and permanent wilting point determined from each respective soil layer’s moisture characteristic curve. The soil properties used as input parameters are summarized in Attachment G-1.

G-3.7 Modeled Percolation

Percolation results from the redistribution of water through a soil profile in response to gradients formed by differences in the energy state of the water. Annual percolation, as an annual total rate, is provided in Attachment G-1. Percolation through layer 4, which is the compacted clay layer, is estimated to be 0.075 cm (0.75 mm) in year 1. The total percolation through this layer is estimated to be 2.70 cm over a 30-yr time frame, or an average of 0.09 cm/yr (0.9 mm/yr).

G-4.0 REFERENCES

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

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

Dwyer, S.F., May 2003. "Water Balance Measurements and Computer Simulations of Landfill Covers," Ph.D. dissertation, University of New Mexico, Albuquerque, New Mexico. (Dwyer 2003, 097902)

Dwyer, S.F., R.E. Rager, and J. Hopkins, April 2007. "Cover System Design Guidance and Requirements Document," Los Alamos National Laboratory document LA-UR-06-4715, Los Alamos, New Mexico. (Dwyer et al. 2007, 096232)

EPA (U.S. Environmental Protection Agency), May 1991. "Design and Construction of RCRA/CERCLA Final Covers," Seminar Publication, EPA/625/4-91/025, Office of Research and Development, Washington, D.C. (EPA 1991, 097899)

McDowell, N.G., S. White, and W.T. Pockman, 2008. "Transpiration and Stomatal Conductance across a Steep Climate Gradient in the Southern Rocky Mountains," *Ecohydrology,* Vol. 1, No. 3, pp. 193–204. (McDowell et al. 2008, 205356)

Schroeder, P.R., T.S. Dozier, P.A. Zappi, B.M. McEnroe, J.W. Sjostrom, and R.L. Peyton, September 1994. "The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3," EPA/600/R-94/168b, Office of Research and Development, Washington, D.C. (Schroeder et al. 1994, 205357)

Shaw Environmental Inc., February 2006. "Geotechnical and Hydraulic Characterization at the Technical Area 61 Borrow Area," report prepared for Los Alamos National Laboratory, Albuquerque, New Mexico. (Shaw Environmental, Inc. 2006, 091368)

van Genuchten, M.T., 1980. "A Closed-Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils," *Soil Science Society of America Journal,* Vol. 44, pp. 892-898. (van Genuchten 1980, 063542)

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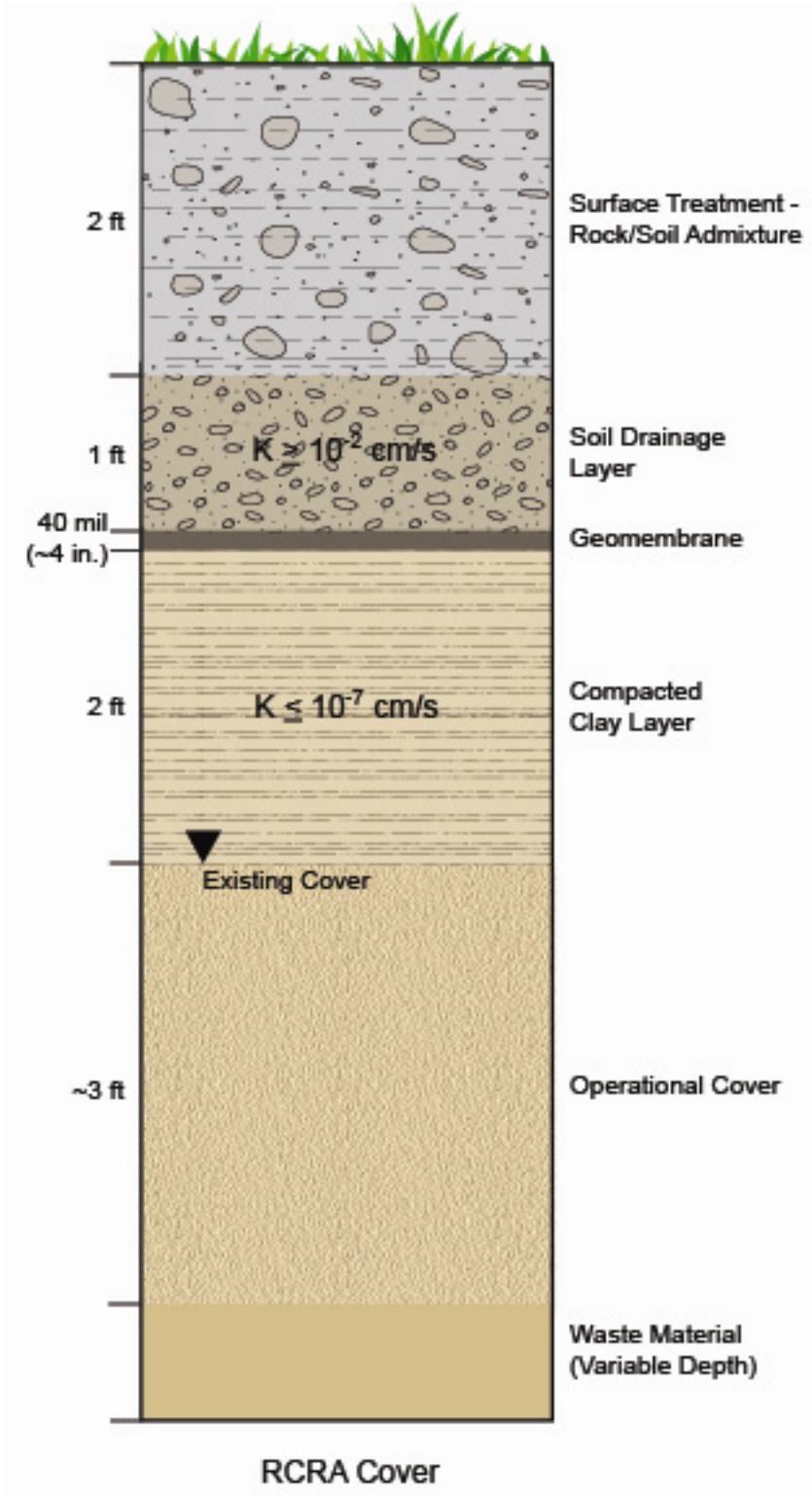


Figure G-2.0-1 RCRA cover conceptual design

Table G-2.0-1
RCRA Conceptual Cover Profile Layer Details and Justification

Cover-System Layer	Design Details	Design Justification
Vegetation	The site is to be seeded with native vegetation composed of both cool and warm weather species (grasses). Refer to Table G-2.1-1 for a recommended seed mix.	The vegetation will help stabilize the cover surface, minimize erosion, and remove limited infiltrated water via transpiration.
Surface Treatment	Mixture of cover soil and gravel. The gravel is to be mixed into the cover soil at a rate of 33% by weight. The gravel will be1.5 in. (3.8 cm) to 3 in. (7.6 cm) in diameter. The cover soil will be capable of maintaining native vegetation with adequate storage capacity and nutrient availability.	The gravel/soil admixture is designed to minimize erosion due to both wind and surface runoff.
Soil Drainage Layer	The granular material will be 12 in. thick and have a hydraulic conductivity of at least 1×10^{-2} cm/s. To maximize the hydraulic conductivity of this layer, the material will be relatively free of fines, defined as materials that will pass through the openings of a No. 200 sieve (0.075 mm).	The soil drainage layer is designed to minimize the time the infiltrated water is in contact with the bottom, low-hydraulic-conductivity layer.
Geomembrane	For the purposes of this conceptual design, HDPE, 40-mm thick, will be used.	In conjunction with the compacted clay layer, the geomembrane will act to provide a low-hydraulic-conductivity geomembrane/soil layer.
Compacted Clay Layer	The low-hydraulic-conductivity soil component placed over the waste will be at least 2 ft thick and free of detrimental rock, clods, and other soil debris; have an upper surface with a 3% maximum slope; have a hydraulic conductivity of no greater than 1×10^{-7} cm/s; and be below the maximum frost line.	In conjunction with the geomembrane, the compacted clay layer will act to provide a low-hydraulic-conductivity geomembrane/soil layer. This low hydraulic conductivity has been prescribed by the EPA to be no greater than 1×10^{-7} cm/s.
Operational Cover/Subgrade	The upper foot of existing operational cover soil shall be scarified and recompacted to a minimum of 95% of the maximum dry density and dry of the optimum moisture content as determined by ASTM D698.	The operational cover/subgrade will provide a firm foundation for the construction of the cover profile and will provide the final grades and slopes for installation of a uniform cover profile.

Table G-2.1-1
Seed Mix

Common Name	Scientific Name	Percent of Mix	PLS (lb/acre)
Sideoats grama	*Bouteloua curtipendula*	15%	3.75
Blue grama	*Bouteloua gracilis*	15%	3.75
Indian ricegrass	*Oryzopsis hymenoides*	10%	2.5
Western wheatgrass	*Agropyron smithii*	15%	3.75
Sand dropseed	*Sporobolus cryptandrus*	10%	2.5
Sheep fescue	*Festuca ovina*	20%	5
Firewheel	*Gaillardia pulchella*	3%	0.75
Western yarrow	*Achillea millefoium*	2%	0.5
Prairie coneflower	*Ratibida columnifera*	4%	1
Blue flax	*Linum perenne lewisii*	6%	1.5
		Total	**25**

Source: (Dwyer et al. 2007, 096232).

Attachment G-1

HELP Model Run Output

Description

Model : HELP

An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Client : LANL MDA-G RCRA CAP

Location : TA-54

8/20/2011

1. Profile. RCRA Cover

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Good stand of grass	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Loamy Sand	0.0000	-2.0000	2.0000
Coarse Sand	-1.9995	-2.9995	1.0000
High Density Polyethylene	-2.9995	-3.0028	0.0033
Barrier Soil	-3.0028	-5.0028	2.0000
Silty Loam	-5.0028	-8.0028	3.0000
Municipal Waste (312 kg/cub.m)	-8.0023	-68.0023	60.0000
Sand	-68.0023	-968.0023	900.0000

1.1. Layer. Loamy Sand

Top Slope Length: 100.0000
Bottom Slope Length: 100.0000
Top Slope: 3.0000
Bottom Slope : 3.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.437	(vol/vol)
field capacity	0.105	(vol/vol)
wilting point	0.047	(vol/vol)
sat.hydr.conductivity	4.4E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.2. Layer. Coarse Sand

Top Slope Length: 100.0000
Bottom Slope Length: 100.0000
Top Slope: 3.0000
Bottom Slope : 3.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.417	(vol/vol)
field capacity	0.045	(vol/vol)
wilting point	0.018	(vol/vol)
sat.hydr.conductivity	0.01	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. High Density Polyethylene

Top Slope Length: 100.0000
Bottom Slope Length: 100.0000
Top Slope: 3.0000
Bottom Slope : 3.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	4	(-)
geotextile transmissivity	0	(cm2/sec)

1.4. Layer. Barrier Soil

Top Slope Length: 100.0000
Bottom Slope Length: 100.0000
Top Slope: 3.0000
Bottom Slope : 3.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.427	(vol/vol)
field capacity	0.418	(vol/vol)
wilting point	0.367	(vol/vol)
sat.hydr.conductivity	1E-7	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Silty Loam

Top Slope Length: 100.0000
Bottom Slope Length: 100.0000
Top Slope: 3.0000
Bottom Slope : 3.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.501	(vol/vol)
field capacity	0.284	(vol/vol)
wilting point	0.135	(vol/vol)
sat.hydr.conductivity	4.9E-3	(cm/sec)
subsurface inflow	0	(mm/year)

1.6. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 100.0000
Bottom Slope Length: 0.0000
Top Slope: 3.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.6710	(vol/vol)
field capacity	0.2920	(vol/vol)
wilting point	0.0770	(vol/vol)
sat.hydr.conductivity	86.40000000000001	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.7. Layer. Sand

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.437	(vol/vol)
field capacity	0.062	(vol/vol)
wilting point	0.024	(vol/vol)
sat.hydr.conductivity	0.0058	(cm/sec)
subsurface inflow	0	(mm/year)

Annual Totals rate (cm)

	Year-1 (cm)	Year-10 (cm)	Year-20 (cm)	Year-30 (cm)
Precipitation (cm)	5.4127E+01	5.4178E+01	5.1130E+01	4.8870E+01
Runoff (cm)	7.6646E+00	1.8393E+01	1.9691E+01	1.3394E+01
Evapotranspiration (cm)	3.5990E+01	3.6686E+01	3.9274E+01	4.1411E+01
Change in water storage (cm)	1.0471E+01	-9.3167E-01	-7.9243E+00	-6.0261E+00
Water budget balance (cm)	-8.1291E-07	-8.1368E-07	-7.6790E-07	-7.3395E-07
Soil water (cm)	2.3260E+03	2.3241E+03	2.3245E+03	2.3254E+03
Snow water (cm)	0.0000E+00	1.0333E+00	0.0000E+00	0.0000E+00
Lateral drainage collected from Layer 2 (cm)	1.0033E-03	1.2668E-03	1.2007E-03	1.2193E-03
Percolation or leakance through Layer 4 (cm)	7.5335E-02	9.2321E-02	8.8096E-02	8.9290E-02
Average head on top of Layer 3 (cm)	6.1441E+01	7.5760E+01	7.2017E+01	7.3143E+01
Percolation or leakance through Layer 7 (cm)	1.0272E-03	3.0003E-02	8.7986E-02	8.8983E-02

(continued)

	Total (cm)
Precipitation (cm)	1.6584E+03
Runoff (cm)	4.4619E+02
Evapotranspiration (cm)	1.2006E+03
Change in water storage (cm)	9.8332E+00
Water budget balance (cm)	-2.4907E-05
Soil water (cm)	6.9757E+04
Snow water (cm)	5.0184E+01
Lateral drainage collected from Layer 2 (cm)	3.7037E-02
Percolation or leakance through Layer 4 (cm)	2.7076E+00
Average head on top of Layer 3 (cm)	2.2188E+03
Percolation or leakance through Layer 7 (cm)	1.7103E+00

Annual Totals volume (m3)

	Year-1 (m3)	Year-10 (m3)	Year-20 (m3)	Year-30 (m3)
Precipitation (m3)	1.1171E+05	1.1182E+05	1.0553E+05	1.0086E+05
Runoff (m3)	1.5819E+04	3.7961E+04	4.0640E+04	2.7644E+04
Evapotranspiration (m3)	7.4280E+04	7.5716E+04	8.1058E+04	8.5469E+04
Change in water storage (m3)	2.1610E+04	-1.9229E+03	-1.6355E+04	-1.2437E+04
Water budget balance (m3)	-1.6778E-03	-1.6793E-03	-1.5849E-03	-1.5148E-03
Soil water (m3)	4.8006E+06	4.7967E+06	4.7976E+06	4.7993E+06
Snow water (m3)	0.0000E+00	2.1326E+03	0.0000E+00	0.0000E+00
Lateral drainage collected from Layer 2 (m3)	2.0708E+00	2.6146E+00	2.4782E+00	2.5164E+00
Percolation or leakance through Layer 4 (m3)	1.5548E+02	1.9054E+02	1.8182E+02	1.8428E+02
Percolation or leakance through Layer 7 (m3)	2.1201E+00	6.1922E+01	1.8159E+02	1.8365E+02

(continued)

	Total (m3)
Precipitation (m3)	3.4228E+06
Runoff (m3)	9.2089E+05
Evapotranspiration (m3)	2.4780E+06
Change in water storage (m3)	2.0295E+04
Water budget balance (m3)	-5.1405E-02
Soil water (m3)	1.4397E+08
Snow water (m3)	1.0358E+05
Lateral drainage collected from Layer 2 (m3)	7.6440E+01
Percolation or leakance through Layer 4 (m3)	5.5882E+03
Percolation or leakance through Layer 7 (m3)	3.5298E+03

Accumulated rate (cm)

	Year-1 (cm)	Year-10 (cm)	Year-20 (cm)	Year-30 (cm)
Precipitation (cm)	5.4127E+01	5.9774E+02	1.1192E+03	1.6584E+03
Runoff (cm)	7.6646E+00	1.8243E+02	3.0175E+02	4.4619E+02
Evapotranspiration (cm)	3.5990E+01	4.0559E+02	8.0761E+02	1.2006E+03
Lateral drainage collected from Layer 2 (cm)	1.0033E-03	1.2264E-02	2.4502E-02	3.7037E-02
Percolation or leakance through Layer 4 (cm)	7.5335E-02	8.9715E-01	1.7931E+00	2.7076E+00
Percolation or leakance through Layer 7 (cm)	1.0272E-03	1.0724E-01	8.1466E-01	1.7103E+00

Accumulated volume (m3)

	Year-1 (m3)	Year-10 (m3)	Year-20 (m3)	Year-30 (m3)
Precipitation (m3)	1.1171E+05	1.2337E+06	2.3100E+06	3.4228E+06
Runoff (m3)	1.5819E+04	3.7651E+05	6.2278E+05	9.2089E+05
Evapotranspiration (m3)	7.4280E+04	8.3709E+05	1.6668E+06	2.4780E+06
Lateral drainage collected from Layer 2 (m3)	2.0708E+00	2.5312E+01	5.0569E+01	7.6440E+01
Percolation or leakance through Layer 4 (m3)	1.5548E+02	1.8516E+03	3.7007E+03	5.5882E+03
Percolation or leakance through Layer 7 (m3)	2.1201E+00	2.2132E+02	1.6814E+03	3.5298E+03

Peak daily values

	Rate (cm)	Volume (m3)	Day	Year
Precipitation	1.2395E+01	2.5582E+04	113	23
Runoff	1.2109E+01	2.4991E+04	113	23
Lateral drainage collected from Layer 2	4.2760E-06	8.8251E-03	319	1
Percolation or leakance through Layer 4	3.0367E-04	6.2674E-01	319	1
Percolation or leakance through Layer 7	4.0114E-04	8.2791E-01	74	30
Snow water	1.2041E+01	2.4852E+04	19	18

Appendix H

Conceptual Evapotranspiration Cover Design

H-1.0 INTRODUCTION

This appendix describes modeling used to develop specifications for an evapotranspiration (ET) cover at Material Disposal Area (MDA) L within Technical Area 54 (TA-54) at Los Alamos National Laboratory (LANL or the Laboratory). The specifications are based on modeling produced for MDA G that is applicable to MDA L as well. Both MDAs G and L are located on the eastern end of Mesita del Buey and are impacted by the same kind of weather patterns. The effectiveness of an ET cover depends on precipitation, potential ET, and unsaturated soil hydraulic properties. These three major factors are identical for both MDAs L and G and thus allow previous analysis of MDA G covers to provide guidance at MDA L. The MDA L cover is smaller and would have less steep and shorter slopes than MDA G. These differences allow the conceptual cover design cross-section produced for MDA G to fall into the design envelope for MDA L.

Borrow soil with amendments will be used to construct the ET covers at MDA L. TA-61 is a likely source of the borrow soil. Attachment H-1 provides supporting documentation for the modeling and specifications. The UNSAT-H infiltration modeling used to calculate cover thickness was based on precipitation data of the wettest decade on record, which is a common data set used for Resource Conservation and Recovery Act (RCRA) hazardous waste landfill cover design (Benson 2007, 097054, p. 3). The conceptual design includes a 3.5-ft (1-m) cover depth with 1.5 ft (0.45 m) of soil-gravel admixture to reduce flux through the cover to less than 0.04 in./yr (1 mm/yr), the RCRA Subtitle C–equivalent infiltration rate. Burrowing animals and plant roots on Mesita del Buey will be deterred by the biobarrier that consists of a thin filter layer and a cobble layer. This biobarrier is described below. These cover layers will be placed on the existing subgrade of interim (operational) cover. The existing subgrade will be prepared through necessary cut and fill, will be scarified to promote adhesion to the final cover, and will be highly compacted to reduce possible subsidence. All necessary precautions will be taken during the final design not to impact in place waste during the cut and fill process.

This appendix describes the purpose for each layer of the ET cover, the design methodology used, and the calculations and modeling results that validate the design (Attachment H-1). Most of the input parameters are identical for the MDA L and MDA G sites, with only differences in the cover slopes and slope lengths, which are conservative for MDA L.

H-2.0 BACKGROUND

MDA L is located within TA-54 the Laboratory in Los Alamos, New Mexico. TA-54 is located on Mesita del Buey and spans the boundary of the Cañada del Buey and Pajarito Canyon watersheds. TA-54 ranges in elevation from 6700 ft to 6800 ft with a depth to groundwater ranging between 900 ft and 980 ft. The major industrial activity at TA-54 has been waste storage and disposal. MDA L is a 2.5-acre site that has served as the Laboratory's nonradioactive liquid chemical waste subsurface disposal site from the early 1960s to 1986. The majority of stormwater runoff from MDA L enters the Pajarito Canyon watershed with a much smaller portion draining into Cañada del Buey, which is located within the Mortandad Canyon watershed.

This appendix summarizes the basis for the conceptual ET cover design for MDA L as part of the corrective measures evaluation (CME) for remediation of the site. Many of the calculations and specifications for the MDA L site are similar to those developed by Dwyer in the report titled "Conceptual Cover Design Report for the Corrective Evaluation Measure for Closure of MDA G" (Dwyer 2007, 098276). At MDA L, an ET cover with an erosion-resistant surface treatment and a biobarrier can be constructed to provide adequate protection and risk reduction. ET covers consist of a vegetated soil layer

constructed to represent an optimum mix of soil texture, soil thickness, and vegetation cover (Figure H-2.0-1).

The ET cover concept relies on the soil to act as a sponge (Dwyer 2003, 097902, p. 162). Infiltrated water is held in this “sponge” until it can be removed via ET. Generally, ET is defined as water removed because of both evaporation from the surface and transpiration by vegetation. Previous research has shown that a simple soil cover with vegetation can be very effective at minimizing percolation and erosion, particularly in dry environments.

The MDA L site is an ideal site for an ET cover. In Los Alamos, the climate’s demand for water or potential evapotranspiration (PET) far exceeds the actual supply of water (precipitation) as shown in Figure H-2.0-2. The ET cover also provides for a deep-rooting medium that will provide an opportunity for native vegetation to survive lengthy drought periods.

H-3.0 CONCEPTUAL DESIGN

The ET cover system proposed for MDA L is shown in Figure H-3.0-1. A brief description of each layer in the cover profile is presented in Table H-3.0-1, with more complete descriptions presented in sections H-3.1 through H-3.5.

H-3.1 Vegetation

Seed and/or live plants used to revegetate disturbed areas at the Laboratory will be native to the Los Alamos vicinity. Table H-3.1-1 lists the seed mix to be used for the cover system at MDA L.

Seed Application

Seeding of native vegetation on the cover systems will be performed in the spring, after the last frost of the season and before the arrival of the summer rains that typically occur in July and August. Seeding will not be done from August 1 to September 30 to avoid germination too close to the first frost, which can kill the new seedlings.

Revegetation will be done by first preparing the soil by tilling and applying fertilizer. Care will be taken to ensure the rock-soil surface treatment maintains the desired ratio during this activity. Care will also be taken to ensure the rock-soil surface treatment layer is not mixed deeper into the cover profile. Slow-release organic fertilizers will be applied as necessary to eliminate any deficiencies of the topsoil. Table H-3.1-1 lists the recommended levels of available plant nutrients. Bio-Sol or a similar fertilizer will be applied at rates up to 1500 lb/acre. Analyses of cover soils used will dictate the actual fertilizer rate required. Granular humate can be applied at 400 lb/acre to 500 lb/acre if it is in a hydroseeding slurry and up to 1800 lb/acre if it is incorporated into the top 4 in. of the soil. Application rates of composted manure vary depending on the source (chicken, horse, etc.) and the type of materials (wood chips, paper, soil, etc.) used to compost. If composted manure is to be applied, the nutrient content will be tested and interpreted before it is used.

Drill seeding will be the method used to apply the seed mix. Drilling introduces seed directly into the prepared seedbed by machine. Seeding will be performed by drilling at a minimum rate of 25 pure live seed (PLS) lb/acre. In areas that limit equipment access, broadcast seeding may be used at a rate of 40 PLS lb/acre.

H-3.2 Surface Treatment

To address potential erosion of the cover system, a surface treatment composed of a mixture of gravel and cover soil will be used. This admixture was designed following the procedure described in Dwyer et al. (1999, 099309, p. 34; 2007, 096232, pp. 5-19-5-25).

The gravel-to-soil ratio and gravel size were determined based on the most critical drainage section (north-south). With the addition of the gravel-soil admixture to the surface, annual soil loss because of both wind and runoff was estimated to be minimal. The gravel-soil admixture will include a mixture of 33% gravel by weight. The cover soil will exhibit the storage capacity and soil nutrients described in section H-3.3. Salts in this soil will also be limited in the cover soil as described in section H-3.3. The critical gravel size was determined to be 1.5 in. (3.8 cm) (gravel size between 1.5 in. [3.8 cm] and 3 in. [7.6 cm] in diameter to be used), and the total gravel-soil admixture thickness is to be no less than 18 in. (0.5 m). The design methodology and procedure with input and output specifics are included in Attachment H-1. Many of the input parameters required to calculate the specifics of this gravel admixture, surface treatment such as bulk density and percentage of silt/clay in the soil were estimated based on soil-amendment requirements. Slopes and slope lengths were estimated, and these estimates will be replaced with measured values during the final design phase.

Soil Placement

The gravel-soil admixture used as a surface treatment will be placed in one uncompacted lift, if practical. Two lifts are also acceptable provided the bottom lift is not overcompacted because of placement of the top lift. This surface treatment layer will be placed as dry as possible but no wetter than the optimum moisture content as determined by American Society for Testing and Materials (ASTM) D698. Any excessive compaction this layer receives during placement will be scarified. The loose placement is to provide the best means for vegetation establishment. Overcompaction is one of the primary causes of unsuccessful revegetation efforts.

H-3.3 Cover Soil

The cover soil layer beneath the gravel-soil admixture will be a minimum of 3.5 ft (1 m) of amended soil meeting the water storage capacity properties of a typical sandy loam soil, based on the ROSETTA Software, Version 1.2, developed in 2000 by Marcel G. Schaap of the U.S. Salinity Laboratory, Riverside, California. The cover soil, including the soil in the surface treatment (gravel admixture), must have adequate storage capacity to retain infiltrated water until that water can be removed via ET. This soil must provide a quality rooting medium to maintain native vegetation; therefore, the soil must have acceptable levels of available plant nutrients, and its salt content must be below acceptable levels.

The depth of the cover soil was determined based on water storage requirements to meet RCRA-equivalency of less than 1 mm/yr. Modeling using UNSAT-H (Fayer 2000, 072734) was performed to determine the minimum thickness required to provide adequate storage capacity for an upper boundary condition consisting of the wettest decade in recorded history in Los Alamos (1985 to 1994).

Average hydraulic properties (Shaw Environmental Inc. 2006, 091368, Appendix D) from the TA-61 soil borrow site were used as input parameters. The modeling output determined that a depth greater than 6.6 ft (2 m) would be required to minimize flux largely because of the lack of water-storage capacity in the TA-61 soils (Figure H-3.3-1). The TA-61 soils consist of crushed tuff and were classified as a sandy loam but are on the coarser side of sandy loam soils. The ROSETTA software, Version 1.2, was used to perform another modeling exercise using typical sandy loam hydraulic properties to ascertain if this soil

type would decrease the soil depth requirement. This output (Figure H-3.3-2) determined that approximately 5 ft (1.5 m) of typical sandy loam soil would minimize flux to a point of diminishing returns (Dwyer et al. 2007, 096232, pp. 3-10-3-11).

The depth of the surface treatment was determined to be a minimum of 1.5 ft (0.5 m). Therefore, the additional cover soil depth required to minimize flux is 3.5 ft (1 m). This depth provides for a minimum cover soil depth of 5 ft (1.5 m). A third modeling exercise was performed to capture the entire conceptual design that includes all layers above the existing subgrade. This modeling output determined that flux through the cover will be negligible with the conditions modeled. It is important to note that the inclusion of a filter medium above the biobarrier and the inclusion of a biobarrier create a capillary barrier. Details of the modeling performed, including specific input and output parameters, are included in Attachment H-1.

The amendments will ensure the cover soil is capable of maintaining a desired stand of native vegetation. The plant nutrients should allow for the final amended soil to meet the requirements listed in Table H-3.3-1.

Additionally, the salt content in the soils must be below levels that would hinder the establishment and growth of native vegetation. The final amended soils will comply with the requirements outlined in Table H-3.3-2.

Soil Placement

An important aspect involved with the construction of a soil cover system is that the soils are placed in a uniform manner to help limit preferential flow through the cover. Dwyer (2003, 097902, p. 32) describes the impact of preferential flow in landfill covers. Preferential flow cannot be avoided, but necessary precautions will be taken to ensure it is minimized. An important feature of the design specifications will involve determining an acceptable density range for installation of the cover soils. To increase the initial storage capacity of the cover system and mitigate the potential for desiccation cracking, the soils will be placed as dry as possible but not more than the optimum moisture content as determined by ASTM D698. The acceptable density and moisture content placement range is described as the acceptable compaction zone (ACZ).

The ACZ (Figure H-3.3-2) is unknown as of the date of this CME report because the desired soil will require amendment to meet the performance objectives of the cover system. Therefore, the process involved in determining this ACZ is briefly described here. Further details may be found in Dwyer et al. (2007, 096232, pp. 3-7-3-8).

The determination of the ACZ for placement of cover soil follows.

1. Cover soil shall be placed at the goal density. The goal density is best determined from the borrow soil's in situ density. That is, over an extended period of time, a given soil will move toward its "natural" density state. Therefore, it is the goal of the soil installation to place the soil at a density that is as close to that "goal" density as possible from the onset. In this case, because the soil will be amended, the goal density shall be assumed to be between 85% to 90% of the maximum dry density (MDD), as determined by ASTM D698.
2. A standard proctor curve must be determined for the amended soil used per ASTM D698, "Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort," to obtain the respective MDD and optimum moisture content.

3. The allowable dry unit weight or soil density during construction shall be the goal density, plus or minus 5 lb/ft^3 (80.1 g/L).
4. The cover soils shall be placed as dry as possible not to exceed the optimum moisture content per ASTM D698 derived for each borrow soil used. Installing soil dry will provide for a maximum initial water-storage capacity in the cover and minimize the potential for desiccation cracking, particularly when clays are used (Dwyer 2003, 097902). This moisture content is applicable for all soils in the cover system, including the upper 1 ft (31 cm) of the interim (operational) cover or subgrade.

H-3.4 Filter Medium

A filter medium composed of sand and/or gravel will be placed above the biobarrier, between the biobarrier and the overlying cover soil layer. This layer is designed to prevent the mixing of soil layers and meet specified filter criteria. The depth of this layer is to be determined in the field and will be the minimum depth required to completely cover the biobarrier layer and provide a smooth and continuous surface layer for placement of the cover soil. For estimating purposes, this layer is assumed to be 6 in. (15 cm) thick.

Two primary mechanisms of concern for transport of contaminants from the MDA L site are biointrusion and erosion. Both burrowing animals and roots are of concern because they can bring contaminants to the surface. A biobarrier of cobbles is included in the conceptual design to minimize the potential for burrowing animals and roots from accessing the buried source materials. To prevent the mixing of finer cover soil into the cobble layer, a filter layer is included.

The filter medium will be composed of coarse material (sand and/or gravel) that meets specific filter criteria to prevent the mixing of materials. These criteria are as follows:

$$D_{15}/ d_{85} \leq 5 \qquad \textbf{Equation H-3.4-1}$$

where D_{15} = particle size of the coarse soil for which 15% of the particles are finer, and

d_{85} = particle size of the fine soil for which 85% of the particles are finer.

The filter design criteria, summarized in a U.S. Department of Energy technical report (DOE 1989, 099296, Table 4.2-3), and the following requirements will also be used. The filter material must pass the 3-in. sieve for minimizing particle segregation and bridging during placement. Smaller maximum particle sizes may be specified if practical. Also, filters must not have more than 5% passing the No. 200 mesh sieve to prevent excessive movement of fines in the filter. Filter material needs to be reasonably well-graded throughout the in-place layer thickness.

A capillary barrier will be formed with the inclusion of the filter medium beneath the fine cover soils. A second capillary barrier may also be formed between the filter medium and the cobble biobarrier. Consequently, all requirements for a capillary barrier must be followed, as outlined in Dwyer et al. (2007, 096232). Of particular concern are long slope lengths and consequently the diversion capacity of the capillary barrier. The interface between the materials forming the capillary barrier(s) must be a smooth and continuous interface. Discontinuities in this interface may result in significant preferential flow and must be prevented.

H-3.5 Biobarrier

As stated in section H-3.4, a biobarrier is included in the cover profile to minimize the intrusion of flora and fauna into the buried source materials. A minimum 1-ft- (0.3-m-) thick layer of cobble with a minimum diameter of 6 in. (15 cm) will be included in the cover profile. This layer will minimize the potential burrowing of the animal of most concern at the site (gophers) as well as the intrusion of woody roots from plants such as shrubs, piñon, and juniper.

Biointrusion in a landfill cover system refers to the flora and fauna (including insects) interactions or intrusion into the cover system. Biointrusion is important in that it can represent a mechanism leading to vertical transport of contaminants to the ground surface via plant root uptake or soil excavation by burrowing animals and insects. Biointrusion can also lead to increased infiltration and preferential flow of surface water through the cover system and contribute to a change in the soil layer's hydraulic properties. However, the increased soil moisture resulting from burrowing effects on infiltration can actually stimulate increased plant growth, leading to an increase in plant transpiration (Gonzales et al. 1995, 073708; Hakonson 2002, 099469) and a net decrease in flux.

Vertical transport by biota may be small over a short time scale; however, over many decades these processes may become dominant in mobilizing buried waste or contaminated soil (Dwyer et al. 2007, 096232, p. 4-7). Burrowing by animals and insects has the potential to access buried waste several meters below ground surface, which may lead to chemical and radiation exposures to organisms and physical transport of waste upward in the soil profile to ground surface, to biota, and across the landfill surface to off-site areas. These processes are enhanced by erosion (wind/water), transport of animals moving on/off the landfill, deposition of soil particles on biological surfaces from rain splash and wind resuspension, and wind transport of senescent vegetation to off-site areas.

H-3.6 Subgrade/Interim (Operational) Cover Preparation

MDA L currently has an interim (operational) soil cover over it. This site will require clearing, grubbing, and some regrading (including cut/fill operations to bring the site to grade) before placement of the final cover system. The elevations and grades will comply with those shown on the project drawings. At a minimum depth, the upper 1 ft (31 cm) of the interim (operational) cover or subgrade will be scarified and recompacted before the biobarrier is emplaced. This recompaction is expected to produce a density not less than 95% of the maximum dry density as determined by ASTM D698. The moisture content will be placed dry of the optimum moisture content as determined by ASTM D698.

H-4.0 REFERENCES

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

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

Benson, C.H., January 23-25, 2007. “Preliminary Design Methods,” presented at the U.S. Environmental Protection Agency's Alternative Covers for Landfills, Waste Repositories, and Mine Wastes: Design, Modeling, Construction, and Monitoring, Riverside, California. (Benson 2007, 097054)

DOE (U.S. Department of Energy), December 1989. “Technical Approach Document,” report no. DOE/UMTRA-050425-002, DE91-005807, Washington, D.C. (DOE 1989, 099296)

Dwyer, S.F., May 2003. “Water Balance Measurements and Computer Simulations of Landfill Covers,” Ph.D. dissertation, University of New Mexico, Albuquerque, New Mexico. (Dwyer 2003, 097902)

Dwyer, S.F., May 2007. “Conceptual Cover Design Report for the Corrective Measures Evaluation for Closure of MDA G,” report prepared for Los Alamos National Laboratory by Dwyer Engineering, LLC, Albuquerque, New Mexico. (Dwyer 2007, 098276)

Dwyer, S.F., R.E. Rager, and J. Hopkins, April 2007. “Cover System Design Guidance and Requirements Document,” Los Alamos National Laboratory document LA-UR-06-4715, Los Alamos, New Mexico. (Dwyer et al. 2007, 096232)

Dwyer, S.F., J.C. Stormont, and C.E. Anderson, October 1999. “Mixed Waste Landfill Design Report,” report SAND99-2514, Sandia National Laboratories, Albuquerque, New Mexico. (Dwyer et al. 1999, 099309)

Fayer, M.J., June 2000. “UNSAT-H Version 3.0: Unsaturated Soil Water and Heat Flow Model, Theory, User Manual, and Examples,” document PNNL-13249, Pacific Northwest National Laboratory, Richland, Washington. (Fayer 2000, 072734)

Gonzales, G.J., M.T. Saladen, and T.E. Hakonson, 1995. “Effects of Pocket Gopher Burrowing on Cesium-133 Distribution on Engineered Test Plots,” *Journal of Environmental Quality,* Vol. 24, pp. 1056-1062. (Gonzales et al. 1995, 073708)

Hakonson, T.E., February 15, 2002. “Review of Sandia National Laboratories/New Mexico Evapotranspiration Cap Closure Plans for the Mixed Waste Landfill,” Environmental Evaluation Services, LLC, Daniel, Wyoming. (Hakonson 2002, 099469)

NRC (U.S. Nuclear Regulatory Commission), September 2002. “Design of Erosion Protection for Long-Term Stabilization,” Final Report, report no. NUREG-1853, Washington, D.C. (NRC 2002, 097900)

Shaw Environmental Inc., February 2006. “Geotechnical and Hydraulic Characterization at the Technical Area 61 Borrow Area,” report prepared for Los Alamos National Laboratory, Albuquerque, New Mexico. (Shaw Environmental, Inc. 2006, 091368)

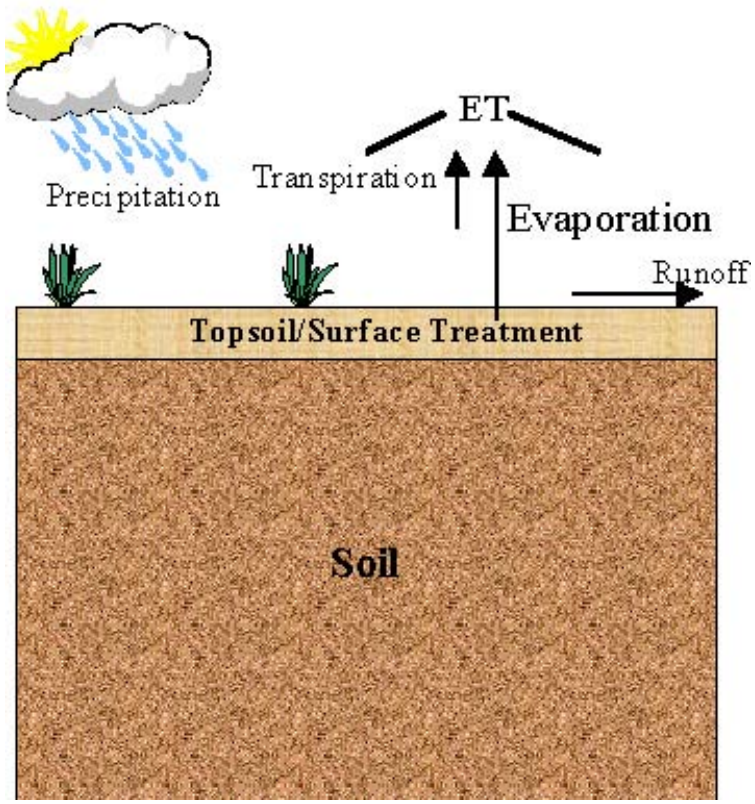


Figure H-2.0-1 Typical ET cover profile

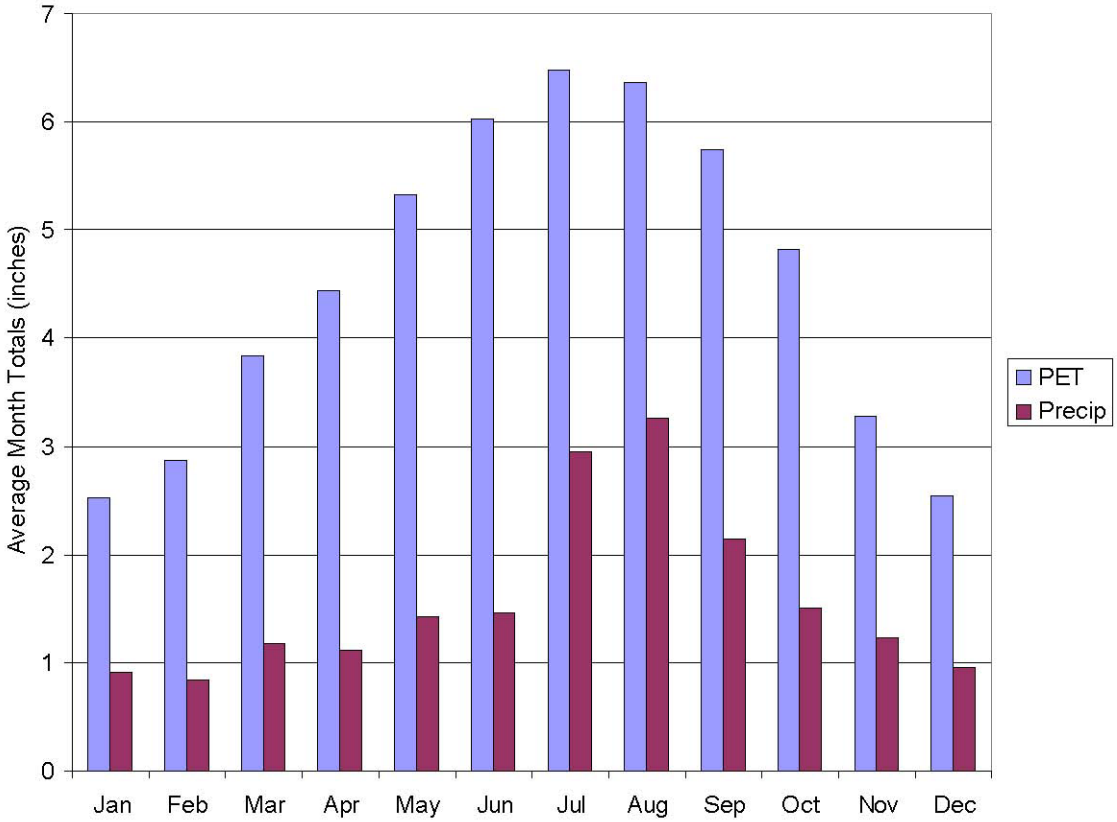


Figure H-2.0-2 Climate's demand for water (PET) versus supply of water (precipitation) for Los Alamos, New Mexico

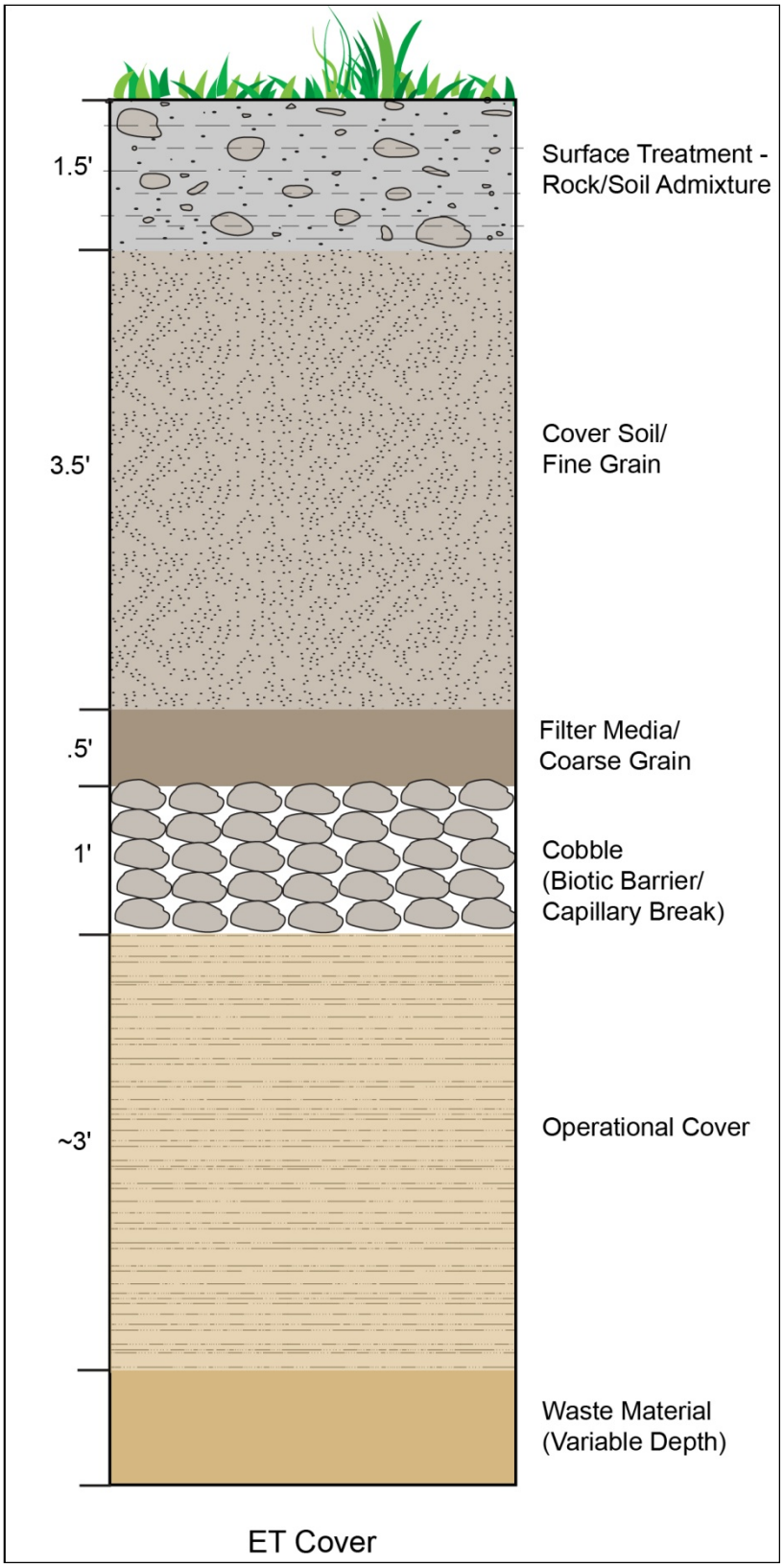


Figure H-3.0-1 MDA L CME conceptual ET cover profile

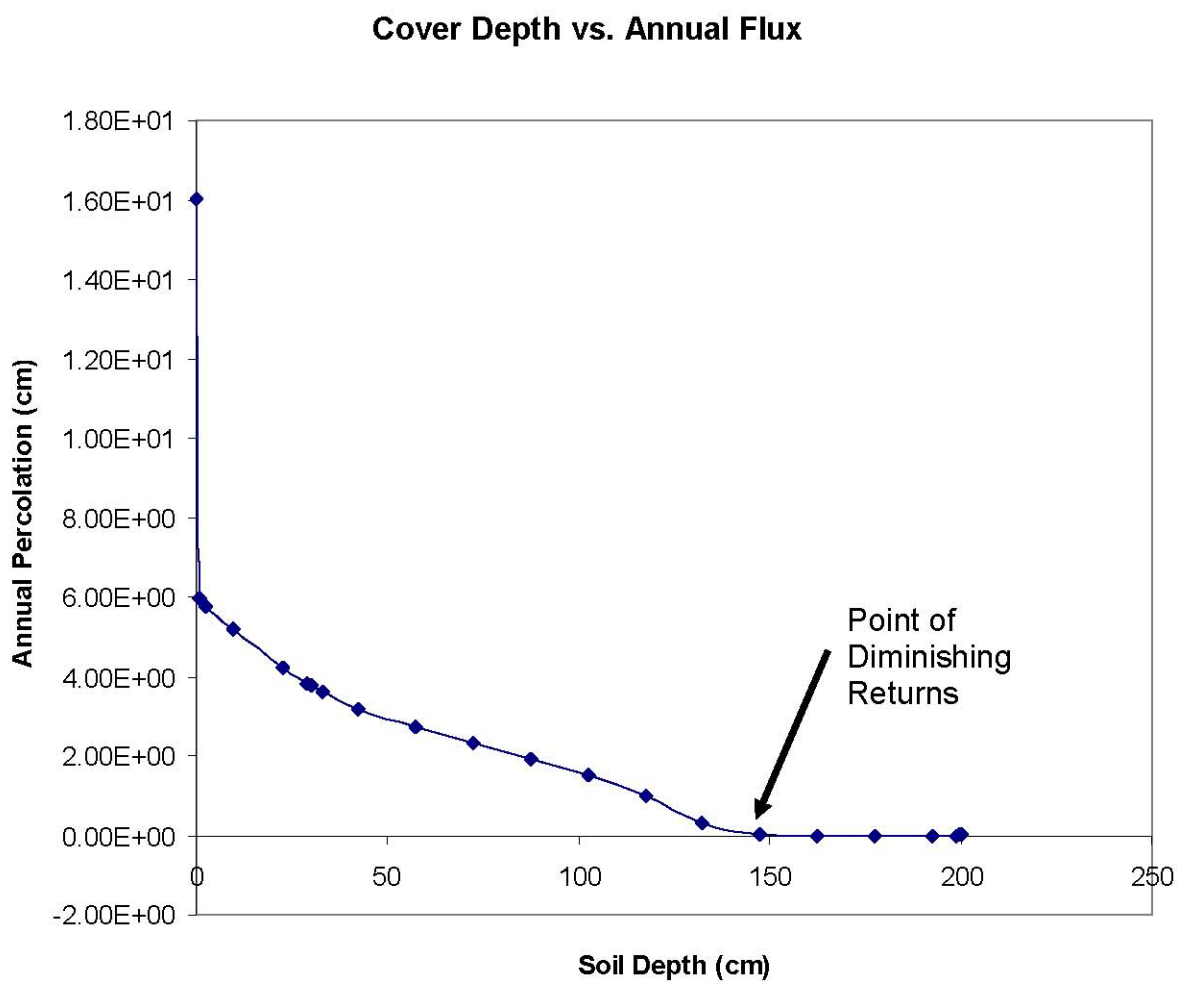


Figure H-3.3-1 Typical sandy loam soil: point of diminishing returns (1.5 m)

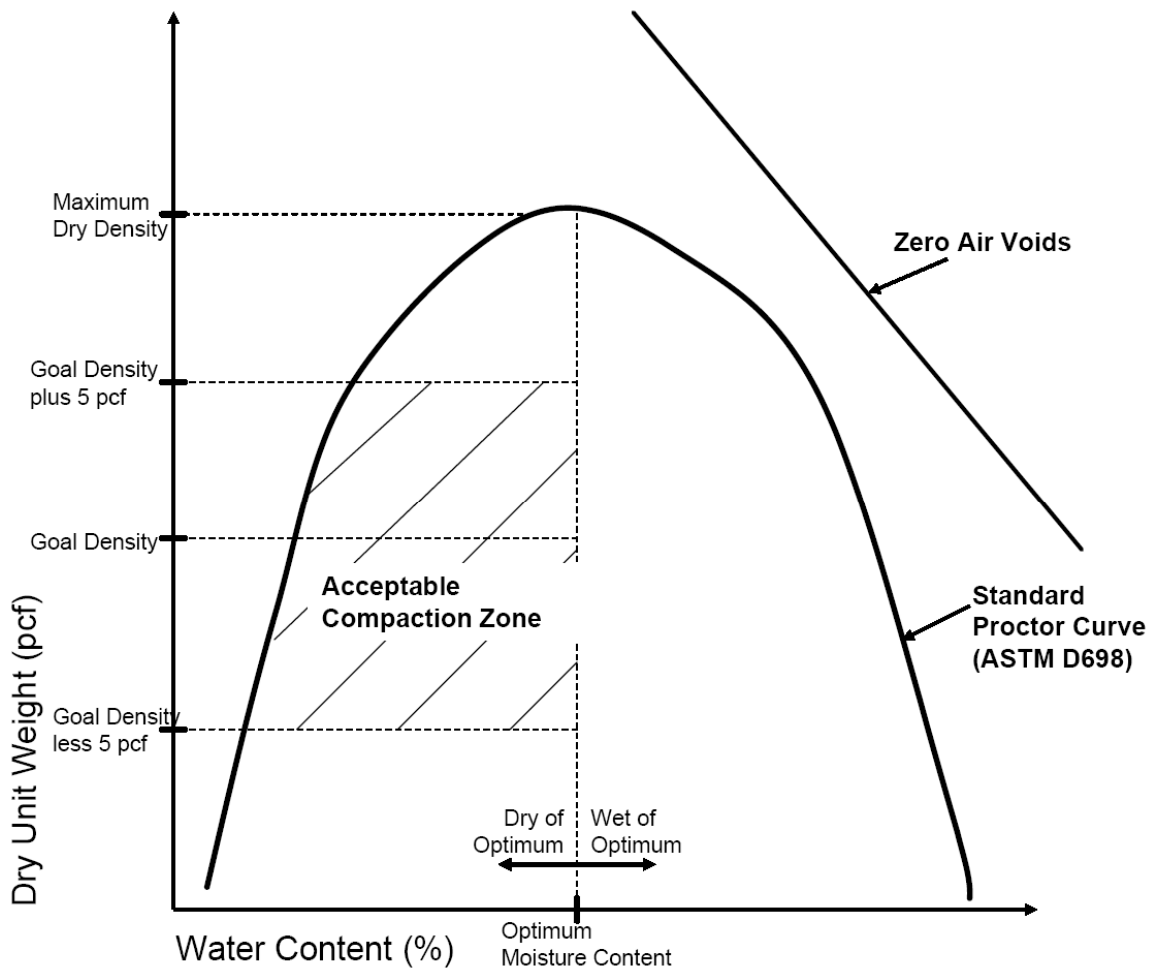


Figure H-3.3-2 Acceptable compaction zone for soil placement

Table H-3.0-1
ET Conceptual Cover Profile Layer Specifics and Justification

Cover System Layer	Design Specifics	Design Justification
Vegetation	The site is to be seeded with native vegetation composed of both cool and warm weather species (grasses). Table H-3.1-1 lists the recommended seed mix.	The vegetation will help stabilize the cover surface, minimize erosion, and remove infiltrated water via transpiration.
Surface Treatment	Mixture of cover soil and gravel. The gravel is to be mixed into the cover soil at a rate of 33% by weight. The gravel will be 1.5 in. (3.8 cm) to 3 in. (7.6 cm) in diameter. The cover soil will be capable of maintaining native vegetation with adequate storage capacity and nutrient availability. This layer will be a minimum of 18 in. (0.5 m) thick.	The gravel-soil admixture is designed to minimize erosion because of both wind and surface runoff.
Cover Soil	The cover soil depth will be a minimum of 3.5 ft (1 m). The layer will consist of soil from TA-61 with a determined mix of soil amendments. The cover soil will be capable of maintaining native vegetation with adequate storage capacity and nutrient availability.	Hydraulic characteristics of a typical sandy loam were used to determine the required soil depth because it is recommended that the TA-61 borrow soils be amended to possess the storage capacity of this soil type. The soil depth was determined using modeling where a depth of soil was determined to minimize flux. The modeling used the wettest decade on record as the upper boundary condition. However, because the site requires a 30-yr performance period, it was estimated that the added storage capacity offered by the inclusion of a biobarrier that creates a capillary barrier was more than adequate to store any infiltration events that would occur over this return period.
Filter Layer	This layer is composed of sand and gravel that meet determined filter criteria to prevent the overlying finer cover soils from migrating into the underlying biobarrier.	A thin layer placed directly on the biobarrier to serve as a filter medium to prevent the overlying finer soils from migrating into the underlying biobarrier.
Biobarrier	A layer of minimum 6-in.- (15-cm-) diameter cobble composed of rock or concrete. The layer is to be a minimum of 1 ft (0.3 m) thick.	The layer prevents biointrusion (burrowing animals and plant roots) from entering the underlying source material.
Subgrade	The upper foot of existing interim cover soil will be scarified and recompacted to a minimum of 95% of the maximum dry density and dry of the optimum moisture content as determined per ASTM D698.	The subgrade provides a firm foundation for the construction of the cover profile and the final grades and slopes for installation of a uniform cover profile.

Table H-3.1-1
Seed Mix

Common Name	Scientific Name	% of Mix	PLS (lb/acre)
Sideoats grama	*Bouteloua curtipendula*	15%	3.75
Blue grama	*Bouteloua gracilis*	15%	3.75
Indian ricegrass	*Oryzopsis hymenoides*	10%	2.5
Western wheatgrass	*Agropyron smithii*	15%	3.75
Sand dropseed	*Sporobolus cryptandrus*	10%	2.5
Sheep fescue	*Festuca ovina*	20%	5
Firewheel	*Gaillardia pulchella*	3%	0.75
Western yarrow	*Achillea millefoium*	2%	0.5
Prairie coneflower	*Ratibida columnifera*	4%	1
Blue flax	*Linum perenne lewisii*	6%	1.5
Total			**25**

Source: Dwyer et al. 2007, 096232.

Table H-3.2-1
Scoring Criteria for Determining Rock Quality

	Weighting Factor			Score										
	Limestone	Sandstone	Igneous	10	9	8	7	6	5	4	3	2	1	0
Specific Gravity (SSD[a])	12	6	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.40	2.25
Absorption (%)	13	5	2	0.1	0.3	0.5	0.67	0.83	1.0	1.5	2.0	2.5	3.0	3.5
Sodium Sulfate (%)	4	3	11	1	3	5	6.7	8.3	10	12.5	15	20	25	30
Abrasion (%)	1	8	1	1	3	5	6.7	8.3	10	12.5	15	20	25	30
Schmidt Hammer	11	13	1	70	65	60	54	47	40	32	24	16	8	0
Tensile Strength (psi[b])	5	4	10	1400	1200	1000	833	666	500	400	300	200	100	<100

Source: Modified from U.S. Nuclear Regulatory Commission guidance (NRC 2002, 097900).

[a] SSD = Saturated surface dry.

[b] psi = Pounds per square inch.

Table H-3.3-1
Recommended Available Plant Nutrients for Cover Soil

Test	Limits
Cation exchange capacity	Greater than 15
Percent organic matter	Greater than 2% (g/g)
N	Greater than 6 ppm
P	4 to 7 ppm
K	61 to 120 ppm

Table H-3.3-2
Recommended Limitations of Salt in Cover Soil

Test	Limits
Electrical conductivity	Less than 8 µS/cm
Sodium absorption ratio	Less than 6
Exchangeable sodium percentage	Less than 15% (g/g)
$CaCO_3$	Less than 15% (g/g) to 3-ft (91-cm) depth of cover; no limit below 3 ft (91 cm)

Attachment H-1

Attachments A–C of the "Conceptual Design Report for the Corrective Evaluations Measure for the Closure of MDA G"

Attachment A
GRAVEL ADMIXTURE DESIGN

DESIGN RAINFALL EVENT

The rainfall intensity value used to calculate the runoff volume was determined using data supplied by the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Hydrometerological Design Studies Center and is available on the internet on NOAA's Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nm_pfds.html). The data from NOAA Atlas 14 for Los Alamos, NM was used whereby the 30 minute precipitation frequency estimate for a 1000 return period is 2.46 inches (6.25 cm). The 30 minute time of concentration is conservative for any contributory area less than 50 acres (20 hectares) (Lindeburg 1989).

RUNOFF PREDICTION

The "rational method" was used to estimate runoff volumes. This method is commonly used in civil engineering applications and is a method approved by DOE (1989) for design of cover systems for sites regulated by the Uranium Mill Tailings Radiation Control Act of 1978 (i.e., UMTRA sites). Refer to "LANL Engineering Standards Manual," Section G20 (http://engstandards.lanl.gov/engrman/3civ/pdfs/Ch3_G20-R1.pdf). The rational method is based on the assumption that rainfall occurs uniformly over the watershed at a constant intensity for a duration equal to the time of concentration.

Using the rational method, the peak rate of runoff, (Q), in cubic feet per second (cfs) (runoff is actually in acre-inches/hour but is rounded to cfs is given by the following expression:

$$Q = C\ I\ A \qquad \textbf{Equation A.1}$$

where:

C = Runoff coefficient (dimensionless)

I = Rainfall intensity (in/hr)

A = Surface area that contributes to runoff (acres)

The value for "I" in this case was 2.46 inches/hour (6.25 cm/hr). For storms with return periods longer than 100 years, DOE recommends the use of C = 1.0 (DOE 1989). The surface area was calculated based on the assumed configuration shown in figure A.1 where L is the critical slope length. Slopes and slope lengths were estimated from proposed contoured plans of the MDA G conceptual cover. Because most of the drainage areas from the cover were irregularly shaped, the slopes and slope lengths were estimated to match the area configuration described here.

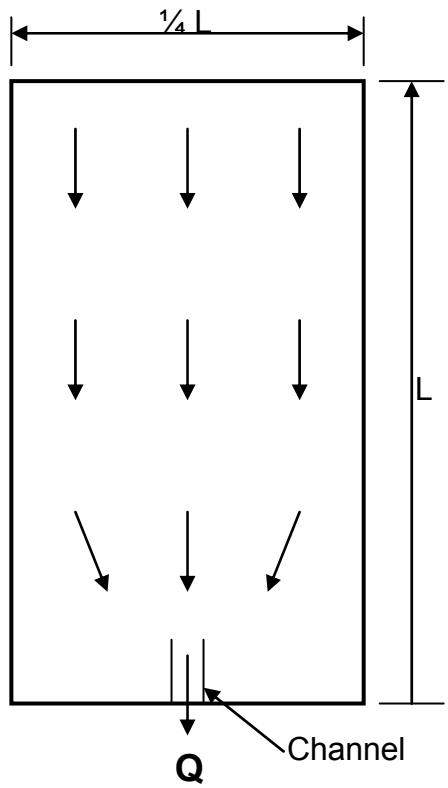


Figure A.1
Contributory area for gully formation

Channel Geometry

The channel geometry shown in Figure A.2 is that assumed for the gully formation.

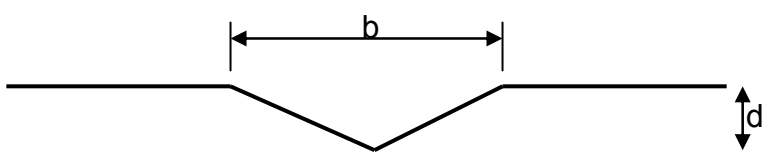


Figure A.2
Channel geometry

The geometry of the channel that forms is based on regression equations developed from analysis of a large number of channels (Simon, Li & Assoc. 1982). The channel width is given by:

$$b = 37\ (Q_m^{0.38} / M^{0.39})$$ **Equation A.2**

where:

b = width of flow (ft);

Q_m = mean annual flow (cfs);

M = percentage of silts and clays in soils.

The mean annual flow (Q_m) is assumed to be between 10% and 20% of the peak rate of runoff (Q) (Dwyer et al. 1999). In this case 20% was conservatively used.

For the given discharge point of geometry, the hydraulic depth (d_h), defined as the flow cross-sectional area divided by the width of water surface, is half of the gully depth (d).

For flows at the critical slope:

$$b = 0.5\ F^{0.6}\ F_r^{-0.4} Q^{0.4}$$ **Equation A.3**

where:

F = width to depth ratio = b/dh;

F_r = Froude Number ≈ 1.0.

These equations were solved simultaneously to yield the channel width and depth for the given peak flow rate and percentage of silt and clay. Refer to Table A.1 for the summary of calculations performed.

Incipient Particle Size

The incipient particle size is the particle that is on the brink of movement at the assumed conditions. Any increase in the erosional forces acting on the particle, due to an increase in velocity or slope, for example, will cause its movement. This incipient particle size (D_c) was calculated using the Shield's Equation:

$$D_c = \tau / F_s(\gamma_s - \gamma)$$ **Equation A.4**

where:

τ = total average shear stress (pcf);

F_s = Shield's dimensionless shear stress = 0.047;

γ_s = specific weight of soil (pcf);

γ = water density = 62.4 pcf.

The total average shear stress is given by:

$$\tau = \gamma\ d_h\ S$$ **Equation A.5**

where:

S = slope (ft/ft).

d_h = hydraulic depth (ft)

Depth of Scour and Armoring Required

The incipient particle size defines the maximum size of particle that will be eroded for a given set of conditions. The material larger than the incipient particle size will not be displaced or eroded, and can form an armoring that will protect the channel from further erosion from similar or lesser storm events.

The depth of scour (Ys) (Figure A.3) to establish an armor layer is given by (Pemberton and Lara 1984):

$$Y_s = Y_a\,[(1/P_c)-1]$$ **Equation A.6**

where:

Y_s = scour depth;

Y_a = armor layer thickness;

P_c = decimal fraction of material coarser than the incipient particle size.

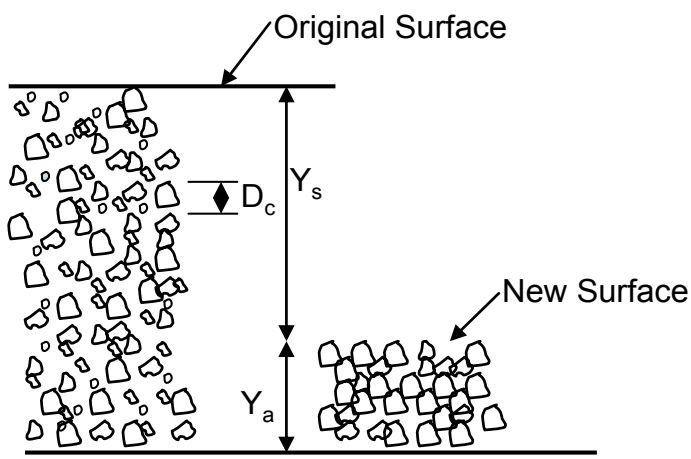


Figure A.3
"Desert Pavement" development

Table A.1 summarizes the gravel admixture calculations performed including critical input and output parameters. The slopes and slope lengths were estimated based on approximate drainage paths and contributory areas as they relate to that assumed in this set of calculations. The first column describes the section that is related to the project drawings produced by PRO2SERVE (not part of this report).

TABLE A.1
GRAVEL ADMIXTURE CALCULATIONS SUMMARY

Section	C Value	I (in/hr)	S (%)	Slope Length (ft)	Q (cfs)	Q_m (cfs)	% silt/clay[1]	Bulk Density[1] (pcf)	Critical Gravel Size [2] (in)	Ratio	Total depth req'd (inches)
DA1	1.0	2.46	2.7	350	1.73	0.17	20	115	0.75	33%	9
DA2	1.0	2.46	3	500	3.53	0.35	20	115	1.25	33%	15
DA3	1.0	2.46	4	375	1.99	0.20	20	115	1.25	33%	15
DA4	1.0	2.46	2.8	800	9.04	0.90	20	115	1.50	33%	18
DA5	1.0	2.46	3.5	500	3.53	0.35	20	115	1.25	33%	15
DA6	1.0	2.46	2	750	7.94	0.79	20	115	1.00	33%	12
DA7	1.0	2.46	2	750	7.94	0.79	20	115	1.00	33%	12

[1] assumed values based on amendments and gravel mixture
[2] value rounded up to nearest quarter inch

Attachment B
BIOINTRUSION STUDIES

Plutonium is the best example of a radionuclide whose transport to animals in arid ecosystems is dominated by physical processes. Data from many field sites and source conditions show that gut availability of plutonium and other contaminants bound to soil in a variety of animals including rodents, deer and cattle is very low (gut to blood transfer $<10^{-5}$) leading to very low concentrations of contaminant in internal tissues and organs (Smith, 1977; Moore et al., 1977; Hakonson and Nyhan, 1980; Arthur et al., 1987). Highest concentrations of most soil contaminants in dry, dusty environments are usually found in tissues exposed to the external environment. Those tissues include the pelt, gastro-intestinal tract, and lungs. At Los Alamos, about 96% of the plutonium body burden in rodents from the canyon liquid waste disposal areas was in the pelt and gastro-intestinal tract (Hakonson and Nyhan, 1980).

Because soil passes through the gastro-intestinal tract of free-ranging animals on a daily basis, there is a potential to redistribute soil radionuclides across the landscape. Studies at Nevada Test Site with cattle (Moore et al., 1977), at Rocky Flats Plant with mule deer and small mammals (Little, 1980; Arthur, 1979), and at Idaho National Engineering Laboratory with small mammals and coyotes (Arthur and Markham, 1983; Arthur et al., 1980) demonstrate that horizontal (and vertical in the case of burrowing animals) redistribution of soil plutonium does occur as animals move within and outside contaminated areas. However, the magnitude of this transport was shown to be very small over the short-term (Arthur, 1979; Arthur and Markham, 1983; Arthur et al., 1980).

There are circumstances where animal transport of soil contaminants can assume more importance. For example, fission product sludge containing 90Sr and 137Cs in a salt form was released to unlined cribs at Hanford and the cribs were backfilled with clean soil. A large animal, probably a coyote or badger then burrowed down to the sludge and created direct access for other animals seeking the salts including jackrabbits (O'Farrell and Gilbert, 1975). Jackrabbits ingested the radioactive salts, became contaminated and then excreted 90Sr on the ground surface. Levels of 90Sr in excreta were found over a 15 km^2 surface area (O'Farrell and Gilbert, 1975). This incident with 90Sr and jackrabbits was a special case that involved liquid waste sludge disposal trenches that were not adequately covered.

Potentially more soluble strontium and cesium transport to animals in arid ecosystems involves a combination of physical and physiological processes. The more tightly bound these radionuclides are to soil (related to clay content of soil and local climate); the more their transport will be governed by soil particle transport. Data on Sr90 and Cs137 in small mammals from the Nevada Test Site (Romney et al., 1983) and at a burial ground at Idaho National Engineering Laboratory (Arthur et al., 1987) show relatively high concentrations of these radionuclides in lung, pelt and gastro-intestinal tract similar to plutonium. This suggests that physical transport of these more "soluble" radionuclides is also important as with plutonium. The bioavailability of radionuclides such as cesium and strontium will depend on chemical form, local environmental conditions, and the structure and function of the relevant food webs.

Tritium would be one of the few exceptions to the general observation that physical transport mechanisms dominate in the transport of soil surface contaminants to biota. Uptake by roots or sorption through the leaf surface would dominate in tritium transport to vegetation. Levels of tritium in animals would reflect levels in the source (i.e.,

concentration ratios are 1 or less) since tritium is not concentrated as it moves through abiotic and biotic pathways. Furthermore, tritium in vegetation is available to nectivorous organisms such as honeybees as well as herbivores. While tritium is readily transported through ecosystems, it is rapidly turned over in biological systems at rates corresponding to water turnover in these systems. In humans, body water turnover is about 3 days (RHH, 1970).

Although vegetation is very important in controlling erosion and percolation in landfill covers (Nyhan et al., 1984), deeply penetrating plant roots have the potential to access buried waste and bring plant available constituents including landfill contaminants to the surface of the site (Klepper et al., 1979; Foxx et al., 1984; Tierney and Foxx, 1987). Contaminants such as tritium can be incorporated within plant tissue and enter the food web of herbivorous or nectivorous organisms. For example, at Los Alamos National Laboratory tritium transport away from a controlled low-level waste site occurred via the soil moisture/plant nectar/honey bee/ honey pathway (Hakonson and Bostick, 1976). As another example, deep-rooted Russian Thistle (Salsola kali) growing over the waste burial cribs at Hanford penetrated into the waste, mobilized 90Sr, and then transferred it to the ground surface. The contaminated surface foliage was transferred away from the cribs when the matured Thistle (tumbleweeds) blew away from the site (Klepper et al., 1979). Two mechanisms for soil contaminant transport to terrestrial plants are absorption by roots and deposition of contaminated soil particles on foliage surfaces. Field studies suggest that deposition of soil particles on foliage surfaces is a major transport mechanism for soil associated contaminants under many arid site and contaminant source conditions (Romney and Wallace, 1976; Romney et al., 1987; White et al., 1981; Arthur and Alldredge, 1982).

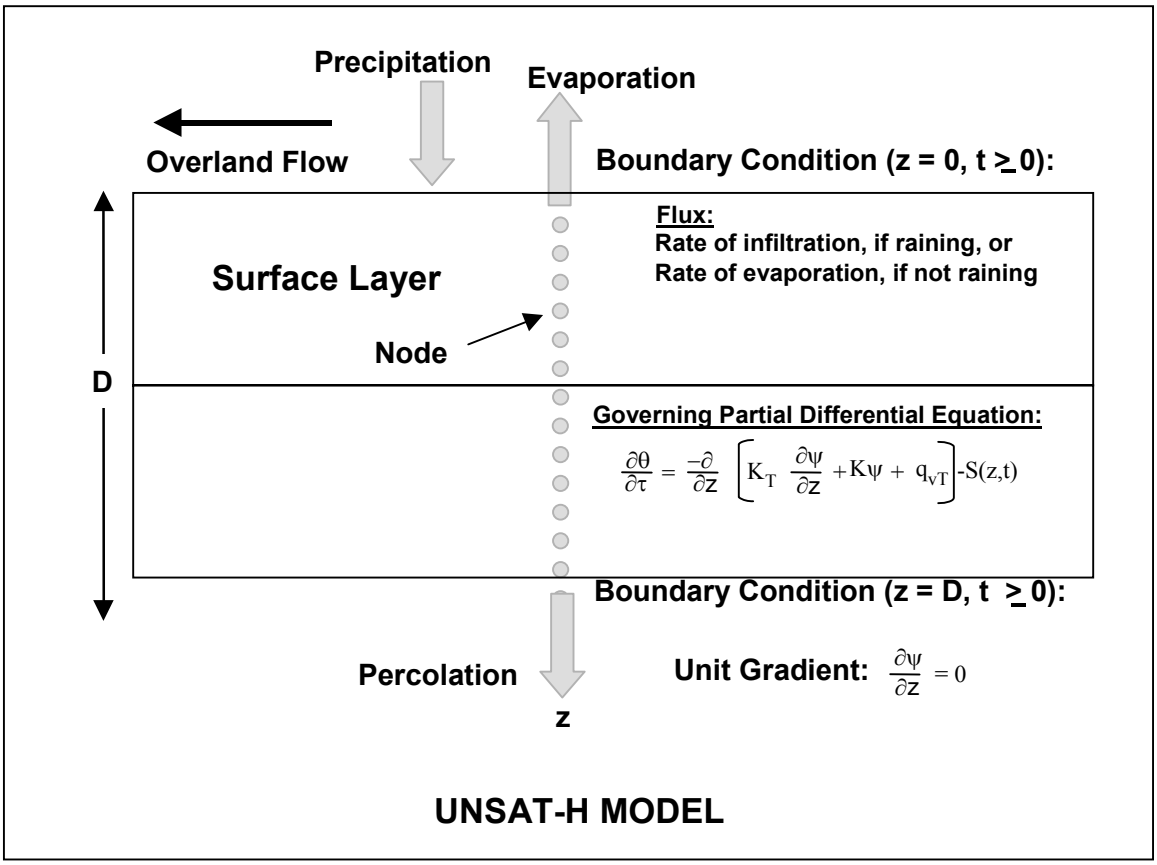
Attachment C
MODELING

Overview of UNSAT-H

UNSAT-H has been used to design many recent alternative earthen cover designs (Dwyer 2003). Unlike most unsaturated flow programs, UNSAT-H was specifically developed for the evaluation of earthen covers. UNSAT-H is a one-dimensional, finite-difference computer program developed at the Pacific Northwest National Laboratory by Fayer and Jones (1990). UNSAT-H can be used to simulate the water balance of earthen covers as well as soil heat flow (Fayer 2000). UNSAT-H simulates water flow through soils by solving Richards' equation and simulates heat flow by solving Fourier's heat conduction equation.

A schematic illustration showing how UNSAT-H computes the water balance is shown in Figure C.1. UNSAT-H separates precipitation falling on an earthen cover into infiltration and overland flow. The quantity of water that infiltrates depends on the infiltration capacity of the soil profile immediately prior to rainfall (e.g., total available porosity). Thus, the fraction of precipitation shed as overland flow depends on the saturated and unsaturated hydraulic conductivities of the soils characteristic of the final cover. If the rate of precipitation exceeds the soil's infiltration capacity, the extra water is shed as surface runoff. UNSAT-H does not consider absorption and interception of water by the plant canopy, or the effect of slope and slope-length when computing surface runoff.

Figure C.1
SCHEMATIC REPRESENTATION OF WATER BALANCE COMPUTATION BY UNSAT-H (modified from Khire 1995)



Water that has infiltrated a soil profile during an UNSAT-H simulation moves upward or downward as a consequence of gravity and matric potential. Evaporation from the cover surface is computed using Fick's law. Water removal by transpiration of plants is treated as a sink term in Richards' equation. Potential evapotranspiration (PET) is computed from the daily wind speed, relative humidity, net solar radiation, and daily minimum and maximum air temperatures using a modified form of Penman's equation given by Doorenbos and Pruitt (1977). Soil water storage is computed by integrating the water content profile. Flux from the lower boundary is via percolation. UNSAT-H, being a one-dimensional program, does not compute lateral drainage.

UNSAT-H Input Parameters

A set of input parameters were developed for simulations using UNSAT-H for the given cover profiles. These parameters were developed based on field and laboratory measurements, values from the literature, and expert opinion.

Model Geometry

The model geometry was based on the depth of the cover profile modeled.

Boundary Conditions

The MDA G site in Los Alamos, NM is located in a dry environment where the climate's demand for water referred to as PET far exceeds the actual supply of water or precipitation (Figure 2.2). These are ideal conditions for deployment of an earthen soil cover such as an ET Cover.

The flow of water across the surface and lower boundary of the cover profile is determined by boundary condition specifications. The UNSAT-H program partitions PET into potential evaporation (E_p) and potential transpiration (T_p). Potential evaporation is estimated or derived from daily weather parameters (Fayer 2000). Potential transpiration is calculated using a function (Equation C.1) that is based on the value of the assigned leaf area index (LAI) and an equation developed by Ritchie and Burnett (1971) as follows:

$$T_p = PET\,[a + b(LAI)^c] \quad \text{where } d \leq LAI \leq e \qquad \textbf{Equation C.1}$$

Where:

a,b,c,d, and e are fitting parameters;
a = 0.0, b = 0.52, and c = 0.5, d = 0.1, and e = 2.7 (Fayer 2000)

The UNSAT-H program partitioned PET into E_p and T_p. PET was derived from daily weather parameters obtained from this weather data. T_p was calculated using a function developed by Equation 1 above.

The lower boundary condition was a unit gradient. With the unit gradient, the calculated drainage flux depended upon the hydraulic conductivity of the lower boundary node. The unit gradient corresponded to gravity-induced drainage and was most appropriate when drainage was not impeded.

Upper Boundary Condition - Climate Data

The surface boundary condition during evaporation was modeled as a flux that required daily weather data. The wettest decade on record was used (1985 to 1994) from Los Alamos National Laboratory (weather.lanl.gov). The annual precipitation totals for this decade are summarized in Tables C.2 to C.4. Because the RCRA requirements to minimize flux was the regulatory driver for determining the storage capacity requirements of the cover profile, it was determined that the wettest decade on record would provide a conservative measure to evaluate the RCRA-equivalency of the cover profile.

VEGETATION DATA

Vegetation will generally increase ET from the cover because a plant's matric potential or suction is orders of magnitude higher than that of the soil (Figure C.2). The input parameters representing vegetation include the LAI, rooting depth and density, root growth rate, the suction head values that corresponds to the soil's field capacity, wilting point, and water content above which plants do not transpire because of anaerobic conditions. The onset and termination of the growing season for the site are defined in terms of Julian days. The root length density (RLD) is assumed to follow an exponential function such as that defined in Equation C.2:

$$RLD = a \exp(-bz) + c \qquad \textbf{Equation C.2}$$

where:

a,b, and c are fitting parameters

z = depth below surface

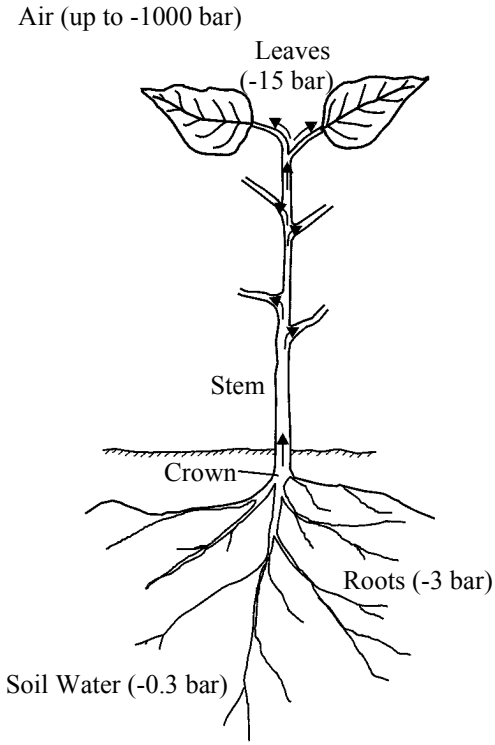
The parameters used for the RLD functions in Equation C.2 were: a = 0.315, b=0.0073, and c = 0.076 (Fayer 2000). The time required for maximum rooting depth establishment was set at full depth beginning on day 1. The rooting depth was set at 6.6-feet (200 cm) (Foxx et al 1984). An average LAI of 0.65 was used (McDowell et al 2005). This value represents an average of values reported for the site of 0.3 and 1.0. The onset and termination of the growing season for the site were Julian days 74 and 288, respectively (EIS, Appendix E). The LAI was transitioned from 0 to 0.65 starting with Julian day 74 to 90. Day 91 through 270, the full LAI equal to 0.65 was utilized. The LAI was then transitioned down from 0.65 to 0 from Julian day 271 to 288. This was conservative since it is realistic that plants can transpire longer than indicated at this site. An average percent bare area of 84.4% was used. This value represents an average of reported values for the area of 91.5% and 77.3 % (Tierney and Foxx 1982). The relative humidity for the site was set at 51% based on the average conditions for Los Alamos (Los Alamos Climatology internet site).

SOIL PROPERTIES RELATED TO VEGETATION

Suction head values corresponding to the wilting point, field capacity, and a head value corresponding to the water content above which plants do not transpire because of anaerobic conditions were defined. Matric potential or suction heads are generally written as positive numbers, but in reality are negative values. Consequently, the higher the value, the greater the soil suction. The maximum water content a soil can hold after all downward drainage resulting from gravitational forces is referred to as its field capacity. Field capacity is often arbitrarily reported as the water content at about 330 cm of matric potential head (Jury et al, 1991). Below field capacity, the hydraulic conductivity is assumed to be so low that gravity drainage becomes negligible and the soil moisture is held in place by suction or matric potential.

Not all of the water stored in the soil can be removed via transpiration. Vegetation is generally assumed to reduce the soil moisture content to the permanent wilting point. The wilting point was conservatively assumed to be 20,000 cm (typical for native grasses) used although the shrubs present at the site could remove water from the soil to a suction of 100,000 cm (Figure C.2). Evaporation from the soil surface can further reduce the soil moisture below the wilting point toward the residual saturation, which is the water content at an infinite matric potential.

Figure C.2
TYPICAL SOIL-PLANT-ATMOSPHERE WATER POTENTIAL VARIATION
(Hillel 1998)



Soil Properties

Soil hydraulic properties were obtained from laboratory testing of soil samples collected from the TA61 borrow site (Shaw 2006). The saturated hydraulic conductivity of the soils were obtained using flexible wall permeameters in accordance with ASTM D 5084. Unsaturated soil properties were obtained from data using pressure plates and water columns (depending on the suction values) to develop values of water content as a function of pressure head (ASTM D 6836). These data were then used as input into the RETC code (van Genuchten et al 1991) to compute curve fitting parameters used to estimate the moisture characteristic curve (van Genuchten 1980). The Mualem conductivity function was used to describe the unsaturated hydraulic conductivity of the soils. The van Genuchten ‘m’ parameter for this function is assumed to be‘1-1/n’; ‘n’ being one of the established van Genuchten parameters. The initial soil conditions are expressed in terms of suction head values that correspond to the average moisture

content between each soil layer's field capacity and permanent wilting point determined from each respective soil layer's moisture characteristic curve. The soil properties used as input parameters are summarized in Table C.1.

Table C.1
COVER SOIL PROPERTIES

Cover Profile	Soil Layer Type	Soil Layer Depth	van Genuchten Parameters				Sat. Hydr. Cond. (cm/hr)
			Θ_s	Θ_r	α	n	
TA61 BORROW SOILS USED (BH1 @ 15 TO 25-FT DEPTH)							
Cover Soil Only	Cover Soil	6.6 ft (200 cm)	0.2454	0	0.0027	1.6175	17.64
TYPICAL SANDY LOAM (ROSETTA 2000)							
Cover Soil Only	Cover Soil	6.6 ft (200 cm)	0.387	0.039	0.0267	1.4488	1.5951
CONCEPTUAL COVER DESIGN WITH TYPICAL SANDY LOAM							
Conceptual Cover Profile	Gravel/ Soil Admixt ure	1.5 ft (46 cm)	0.383	0.039	0.0267	1.4488	1.5951
	Cover Soil	3.5 ft (108 cm)	0.383	0.039	0.0267	1.4488	1.5951
	Filter Layer	6 in (15 cm)	0.34	0.026	0.0597	2.81	65.52
	Bio-barrier	1 ft (31 cm)	0.374	0.017	2.5075	2.47	15912.0

Modeled Percolation

Percolation results from the redistribution of water through a soil profile in response to gradients formed by differences in the energy state of the water. Flux is defined as the volume flow rate per unit area (Jury et al 1991) through a given soil profile. Other mechanisms that might induce water redistribution, such as geothermal gradients and barometric pressure fluctuations, have been shown to be minor contributors to water flow in most instances (Jones 1978, Gee and Simmons 1979). Tables C.2 TO C.4 present predicted annual flux values for the modeled cover profiles under the typical or average annual precipitation volumes.

Table C.2 summarizes a monolithic soil profile modeled with hydraulic soil properties from the TA61 borrow site. The soil sample that possessed a saturated hydraulic conductivity closest to the overall average of all soil samples tested form the site was used. The overall average was calculated to be 6.6E-03 cm/sec. This soil sample was BH1 taken from a depth of 15 to 25-ft. The saturated hydraulic conductivity for sample BH1 was 4.9E-03 cm/sec. As seen in figure 3.2, the Point of Diminishing Returns (Dwyer et al 2006) was greater than 6.6 ft (200 cm). Consequently, it was determined that the soil would require amendment to improve its water storage capacity and thus decrease the soil depth required. The soil amendment will also provide for adequate plant available nutrients.

The TA61 soils were characterized as sandy loams. However, they were relatively coarse sandy loams. Table C.3 summarizes a monolithic soil profile that used a typical sandy loam with somewhat better storage capacity than the TA61 soils. This value was obtained from ROSETTA (2000). These soils are commonly found throughout New Mexico. These soils significantly improved the cover performance by producing a Point of Diminishing Returns at about 5 ft (1.5 m).

Table C.4 summarizes the output from the actual conceptual cover profile that includes all layers. The addition of the bio-barrier created a capillary barrier. The final predicted flux through the cover profile utilizing a sandy loam soil overlying a coarse material was zero.

Table C.2.
WETTEST DECADE CLIMATE DATA WITH TA61 SOILS

Cover Depth (cm)	Annual Flux (cm/year)										
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**Average**
50	5.53	4.11	3.14	4.68	3.17	3.92	6.01	0.98	2.05	4.43	3.80
100	2.84	1.70	1.42	2.37	1.31	1.51	3.06	0.47	1.22	2.04	1.79
150	1.12	0.56	0.71	0.95	0.40	0.06	1.19	0.30	0.49	0.72	0.65
200	.05	0.03	0.03	0.03	0.29	0.26	0.03	0.04	0.02	0.02	0.08
Precipitation (cm)	49.76	47.48	40.34	42.55	35.74	43.31	47.78	32.11	32.54	43.05	41.47

Table C.3.
WETTEST DECADE CLIMATE DATA WITH TYPICAL SOILS FOR SANDY LOAM (ROSETTA 2000)

Cover Depth (cm)	Annual Flux (cm/year)										
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**Average**
50	4.31	3.37	2.94	4.28	1.69	3.03	5.39	1.19	2.07	3.64	3.20
100	7.16E-2	1.13	1.59	1.94	8.43E-1	8.17E-1	2.31	1.37	6.15E-1	7.31E-1	1.14
150	0	0	5.41E-4	9.12E-2	5.33E-1	1.69E-1	1.96E-1	7.70E-1	2.29E-1	9.21E-2	2.08E-1
200	0	0	0	0	0	6.93E-6	6.72E-6	7.25E-6	9.14E-6	1.71E-5	4.71E-6
Precipitation (cm)	49.76	47.48	40.34	42.55	35.74	43.31	47.78	32.11	32.54	43.05	41.47

Table C.4.
WETTEST DECADE CLIMATE DATA WITH CONCEPTUAL COVER PROFILE THAT UTILIZED TYPICAL SOILS FOR SANDY LOAM (ROSETTA 2000)

Cover Depth (cm)	Annual Flux (cm/year)[1]										
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Average
Base of Cover	0	0	0	0	0	0	0	0	0	0	0
Precipitation (cm)	49.76	47.48	40.34	42.55	35.74	43.31	47.78	32.11	32.54	43.05	41.47

[1] values less than 1E-10 cm/year were approximated to be zero

Appendix I

Soil-Vapor Extraction and Long-Term Vapor-Monitoring Plan for Material Disposal Area L

I-1.0 INTRODUCTION

This appendix describes the conceptual soil-vapor extraction (SVE) design and operations plan, and the long-term vapor-monitoring plan for the vadose zone in and around Material Disposal Area (MDA) L in Technical Area 54 at Los Alamos National Laboratory (LANL or the Laboratory).

I-2.0 CONCEPTUAL SVE DESIGN

This section presents a preliminary conceptual design of an SVE system to be implemented as part of the corrective measures alternatives for MDA L. The final design of the system will be provided as part of the corrective measures implementation (CMI) plan.

I-2.1 Performance Objectives

SVE will be performed to remove volatile organic compound (VOC) vapors from the subsurface. The objective of removing VOCs is to prevent their migration to the regional aquifer at concentrations that could result in groundwater contamination in excess of the groundwater-quality standards in Section VIII.A of the Compliance Order on Consent (the Consent Order).

The Consent Order does not specify any screening or cleanup levels for VOCs in pore gas. For this corrective measures evaluation (CME), a two-tiered approach to evaluate vapor-phase VOCs and the potential impact to groundwater has been applied. The approach and screening values are discussed in detail in Appendix B of this report. For the Tier I screen, Henry's law is used to identify the VOC vapor-phase concentration threshold that has to be exceeded for a given VOC to potentially impact groundwater above the applicable standard. The Tier II evaluation is less conservative than the Tier I screen. The Tier II evaluation considers the migration of the VOCs to the water table and their subsequent mixing with groundwater. The SVE performance objective is to reduce VOC pore-gas concentrations to less than their respective Tier II limits.

As discussed in Appendix B, 12 VOCs exceed their Tier I screening limits. Of these, seven exceed the Tier II screening limits. The target vapor plume of these seven VOCs combined is shown on Figure I-2.1-1. The 12 VOCs of concern at MDA L and the corresponding Tier I and Tier II limits are provided in Table I-2.1-1. The analyte 1,4-dioxane is not included in Table 1-2.1-1 although it failed the Tier II screen discussed in Appendix B because its frequency of detection is extremely low at MDA L.

I-2.2 Extraction Well Specifications

Based on the evaluation presented in Appendix B of this CME, VOC vapor concentrations greater than the Tier II limits are generally in the Qbt 2, Qbt1v, Qbt 1g, and Qct units, with the majority of the mass in the upper Qbt 2, Qbt 1v, and Qbt 1g (approximately the upper 200 ft). SVE boreholes are proposed to remediate the upper 200 ft as well as the base of the plume in the Qct unit. Permeability testing during previous pilot tests at MDAs G and L (LANL 2006, 094152; LANL 2010, 109657) demonstrated that the permeability of the Qct unit is much higher than the overlying units. To avoid a preferential flow pathway in the Qct unit, SVE boreholes will be installed down to a depth of approximately 200 ft within the lower reaches of the Qbt 1g unit. Each SVE borehole will be logged in accordance with Laboratory standard operating procedures (SOPs) to determine the geologic units and identify any significant fracturing in the subsurface. As recommended in the SVE pilot test report for MDA G (LANL 2010, 109657), air-permeability testing will be performed at each borehole to verify design assumptions. For the initial design

of the 200-ft deep extraction well, it is assumed the Qct unit begins approximately 250 ft below ground surface (bgs).

The Qbt unit extraction borehole design (Figure I-2.2-1) is as follows:

- total depth (TD) of 200 ft bgs,
- drilled with 10-in.-outside diameter hollow-stem auger,
- 4-in. polyvinyl chloride (PVC) slotted well screen from 40 to 200 ft bgs,
- 4-in. PVC solid casing from the surface to 40 ft bgs,
- sand filter pack outside the well screen in the borehole annulus from 38 to 200 ft bgs,
- bentonite seal from 35 to 38 ft bgs, and
- grout from the surface to 35 ft bgs.

Because of the efficient airflow capability of the Qct unit, several extraction boreholes are targeted specifically to this unit to take advantage of a larger radius of influence (ROI) and to provide a barrier against further downward migration of VOC vapors in the vadose zone. Although the high moisture content of the underlying Qbo unit helps impede downward diffusion of VOC vapors, extraction in the Qct interval will provide additional protection. The initial design of the Qct unit extraction boreholes is as follows (Figure I-2.2-1):

- TD of 300 ft bgs,
- drilled with 10-in.-outside diameter hollow-stem auger,
- 4-in. PVC slotted well screen from 250 to 300 ft bgs,
- 4-in. PVC solid casing from the surface to 250 ft bgs,
- sand filter pack outside the well screen in the borehole annulus from 245 to 300 ft bgs
- bentonite seal from 240 to 245 ft bgs, and
- grout from the surface to 240 ft.

I-2.3 Number of Extraction Wells

The previous SVE pilot tests at MDA L demonstrated ROIs of 140 ft for an extraction interval that extended from 75 to 150 ft bgs (ERM/Golder 1997, 070334) and 125 ft for an extraction interval that extended from 65 to 215 ft bgs (LANL 2006, 094152). To be conservative, an ROI of 125 ft is used in the layout design for the 200-ft-deep Qbt extraction boreholes associated with primary VOC mass removal, despite the proposed SVE blower being larger than those used in the previous two pilot tests (see section 2.5.3 of the corrective measures evaluation and section I-2.4 of this appendix). Based on previous permeability testing at MDA G (LANL 2010, 109657), it is believed that an ROI greater than 150 ft will be achieved in the SVE boreholes that target the Qct unit. However, for the purposes of the initial design, a 150-ft ROI is assumed for these deeper extraction wells.

Six SVE wells for primary VOC mass removal in the Qbt units are included in the initial design for the MDA L alternatives. The proposed location of these extraction wells is shown in Figure I-2.3-1; the configuration is arranged to remediate the combined target vapor plume that has concentrations exceeding the Tier II limits within the upper 200 ft in the vadose zone. Depending on the performance of the system after operations begin, additional wells may be added as necessary.

Three additional extraction wells in the Qct unit that will act as a barrier to downward migration are also included in the initial design. The proposed location of these extraction wells is shown in Figure I-2.3-1; the configuration is designed to remediate the combined extent of the vapor plume that exceeds Tier II concentration limits within the Qct unit (approximately 250 to 300 ft bgs). Depending on the performance of the system after operations begin, additional wells may be added as necessary.

I-2.4 SVE Unit Specifications

The proposed SVE system is similar in features to the system used during the supplemental SVE pilot test at MDA G (LANL 2010, 109657). The SVE systems will be portable, skid-mounted utilizing a 15 horsepower blower motor, providing up to 200 standard cubic ft per minute at a vacuum of 120 in. of water. Rotation of three SVE units is proposed for extraction at the nine SVE wells. Extracted air will be directed from the borehole through a liquid/vapor separator, an in-line filter, a vacuum blower, and a heat exchanger. Vapor effluent will be directed through an off-gas treatment system, such as granular activated carbon (GAC) filters connected in series.

For MDA L, three SVE units are proposed for use.

I-2.5 Monitoring Requirements

Performance monitoring will be carried out in several ways.

- Differential pressure values will be collected from selected pore-gas monitoring borehole sampling ports using an OMEGA pressure sensor, a Dwyer Series 475 Mark III Digital manometer, or equivalent. Differential pressure will be recorded at the select monitoring boreholes with a Campbell Scientific data logger Model CR1000 or equivalent.
- Extraction air flow will be determined using a Dwyer Series PE inline orifice plate flow meter and a Dwyer model 677-8 differential pressure transducer or equivalent. The air flow rate will be established by closing the SVE system's dilution valve to the differential pressure corresponding with the desired flow rate (calculated per equations provided by Dwyer).
- Extracted air temperature and relative humidity will be collected using a Viasala HMP45AC humidity and temperature probe or equivalent. Vacuum at the top of the extraction borehole will be monitored using a 0–150 in. water vacuum gauge or equivalent.
- Differential pressure, extraction air temperature, and relative humidity measured at the extraction wellhead will be recorded using a Campbell Scientific CR1000 data logger or equivalent.
- A Brüel and Kjær (B&K) photoacoustic multi-gas analyzer, or equivalent, will be used to monitor concentrations of 1,1,1-trichloroethane (TCA), trichloroethene (TCE), carbon dioxide, oxygen, and water vapor in the extracted air.
- A vapor sample will be collected from the extracted air using a SUMMA canister for VOC analysis. All samples will be collected in accordance with the current version of SOP-5074, Sampling for Subsurface Vapor. These samples will be collected weekly during the SVE operational cycle.

Extracted air will be directed through GAC canisters for treatment and the effluent monitored for emissions compliance. Waste GAC containers will be managed in accordance with an approved waste management plan. All waste generated from sampling activities will be handled in accordance with SOP-5238, Characterization and Management of Environmental Program Wastes.

To evaluate the effectiveness of the shallow and deep extraction intervals, pore-gas monitoring for rebound effects for Alternatives 2A, 2B, 3A, and 3B will be performed at nine pore-gas monitoring wells shown on Figure I-2.5-1. Sampling will include field screening and VOC sample collection with SUMMA canisters. The same wells will be used for rebound monitoring under Alternative 4 unless the excavation impacts a selected well, in which case an alternate well will be proposed. The selected rebound monitoring wells are provided in Table I-2.5-1.

I-2.6 Operational Schedule—Alternatives 2A, 2B, 3A, and 3B

The following operational schedule is proposed after the installation of the extraction wells, installation and connection of the SVE systems, and connection of the monitoring systems:

- baseline data collection of rebound monitoring wells,
- 30-d SVE operations at the first group of three SVE wells,
- 30-d rebound monitoring and relocation of SVE units to next group of three SVE wells,
- 30-d SVE operations at next group of three SVE wells,
- 30-d rebound monitoring and relocation of SVE units to next group of three SVE wells,
- 30-d SVE operations at final group of three SVE wells, and
- 30-d rebound monitoring and relocation of SVE units to first group of three SVE wells.

At this point, SVE will have been operated on all nine extraction wells. Performance monitoring will provide important information on the effectiveness of the removal and the rebound behavior of the VOC plume, allowing for the opportunity to optimize the operation of the system as necessary.

I-2.7 Operational Schedule—Alternative 4

The following operational schedule is proposed after the excavation of the pit, impoundments, and shafts; installation of the extraction wells; installation and connection of the SVE systems; and connection of the monitoring systems:

- baseline data collection of rebound monitoring wells,
- 90-d SVE operations at three SVE wells,
- 30-d rebound monitoring and relocation of SVE units to next group of three SVE wells,
- 90-d SVE operations,
- 30-d rebound monitoring and relocation of SVE units to next group of three SVE wells,
- 90-d SVE operations, and
- 30-d rebound monitoring.

At this point, SVE will have been operated on all nine extraction wells. An evaluation of the rebound effect will be performed to determine if additional SVE operations are needed. If so, the SVE units will be relocated and the operational parameters will be adjusted as necessary.

I-2.8 Shutdown Parameters

The following shutdown parameters are proposed for the operation of the SVE system.

- The first parameter is the Tier II evaluation limit for each of the seven VOCs that currently exceed their respective Tier II limits (Table I-2.1-1). Remedial activities are considered successful as concentrations are reduced below these limits.
- The second parameter is a follow-up to the first parameter. Mass removed during operational intervals can be calculated using vapor concentrations and flow-rate measurements taken at the manifold. The continuous and cumulative mass removal is plotted versus time. As the mass is depleted, these curves begin to exhibit asymptotic behavior. This behavior is an indicator that the retrievable VOC mass has been removed.
- After the first two parameters have been met, a 6-mo rebound period will be observed. If sampling indicates that concentrations have rebounded to above Tier II limits, operations will continue. If sampling indicates that key VOC concentrations are still below their respective Tier II evaluation limits, then primary operations will be considered complete and long-term vapor monitoring will be initiated for Alternatives 2A, 2B, 3A, and 3B. Long-term vapor monitoring will not be required for Alternative 4 because no additional releases will occur following excavation.
- The SVE extraction boreholes will be maintained in the event that long-term vapor monitoring identifies a post-remedy release from the disposal units. Additional operation of SVE will be performed as necessary.

I-2.9 Reporting

SVE activities and results will be detailed in an annual report. Interim status and results can be provided as necessary. The report format will be provided with the CMI plan.

I-3.0 LONG-TERM VAPOR MONITORING

Pore-gas monitoring activities have been conducted at MDA L since 1985. The existing pore-gas monitoring program has been successful in defining the nature and extent of the vapor-phase VOC plume at MDA L. The conceptual SVE design described above is intended to remove VOC vapors from the subsurface. The long-term vapor-monitoring program is designed to ensure the active SVE system has performed as planned and to provide a monitoring system for Alternatives 2A, 2B, 3A, and 3B in the event an additional release of VOCs from the source areas occurs.

Long-term monitoring is not a component of Alternative 4. Extraction wells and vapor-monitoring wells will be abandoned after the shutdown parameters have been met.

I-3.1 Monitoring Distribution and Frequency—Alternatives 2A, 2B, 3A, and 3B

The long-term monitoring distribution and frequency have been developed to identify potential new releases from the source regions (i.e., disposal units) following completion of the active SVE period and to assess the long-term performance of SVE. If evaluation of pore-gas monitoring data indicates changes to the nature and extent of the vapor plume (e.g., increasing VOC concentrations), the New Mexico Environment Department (NMED) will be informed of the change. The long-term monitoring distribution and frequency may be modified if VOC concentrations are found to be increasing during the monitoring period.

Long-term subsurface vapor-monitoring activities will be conducted for a total of 30 yr for Alternatives 2A, 2B, 3A, and 3B. Pore-gas monitoring will be conducted once per year at the monitoring borehole locations identified in Table I-3.1-1.

The following boreholes are proposed to be plugged and abandoned: 54-01015, 54-01016, 54-02020, and 54-24238. Boreholes 54-01015 and 54-01016 are angled boreholes that currently provide screening-level data only. Borehole 54-02020 also currently provides screening level data only. Borehole 54-24238 contains a Flexible Liner Underground Technologies (FLUTe) sampling system but is located in an area with a high density of boreholes and sampling ports.

The following boreholes are currently constructed with the FLUTe sampling system and are proposed to be retrofitted with dedicated stainless-steel sampling systems: 54-24239, 54-24240, 54-24241, 54-24242, and 54-24243. Additionally, borehole 54-24399, currently a borehole that is open in the Cerros del Rio basalt (Tb 4) from 550 to 608 ft bgs, is proposed to be retrofitted with a dedicated stainless-steel sampling system with two ports in the basalt. The proposed port depths for the stainless-steel sampling systems in these wells are provided in Table I-3.1-1.

I-3.2 Monitoring Methods—Alternatives 2A, 2B, 3A, and 3B

Monitoring activities will be conducted in accordance with the Laboratory's current revision of SOP-5074, Sampling Subsurface Vapor, or equivalent.

I-3.3 Reporting—Alternatives 2A, 2B, 3A, and 3B

Pore-gas monitoring activities and results will be provided in an annual report in accordance with the requirements of Section XI.D of the Consent Order.

I-4.0 REFERENCES

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

Copies of the master reference set are maintained at the 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.

ERM/Golder, October 1997. "Pilot Vapor Extract Test at TA-54, MDA L," report prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (ERM/Golder 1997, 070334)

LANL (Los Alamos National Laboratory), November 2006. "Summary Report: 2006 In Situ Soil Vapor Extraction Pilot Study at Material Disposal Area L, Technical Area 54, Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-06-7900, Los Alamos, New Mexico. (LANL 2006, 094152)

LANL (Los Alamos National Laboratory), May 2010. "Report for Supplemental Soil-Vapor Extraction Pilot Test at Material Disposal Area G, Technical Area 54," Los Alamos National Laboratory document LA-UR-10-3409, Los Alamos, New Mexico. (LANL 2010, 109657)

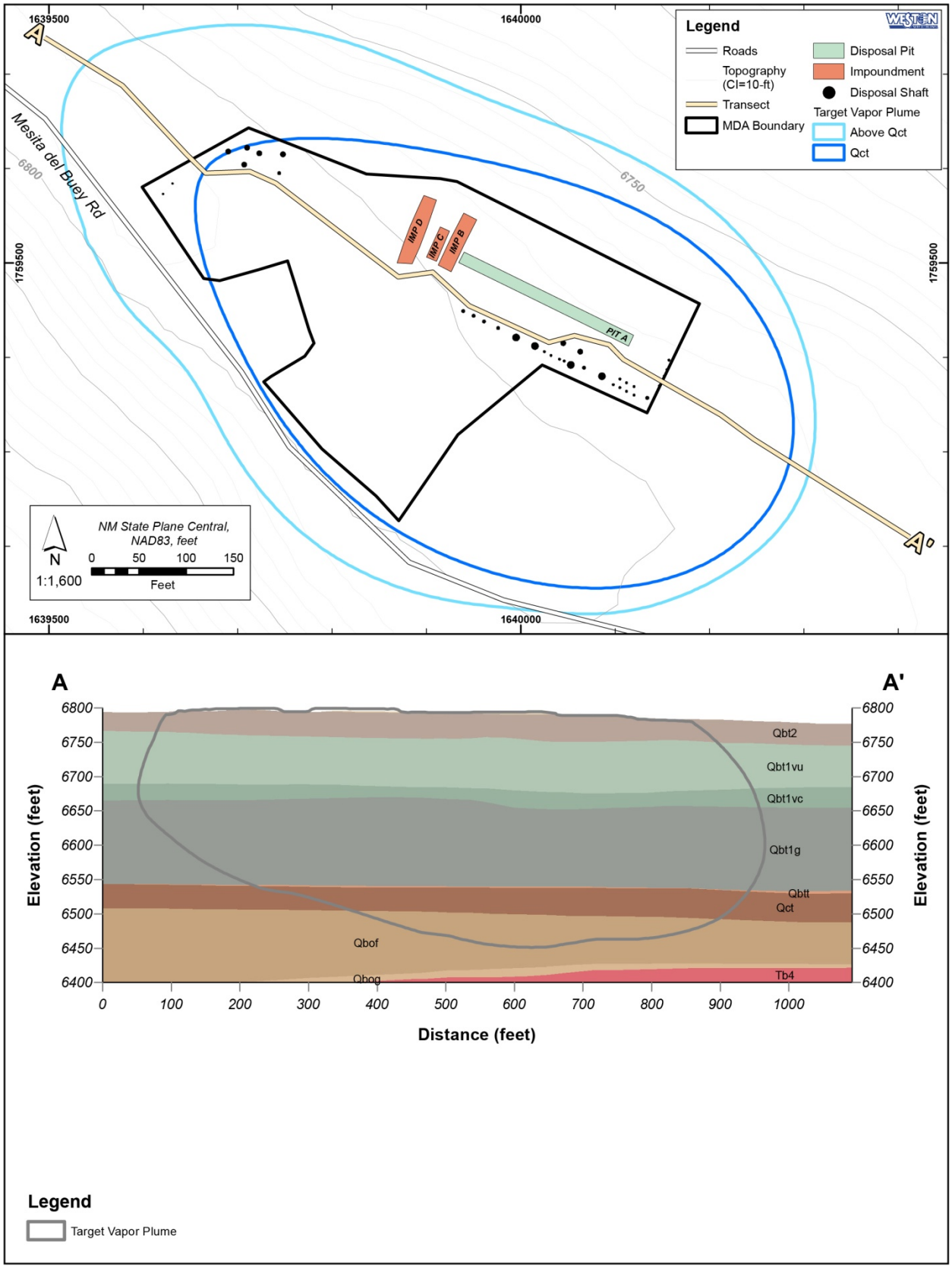


Figure I-2.1-1 Extent of target vapor plume for seven VOCs that exceed Tier II screening limits

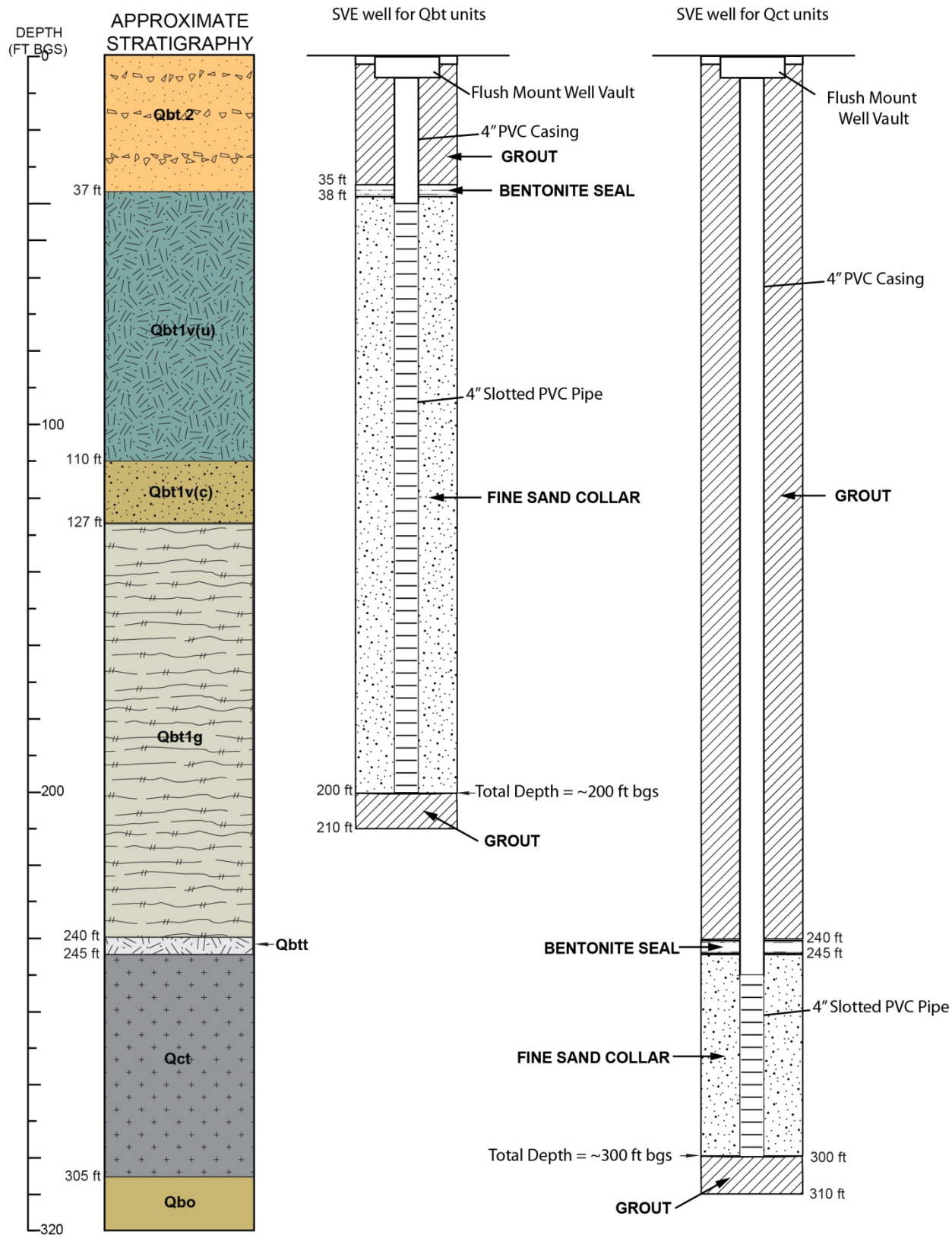


Figure I-2.2-1 Proposed extraction well designs for SVE at MDA L

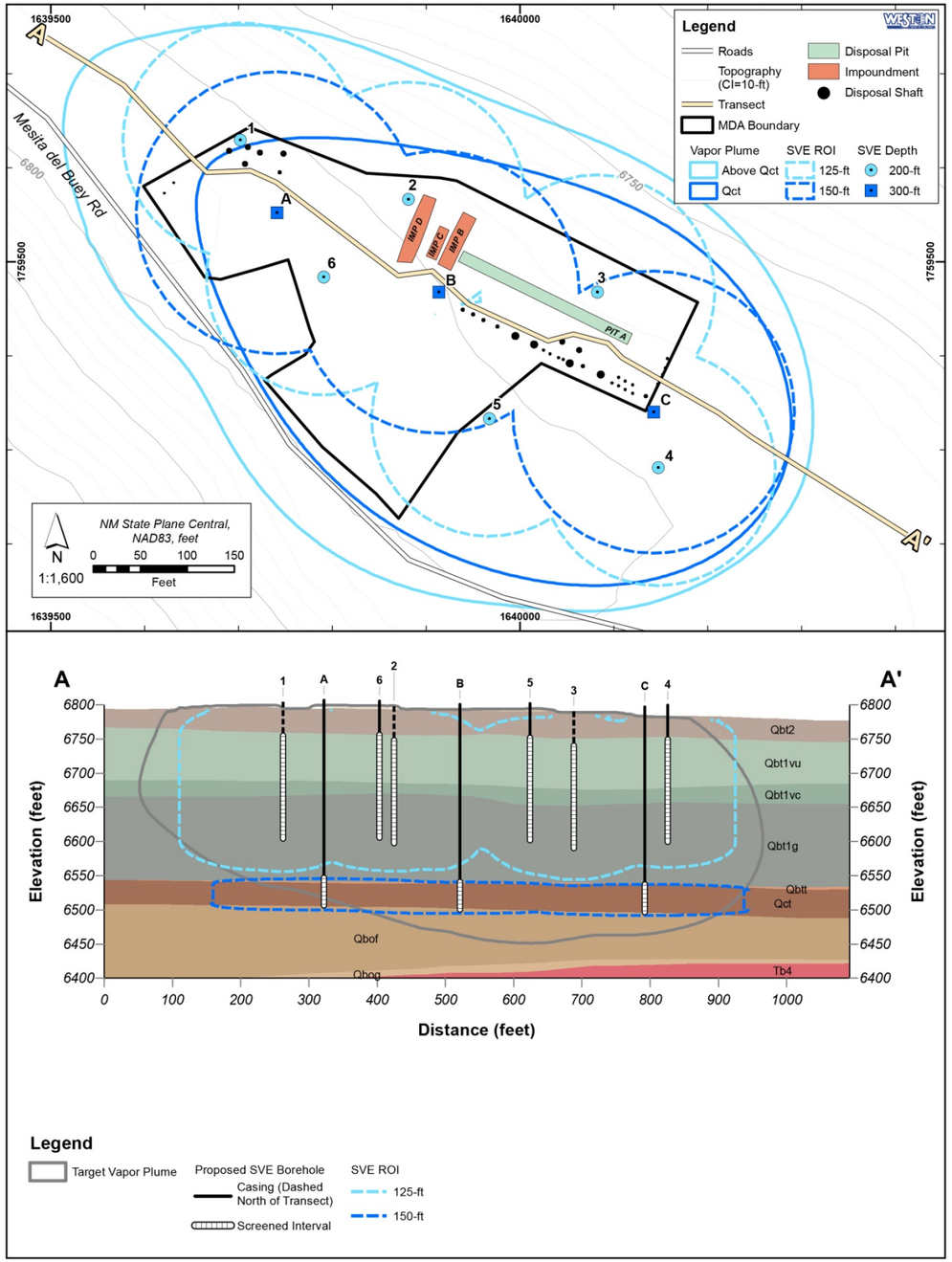


Figure I-2.3-1 Proposed extraction well placement for SVE at MDA L

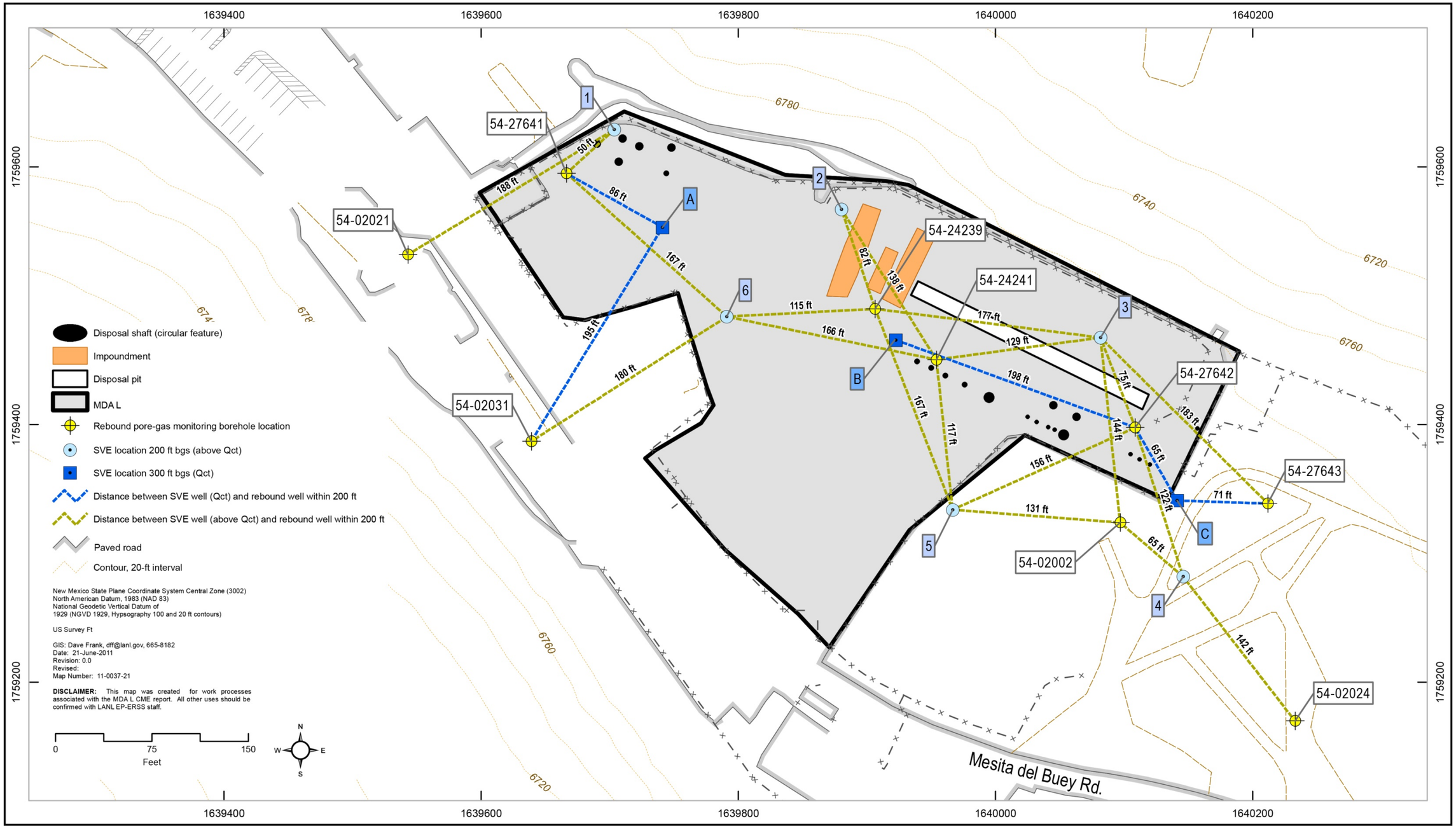


Figure I-2.5-1 Proposed pore-gas monitoring boreholes for measuring rebound effects following SVE, including the distance between the monitoring boreholes and nearby extraction wells

Table I-2.1-1
Tier I and Tier II Pore-Gas Concentration Limits for VOCs of Concern at MDA L

VOC	Groundwater Limit (µg/L)	Source of Groundwater Limit	Tier I Pore-Gas Concentration Limit (µg/m^3)	Tier II Pore-Gas Concentration Limit (µg/m^3)
Benzene	5	EPA MCL	1140	34,900
Carbon Tetrachloride	5	EPA MCL	5500	74,200
Chloroform	100	NMWQCC	15,000	508,000
1,1-Dichloroethane	25	NMWQCC	5750	185,000
1,2-Dichloroethane	5	EPA MCL	240	8120
1,1-Dichloroethene	5	NMWQCC	5500	58,800
1,2-Dichloropropane	5	EPA MCL	600	20,300
Methylene Chloride	5	EPA MCL	650	22,000
Tetrachloroethene	5	EPA MCL	3600	70,500
1,1,1-Trichloroethane	60	NMWQCC	42,300	700,000
1,1,2-Trichloroethane	5	EPA MCL	170	5760
Trichloroethene	5	EPA MCL	2000	48,100

Notes: VOCs in bold exceed both the Tier I and Tier II limits. This table is derived from Tables B-2.1-1 and B-2.1-2 of this report. EPA MCL = U.S. Environmental Protection Agency maximum contaminant level; NMWQCC = New Mexico Water Quality Control Commission.

Table I-2.5-1
Proposed Rebound Monitoring Boreholes and Ports

Borehole ID	VOC Rebound Monitoring Port Depths (ft bgs)
54-02002	100, 180
54-02021	120
54-02024	120
54-02031	100, 260
54-24239	75
54-24241	75, 175
54-27641	82, 182, 271
54-27642	75, 175, 275
54-27643	74, 167, 275, 354

Note: Boreholes 54-24239 and 54-24241 are constructed with FLUTe membranes and will be converted to stainless-steel monitoring ports at the depths indicated.

Table I-3.1-1
Proposed MDA L Long-Term Subsurface Vapor-Monitoring Locations, Borehole Status, Port Depths, and Corresponding VOC and Tritium Sampling Intervals

Borehole ID	Borehole Status	Port-Depths (Corresponding Sampling Intervals, ft bgs)
54-01015	Proposed to be abandoned	n/a*
54-01016	Proposed to be abandoned	n/a
54-02001	Annual Vapor-Monitoring Program	40 (37.5–42.5), 80 (77.5–82.5), 140 (137.5–142.5)
54-02002	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	40 (37.5–42.5), 100 (97.5–102.5), 180 (177.5–182.5)
54-02016	Annual Vapor-Monitoring Program	31 (28.5–33.5), 82 (79.5–84.5)
54-02020	Proposed to be Abandoned	n/a
54-02021	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	20 (10–30), 100 (90–110), 120 (110–130), 140 (130–150)
54-02022	Annual Vapor-Monitoring Program	40 (37.5–42.5), 120 (117.5–122.5)
54-02023	Annual Vapor-Monitoring Program	40 (30–50), 100 (90–110), 159 (149–169)
54-02024	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	40 (30–50), 120 (110–130)
54-02025	Annual Vapor-Monitoring Program	20 (20), 100 (100), 160 (160)
54-02026	Annual Vapor-Monitoring Program	100 (100), 160 (160)
54-02027	Annual Vapor-Monitoring Program	20 (20), 100 (100), 200 (200)
54-02028	Annual Vapor-Monitoring Program	100 (100), 160 (160)
54-02031	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	20 (20), 100 (100), 160 (160), 260 (260)
54-02034	Annual Vapor-Monitoring Program	60 (60),160 (160), 260 (260), 300 (300)
54-02089	Annual Vapor-Monitoring Program	46 (46)
54-24238	Proposed to be Abandoned	n/a
54-24239	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	Proposed monitoring ports at 25 ft (Qbt 2) and 75 ft (Qbt 1v)
54-24240	Annual Vapor-Monitoring Program	Proposed monitoring ports at 75 ft (Qbt 1v) and 150 ft (Qbt 1g)
54-24241	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	Proposed monitoring ports at 75 ft (Qbt 1v), 175 ft (Qbt 1g)
54-24242	Annual Vapor-Monitoring Program	Proposed monitoring ports at 25 ft (Qbt 2) and 100 ft (Qbt 1v)
54-24243	Annual Vapor-Monitoring Program	Proposed monitoring ports at 25 ft (Qbt 2), 75 ft (Qbt-1v), 125 ft (Qbt 1v)
54-24399	Annual Vapor-Monitoring Program	Proposed monitoring ports at 560 ft (Tb 4), 590 ft (Tb 4)
54-27641	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	32 (29.5–34.5), 82 (79.5–84.5), 115 (112.5–117.5), 182 (179.5–184.5), 271 (268.5–273.5), 332.5 (330–335)
54-27642	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	30 (27.5–32.5), 75 (71.5–76.5), 116 (114.5–119.5), 175 (172.5–177.5), 275 (272.5–277.5), 338 (335.5–340.5)
54-27643	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	30 (27.5–32.5), 74 (71.5–76.5), 117 (114.5–119.5), 167 (164.5–169.5), 275 (272.5–277.5), 354 (351.5–356.5)
54-610786	Annual Vapor-Monitoring Program	25 (22.5-27.5), 100 (97.5-102.5), 118.5 (116-121)

Notes: Borehole 54-24238 is constructed with a FLUTe membrane and is proposed for abandonment. Boreholes 54-24239, 54-24240, 54-24241, 54-24242, and 54-24243 are constructed with FLUTe membranes and will be converted to stainless-steel monitoring ports at the depths indicated. Borehole 54-24399 is cased to 550 ft bgs and open from 550 to 608 ft bgs. It will be converted to stainless-steel monitoring ports at the depths indicated.

*n/a = Not applicable.